A Pest Management Strategic Plan for Pear Production in California

The California Pear Advisory Board (CPAB)

The California Minor Crops Council (CMCC)

The California Minor Crops Council (CMCC) received funding for this project from the EPA Region 9 Agricultural Initiative and the USDA Cooperative States Research, Education, and Extension Service (CSREES) Pest Management Alternatives Program (PMAP). CMCC received additional support from the California Pear Advisory Board and the Western Regional Integrated Pest Management Center at UC Davis.

Funding for this project has also been made available by the Governor's *Buy California* initiative, the California Department of Food and Agriculture, and the U.S. Department of Agriculture, through the University of California's Specialty Crops Research Program.

We gratefully acknowledge the contributions of all of these organizations and their participation in this process.

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Introduction

The pear industry in California is an extremely important source of income for growers, with a value of over $90 million grown on approximately 15,000 acres in 2002. Pears may be sold as fresh produce to domestic and export markets, or they may be a primary component of several processed products (e.g., pear halves, fruit cocktail, mixed fruit, baby food, dried pears, and juice-concentrate).

Pears, along with apples, are considered to be among the most challenging crops to grow in terms of the multitude and complexity of pest issues that growers must manage. A highly productive relationship between the California pear industry and the University of California (UC) has resulted in the adoption of an integrated pest management (IPM) system for this commodity. The California pear industry, through the California Pear Advisory Board and the Pear Pest Management Research Fund (PPMRF), has worked very closely with its counterparts in Washington and Oregon, and other important pear production states, to maximize the return on the investment in research and technology for this important industry.

New safety standards set forth by the 1996 Food Quality Protection Act (FQPA) have significantly impacted the availability of important crop protection tools used by pear growers. In particular, methyl parathion, azinphos methyl (Guthion®), and other organophosphate insecticides have been cancelled and/or restricted as a result of the new safety standards. Other pesticides will certainly come under regulatory scrutiny as products proceed through the re-registration process. Minor crops, such as pears, are at risk of losing important pest management tools for two reasons. First, as pears are a significant part of the diets of infants and children, this commodity will be held to higher safety standards per provisions of the FQPA. Second, as the costs to develop and register new materials increase, registrants are less willing to focus on commodities with relatively few acres as compared to major crops (e.g., corn, soybeans, etc.) simply because of lower returns on their investment. Therefore, many minor crop commodities, like pears, are more likely to lose pest management tools, with less likelihood that they will be replaced by new products.

To help transition to “Reduced Risk” pest management, the USDA has requested that all commodities develop Pest Management Strategic Plans (PMSPs) to identify growers’ critical research, registration, and educational needs. “Reduced Risk” broadly describes pest management techniques and tools that have low inherent toxicities and minimal impact on the environment. Pest management practices and products should be safe for both consumers and field workers, and crop protection tactics should have little or no impact on air, soil, or water quality.

The pear industry has been evaluating its current pest management system to provide for a smooth transition to new chemical applications and non-chemical practices as a result of the Food Quality Protection Act. The industry initiated its activities in this area by organizing a multi-state meeting in 1999 to begin developing a long-term approach to managing insects and mites in Western pear production. In 2002, key members of the California pear industry met to focus specifically on California growers’ need. The coalition of growers, packers, shippers, processors, pest control advisors (PCAs), cooperative extension farm advisors, and researchers formed a work group to evaluate management of all pear pests, including insects, mites, diseases, weeds, and vertebrates. Agency representatives from the United States Department of Agriculture, the Environmental Protection Agency, Western Region IR-4, and the Western Region Pest Management Center also participated In the work group, whose aim was to develop a pest management strategic plan (PMSP) to address the critical issues of California pear growers. Focusing on the pests with the greatest economic impact on the California pear industry, the steakholders identified the critical research, regulatory, and educational needs of the California pear industry.

The Pest Management Strategic Plan (PMSP) for California pear production comprehensively summarizes the industry’s crop production and pest management practices, and the pesticides and alternative pest control strategies used in recent production seasons. It also suggests how new products can provide acceptable pest control and fit well into an integrated pest management system for California pears. The foundation for this document is *Crop Profile for California Pears* found at http://pestdata.ncsu.edu/cropprofiles/docs/capears.html, and UC Publication 3340 (*Integrated Pest Management for Pears)*.

The California pear industry intends that this document be used as a resource by US EPA, USDA, CDPR, and other agencies concerned with pest management issues, needs, and practices in California; this strategic plan will be periodically updated to remain current with industry developments and issues. Contact information for the work group members has been provided in Appendix 14.

The mention of any product in this document does not represent endorsement by any member or organization within the California Pear Work Group. Chemical and trade names for products used in pears are listed in the efficacy tables found in the Appendices.

Stakeholder Recommendations

As a result of the planning meeting held in April 2002, the California Pear Work Group identified the following research, regulatory, and educational priorities. These critical areas must be addressed to maintain the economic viability of the fresh and processed pear industry in California.

Research Priorities

Finding effective solutions to insect control problems is the most immediate and serious concern of California pear growers. Of paramount importance is the need to find alternatives to the highly effective organophosphate insecticide methyl parathion (Penncap-M®) used for codling moth control. The organophosphates are under threat of removal as crop protection tools due to worker exposure and environmental concerns. Risk mitigation measures to reduce exposure and contamination should be investigated and developed. Identifying and developing disease management tools for fireblight control and pear scab is also critical. Reduced risk products and biological control agents, including those for use in organic pear production, are needed.

- Evaluate and develop Guthion® alternatives for codling moth control
- Develop monitoring techniques and economic thresholds for new codling moth control systems
- Evaluate and develop reduced risk management techniques for psylla, true bugs, and leaf rollers
- Develop an “attract and kill” device for true bugs
- Evaluate and develop organically acceptable management techniques for codling moth and fireblight
- Develop new techniques and reduced risk products for control of fireblight and pear scab
- Evaluate resistance status for insecticides and fungicides used in pear pest management
- Evaluate biological control techniques for all pear pests
- Evaluate reduced risk compounds for all pest categories in pears
- Study the environmental impact of organophosphates and antibiotics

Regulatory Priorities

The pear industry needs new materials registered for codling moth control, particularly organophosphate replacement products and new chemistries for fireblight and pear scab control. Policies limiting the use of antibiotics in plant-based agriculture should be re-evaluated. Harmonization between Cal/EPA and US EPA should be encouraged to facilitate and hasten the registration of fludioxonil, fenhexamid, sodium ortho-phenylphenate (SOPP), ethephon, and all reduced risk products for pears. Abandoned orchards should be removed to reduce over-wintering sites and related pests (e.g., codling moth) so that area-wide pest management programs relying on reduced risk practices (e.g., pheromones) will be more effective.

- Register reduced risk insecticides for codling moth - the key insect pest of pears
- Register reduced risk insecticides for control of psylla, true bugs, and leaf rollers
- Register ethephon with a 24c for managing codling moth infestations post-harvest
- Allow the industry to maintain its post-harvest chlorpyriphos 24c for codling moth resistance management programs
- Enforce removal of abandoned orchards to aid in establishing area-wide pest management programs
- Register fludioxonil, fenhexamid, pyrimethanil, and sodium ortho-phenylphenate (SOPP) for control of scald, *Botrytis,* and other diseases
- Register alternative antibiotics for fireblight control
- Obtain approval by the California League of Food Processors and Del Monte Foods, Inc. for the use of PGRs Apogee® and Retain® on pears

Educational Priorities

Regulators and consumer groups must be educated about how Integrated Pest Management (IPM) in pears optimizes food production while minimizing risks to workers and the environment. A serious concern exists that state and county budgets will be insufficient to support the university and extension programs vital to the survival of the pear industry. Technology transfer and demonstration plots are needed for PCAs and growers to provide timely information on new products, techniques, and resistance management. Growers need to be educated on the value of removing abandoned orchards to improve the efficacy of pheromone-based and other area-wide pest management systems. Fireblight models need to be validated, and training is needed on the judicious use of antibiotics. Field diagnosis and monitoring techniques should be disseminated to increase the number of trained and qualified field scouts. Spanish language training materials should be provided to insure safe and effective use of pesticides, particularly by field workers. Finally, the public should be reminded through effective media campaigns (e.g., “Buy California,” “Five a Day” programs) that the consumption of pears contributes to a nutritious diet and healthy lifestyle.

- Demonstrate new materials and techniques for codling moth control
- Inform the industry of the benefits of removing abandoned orchards
- Educate growers, PCAs, and the community on the importance of removing abandoned orchards in establishing effective area-wide pest management programs
- Educate growers and PCAs on environmental and water impacts of organophosphate insecticides, antibiotics, and other materials used in pest control
- Train growers and PCAs on resistance management
- Document the current use of fireblight models to support antibiotic use
- Insure that adequate levels of UCCE field staff are available to assist with research and extension needs of pear growers
- Improve quality and increase quantity of field level monitoring with trained scouts
- Continue the availability of training materials in Spanish
- Educate the public on the value of consuming pears as an important part of a healthy diet
- Increase public awareness of using integrated pest management tactics (e.g., pheromones) in California pear production

The California pear industry appreciates the support of US EPA, USDA, CDPR, and the University of California Land Grant system throughout the development of this strategic plan. We look forward to the valuable assistance provided by these agencies and institutions as we develop responses to the many issues facing the California pear industry.

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November 2003

A PEST MANAGEMENT STRATEGIC PLAN FOR CALIFORNIA PEARS

1. CALIFORNIA PEAR PRODUCTION OVERVIEW

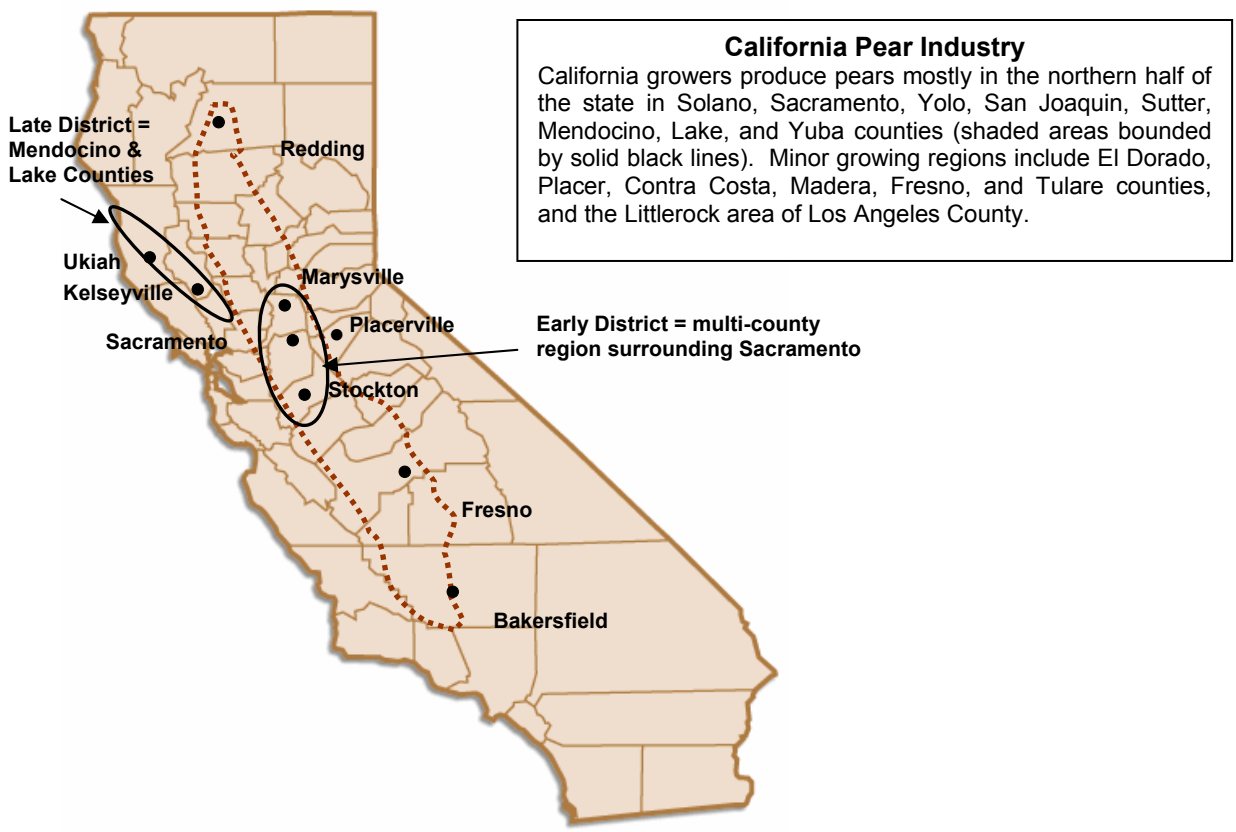
The majority of pears produced in California are found in the northern third of the state in the counties of Sacramento, Yolo, Solano, San Joaquin, Mendocino, Lake, Yuba, and Sutter (Figure 1). Pears are most productive on loam-textured, deep, uniform soil; however, many are planted on less than ideal sites where soil modification or special treatment may be necessary. Sprinkler irrigation is the predominant form of irrigation, with a few orchards still using flood and furrow irrigation where these methods are practical.

California Pear Production Summary

- California is the second most important state for pear production, accounting for 32% of U.S. production; Washington and Oregon produce 42% and 24% of the U.S. crop, respectively.
- Pear acreage in California in 2002 was approximately 15,000 acres (of the U.S. total of about 65,000 acres) with a harvest value over $90,000,000.
- Bartlett is the major summer variety (>98% acreage) in California, with minor varieties including Red Clapp Favorite, Rosie Red, Buterra Precoce Moritini, Red Sensation, and Max Red.
- California Bartlett pear trees begin producing in 5-7 years and may produce on average 50-75 years, with some lasting 100 years.
- There are essentially no new pear orchards being planted.
- The major fall variety is Bosc, with Comice, Seckel, Buerre Hardy, and Forelle being minor varieties.
- Asian pears are a small component of total pear production in California.
- Approximately 70% of California Bartlett pears go to the processing market for canned fruit, juice, fruit cocktail, concentrate, baby food, dried pears, and fermentation products. There are tight restrictions on insect infestation and disease damage for pears used in these products.
- An average of 30% of the crop is shipped to the fresh market.
- Fresh pear exports can be up to 30% of the total fresh pack. Mexico has become the main export market, followed by Canada, Costa Rica, Honduras, Guatemala, and others.
- Codling moth is the primary pest of pears in California. Other very important pests include pear psylla, surface feeding insects, russet mites, fireblight, Oriental fruit moth, and scab disease. *Botrytis* and *Penicillium* are the most important post-harvest diseases of pears.
- Organic farms account for less than 1% of the total pear growing acreage in California.
- The California pear industry has been a leader in transitioning to reduced risk pest management over the last ten years; a collaborative project between the industry and the University of California has developed a very successful pheromone-based codling moth control program. However, augmenting the pheromones with chemical controls usually has been necessary.
- The use of organophosphate (OP) insecticides in California pears has been reduced by over two thirds since the early 1990s.
- Grower interest in biologically-based pest management systems will largely depend on reducing their costs, which have been higher than costs of the older chemical-based tactics. The new systems (e.g. area-wide pheromone-based IPM) also have made pear orchards more vulnerable to pest infestations from neighboring orchards.
- The pear industry concentrates its pest management efforts on research and demonstration projects that have the potential to maintain a viable reduced risk pest management system long into the future.

California pear production areas are shown in Figure 1. Appendix 3 contains seasonal profiles of pear crop development, cultural practices, and pest management activities.

Fig. 1: Major California Pear Production Regions



The two primary pear growing regions of Northern California comprise about 15,000 acres. Since the 1990s, pear acreage in California has been declining. New pear orchards are rare because of the trees' longevity, the cost and length of time from planting to full production, and the lack of a processing home for the pears. Therefore, this PMSP concerns itself only with established pear orchards.

The pear growing regions are divided into "early" and "late" districts based on the timing of the harvest. The early district spans the Upper Sacramento Valley in Sutter and Yuba counties and runs along the Sacramento River Delta in the counties of Sacramento, San Joaquin, Yolo, Solano, and Contra Costa. The early district produces approximately 150,000 tons, about one-half of California's annual pear crop. The late district spans Mendocino, Lake, and El Dorado counties and produces approximately 120,000 tons of pears annually.

Early District:	~55% of total pear production
Late District:	~40% of total pear production
San Joaquin Valley:	~5% of total pear production

Generalized Timing for the Stages of Pear Development in California

This strategic plan will follow these major stages of pear production as identified by the Pear Work Group. The pest management activities that generally occur during these stages will be presented throughout the document.

District	Dormancy	Delayed Dormancy	Bloom (Green Tip through Petal Fall)	Post Petal Fall through Harvest	Post- Harvest (storage)
Early	Dec 15 – Feb 5	Feb 5 – Feb 20	Feb 20 – Apr 1	Apr 1 – Jul 10	Through Oct 15
Late	Dec 1 – Feb 15	Feb 15 – Mar 5	Mar 5 – Apr 15	Apr 15 – Aug 1	Through Dec 31

Characteristics of the Major Pear Production Areas in California

CHARACTERISTIC	EARLY DISTRICT Sacramento Region	LATE DISTRICT Mendocino County	LATE DISTRICT Lake County
% of Total Acreage	55	20	20
Main Varieties	Bartlett and Bosc	Bartlett and Bosc	Bartlett and Bosc
Minor Varieties	Red Clapp, Comice, and Seckel	Red Clapp, Comice, and Seckel	Red Clapp, Comice, and Seckel
Dormancy (Length)	Dec 15 – Feb 5	Dec 5 – Feb 10	Dec 1 – Feb 15
Delayed Dormancy	Feb 5 – Feb 20	Feb 10 – Mar 1	Feb 15 – Mar 5
Bloom Period	Feb 20 – Apr 1	Mar 1 – Apr 5	Mar 5 – Apr 15
Harvest	Jul 10	Jul 28	Aug 4
Annual Rainfall	19”	36”	29”
Temperatures	Hottest	Coolest	Hot

Note: Summary table based on “average” years

Pear Varieties in California

The predominant summer variety of pear grown in California is the smooth skinned Bartlett. Other varieties include European summer pears such as Clapp Favorite, Rosie Red, Buterra Precoce Morettini, Red Sensation, and Max Red. The predominant fall pear variety is Bosc. Other fall pears in order of importance are Comice, Seckel, Beurre Hardy (French Butter Pear), and Forelle.

The above varieties are grafted onto rootstocks. Rootstock selection is based on cultivar compatibility, soil characteristics and drainage, pests (primarily fireblight, oak root fungus, pear decline susceptibility), and weather conditions of the orchard site. The most common European rootstocks are Winter Nelis, *Pyrus betulifolia,* and the *Old Home X Farmingdale* crosses.

VARIETY	% of CA ACRES	HARVEST PERIOD
Bartlett	>95%	July - August
Clapp Favorite	< 1%	Early July-August
Buterra Precoce Morettini	< 1%	Late June
Max Red	< 1%	July - August
Bosc	< 3%	Late July - September
Asian Pear varieties	< 1%	August - September

Pest Overview

Insects and Mites - Numerous insect and mite pests occur in California pear orchards, feeding directly on fruit, leaves, bark, or roots. Consumers do not accept fruits damaged by insect feeding or its byproducts. Growers can tolerate a low level of insect damage to pears when implementing IPM programs; however, if damage exceeds 1%, sorting fruit prior to packing becomes very difficult, threatening the integrity of the product delivered to the consumer. The presence of too many insects in culled fruit destined for the processing markets is not acceptable due to the risk of contamination of processed products by insect parts and rot. Thus, biological and natural methods have not provided the level of control needed to produce a commercially acceptable pear crop.

The single most important pest of pears in California[1] is the codling moth (CM), whose larva bores into the pear. CM has the potential to destroy a high proportion (50-80%) of the crop each year if not controlled. Most pear orchards receive two to four (average = three) insecticide applications for CM control. Current control programs result in less than 0.25% CM infested fruit at harvest. In some areas in the western United States high levels of organophosphate (OP) insecticide resistance have been documented. There is known cross-resistance between OP-resistant CM populations and insecticides having different modes of action, including some newer "soft" materials and several unregistered insecticides. Cross-resistance has been positively correlated with azinphos-methyl and two OPs (diazinon and phosmet), a carbamate (carbaryl), a chlorinated hydrocarbon (DDT), two pyrethroids (esfenvalerate and fenpropathrin[2]), and two insect growth regulators (tebufenozide and methoxyfenozide).

In addition, at least two species of leaf roller (*Tortricidae*), western flower thrips, Oriental fruit moth (OFM), rust mites, blister mites, lygus bug, mullein plant bug, campylomma (*Campylomma verbasci*), several species of stink bug (*Pentatomidae*), boxelder bug, and San Jose scale feed directly on fruit and can cause major crop loss. Only low densities of these pests can be tolerated in a pear orchard before significant crop loss occurs.

Insects that feed on the bark or foliage, called "indirect pests," can cause reduced fruit size, reduced quality, and eventually reduced tree vigor; they also may leave a residue (honeydew) on fruit, which permanently marks the fruit. Pear orchards can tolerate higher densities of indirect pests than direct pests before significant damage occurs; thus the former are usually more amenable to biological control. Indirect pests of pears include leafhoppers, leafminers, spider mites, pear aphid, spirea aphid, rosy pear aphid, woolly pear aphid, ten-lined June beetle, dock aphid, and green peach aphid.

The occurrence of some pests in pear orchards has historically been infrequent or rare. Examples include grasshoppers, katydids, six-spotted cucumber beetle, pear slug, shothole borers, red-humped caterpillar, lesser appleworm, and Oriental fruit moth (OFM). OP or carbamate insecticides used to control other pests have most likely kept these infrequent pests in a non-critical status. Two pests of great importance to eastern U.S. pear growers, the plum curculio and apple maggot, do not threaten most commercial orchards in the west. However, elimination of known effective chemical controls for these pests prior to the development, testing, and grower acceptance of effective alternatives would not only affect eastern pear growers but also put western growers at risk. Further, the introduction and establishment of pests of foreign origin in the western U.S. is a major concern for pear growers. Several species have the potential to become important pests of pear and other fruit crops.

Organophosphate (OP) insecticides, the most widely used class of insecticides in pear orchards in California, have a broad-spectrum action. They not only economically control key insect pests but also incidentally suppress many secondary and sporadic pests. Frequently a single application of OP insecticide controls two or more key pests simultaneously. Resistance of key pests to OP insecticides in western U.S. pear orchards is not widespread. Many secondary insects (e.g., aphids, leafhoppers, and leafminers) have developed high levels of OP resistance; non-OP insecticides are used to control these pests.

Several species of beneficial arthropods that are essential to western pear IPM programs have developed a tolerance of or resistance to OP insecticides. These natural enemies provide consistent, reliable suppression of many secondary pests. However, other potential biological control agents are suppressed by use of OP insecticides. Any transition to new insecticides or other pest control technologies must consider the impact on existing biological control programs.

[1] We emphasize California here because pear psylla is more important as a pest in Washington and Oregon.
[2] Journal of Economic Entomology 93(3): 955-962 (2000) Correlated Insecticide Cross-Resistance in Azinphos-methyl Resistant Codling Moth (Lepidoptera: Torticidea; John E. Dunley and Steven C. Welter

Diseases - The most important diseases of pears in California are fireblight, scab, pear decline, and blossom blast. In the spring, fireblight symptoms can appear in blossom clusters and shoot tips. If allowed to spread, the infection can move into twigs, stems, and branches. Severe infections may not only cause loss of fruit for the year, but may kill entire branches or trees. Conditions ideal for rapid fireblight infection and spread are rainy or humid weather following periods of temperatures ranging from 75°F to 85°F. Fireblight management includes applications of copper compounds or antibiotics, avoidance of excessive tree vigor, and elimination of infected branches below any visible infection. During years of heavy disease pressure, fireblight may require 10 or more applications of pesticides, which results in three- to four-day spray cycles.

Scab can infect blossoms, leaves, and fruit. It generally causes only minor damage to the leaves, but can cause major damage by thinning the crop. Fruit "scabbed" in early (March and April) will often fall off. The infected fruit develops an exterior scab, causing the fruit to be misshapen and unsuitable for the fresh market, canning, or baby food. Gerber will not accept scab infested fruit. In light scab years, processors will be able to salvage much of the crop provided it is not also badly misshapen.

Disease management begins in the first year of significant crop set with a foliar application of lime sulfur solution and supreme oil at bud-break, but prior to cluster bud for pear scab and pear psylla control. Additional scab sprays of ziram, Flint®, or Syllit® may be made from March through May depending on weather conditions. No biological methods provide commercially acceptable control of pear scab.

Weeds - The primary weed species of concern in California pear orchards are Johnsongrass, dallisgrass, Bermuda grass, nutsedge, bindweed, mallow, and flaxleaf fleabane. Weed management consists of cultural techniques (mowing, cultivating, mulching, and hand hoeing) along with herbicide applications throughout the year. Chemical weed control begins in the fall/winter (October to February) with a mixture of a contact herbicide (such as Roundup® or Gramoxone®) and a pre-emergence herbicide (such as Surflan®) sprayed in the tree rows. This combination is generally followed in the spring with separate in-season applications of contact herbicides such as Gramoxone® or Roundup®.

Nematodes - Nematodes are not generally considered pests of pears, since few, if any, new orchards are being planted. Plant parasitic nematodes move from the soil environment into the root tissues and feed by puncturing the roots and sucking their cell contents; plant damage sustained by feeding interferes with nutrient and water uptake. Major nematode species found in pears include the root lesion nematode, root knot nematode, and dagger nematode.

Occasionally, when a single tree needs to be replaced in an orchard fumigation is used to reduce or eliminate all nematodes in the immediate area. Use of resistant or tolerant root stocks in combination with fumigant treatments usually provides sufficient protection for young pear trees. Overall, the best management in established pear orchards is to maintain good tree vigor with proper irrigation and fertilization. Due to the limited importance of these organisms in pear production, nematodes will not be discussed further in this document.

Vertebrates - Mice, voles, gophers, ground squirrels, and deer are the most troublesome vertebrate species in pear orchards. These pests can significantly damage young trees, and may also interfere with irrigation and other cultural activities. A variety of physical and mechanical tools helps to manage these pests; few chemical options are readily available. Vegetation management helps control infestations of several vertebrate pests; no biological controls are available.

2. PEST MANAGEMENT FOR PEAR ORCHARDS

This section tracks progression of pear development in California and provides information on typical field activities and major pest issues which occur during these intervals. The work group identified the following seasonal intervals which are important in terms of horticultural and pest management events:

- Dormancy
- Delayed dormancy
- Green tip through petal fall
- Post petal fall to harvest
- Harvest
- Post-harvest

Calendars for crop development and pest presence in the two major pear production districts in California are provided in Appendices 2 and 3.

The critical research, regulatory, and educational issues of the California pear industry, as identified by the work group, are summarized at the end of this document. In order to address these issues in the most systematic manner, these topics will be categorized by the research, regulatory, and educational issues identified by the work group.

DORMANCY and DELAYED DORMANCY
(December through February)

Pears, being deciduous, lose their leaves in winter. During this period growers monitor for weeds, insects (pear psylla), and mite pests, and may apply insecticides and herbicides. A variety of cultural activities, including pruning and orchard sanitation, are carried out. In addition, irrigation may take place in drought years. If any trees have been removed, replanting usually will be done at this time or early in the spring if it is a wet year.

Cultural and Worker Activities

- Mowing
- Scouting for psylla, mites, insect eggs, SJS, and rust mites
- Pruning
- Sanitation control of prunings on orchard floor
- Herbicide application
- Dormant oil applications
- Irrigation (occasionally in the Early District when drought conditions exist)
- Replant
- Monitor winter weeds

INSECTS AND MITES

Pear psylla, an extremely important insect pest of pears, is managed mainly by activities in the dormant and delayed dormant season.

Pear psylla insects inject toxin into the pear trees, produce honeydew, and vector pear decline disease, which is caused by a mycoplasm. Psylla toxin also causes psylla shock. The toxin burns the foliage, which can lead to reduced yield, smaller fruit size, and loss of tree vigor. Honeydew excreted by psylla can cause russeting on fruit and sooty mold on leaves, reducing photosynthesis. Pear decline is not considered a major problem if trees are grafted to a resistant rootstock, but can result in loss of vigor.

Managing psylla during dormancy season will impact the success of an IPM program throughout the entire season. This management is accomplished primarily through the use of dormant oils, or dormant oils in combination with an insecticide. With proper timing, these oil sprays can also stimulate uniform bloom in the spring, increasing yield and quality of the pears, and making harvest easier to manage.

Where climatic conditions favor pear psylla development, growers probably spend more money for control of it than for any other pear pest. Pear orchards receive two to three pre-bloom and one to three foliar insecticide applications for psylla control. Control has been hampered by often rapid development of resistance, which at times has led to a shortage of effective insecticides. In addition, the minor crop status of pears has limited development and registrations of new pear psylla materials. Biological control can be effective and reduce the need for chemical pear psylla control if growers avoid the in-season use of broad-spectrum insecticides (e.g., organophosphate and pyrethroid insecticides), for other pests, especially after bloom. It is estimated that pear psylla can destroy up to 50% (see below) of the crop if uncontrolled. Presently, crop losses can be kept below 1 % with available insecticide control programs.

Horticultural mineral oil sprays are applied either post-harvest or, primarily, at the dormant/delayed dormant period to control over-wintering pear psylla adults. These sprays reduce adults by about 80%. In addition, a dormant oil spray delays egg laying for at least four weeks, which makes post-bloom pear psylla control easier. Horticultural mineral oil has been used some in recent years during the foliar period to supplement mating disruption of codling moth, and to suppress pear psylla and mites. Concerns about possible negative effects on tree growth, fruit quality, and yields have limited more frequent use of horticultural mineral oil sprays.

Predators and parasitoids can play a major role in the control of pear psylla. More than 30 different natural enemy species reportedly feed on pear psylla in western North America. The most important ones are several mirid and anthocorid bugs, lacewing larvae, several species of coccinellids, spiders, and encyrtid parasitoids. Except for the parasitoids, most natural enemies of pear psylla are generalist predators, not closely associated with this pest. Biological psylla control is easier to achieve in orchards bordering native vegetation where generalist predators can build up on aphids and other prey and then disperse to pears. Key to biological control of pear psylla and other pear pests is avoiding the use of broad-spectrum pesticides in-season.

For successful biological control of pear psylla, the interaction between natural enemies and pear psylla must begin early in the season and continue through the summer. The more effective natural enemies are those which over-winter as adults and migrate early to pears. Pear psylla has a high reproductive potential and if natural enemies arrive late in the season, then they cannot reproduce at a sufficient rate to maintain a low psylla population. Unfortunately, most natural enemies do not become abundant until mid-summer, when pear psylla levels are already quite high. Thus, biological control by itself is rarely sufficient to keep pear psylla under control and it needs to be supplemented with insecticides.

While certain cultural practices will help with overall control of psylla, their effect is not sufficient to keep psylla populations in check. Cultural practices employed to minimize pear psylla damage include summer pruning to reduce vigor, removal of the lush growth which pear psylla prefers, and use of overhead irrigation to wash psylla honeydew off the fruit. However, these practices are prohibitively expensive and not routinely used in many orchards. None of the commercially planted European pear cultivars have useful levels of resistance to pear psylla.

Spider and eriophyid mites, even at low levels, can damage pears. Dormant oil sprays during the winter control mites before damage occurs by killing eggs and over-wintering motiles. The use of certain insecticides, however, can suppress mite predators and create outbreaks of harmful mites during the growing season. For this reason follow-up control is needed during the season, generally in conjunction with the April pear psylla treatment followed by another application in June.

The major mite species which must be monitored and controlled during the dormant season is European red mite. Other mites in pears include two-spotted mite, brown mite, rust mite, and pear leaf blister mite. Pesticides applied for other pests can induce spider mite outbreaks by disrupting biological mite control or by allowing an increase in the population of spider mites. Pear trees are very sensitive to feeding by mites and defoliate easily. Most pear growers apply at least one miticide spray a year. Where climatic conditions favor spider mites, growers apply up to three miticide sprays in a single season in a chemically-managed orchard. All spider mite species tend to develop resistance to miticides in a short time. Resistance problems are more serious on pears than on apples due pears' low economic threshold for spider mites, and the increased need for chemical mite control. As with pear psylla, resistance development has often caused a shortage of miticides on pears.

The more widely used miticides on pears include horticultural mineral oil, abamectin, hexythiazox, fenbutatin oxide, and pyridaben. However, some registered miticides have very limited use in some growing districts, due to resistance, inadequate spectrum of activity (e.g., not effective against pear rust mite), poor IPM fit, high cost, or availability of a more effective miticide (e.g., abamectin). Miticides that fall into at least one of these categories are clofentezine, oxamyl, dicofol, and formetanate hydrochloride.

Horticultural mineral oil sprays are used primarily during the pre-bloom period for control of European red mite eggs. Horticultural mineral oil has been used in recent years during the foliar period as an additive to other miticides (e.g., abamectin) to improve performance and increase persistence. Multiple applications of 1% oil sprays have been used in southern Oregon to supplement mating disruption of codling moth and suppress pear psylla and mites. However, concerns about possible negative effects on tree growth, fruit quality, and yields have limited the more frequent use of foliar oil sprays.

Naturally occurring predators can also play an important role in regulating mite populations on pear. Important mite predators include six-spotted thrips, minute pirate bug, and a small black lady beetle, *Stethorus* sp.

Unfortunately, biological mite control, is generally not very successful on pears. The insecticides applied for pear psylla control often disrupt mite control. For instance, foliar sprays of abamectin, amitraz, or pyridaben prevent phytoseid mites from building up to levels where they can suppress spider mites. The low treatment threshold for spider mites on pear (i.e., one to two actively feeding mites per leaf), due to the high susceptibility of pear foliage to mite damage, makes it difficult to maintain predator populations, even when selective chemicals are used. Another complicating factor is that an acceptable alternate food source, such as the apple rust mite, is not available on pears to maintain predators when spider mite populations are very low. With a gradual change to more selective pest control programs on pears and avoidance of broad-spectrum pesticides, growers may be able to rely more on biological mite control.

Cultural practices such as minimizing dust and maintaining a well managed ground cover will minimize spider mite outbreaks. The ground cover plants should not favorable hosts for spider mites. Also, healthy trees which are adequately supplied with water and nutrients are less susceptible to mite damage. However, excess vigor (especially too much nitrogen) will invite mite problems.

San Jose Scale (SJS), has become an increasing pest problem due to phytosanitary restrictions imposed by export markets. If uncontrolled, SJS can kill trees; and when scale settles on fruit, it becomes unmarketable. SJS is a greater problem in the early district, especially in large, older trees where spray coverage is more difficult to achieve and unsprayed refugia are more common than on younger trees. Living primarily on the tree bark, SJS is generally first detected as small red spots on fruits and leaves. SJS populations can increase rapidly due to its high reproductive rate. A single infested fruit can have more than 1,000 scale insects.

SJS is generally managed by a dormant application of horticultural mineral oil, with supplemental OP insecticides applied in summer to control the crawler stage. SJS was the first insect in the United States documented to have developed resistance to an insecticide, lime-sulfur. SJS is thought to have a variable level of resistance to OP insecticides; fruit infestation levels can be 30 to 40%. Several species of hymenopteran parasitoids and coleopteran predators attack SJS, but it is not clear whether they are capable of maintaining populations below the economic threshold. Even limited use of OP insecticides eliminates these parasitoids and predators.

Diazinon with oil is used during delayed dormancy in California, where SJS populations have a low level of OP resistance. Methidathion is highly effective against SJS. Horticultural mineral oil applied at dormancy or delayed dormant is the primary tactic used to manage SJS populations in pear. Sanitation aids in controlling SJS. Pruning the infested wood may help reduce populations over-wintering in orchards, but is probably not economical.

Work Group Recommendations for Insect Management during Dormancy

RESEARCH	• Evaluate new oils for psylla control

WEEDS

Most growers attempt to control weeds before the cold winter months. Orchard floor management helps to control frost damage in the spring. Winter annual weeds are generally well controlled by very effective residual herbicides used in conjunction with cultivation. Contact herbicides are used as weeds germinate in the spring. Non-chemical controls for weeds include cultivation, water management, irrigation type, use of cover crops, and hand weeding.

• Annual Bluegrass	• Mustard	• Bindweed
• Filaree	• Bermuda grass	• Lambsquarters
• Mallow	• Johnsongrass	• Puncture vine
• Purslane	• Nutsedge	• Curly dock
• Fleabane		

During November to February, pre-emergent weeds are controlled in the tree row with a dormant strip spray of residual and contact herbicides (Surflan® and Gramoxone®). The middles are mowed to control weeds, frost, rodents, and to chop up prunings.

The pre-emergence herbicide Goal® provides good to excellent control of most broadleaf weeds in pear orchards. This product can be used around young trees until the February 15th cutoff date, and may be used again after harvest. Karmex® also is a very effective, economical choice for growers, but some resistance has been reported with certain weeds.

Surflan® can be used around young trees and provides excellent efficacy; however, it has been difficult to obtain due to manufacturer issues. Simazine®, a triazine herbicide, provides very good and economical control of a wide variety of weeds, although some resistance has been noted. Unfortunately, ground water problems associated with trizine products may limit its use and availability.

Solicam® is very expensive and provides fair to good control of nutsedge in pear orchards only if numerous applications are made. Devrinol® provides good control of grasses but requires quick incorporation.

The Work Group has no recommendation for weed management at this time.

DISEASES

Fireblight is the single most important disease of pears. During the dormant season, only cultural control options are available. Immediate pruning of cankers, if done properly and with good sanitary technique, can help eliminate infected tissue.

Pear scab (*Venturi piranha*) affects foliage; however, the most significant losses from this disease are from infection on the fruit. Mendocino County has the greatest problem with scab, followed by Lake County; in certain areas this disease seems to be increasing in importance. Scab is most prevalent during wet springs. Since the pear scab fungi over-winter in leaf trash on the orchard floor, management activities during the dormant season will reduce problems which proliferate as green tissue emerges in the spring.

Lime sulfur applied with the dormant oils for psylla control provides some control of scab. Copper and sulfur are options for organic growers; however, these product provide only poor control of this disease.

Work Group Recommendations for Disease Management during Dormancy

RESEARCH	• Develop improved sanitation techniques for scab control
REGULATORY	• Allow orchard floor heat treating with burners to kill spores

VERTEBRATE PESTS

Rodents and other vertebrate pests can feed directly on the roots, bark, and inner tissues of trees, and can also disrupt irrigation and other equipment used in the orchards. Orchards near fields, pastures, and trashy areas are especially susceptible; therefore, sanitation in and around orchards is important. Monitoring for damage and presence of rodents and vertebrates is critical even during dormancy.

Techniques used with variable success for vertebrate control include baiting, fumigating, trapping, lethal control, and habitat management. Zinc phosphide helps to reduce vole (meadow mice) problems. Strychnine effectively controls gophers when bait shaking machines are used regularly. Ground squirrels are controlled by using blasting devices or by injecting propane into the squirrel hole and then igniting it.

There are no current work group recommendations for vertebrate control.

DELAYED DORMANCY
(February)

At this period, buds have begun to swell, but no green tissue is present on the trees.

Cultural and Worker Activities

- Mowing
- Scouting for codling moth, psylla, mite and insect eggs, SJS, and rust mites
- Herbicide applications
- Delayed dormancy oil and pyrethroid applications
- Irrigation
- Monitoring winter weeds

INSECTS AND MITES

Some key pests are managed largely by control measures taken during delayed dormancy. Almost all orchards apply chemical and oil to target over-wintering populations of several pests including pear psylla and mites.

Pear psylla is the primary pest at this time and major efforts continue in this season to manage it with the same pest control techniques used during the earlier portion of the dormant season for this insect. Oils and chemical controls are the only highly effective management tool that growers can use at this critical time. During the delayed dormant period, oils in combination with a pyrethroid provide good to excellent control in the Sacramento production area, if timing is correct. In the Mendocino/Lake district, only fair control of psylla is achieved with this combination due to resistance. Oil alone can be used in organic as well as conventional pear orchards with fair results.

Two types of leaf rollers use pears as a host: fruit tree leaf roller (FTLR) and oblique-banded leaf roller (OBLR). Leaf rollers are the most important secondary pest in pear orchards, especially where codling moth mating disruption is used and broad-spectrum insecticides have been reduced. These lepidopterous pests produce several generations per year, damaging commercial orchards. Most orchards receive a pre-bloom insecticide application mixed with oil for control of leaf rollers. Confirm® (tebufenozide) is also used as a pre-bloom control. Chlorpyrifos, alone or in combination with mineral oil, is effective against leaf rollers in most orchards as a delayed-dormant treatment and this treatment also helps control pear psylla. However, some regions have developed leaf roller populations tolerant of chlorpyrifos.

Pheromones have produced good results when used for mating disruption as a “stand-alone” control for leaf rollers, but much more research is required to assess this technology and its place in IPM programs. Several species of parasites of leaf rollers have been identified; however, most parasites are highly susceptible to neuron-active (OP, carbamate, pyrethroid) insecticides. Managing the orchard habitat, especially the cover crop, could help stabilize leaf roller populations and enhance the efficacy of biological control agents.

Oil helps to control mites during the delayed dormant period.

Western flower thrips can be an occasional pest in the Mendocino/Lake District. Asana® (esfenvalerate) plus oil and dimethoate are both excellent treatments to reduce thrip populations.

True bugs (boxelder, lygus, and stinkbugs) are considered secondary pests and are generally suppressed by application of a pyrethroid. Boxelder bugs have become an increasing problem in some orchards in which mating disruption is used. Control of this pest negates the development of predatory control of mites and psylla in these orchards.

DISEASES

Canker fungi infect and destroy fruit wood which can significantly affect fruit yield. During the delayed dormant period, pruning out diseased wood helps reduce the severity and spread of this disease.

Work Group Recommendations for Insect and Disease Management during Delayed Dormancy

RESEARCH	• Conduct research on the biology and management of true bugs • Evaluate the use of pheromones for control of leaf rollers • Determine the effect of Lorsban® applications on leaf rollers

GREEN TIP THROUGH PETAL FALL
(February – April)

This period encompasses the time from which green tissue can be observed on buds, through bloom and pollination, to loss of petals. Timing of bloom depends on growing region, amount of chilling, and seasonal temperatures. There may be more than one bloom period in pears, although a secondary bloom produces small, misshapen "rattail" fruit; this fruit poses significant problems in managing certain insect and disease pests. Bees or other pollinators are not needed to set a crop, although the presence of pollinators may enhance yield. Thus, care should be taken when applying pesticides to blooming pear trees to avoid bee kills.

Cultural and Worker Activities

- Mowing
- Frost protection (irrigation, wind machines, orchard heaters, Blightban® and/or Mycoschield®
- Fertilization
- Irrigation
- Pesticide and fungicide applications
- Scouting
- Budding/grafting
- Cutting holdover blight cankers
- Pruning

INSECTS AND MITES

Monitoring and sampling must continue for pear psylla and mites at this time. In addition, pheromone traps should be established to begin monitoring of codling moths, and degree day accumulations should be initiated at this time.

Please refer to earlier comments about psylla control. At this time of the season, Asana®, Ambush®, and Danitol® provide good to excellent control of psylla and are especially effective on nymphs. However, all pyrethroids disrupt beneficial insects.

Leaf rollers and green fruit worms can be important secondary pests in pear orchards, especially where codling moth mating disruption has been used. Intrepid®, Confirm®, and Success® are new products that provide excellent control of leaf rollers and green fruit worms. Success® must be applied at night due to concerns over potential bee kills.

*Bacillus thuringiensis (*Bt) products are fairly effective when applied in spring, but usually require at least two applications; coverage and temperatures are critical to efficacy. If rain occurs, control will be poor with these materials. Bt products are acceptable for use in organic orchards.

True bugs (boxelder, lygus, stinkbugs) now cause the most fruit damage in many pear orchards because in recent years growers have implemented codling moth mating disruption and reduced the number of organophosphate (OP) insecticide applications. Lygus and boxelder bugs are more important in the early part of the growing season, while stinkbugs can cause damage late in the season when they invade the orchard from surrounding habitats. Boxelder bugs are associated with riparian habitat that contains ash, maple and boxelder trees.

Many important predators within the orchard are true bugs (e.g. *Deraeocoris, Campylomma, Orius, Nabis*). *Campylomma* acts primarily as a beneficial in pears, but is an important early season pest in apple orchards. These beneficial true bugs can provide significant natural control of pear psylla. However, insecticides applied for control of pest true bugs can be very disruptive to those true bugs that act as natural control agents.

Several insecticides provide limited control of these hard to manage pests; no effective biological or cultural controls are known. Carzol® provides good control of boxelder bugs and lygus, but does not perform well on stinkbugs and is very harsh on beneficials. Dimethoate provides only fair control at the labeled rate. Danitol® controls lygus, stinkbugs, and boxelder bugs; if timing is coincidental to CM egg laying, it provides a measure of codling moth control. Provado® and Actara® both provide good control of the true bug complex, but they are expensive. A variety of pyrethroids provide good control, but since they can be disruptive to beneficials their use is restricted to before bloom.

Rust mites can be a serious pest of fresh market pears; their feeding on the fruit and foliage causes bronzing of the tissue. If not monitored, rust mites often are not detected until after damage has occurred because the russeting becomes visible only later in the spring and summer.

Carzol® provides excellent control of rust mites, but is very harsh on beneficials and is also expensive. It is used primarily as a last resort rescue treatment. Applied at finger stage (pre-bloom), sulfur in wettable and miocronized formulations will control moderate populations of rust mite. For heavy populations of rust mite, liquid lime sulfur applications in the fall before leaf fall and again at bud break may be needed for season-long control. The wettable formulation of sulfur is also acceptable for use in organic orchards, but must be applied at high rates, and can cause fruit finish damage in the coastal growing areas.

Occasional outbreaks of Western flower thrips can occur, especially in Lake County. Damage from thrips feeding on fruit appears as silvering or russeting. Asana®, a pyrethroid, provides good control of thrips when applied at green tip prior to bloom; this timing is also less disruptive to beneficials. Success® is newly registered for use on pears for thrip control, but it has not been used yet, partially due to its high cost.

Several new products are recently registered insecticides or soon to be registered in California (listed by active ingredient and registrant company): clothianidin, Arvesta; etoxazole, Valent; milbemectin, Sankyo; indoxacarb, Dupont; thiocloprid, Bayer; methoxyfenozide, Bayer; thiamethoxam, Syngenta. Acequinocyl has just been granted "reduced risk" status as a miticide by US EPA.

Work Group Recommendations for Insect Management during Green Tip through Petal Fall

RESEARCH	• Evaluate new leaf roller management techniques • Develop attract-and-kill techniques for true bug control • Evaluate new psylla management techniques
REGULATORY	• Expedite registrations of new products, especially OP alternatives

WEEDS

During this season some pre-emergence herbicides are still being applied. Products used are the same as in dormancy. Contact herbicide applications may occur also. Roundup® and Gramoxone® provide good to excellent control of most annuals. Gramoxone® is safer on young trees than Roundup®; however, it is a restricted use material, with worker issues. California requires that a closed mixing system be used.

Chemical mowing reduces growth of winter ground cover in irrigated orchards. Reducing grasses before and during bloom reduces hosts for bacteria that produce the plant growth hormone 3-indoleacetic acid, which causes russeting in the smooth skinned Bartlett variety.

The Work Group has no current recommendations for weed pest management at this time.

DISEASES

Monitoring for and treatment of fireblight, bacterial blossom blight, and scab should be done when new green tissue appears on the trees.

Fireblight is the most important disease of pears; several products are registered for its management, but none provides excellent control. Streptomycin combined or alternating with Blightban® has poor to good efficacy. A great deal of resistance to streptomycin exists in some orchards. Mycoshield® (terramycin) works fairly well, but is not as effective as streptomycin. Timing of applications is critical for best results. Alternating streptomycin and Mycoshield®, or using them in combination, provides fair to good control. Copper provides fair control of fireblight, but can cause russeting on the fruit. Aliette® has provided only very low levels of control in the Sacramento area, but product efficacy ranges from poor to good in the Lake County area. Blight Ban® A506 is a naturally occurring bacterial organism, *Pseudomonas fluorescens*. It assists in controlling fireblight, frost injury, and russeting by acting as a competitive exclusion agent. It was the first biological agent for disease control registered, and the pear industry funded a portion of its initial development. Sprayed on the flowers at about 10% bloom, *P. fluorescens* prevents the fireblight organism, *Erwinia amylovora*, and ice-nucleating bacteria from growing on treated plant tissue by out-competing them. It is only about 50% effective however, and must be augmented with other controls. The efficacy of a new product, Serenade®, is currently unknown.

Bacterial blossom blight (sometimes called blossom blast) occurs occasionally in pears. Copper provides good control of this disease, but the high rates needed make it an expensive treatment. Timing of the application is critical and the results are often weather-dependent.

Pear scab responds well to several fungicides available for disease management during this time. Flint® *(Trifloxystrobin)* and Sovran® (kresoxim-methyl) are strobilurins with broad spectrum preventative and curative properties. Silett® (dodine) provides good control with some curative properties. Procure® is a good, but expensive, fungicide. Dithane® works when used in combination with other products; however, it washes off easily and its performance is weather-related. Also, Gerber Inc. does not allow use of this product on pears that they purchase. Vangard® must be used in combination with another fungicide, and its efficacy is still only poor to fair. Ziram is only moderately effective and is a Category I material. Lime sulfur used with wettable sulfur provides fair to good control when applied prior to bloom, but, depending on the temperature, it injures the fruit finish if applied later.

Work Group Recommendations for Disease Management during Green Tip through Petal Fall

RESEARCH	• Evaluate streptomycin replacements for fireblight control • Evaluate the efficacy or Serenade® for fireblight • Evaluate Oxycom® for fireblight control • Evaluate inoculum control for scab • Conduct research on the stabilization of Mycoshield®
REGULATORY	• Maintain therapeutic use of antibiotics for plant agriculture
EDUCATION	• Educate growers on resistance management for scab complex • Educate regulators on the critical need for therapeutic uses of antibiotics for plant agriculture

POST PETAL FALL THROUGH HARVEST
(April – August)

During the seven to nine weeks following bloom, growth of the fruit is basically a process of rapid cell division. The tree's energy is directed towards shoot and fruit growth, and these two processes compete for nutrients and water. Irrigation and nutrient management are therefore very important to promoting good fruit sizing. Harvest begins in July and continues through August; all harvesting is done by hand.

Cultural and Worker Activities

- Mowing or cultivating
- Frost protection
- Fertilization
- Irrigation
- Scouting/leaf sampling for nutrient levels
- Pesticide applications, including hormone sprays
- Blight cutting/Pruning
- Pheromone applications/Setting traps and ties, puffers
- Harvest

INSECTS AND MITES

Codling moth (CM), the single most important insect pest of pears in California, could destroy 50-80% of the crop each year if not controlled. Most pear orchards receive an average of three insecticide applications for CM control, resulting in less than 0.25% CM infested fruit at harvest. However, in the western United States high levels of resistance to organophosphate (OP) insecticide have been documented in some areas. Also, there is known cross-resistance between OP-resistant CM populations and insecticides having different modes of action, including several unregistered insecticides.

The use of mating disruption pheromones to control CM has grown substantially in the last several years, but this is expensive and is more effective in area-wide IPM programs. Used by over 90% of pear growers in California, pheromones are not a "stand alone" tactic in most orchards; supplemental insecticide applications are required to maintain CM populations within grower-acceptable infestation levels. Use of "puffer" devices to deliver

aerosol formulations is less labor intensive than using “ties”; however, the aerosol technology is not as widely accepted in areas which historically have more wind (e.g., the Sacramento District).

Azinphos-methyl is the primary OP insecticide used to supplement pheromone mating disruption of CM, and the most commonly used OP insecticide for CM control. Many beneficial insects have developed tolerance to this insecticide. Examples include *Typhlodromus occidentalis* (western predatory mite), *Pnigalio flavipes* (an important parasite of leafminer) and green lacewings. Azinphos-methyl suppresses leaf roller and other pest populations when applied for control of CM. However, softer insect growth regulators (IGRs) like tebufenozide and methoxyfenozide are currently used more frequently to augment mating disruption for CM control.

Imidan® is only partially effective against CM, but it has a favorably short PHI. It is not widely used because it is more expensive than azinphos-methyl and less efficacious. However, Imidan® may be less toxic to most natural enemies. It should be applied at the maximum rate with a buffering agent added to the tank solution.

Pyrethroids provide good control of codling moth, but care must be taken to avoid development of resistance. Use of these products is harsh on predators and can cause mite flare ups. Danitol®, recently requested for use on pears, will control CM in the short term.

Sevin® provides only poor control of CM and causes mite flare-ups. The benefit of using this product is that it has a short PH,I which is useful between pickings. Confirm® provides only poor to fair control of CM, but does not injure beneficials.

Horticultural mineral oil provides some control of CM. Oil is approved for organic production, but provides only poor control. Oils can be applied weekly throughout CM season, but this can be detrimental to return bloom the following season.

Cultural controls of CM mainly involve sanitation. Infested bins stored adjacent to orchards may contribute to problems with CM management. Post-harvest sanitation using Ethrel® (ethephon) to ripen the remaining pears renders the fruit inhospitable to CM larvae, which drown in the mushy fruit. Hand removing pears remaining after harvest is prohibitively expensive and is not widely done.

Mites, such as European red mites, respond well to Savey® and Apollo®, both ovicides, which provide good to excellent control. These products are most effective when used to treat early infestations. Acramite® provides good control of mites, is safe on predators, and is a reduced risk material. Pyramite® is a fairly good miticide with good initial knockdown. Performance of Kelthane® ranges from poor to excellent; its first use produces excellent results, but subsequent applications are less and less effective. This product should not be used more than once every five or six years. Vendex® used with oil provides only poor to fair control of mites. Applications must be avoided during the hottest part of the season when they can cause phytotoxicity. Oil is a good miticide for management of low mite populations. Growers are aware that excessive use of OPs may cause mite flare-ups.

Pear rust mites are only an occasional pest, but are an increasing problem in mating disruption orchards when miticide use is reduced or eliminated. Avermectin® plus oil and Carzol® provide excellent control of this mite species, but Carzol® can be very disruptive to beneficials and may be used only once per season. Thiodan® is a good rust mite miticide that allows for good clean up of residual mite populations after harvest, but its use is restricted because it harms fish. Pyramite® is a new miticide; its efficacy for rust mite control in California pears is unknown.

Psylla can be managed well with Agri-Mek® used with oil; however, as the season progresses, it becomes increasingly difficult to get uptake of these materials, so they have less efficacy. Actara® provides good to excellent psylla control, but causes flare-ups of spider mites. Provado® provides good to excellent control, but is harsh on beneficials. Oil provides fair to good control of psylla and is approved for use in organic production.

Leaf rollers are most often controlled with applications for codling moth under conventional pest management programs. Several good products help to control this pest. Bt, acceptable for use in organic production systems, provides good control with multiple applications, good coverage, and warm temperatures. Confirm® and Success® provide very good control of leaf rollers. Sprayable leaf roller pheromone has been used successfully in pears. Entomologists report that the leaf roller pheromone is more efficacious than the codling moth pheromone.

Leafhoppers are controlled with difficulty by Imidan®, which provides only poor to fair control. Guthion® works fairly well for controlling leafhoppers, while Danitol® has good effectiveness.

True bugs can be managed using several available chemicals. Thiodan®, which is not used earlier in the year, can be used at this time, but it is harmful to fish and provides only fair control of boxelder bugs, lygus, and stinkbugs. On the other hand, Carzol® provides good control of boxelder bugs and lygus, but does not perform well on stinkbugs and is very harsh on beneficials. Danitol® or dimethoate are the insecticides of choice.

Dimethoate provides only a fair level of true bug control at the labeled rate and may not be used less than 28 days before harvest. Provado® and Actara® provide good control of the true bug complex, but are very expensive to use. A variety of pyrethroids provides good control, but they can disrupt beneficials and their use is restricted to before bloom because of potential damage to bees.

Work Group Recommendations for Insect and Mite Management during Post-Petal Fall through Harvest

RESEARCH	• Evaluate and develop reduced risk control techniques for psylla, true bugs, and leaf rollers • Evaluate and develop Guthion® alternatives for codling moth control • Develop attract-and-kill technology for true bug control • Continue pheromone research, especially for attractants for monitoring CM • Determine how to keep materials on-site to avoid TMDLs and other off-site issues • Conduct studies to improve application technology to reduce pesticide drift • Evaluate biological control techniques for all pear pests
REGULATORY	• Establish usable TMDLs • Register sprayable pheromone formulations • Maintain registrations of highly effective insecticides to use in conjunction with pheromone IPM systems in case of a severe pest outbreak • Enforce abandoned orchard pest abatement • Modify label language to keep up with new application methods/technology
EDUCATION	• Provide training on management practices to keep off-site pesticide movement to a minimum • Educate urban users about pesticide use, particularly off-site movement • Improve quality and increase quantity of field level monitoring with trained scouts • Demonstrate new materials and techniques for codling moth control • Inform the industry of the benefits of removing abandoned orchards • Educate growers and PCAs on environmental and water issues with organophosphate insecticides, antibiotics, and other materials used in pest control • Train growers and PCAs on resistance management

WEEDS

Post-emergence herbicides are applied during this time of the year, although not during harvest. Chemical and cultural controls are the same as indicated in previous discussions.

DISEASES

Fireblight management at this time of year focuses on disease which is present due to late fruit, secondary blooms ("rattail" blooms), and young tender shoots with blight strikes. Use of antibiotics such as streptomycin, alone or combined with an earlier application of Blightban®, provides acceptable levels of control. Mycoshield® provides moderate levels of control. Application timing is critical to product performance.

Cultural controls include physical removal of the disease by cutting out fireblight infections. Because workers are needed in the field at this time, its is very important that reentry intervals (REIs) are not prohibitive.

Fungicides used for scab control during this period are similar to products registered for earlier season. All products should be rotated based on knowledge of their differing modes of action.

Armillaria (oak root fungus) and *Phytophthora*, soil-borne diseases of pear tree roots and crown, can significantly damage pear trees in California. Only limited chemical controls are available. Proper irrigation management is the key to controlling these diseases, and adequate drainage should be provided so that water will not stand around the crowns of trees for extended periods.

Work Group Recommendations for Disease Management during Post Petal Fall through Harvest

RESEARCH	• Evaluate oak root fungus and *Phytophthora* management techniques • Evaluate biological control techniques for all pear pests
REGULATORY	• Expedite Enzone® registration for control of oak root fungus

VERTEBRATE PESTS

Gophers, meadow mice, squirrels, and voles continue to cause damage in pear orchards at this time of the year; management tactics are the same as those discussed above. Deer can be pests at this time of year also. Repellents do not work well for deer, and the cost of erecting and maintaining fences to keep deer out can be prohibitive.

There are no work group recommendations concerning vertebrate management for this season.

PLANT GROWTH REGULATORS (PGRs)

PGRs are an essential element of pear management in California; virtually all conventional pear growers use them. NAA (variously naphthaleneacetic acid, 1-naphthylacetic acid, or naphthalic acetic acid) is used to hold fruit on the trees. This product acts by preventing an abscission layer of cells from forming where the stem is attached to the limb; thus fruit is held "tighter" on the trees and does not drop off readily. Applications are made approximately three to ten days prior to harvest.

New PGR products are being registered for use in pears, although their use is currently very limited. These products are very expensive to use and their benefits and use patterns are not yet well-understood. Retain® is used to increase fruit size by allowing the fruit to remain on the tree longer without ripening, and Apogee® (although not yet registered for pears) could be used to reduce vegetative growth and limit the development of rattail blooms which become infected with fireblight.

Work Group Recommendations for Plant Growth Regulators during Post Petal Fall through Harvest

RESEARCH	• Evaluate oak root fungus and *Phytophthora* management techniques
REGULATORY	• Expand the registration of Apogee® to include pears (currently only apples are labeled; however, the industry has worked to develop data for the registrant) • Obtain approval by the California League of Food Processors and Del Monte Foods, Inc. for the use of PGRs Apogee® and Retain® on pears

POST-HARVEST DISEASE ISSUES

Pears are harvested over several weeks and may be stored for several months. The most important post-harvest disease of pears in storage and marketing is blue mold, *Penicillium expansum.* Gray mold, *Botrytis cinerea*, is especially serious in pears held for extended periods in cold storage. Other post-harvest diseases include *Alternaria* rot and *Mucor* rot. The primary commercial control of post-harvest diseases is through maintaining good sanitation and minimizing wounds and bruising during picking and packing.

Good post-harvest disease management starts with healthy pears with firm flesh and skin free of physical injury and inoculum. Most post-harvest losses can be traced back to in-season treatment and handling of the fruit. Thus growers must make every effort to use sound field practices during the season. This will maximize potential fruit storage time, which is critical because an increasing amount of the pear crop is being marketed over longer periods of time.

Mertect® (thiabendazole - TBZ), the only post-harvest fungicide registered in California for use on pears, is a protectant, not an eradicant. As with most benzimidazoles, *Botrytis (*gray mold) and blue mold have developed resistant strains which complicate control with this fungicide. The biological BioSave®, *Pseudomonas syringae,* works by competing for food with the pathogen. Industry research shows very little efficacy with this product.

The reduced-risk fungicide fenhexamid currently is being registered through the IR-4 program, and pyrimethanil and fludioxonil also are in the US EPA registration process for pears. Each of these fungicides has different modes of action which fit well in rotation as resistance management tools. Chlorine as a post-harvest disease control method provides only contact activity with no residual. Ozone stops sporulation of brown rot and other diseases, but has no curative effects. UV light provides little or no control.

Alternaria spp. and *Mucor* can be controlled by fludioxonil and/or pyrimethanil, but these products are yet to be registered for pears.

Botrytis (gray mold) can be reduced with good sanitation in the packing house and use of chlorinated water at appropriate concentrations.

No chemicals are available for control in California of Scald disease.

Work Group Recommendations for Post-Harvest Disease Management

RESEARCH	• Continue research on blue mold and *Botrytis* resistance management • Evaluate California requirements to register SOPP and ethoxyquin for use on California pears
REGULATORY	• Expedite registrations of pyrimethanil, Elevate®, and Scholar® • Expedite scald registrations in California (SOPP, ethoxyquin)

POST-HARVEST ACTIVITIES IN THE ORCHARD
(July through November)

Cultural and Worker Activities

• Fertilization	• Tree hole fumigation (for replants)
• Irrigation	• Scouting
• Cover crops	• Pesticide applications
• Cutting out blight	• Pruning
• Tree removal	• Sanitation

INSECTS AND MITES

Codling moth clean-up in pear orchards occurs during the post-harvest period using Lorsban® (which is a negatively correlated cross-resistant OP). It provides only fair control due to not controlling the larvae in the fruit. Diazinon also provides only poor control of codling moth. Physical removal of old fruit, rattail blooms, etc. is impractical because it is very labor intensive and expensive; however, the importance of removing post-harvest fruit and rattail blooms in codling moth management cannot be overstated. The use of ethephon (as discussed earlier) to encourage fruit ripening is an excellent reduced risk technique to reduce over-wintering codling moths in the early district.

Monitoring actively for various mites and pear psylla should be continued at this time. Psylla receives control from several good products or combinations at this time of year. Oil plus Lorsban®, diazinon, or Thiodan® provides good to excellent control. Oils alone also provide good control. Lime–sulfur plus oil also is a good combination, but care should be taken to apply it only during cooler days due to phytotoxicity issues.

Spider mites are well controlled with oils, often as an offshoot of psylla control. Higher rates may be used at this time of the year because the fruit is off the trees. Rust mites are controlled by combinations that include lime-sulfur and wettable sulfur. As temperatures cool in the fall, lime-sulfur plus oil is also used with good success. Good control of blister mites is achieved from use of oils in combination with diazinon, lime-sulfur, or Thiodan®.

Work Group Recommendations for Insect Management during Post-Harvest in the Orchard

REGULATORY	• Register ethephon; this is one of the most important registrations for pears • Revisit Penncap® registration for orchard post-harvest use

WEEDS

Pre-emergence herbicides and cultural techniques (mowing and disking) typically are used to control weeds during fall. Chemical products for this use are the same as those discussed previously in this document.

There are no work group recommendations for fall weed management.

DISEASES

Fireblight management activities during the fall include cutting our and removing infected tissue.

Scab controls, such as lime-sulfur and urea, used at this time of year provide only very limited poor disease control.

Oak root fungus control must include irrigation management. An air hoe may be used to expose the crown and help limit spread of the disease.

Work Group Recommendations for Disease Management during Post-Harvest in the Orchard

REGULATORY	• Register ethephon; this is one of the most important current registration needs for pears

INTERNATIONAL ISSUES

A significant portion of the California pear crop is shipped to international markets, primarily Mexico and Canada. Export shipments can account for 20% of the gross fresh crop dollar value. It is therefore critical to prevent pest problems in the field and to comply with pre-shipment quarantine protocols. Important pests that cause phytosanitary concerns in pears include internal feeders such as codling moth, and oblique-banded leaf roller (OBLR).

Work Group Recommendations Concerning International Trade

RESEARCH	• Encourage registrants to develop residue data and export tolerances for new products prior to U.S. registration
REGULATORY	• Develop and maintain an approved list of materials that can be used on pears; request that FDA maintain a current log of international registrations • Encourage registrants to establish export tolerances for new products prior to registration • Harmonize registrations between the US EPA and importing countries • Harmonize EPA registration requirements with the MRL and Codex systems used in other countries • Insure that all quarantine protocols are equitable • Encourage EPA and FAS to work with Codex to expedite international registrations so that newer and safer products may be used in the U.S. without fear of trade irritant issues
EDUCATION	• Commodity groups should regularly educate growers and PCAs about which materials are approved by export countries • Educate and encourage registrants to develop tolerances in compliance with importing countries prior to full U.S. registration

3. CRITICAL ISSUES FOR THE CALIFORNIA PEAR INDUSTRY

The Pear Work Group identified the following issues as the most critical to the sustained viability of the California pear industry.

RESEARCH	• Evaluate and develop Guthion® alternatives for codling moth control • Develop monitoring techniques and economic thresholds for new codling moth control systems • Evaluate and develop reduced risk management techniques for psylla, true bugs, and leaf rollers • Develop an "attract and kill" device for true bugs • Evaluate and develop organically acceptable management techniques for codling moth and fireblight • Develop new techniques and reduced risk products for control of fireblight and pear scab • Evaluate resistance status for insecticides and fungicides used in pear pest management • Evaluate biological control techniques for all pear pests • Evaluate reduced risk compounds for all pest categories in pears • Study the environmental impact of organophosphates and antibiotics
REGULATORY	• Register reduced risk insecticides for codling moth - the key insect pest of pears • Register reduced risk insecticides for control of psylla, true bugs, and leaf rollers • Register ethephon with a 24c for managing codling moth infestations in old fruit • Allow the industry to maintain its post-harvest chlorpyriphos 24c for codling moth resistance management programs • Enforce removal of abandoned orchards to aid in establishing area-wide pest management programs • Register fludioxonil, fenhexamid, pyrimethanil, and sodium ortho-phenylphenate (SOPP) for control of scald, *Botrytis,* and other post-harvest diseases • Register alternative antibiotics for fireblight control • Obtain approval by the California League of Food Processors and Del Monte Foods, Inc. for the use of PGRs Apogee® and Retain® on pears
EDUCATION	• Demonstrate new materials and techniques for codling moth control • Inform the industry of the benefits of removing abandoned orchards • Educate growers, PCAs, and the community on the importance of removing abandoned orchards in establishing effective area-wide pest management programs • Educate growers and PCAs on environmental and water impacts of organophosphate insecticides, antibiotics, and other materials used in pest control • Train growers and PCAs on resistance management • Document the current use of fireblight models to support antibiotic use • Insure that adequate levels of UCCE field staff are available to assist with research and extension needs of pear growers • Improve quality and increase quantity of field level monitoring with trained scouts • Continue the availability of training materials in Spanish • Educate the public on the value of consuming pears as an important part of a healthy diet • Increase public awareness of using integrated pest management tactics (e.g., pheromones) in California pear production

4. APPLIED RESEARCH AND EDUCATION NEEDED FOR A PEST MANAGEMENT STRATEGIC PLAN IN PEARS

The creation of the Land Grant University system acknowledged the essential link between research and education needed for the advancement of agriculture. The model of the continuum from researcher through extender and user, and back to researcher, is viewed worldwide as a major factor in the success of U.S. agriculture. As the amount, intensity, and complexity of research increases to meet the demand for new IPM systems, the need for effective user education also increases to ensure the successful immediate and long-term adoption of new strategies. However, the relative proportion of funds designated for extension efforts has declined significantly in recent years. To facilitate the implementation and grower adoption of these new reduced risk strategies, it is recommended that an ongoing educational program be funded and developed as early as possible in the research program to serve as an integral component of the Pest Management Strategic Plan.

The following areas are deemed essential to the successful widespread adoption of reduced risk pest management.

TRANSITION AREA	DESCRIPTION	SPECIFIC METHODS
Applied research directed to the evolving needs of California's pear industry	ongoing communication with the pear industry, entrepreneurs, and registrants about growers' needs; lab studies as needed to identify viable candidates for field evaluation; replicated field trials under realistic field conditions	follow industry directives per requests for proposals; participate in grower meetings; collaborate with pear industry, scientific personnel, and commercial entities
Economic analyses	Identifying detailed costs of implementing new IPM programs must be an integral part of the process, from research through extension	focused crop production studies, interactive computer budget planners
Demonstration projects	large-scale demonstrations to validate and hasten adoption of new research at sites which would be primary locations for hands-on training as well as economic analyses	providing specimens for identification, displaying new devices, providing concise summaries of economic and environmental benefits from IPM
Technology transfer and development of materials for primary users (growers and PCAs)	focused, ongoing activities and educational materials for users of new technology	newsletters, field and indoor meetings, roundtable discussions, dedicated web site with links to related sites
Multi-lingual, hands-on training for applicators, field workers, and monitoring personnel	activities to increase the numbers and skill level of field personnel involved in implementing new technologies	training manuals, audio-visual materials, field training sessions in appropriate languages
Outreach to external parties indirectly involved in poem fruit production	Inform processors, regulatory agencies, retail buyers, etc. of the progress being made to reduce broad-spectrum pesticide use	web site with related links, leaflet series , prepared presentations, orchard tours
Collaboration with and outreach to public agencies with environmental concerns	outreach pertaining to pesticide use, water quality, air quality, wildlife, land use, etc.	leaflet series, prepared presentations, web site with related links orchard tours
Outreach to the non-farming public	materials and programs to solicit and implement help in reducing pests; inform local communities and consumers about new eco-friendly practices	leaflet series, web site with related links, prepared presentations, orchard tours

As the California pear industry continues its transition to integrated pest management systems that minimize reliance on organophosphate insecticides, the critical role of applied research and education in grower adoption of these systems must be recognized. Before growers can properly implement, comfortably adopt, and promote the further adoption of these research-based management systems and strategies, they must gain a working knowledge of the technology, understanding the underlying mechanisms contributing to its success and anticipating how it will impact overall fruit production.

The ultimate adopter and user of any new orchard IPM system or management strategy is the grower. In the end, the grower will decide whether a strategy or method will be adopted, based on cost and effect on other farming practices and priorities. However, other individuals and groups influence grower adoption of new systems in pears. Thus, the inclusion of all stakeholders in this process will greatly improve community acceptance of this technology as well as the rate of grower adoption of the new systems and strategies. The stakeholders include:

- Pest control advisers (PCAs) and associated field personnel
- Orchard managers and employees
- Fruit processors, retailers, and distributors (domestic and international)
- Non-farming neighbors in the surrounding community
- Public agencies with concerns about the environment
- Consumers

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Journal of Economic Entomology 93(3): 955-962 (2000) *Correlated Insecticide Cross-Resistance in Azinphos-methyl Resistant Codling Moth* (Lepidoptera: Torticidea). John E. Dunley and Steven C. Welter

UC IPM Pest Management Guidelines: Pear, September 2002*, UC ANR* Publication 3455

Integrated Pest Management for Apples and Pears, 2nd edition, August 1999, UC ANR Publication 3340

WEBSITES:

Crop Profile for Pears in California, October 1999,
http://pestdata.ncsu.edu/cropprofiles/docs/capears.html

California Pear Advisory Board website
http://www.calpear.com

National Agricultural Statistical Service of the USDA
http://www.nass.usda.gov/ca/rlsetoc.htm

APPENDICES

1. California Pear Production Statistics 1998-2002

BEARING ACREAGE, PRODUCTION, AND UTILIZATION OF CALIFORNIA BARTLETTS
(CPAB Table 2)

Crop Year	Bearing Acreage	Total Production (Tons)	Dried (Tons)	Processed (Tons)	Fresh (Tons)
1998	15,000	277,000	7,600	216,400	53,000
1999	15,000	311,000	7,000	220,000	84,000
2000	15,000	282,000	4,000	182,000	81,000
2001	14,000	275,000	4,200	170,800	62,000
2002	13,000	232,000	3,000	160,000	69,000

CALIFORNIA BARTLETT ACREAGE, PRODUCTION, PRICE, AND VALUE
(CPAB Table 3)

Crop Year	Bearing Acreage	Production Total (Tons)	Production Per Bearing Acre (Tons)	First Delivery Point Value ($,000) *
1998	15,000	277,000	18.5	68,121
1999	15,000	311,000	20.7	64,676
2000	15,000	282,000	18.8	54,666
2001	14,000	275,000	19.6	61,202
2002	13,000	232,000	17.8	56,120

***** Starting in 1995, the Total Value is now reported as the price as delivered to the packing/processing house door x production (includes transport cost)

COMMERCIAL BARTLETT TONNAGE, BY DISTRICT
(CPAB Table 6)

District	1998	1999	2000	2001	2002
Upper Sacramento Valley	8,808	11,503	12,178	13,416	10,230
Sacramento - San Joaquin	135,923	148,088	137,227	126,055	128,416
Solano	5,076	8,071	3,887	3,923	1,492
Contra Costa	329	506	574	0	0
Lake	72,787	82,453	62,749	52,201	55,674
Mendocino	49,257	56,427	47,353	41,644	34,493
El Dorado	1,367	1,622	804	0	0
Santa Clara	66	101	9	0	0
Napa-Sonoma	0	117	19	0	0
Balance of State	127	29	458	738	1,070
TOTAL	**273,740**	**308,917**	**265,258**	**237,977**	**231,375**

Source of data for all three above tables: California Pear Advisory Board (CPAB)

1. 2002 California Pear Production Statistics (continued)

COUNTY	HARVESTED ACRES	YIELD (Tons/Acre)	PRODUCTION (Tons)	VALUE ($)
Asian Pears				
El Dorado	63	8.89	560	313,600
Fresno	962	14.45	13,900	17,452,000
Lake	148	9.31	1,378	950,700
State Subtotals	**1,173**	**Weighted Average 13.50**	**15,838**	**18,806,300**
Bartlett Pears				
El Dorado	303	6.50	1,970	373,900
Lake	2,826	19.70	55,674	19,756,400
Mendocino	2,105	16.39	34,493	12,003,200
Placer	38	3.00	114	21,700
Sacramento	6,015	19.00	114,285	27,352,000
State Subtotals	**11,287**	**Weighted Average 18.30**	**206,536**	**59,507,200**
Unspecified Pears				
Contra Costa	53	18.26	968	197,000
Lake	50	15.66	783	560,600
Mendocino	245	17.69	4,333	2,715,200
San Joaquin	549	19.00	10,430	2,608,000
Solano	965	5.69	5,494	1,248,700
Sutter	272	17.64	4,798	1,060,400
Tulare	422	5.83	2,460	3,641,000
State Subtotals	**2,556**	**Weighted Average 11.45**	**29,266**	**12,030,900**
STATE TOTALS	**15,016**	**Weighted Average 14.4**	**251,640**	**90,344,400**

Source: County Agricultural Commissioners' Data (USDA/NASS/CASS)

Note: the *CDFA Resource Directory – 2002* contains additional production statistics which may be seen at their website (http://www.cdfa.ca.gov/publications.htm).

2. Pear Development, Cultural Practices, and Pest Management Activities

For Sacramento (Early) and Mendocino/Lake (Late) Districts of Pear Production

Crop Development	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Dormancy	■	■	■								■	■
Bud Break		■	■									
Bloom			■	■								
Fruit Development				■	■	■	■	■				
Harvest							■	■	■			
Post-Harvest								■	■	■		
Storage							■	■	■	■	■	■
Cultural Practices	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Cultivation				■	■	■	■	■	■	■		
Irrigation				■	■	■	■	■	■	■		
Pruning	■	■								■	■	■
Frost Protection		■	■	■	■							
Fertilizer Application				■	■	■						
Mowing		■	■	■	■	■	■	■	■	■		
Budding	■											■
Pest Management Activities	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Soil Sampling									■			
Scouting	■	■	■	■	■	■	■	■	■	■	■	■
Insecticide Applications	■	■	■	■	■	■	■		■			■
Dormant Insecticide Applications	■	■										■
Pheromones			■	■	■	■	■	■				
Herbicide Applications				■	■					■	■	
Vertebrate Control	■	■	■	■	■	■	■	■	■	■	■	■
PGR Application						■	■	■	■			
Leaf Sampling						■	■	■				

Data based on collective field observations and experiments

3. Seasonal Pest Occurrence in California Pears

For Sacramento (Early) and Mendocino/Lake (Late) Districts of Pear Production

Insects/Mites	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Codling Moth												
Leaf Rollers												
Fruitworm												
San Jose Scale												
Stink Bugs												
Lygus Bugs												
Thrips												
Leafhoppers												
European Red Mite												
Spider Mite												
Pear Psylla												
Pear Rust Mite												
Boxelder Bug												
Diseases	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Fireblight												
Scab												
Pear Decline												
Bacterial Blossom Blast												
Weeds	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Grasses												
Broadleaves												
Perennials												
Vertebrates	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Gophers												
Ground Squirrels												
Meadow Mice												

Data based on collective field observations and experiments

4. Efficacy of Insect Management Tools Used in California Pears

Registered Insecticides

Efficacy Ratings: E = Excellent, G = Good, F = Fair, P = Poor-to-None, R = Known Resistance

PRODUCT	TRADE NAME	Codling Moth	Leaf Rollers	Green Fruitworm	Stinkbugs	Cutworms	San Jose Scale	Fruit Tree Leaf Roller	Lygus Bug	Thrips	Leafhoppers	European Red Mite	Spider Mites	Pear Psylla	Pear Rust Mites	Boxelder Bug
Abamectin	Agrimek®	F-G										F	F		P	
Amitraz	Mite®															
Azadirachtin	Remix®	P														
Azinphos-methyl	Guthion®	G-E	E-R		P	F	P			F-G	P-F			P		
Bacillus thuringiensis	various	P	G								P					
Carbaryl	Sevin®	G									E				G	
Chlorpyrifos	Lorsban®	G	G-E			E	G-E				F					
Clofentezine	Apollo®											F-E			P	
Diazinon		F	P			E			G		F					
Dicofol	Kelthane®											P-G	P-G			
Dimethoate			P						F-G							
Endosulfan	Thiodan®		F		G-E		G-E		E	F	G-E			G		
Esfenvalerate	Asana®	E	E				G-E		E		G-E			F-G		
Fenbutatin oxide	Vendex®											PE	FG		G	
Formetanate	Carzol®						G-E			G	E		F		G	
Hexythiazox	Savey®											F-E			P	
Imidachloprid	Provado®															
Kaolin	Surround®	F					F-P							G		
Lime-sulfur	various													G	E	
Methomyl	Lannate®					E						G-E				
Naled	Dibrom®	F-G									F-G	F-G	F-G	G	G	
Neem Oil	Trilogy®									F		F	FG			
Oil – dormant		G-E				G	G-E		E		E			F-E		
Oil - summer		G-E	P													
Oxamyl	Vydate®		F								P			P		
Permethrin	Pounce®											E	F-G	G	G	
Pheromones	Isomate®	F-G				E								G		
Phosmet	Imidan®	F-G	F-R													
Pyridaben	Pyramite®															
Pyriproxyfen	Esteem®		F													
Soaps	M-pede®															
Spinosad	Success®															
Sulfur																
Tebufenozide	Confirm®															

Data based on collective field observations and experiments

4. Efficacy of Insect Management Tools Used in California Pears (continued)

Unregistered and/or Potential Chemical Insecticides

Rating System: E = Excellent, G = Good, F = Fair, P = Poor/None, R = Known Resistance

PRODUCT	TRADE NAME	Codling Moth	Leaf Rollers	Green Fruitworm	Cutworms	San Jose Scale	Fruit Tree Leaf Roller	Lygus Bug	Thrips	Leafhoppers	European Red Mite	Spider mites	Pear Psylla	Pear Rust Mites	Boxelder Bug
Acetamiprid	Assail®	G	P	P			P						G		
Bifenazate											G	G			
Buprofezin	Applaud®														
Chlorfenapyr	Alert®	P	P												
Clothianidin	V-10066									G			P		
Diflubenzuron	Dimilin®	F													
Diofenolan	CGA-59205	P				E							G		
Emamectin benzoate	Proclaim®	P													
Fenoxycarb	Comply®	G-E	G-E			G									
Fenpropathrin	Danitol®	G	G							G	F-G		E		
Granulosis virus	Carpo-virusine	F-G													
Indoxacarb	Avaunt®	P	P												
Methoxyfenozide	Intrepid®	G	G-E	E			E								
Milbemectin	Fury®										F	F			
NPV		P													
Pirimicarb	Primor®														
Pymetrozine	Fulfill®														
Thiacloprid	Calypso®														
Thiamethoxam	Actara®							F		G			G		F
Triazamate	Aphistar®														

Data based on collective field observations and experiments

4. Efficacy of Insect Management Tools Used in California Pears (continued)

Non-Chemical Management Aids

Rating System: E = Excellent, G = Good, F = Fair, P = Poor/None

NON-CHEMICAL TOOLS	Codling Moth	Green Fruitworm	Leaf Rollers	Stinkbugs	Cutworms	San Jose Scale	Fruit Tree Leaf Roller	Lygus Bug	Thrips	Leafhoppers	European Red Mite	Spider Mites	Pear psylla	Pear Rust Mites	Boxelder Bug
Cover Crops								F							
Habitat Management								F							G
Monitoring/Use of Action Thresholds															
Natural Enemies		F	F			G	F				G	G	G		
Nutrition															
Sanitation/ Weeding															
Soil/Dust Management															
Use of Models															
Resistant Varieties															
Water Management															
Mulching															
Trap Crops															
Netting															
Pheromones (Mating Disruption)	G														
Pheromones (Population Monitoring)	G		F			F									
Predatory Mites												G			

Data based on collective field observations and experiment

4. Efficacy of Insect Management Tools Used in California Pears (continued)

Relative Toxicities of Insecticides and Miticides to Beneficial Organisms

Toxicity Ratings: H = high, M = moderate, L = low, — = unknown

COMMON NAME (Trade Name)	SELECTIVITY	PREDATORY MITES	GENERAL PREDATORS	PARASITES
Abamectin (Agri-Mek®)	moderate	H	L	M - H
Acetamiprid (Assail®)	—	—	—	—
Amitraz (Mitac®)	broad	—	—	—
Azadirachtin (Neemix®)	broad	—	L	L
Azinphos-methyl (Guthion®)	broad	L/M	H	H
Bacillus thuringiensis (Bt)	narrow	L	L	L
Bifenazate (Acramite®)	narrow	—	—	—
Carbaryl (Sevin®) 50, 80	broad	L/H	H	H
Chlorpyrifos (Lorsban®)	broad	M	H	H
Clofentezine (Apollo®)	narrow	L	L	L
Cypermethrin (Ammo®)	broad	H	H	H
Diazinon-foliar	broad	L	H	H
Dimethoate	broad	H	H	H
Esfenvalerate (Asana®)	broad	H	M	H
Fenbutatin oxide (Vendex®)	narrow	L	L	L
Fenpropathrin (Danitol®)	broad	H	H	H
Formetanate HCL (Carzol®)	broad	L/H	H	H
Hexythiazox (Savey®)	narrow	L	L	L
Imidacloprid (Provado®)	narrow	—	—	H
Insecticidal soap (M-Pede®)	broad	M	M	M
Lime sulfur	narrow	L/H	L	H
Methidathion (Supracide®)	broad	H	H	H
Neem Oil (Trilogy®)	broad	L	L	L
Petroleum Oil	broad	L	L	L
Phosmet (Imidan®)	broad	H	H	H
Pyriproxyfen (Esteem®)	narrow	L	H	L
Sulfur	narrow	L/H	L	H
Tebufenozide (Confirm®)	narrow	L	L	L
Thiamethoxam (Actara®)	moderate	—	—	—

Adapted from *UC IPM Guidelines for California Pears*

4. Efficacy of Insect Management Tools Used in California Pears (continued)

List of Unregistered Insecticides/Miticides of Interest to California Pear Producers

COMPANY	TRADE NAME, CHEMICAL NAME, or PRODUCT NUMBER	POTENTIAL TARGET PEST(S)	COMMENTS (Chemistry or Mode of Action, Registration Status, Selectivity, etc.)
AgrEvo	Applaud®, buprofezin	Pear psylla Grape mealy bug	Section 18 in CA and AZ for whitefly and citrus redscale
Aventis CropScience	Assail®, acetamiprid	Codling moth Scale Pear psylla Grape mealybug	Chlornicotinyl with the same mode of action as imidacloprid; under development; more selective against beneficial Hymenoptera
BASF	Alert®, chlorfenapyr, AC 303,630	Pear psylla Codling moth Spider mites Leaf roller	Pyrole; broad-spectrum activity; more effective against two-spotted spider mite than European red mite; commercial development on tree fruits uncertain; not selective to natural enemies
BASF	B 9143	Codling moth Pear psylla	Currently under development; no tolerances established yet
Bayer	Calypso®, thiocloprid, YRC-2894	Codling moth Leafminer Other lepidoptera Pear psylla Grape mealybug	Chlornicotinyl with the same mode of action as imidacloprid; under development; more selective against beneficial Hymenoptera; has activity against Lepidoptera
Dow AgroSciences	Success®, spinosad	Leaf rollers	Registered on apple in 1998 and soft fruit in 1999; neuroactivity on the post-synaptic site
DuPont	Avaunt®, indoxacarb, DPX-MP062	Codling moth Other lepidoptera Leafhoppers	Neuroactivity identified as a sodium channel blocker; currently under development; full registration on pome fruits anticipated/obtained
Gowan	GWN-1730	Codling moth Leaf rollers	IGR (ecdysone agonist); included in test program on apples in 1999
Gowan	GWN-1701	Spider mites	Under development; little known about chemistry
Syngenta	Comply® fenoxycarb	Codling moth Leaf rollers	IGR (juvenoid); company decided not to pursue further development due to FQPA triggered testing requirements
Syngenta		Pear psylla	Used under Section 18 exemption between 1994 and 1997 for pre-bloom control of pear psylla; company decided not to pursue development
Syngenta	diofenolan, CGA-59205	Codling moth Leaf rollers Pear psylla San Jose scale	IGR (juvenoid); under development on apples between 1995 and 1997; company decided not to pursue development
Syngenta	Actara®, thiamethoxam, CGA-293343	Leafhoppers Leafminers Aphids Pear psylla Grape mealybug	Chlornicotinyl; currently under development on pears and apples (since 1998); registration anticipated/obtained; appears to have effects similar to the neonicotinoid Provado (imidacloprid)

4. Efficacy of Insect Management Tools Used in California Pears (continued)

List of Unregistered Insecticides/Miticides of Interest to California Pear Producers (continued)

COMPANY	TRADE NAME, CHEMICAL NAME, or PRODUCT NUMBER	POTENTIAL TARGET PEST(S)	COMMENTS (Chemistry or Mode of Action, Registration Status; Selectivity, etc.)
Syngenta	Fulfill®, pymetrozine, CGA-215944	Aphids	Pyridine azomethine; registration for apples anticipated/obtained; selective to natural enemies
Syngenta	Proclaim®, emamectin benzoate	Pear psylla Codling moth Leaf rollers Spider mites	Mode of action similar to abamectin; currently under development (since 1999); no tolerances established yet
Rohm & Haas	Intrepid®, methoxyfenozide, RH-2485	Codling moth Leaf rollers Leafminer	IGR (ecdysone agonist); more active than tebufenozide but equally selective to natural enemies; company is pursuing both pome and stone fruit labels
Rohm & Haas	Aphistar®, triazamate, RH-7988	Aphids	Cholinesterase inhibitor; EUP on apples in 1999; registration anticipated/obtained; selective to natural enemies
Sankyo	milbemectin	Spider mites Pear psylla Leafminer	Same mode of action as abamectin
Uniroyal	bifenazate	Spider mites	IGR under development
Uniroyal	Dimilin®, diflubenzuron	Codling moth Leafminer	IGR (chitin synthesis inhibitor); under development on apples and pears since the mid-1970s; currently has an SLN 24c registration as a post-harvest control for leafminer on sweet cherries in Oregon; selective to generalist predators except coccinellids
Uniroyal	Dimilin®, diflubenzuron	Pear psylla	Used in Oregon and Washington in 1999 under a Section 18 exemption for pre-bloom control; tolerances not yet established
Valent USA	V-10066	San Jose scale (crawlers) Aphids Leafhoppers Grape mealybug	Neonicotinoid; under development on apples and pears since 1997; registration package for pome fruits submitted in 2000; insufficient information on selectivity to natural enemies
Valent USA	Tame® fenpropathrin	Spider mites Lepidoptera Leafhoppers	Synthetic pyrethroid with broad spectrum of activity; disruptive to mite biological control

5. Efficacy of Weed Management Tools Used in California Pears

Rating System: E = Excellent, G = Good, F = Fair, P = Poor/None, R = Known Resistance

PRODUCT	TRADE NAME	WEEDS			
		Broadleaves	Annual Grasses	Perennial Grasses	Perennial Broadleaves
Herbicides					
2,4-D	Envy®				
Diuron	Karmex®				
Glyphosate	Roundup®	E	F-G	G	F-G
Napropamide	Devrinol®	F	P-F	P	P
Norflurazon	Solicam®				
Oryzalin	Surflan®	G	G	P	P
Oxyfluorfen	Goal®	P	E	P	F
Paraquat Dichloride	Gramoxone®	E	G-E	P-F	F
Pendimethalin	Prowl®	G	G-E	P	P
Simazine	Princep®		P		
Non-Chemical Tools					
Cultivation		G	G	G	
Soil/Water Management					
Cover Crops					
Hand Weeding					
Mowing		G	G	G	
Burning		P	P	F	

Data based on collective field observations and experiments

6. Efficacy of Disease Management Tools Used in California Pears

Rating System: E = Excellent, G = Good, F = Fair, P = Poor/None, R = Known Resistance

PRODUCT	TRADE NAME	Fireblight	Pear Decline	Scab	Bacterial Blossom Blast	*Phytophthora* Root and Crown Rot	*Dermatophora* Root Rot	Oak Root Fungus	Viruses
Chemical Tools									
Prohexadione Calcium	Apogee®	G	P	P	P	P	P	P	P
Triadimefon	Bayleton®	P	P	P	P	P	P	P	P
Benomyl	Benlate®	P	P	G	P	P	P	P	P
Captan		P	P	F	P	P	P	P	P
Copper	various	E	P	F	P	P	P	P	P
Cyprodonil	Vangard®	P	P	G	P	P	P	P	P
Fenarimol	Rubigan®	P	P	E	P	P	P	P	P
Kresoxim	Sovran®	P	P	E	P	P	P	P	P
Calcium polysulfide	Lime-sulfur	P	P	F	P	P	P	P	P
Mancozeb	Dithane®	P	P	F	P	P	P	P	P
Oxytetracycline	Terramycin®	E	P	P	P	P	P	P	P
Myclobutanil	Rally®	P	P	E	P	P	P	P	P
Streptomycin Sulfate	Agri-mycin®	E-R	P	P	P	P	P	P	P
Sulfur	various	P	P	F	P	P	P	P	P
Thiram		P	P	F	P	P	P	P	P
Trifloxystrobin	Flint®	P	P	E	P	P	P	P	P
Triflumizole	Procure®	P	P	E	P	P	P	P	P
Thiophanate-methyl	Topsin-M®	P	P	G-R	P	P	P	P	P
Ziram		P	P	F	P	P	P	P	P
Non-Chemical Tools									
Models (e.g., disease forecasting)		G	NA	G	NA	NA	NA	NA	NA
Irrigation Management		F	P	F	F	G	F	F	P
Weed Control		F	G	F	F	P	P	P	P
Resistant Varieties		P	P	P	F	F	P	P	?
Cover Crops		P	F	P	P	P	P	P	F-P
Fertilizer Management		F	P	P	P	P	P	P	P
Vector Control		P	G	P	P	P	P	P	F
Biological Control		F	P	P	P	P	P	P	P
Sanitation (removal of diseased tissues, trees, and abandoned orchards)		G	G	P	P	P	F	F	F

Data based on collective field observations and experiments

7. Efficacy of Vertebrate Management Tools Used in California Pears

Efficacy Ratings: E = Excellent, G = Good, F = Fair, P = Poor/None

PRODUCT	TRADE NAME	Gophers	Ground Squirrels	Voles
Chemical				
Strychnine		G-E	G	E
Zinc Phosphide				E
Non-Chemical				
Trapping		F	F	G
Baits		G-E	G-E	G
Repellants		P	P	P
Frightening		P	P	P
Shooting (Lethal Control)		P	E	P
Explosive Devices		E	E	
Owl Boxes		F	F	F
Predators		F	F	F

Data based on collective field observations and experiments

8. Efficacy of PGRs Used in California Pears

Plant Growth Regulators

Efficacy Ratings: E = Excellent

PRODUCT	TRADE NAME	EFFICACY
MCP	Agrofresh®	E
Prohexadione Calcium	Apogee®	E
NAA	Liqui-Stik® Concentrate	E
Ethephon		E

Data based on collective field observations and experiments

9. Efficacy of Post-Harvest Pest Management Tools Used in California Pears

Post-Harvest Materials

Efficacy Ratings: E = Excellent, G = Good, F = Fair, P = Poor/None, R = Known Resistance

PRODUCT	TRADE NAME	Blue-Green Mold	Gray Mold	Rhizopus Rot	Mucor Decay
Sodium hypochlorite*	Bleach	F	F	F	F
Thiabendazole TBZ	Mertect®	R-F	R-F	P	P
Fludioxonil	Scholar®	E	E	E	E
Fenhexamid	Elevate®	P	E	P	P
Pyrimethanil	Penbotec®	E	E	P	P

Data based on collective field observations and experiments

* Active only as a sanitizer of microbial contaminants of wash water

Note: all fungicides listed except TBZ are currently planned for registration

10. Chemical Use on California Pears 1999-2001

% of Pear Crop Acreage Treated

PRODUCT	TRADE NAME	1999	2000	2001	3-YEAR AVERAGE
Insecticides					
Abamectin/Avermectin	Agri-Mek®	69	62	58	63
Azinphos-methyl	Guthion®	51	43	50	48
Bacillus thuringiensis	Bt	10	14	4	9
Carbaryl	Sevin®	1	2	0	1
Chlorpyrifos	Lorsban®	12	22	18	17
Diazinon		12	12	14	13
Dicofol	Kelthane®	1	0	1	1
Dimethoate		1	1	1	1
Endosulfan	Thiodan®	0	1	0	1
Esfenvalerate	Asana® XL	57	53	35	48
Imidacloprid	Admire®	6	7	4	6
Permethrin	Pounce®	0	0	13	4
Pyriproxyfen	Knack®	0	0	1	0
Sulfur		34	26	32	31
Herbicides					
Glyphosate	Roundup®	44	50	58	51
Methyl Bromide		0	0	0	0
Metam-Sodium	Vapam®	<1	<1	0	<1
Oxyfluorfen	Goal	15	16	17	16
Paraquat Dichloride	Gramoxone®	23	20	16	20
Phosmet	Imidan®	30	34	22	29
Sethoxydim	Poast®	2	0	0	1
Fungicides					
Sulfur		34	26	32	31
Nematicides					
Chloropicrin		0	0	0	0
Metam-Sodium	Vapam®	<1	<1	0	<1
PGRs					
Amino Ethoxy Vinyl Glycine	ReTain®	0	0	0	0

Data from CDPR

10. Chemical Use on California Pears 1999-2001 (Continued)

Pounds of Active Ingredient (AI) Used

PRODUCT	TRADE NAME	1999	2000	2001	3-YEAR AVERAGE
Insecticides					
Abamectin/Avermectin	Agri-Mek®	312	212	173	232
Azinphos-methyl	Guthion®	17,835	14,786	17,831	16,817
Bacillus thuringiensis	Bt	250	487	118	285
Carbaryl	Sevin®	426	407	122	319
Chlorpyrifos	Lorsban®	3,122	6,540	8,611	6,091
Diazinon		5,024	4,109	4,765	4,633
Dicofol	Kelthane®	404	105	206	238
Dimethoate		142	136	145	141
Endosulfan	Thiodan®	88	383	86	186
Esfenvalerate	Asana® XL	779	640	382	601
Imidacloprid	Admire®	154	177	58	130
Indoxacarb	Avaunt®	0	0	4	1
Methomyl	Lannate®	27	1	0	9
Permethrin	Pounce®	2	7	371	127
Potash Soap	M-Pede®	0	0	52	17
Pyriproxyfen	Knack®	0	7	10	6
Sulfur		262,435	91,131	80,778	144,782
Herbicides					
Glyphosate	Roundup®	12,935	11,624	11,375	11,978
Metam-Sodium	Vapam®	251	34	0	95
Methyl Bromide		0	0	0	0
Oxyfluorfen	Goal®	1,392	1,518	710	1,207
Paraquat Dichloride	Gramoxone®	7,200	5,264	3,844	5,436
Phosmet	Imidan®	24,600	27,030	24,634	25,421
Sethoxydim	Poast®	37	25	5	22
Fungicides					
Sulfur		128,463	262,435	80,778	157,226
Nematicides					
Chloropicrin		0	0	0	0
Metam-Sodium	Vapam®	251	34	0	95
PGRs					
Amino Ethoxy Vinyl Glycine	ReTain®	0	0	0	0
Prohexadione-calcium	Apogee® PGR	0	0	0	0

Data from CDPR

11. Additional Chemicals Used on California Pears 1999-2001

% of Pear Crop Acreage Treated

PRODUCT	TRADE NAME	1999	2000	2001	3-YEAR AVERAGE
Insecticides					
Clofentezine	Apollo®	23.2	16.4	4.2	14.6
Fenbutatin-oxide	Vendex®	5.5	2.9	1.1	3.2
Fenpropathrin	Danitol®		0.1	4.0	
Formetenate Hydrochloride	Carzol®	0.1	0.1	0.5	0.3
Hexythiazox	Savey®	3.4	2.9	5.1	3.8
Imidacloprid	Provado®	5.9	6.6	4.1	5.6
Indoxacarb	Avant®			0.2	
Kaolin	Surround®		0.0	0.0	
Methidathion	Supracide®	7.2	3.9	2.6	4.6
Petroleum Oil		89.5	84.6	0.0	58.0
Pyridaben	Pyrimite®	1.3	2.6	5.2	3.0
Tebufenozide	Confirm®		4.0	17.4	
Herbicides					
2,4-D		15.4	21.0	15.1	17.1
Diuron	Karmex®	9.0	12.7	5.3	9.0
Norflurazon	Solicam®	2.8	4.5	2.9	3.4
Oryzalin	Surflan®	3.4	1.7	0.4	1.9
Oxyfluorfen	Goal®	14.7	15.6	16.6	15.6
Simazine	Princep®	21.1	19.9	15.0	18.7
Fungicides					
Cyprodinil	Vangard®	31.1	12.8	8.8	17.5
Dodine	Syllit®		9.7	4.9	
Lime-sulfur[1]		27.5	21.1	9.7	19.4
Mancozeb	Dithane®	51.2	37.6	26.2	38.3
Thiabendazole (TBZ)	Mertect®	0.1		0.2	
Trifloxystrobin	Flint®		37.9	37.6	
Triflumizole	Procure®	5.7	3.7	1.9	3.8
Ziram		38.4	29.0	21.0	29.5
Bactericides					
Copper		43.5	40.8	33.8	39.4
Oxytetracycline	Mycoshield®	66.9	71.9	70.1	69.6
Streptomycin	Agri-Mycin®	26.7	2.9	23.9	17.9
Pseudomonas Fluorescens	Blight Ban® A506	57.1	60.6	55.5	57.7
PGRs					
NAA	Liqui-Stik® Concentrate	60.9	63.0	60.2	61.4

Data from CDPR

11. Additional Chemicals Used on California Pears 1999-2001 (Continued)

Pounds of Active Ingredient (AI) Used

PRODUCT	TRADE NAME	1999	2000	2001	3-YEAR AVERAGE
Insecticides					
Clofentezine	Apollo®	525	358	78	320
Fenbutatin-oxide	Vendex®	770	384	137	430
Fenpropathrin	Danitol®	0*	4	243	
Formetenate Hydrochloride	Carzol®	24	18	69	37
Hexythiazox	Savey®	114	54	77	245
Imidacloprid	Provado®	154	177	58	130
Indoxacarb	Avant®	0*	O*	4	
Kaolin	Surround®	0*	150	146	
Methidathion	Supracide®	2,803	1,283	674	1,587
Petroleum Oil		1,668,584	1,610,350	1,008,570	1,429,168
Pyridaben	Pyrimite®	101	169	255	175
Tebufenozide	Confirm®	79	409	1,016	501
Herbicides					
2,4-D		2,951	2,943	2,120	2,671
Diuron	Karmex®	2,147	2,197	1,363	1,902
Norflurazon	Solicam®	1,036	1,586	852	1,158
Oryzalin	Surflan®	1,792	407	193	797
Oxyfluorfen	Goal®	1,524	945	710	1,060
Simazine	Princep®	8,149	5,669	4,423	6,080
Fungicides					
Cyprodinil	Vangard®	1,526	379	315	740
Dodine	Syllit®	0*	4,131	2,150	
Lime-Sulfur		218,628	142,591	31,621	130,947
Mancozeb	Dithane®	58,714	39,183	19,493	39,130
Thiabendazole (TBZ)	Mertect®	79	409	396	295
Trifloxystrobin	Flint®	0*	968	747	
Triflumizole	Procure®	564	184	90	279
Ziram		80,081	51,239	28,694	53,338
Bactericides					
Copper		17,338	14,005	39,700	23,681
Oxytetracycline	Mycoshield®	11,223	14,130	13,772	13,042
Streptomycin	Agri-Mycin®	3,380	4,640	2,928	3,636
Pseudomonas Fluorescens	Blight Ban® A506	1,765	Not Available	963	
PGRs					
NAA	Liqui-Stik® Concentrate	1,019	1033	937	996

Data from CDPR

12. Chemical Use on California Pears 2002

% of Pear Acreage Treated and Total Pounds Active Ingredient (AI) Used

PRODUCT	% BASE ACRES TREATED	TOTAL POUNDS AI
INSECTICIDES		
Avermectin	61.91	10,928
Azinphos-methyl	29.05	5,128
Bacillus thuringiensis (products combined)	4.84	753
Carbaryl	1.77	313
Chlorpyrifos	29.07	5,132
Clofentezine	6.02	1,064
Diazinon	21.90	3,866
Dicofol	0.22	39
Dimethoate	0.45	79
Endosulfan	0.00	1
Esfenvalerate	23.64	4,172
Fenbutatin-oxide	0.26	46
Hexythiazox	0.03	5
Imidacloprid	1.93	341
Indoxacarb	0.06	11
Kaolin	0.20	35
Methidathion	1.55	273
Permethrin	14.89	2,628
Petroleum (products combined)	86.59	15,288
Potash Soap	0.01	1
Pyridaben	0.16	29
Pyriproxyfen	3.96	699
Sulfur	33.59	5,930
Tebufenozide	36.11	6,374
HERBICIDES		
2,4-D (products combined)	28.96	5,114
Diuron	12.17	2,148
Glyphosate (products combined)	59.47	10,497
Methyl Bromide	0.00	0
Oryzalin	0.27	47
Oxyfluorfen	22.18	3,916
Paraquat Dichloride	12.00	2,118
Phosmet	13.43	2,371
Simazine	13.07	2,308
FUNGICIDES		
Cyprodinil	16.75	2,957
Dodine	11.23	1,982
Lime-Sulfur	15.76	2,782
Mancozeb	21.53	3,801
Sulfur	33.59	5,930
Trifloxystrobin	43.19	7,625
Triflumizole	3.43	606
Ziram	20.93	3,694
Nematicides and Other		
Chloropicrin	0.00	0
Copper (products combined)	29.24	5,162
Oxytetracycline, Calcium Complex	73.66	13,002
Pseudomonas Fluorescens, Strain A506	31.80	5,613
Streptomycin Sulfate	59.00	10,415
PGRs		
Amino Ethoxy Vinyl Glycine Hydrochloride	0.06	10
NAA, Ammonium Salt	63.65	11,236

Data from CDPR

13. Members of the California Pear Working Group

UCCE = University of California Cooperative Extension
Note: where provided, the area of interest or production region is included in parentheses

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