

A Pest Management Strategic Plan for Pear Production in California

2011 Revision



California Pear Advisory Board (CPAB)

Pear Pest Management Research Fund (PPMRF)

California Specialty Crops Council (CSCC)

University of California Cooperative Extension (UCCE)

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EXECUTIVE SUMMARY

California continues to be a leader in U.S. pear production with a crop value of over \$60 million produced on 12,000 acres in 2009. The state is nationally and internationally recognized for production of superb quality fruit which meets consumer standards both domestic and export markets. California pears are sold fresh or they are used as the primary component of processed products, including canned pears, fruit cocktail, juice or baby food. Acreage of the California pear industry has been reduced by approximately 25% in the last 10 years; this downward trend is reflective of increased costs on the farm and at the processing facilities in the areas of water, energy, labor and regulatory requirements. Approximately one-third of the total U.S. pear crop is grown in California.

Pest management issues in pears are extremely complex and as a result, the commodity is considered one of the most challenging horticultural crops to grow. The number and severity of pests can quickly reduce product quality, crop yield and/or cause serious reductions in orchard health, and in some severe cases, total loss of an entire orchard.

California pear growers have worked diligently with University of California research and extension personnel to successfully collaborate on integrated pest management (IPM) approaches and to insure premium quality pears for the market. In addition to statewide efforts, the California pear industry, through targeted projects of the California Pear Advisory Board and the Pear Pest Management Research Fund, has also developed partnerships with grower groups in Washington and Oregon to realize an optimum return on investment of research dollars. Over several decades, these strong industry efforts have developed innovative technologies to preserve the viability of the industry; the success story of area-wide pheromone based approaches in pear production is considered to be model system for evolution and adoption of reduced risk approaches in other specialty crops.

In the last decade, California pear growers have focused on transitioning to new food safety standards and initiatives largely driven by regulations and consumer demands. The Food Quality Protection Act of 1996 significantly impacted the availability of certain organophosphate insecticides and as a result, intensive efforts were undertaken to transition to alternative pest management approaches. During the post-FQPA phase, the adoption of pheromone based IPM systems has been extremely successful, however, the need to evaluate and register new crop protection methodologies and chemicals for key pest of pears will remain an industry priority as water quality, air quality and other environmental issues come into greater regulatory focus. More recently, abandoned orchards have brought increased pest pressure at the interface with the pheromone-based IPM systems adopted over the last 10-15 years.

Environmental regulations are having significant effects on the pear industry's pest management strategies. Federal and state mandates for air and water quality, along with retailers' and consumer demands for sustainability contribute to drive pest management challenges for pear growers. To meet these challenges, California pear growers continue to assess new pest management techniques and adopt new tools. These 'reduced risk' strategies have low inherent toxicities and minimal impact on the environment.

As international trade is critically important to the California pear industry, the ability to move pears into current (e.g. Canada) and emerging export markets (e.g. Central and South America, Asia and Russia) also requires that research and regulatory process must be extremely well coordinated between the pear industry and the registrant and regulatory communities since maximum residue levels (MRLs) can drive pest management decisions as well as market access for pears. Without a long term plan to facilitate data development and dissemination amongst regulatory authorities, MRL violations may occur resulting in disruptions of trade; loss of consumer confidence related to food safety and quality in these key markets could have dire consequences for the pear industry.

More recently, the California pear industry has devoted a significant portion of its research budget in undertaking an internal process to develop a sustainability plan. The plan allows the industry to develop a matrix of economic, environmental and social aspects of crop production. Crop production and pest management practices are the foundation of identifying sustainable practices; information compiled in the revised Pest Management Strategic Plan will support this additional project. The combined efforts of balancing economic prosperity, environmental stewardship and social responsibility will lead to an improved quality of life and viability for the pear industry and future generations of California farmers.

USDA and EPA have encouraged all commodities to periodically update their Pest Management Strategic Plans (PMSPs) as each group advances towards 'reduced risk' pest management. The California pear industry completed their original PMSP in 2002 and in 2009 the industry reconvened to review the previous document in order to reflect changes in the pear growers' research, registration and education needs. It also focused on shifts in pest pressure, invasive pests, new chemical registrations, developments in application technology and non-chemical practices. New regulatory initiatives at the state and federal level were also included as important parts of the discussions, including the recent grower survey done as a part of the process to develop a sustainability plan for California pear growers.

The 2010 revision of the Pest Management Strategic Plan (PMSP) for California pear production summarizes the industry's crop production and pest management practices, and the pesticides and alternative pest control strategies used in recent production system seasons. It also suggests how new products can provide acceptable pest control and fit well into an IPM system for California pears.

The California pear industry intends that information generated through the PMSP process 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 and further clarification or questions about the industry may be answered by work group members whose area of expertise and contact information is provided in the Appendix at the end of this document.

STAKEHOLDER RECOMMENDATIONS 2010

The Pear Work Group recognizes the essential link between research and education needed for the advancement of their industry. As the amount, intensity, and complexity of research increases to meet the demand for new IPM systems and to identify agricultural practices which are considered sustainable, the need for effective user education also increases to ensure the successful immediate and long-term adoption of new strategies. There is serious concern that the funding to support these programs has declined significantly in recent years.

To facilitate the implementation and grower adoption of new reduced risk strategies in pears, it is recommended that an ongoing educational program be funded and developed as early as possible in the research program to serve as integral components to serve California pear growers.

As a result of the meeting held in March 2009 at Williams, California, the California Pear Work Group identified several industry priorities with subsequent input in 2010. The following recommendations are not listed in any priority order.

RESEARCH PRIORITIES

Finding effective solutions to insect control problems is the most immediate concern of California pear growers. Of paramount importance is to identify and register codling moth materials which can be incorporated into an IPM program which has an effective resistance management component. Risk mitigation measures to reduce exposure and contamination to all pesticides should be investigated and developed. Identifying and developing disease management tools for fire blight control and pear scab continues to be critical. Efficacy testing of reduced risk products and biological control agents, including those for use in organic pear production, are needed. All of these approaches should be integrated into a summary of "Sustainable Practices" for the California Pear industry. The following critical areas have been identified by the Pear Work Group as those which must be addressed to maintain the economic viability of the fresh and processed pear industry in California.

Insects

- 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 "attract and kill" techniques for true bug monitoring and control
- Evaluate and develop organically acceptable management techniques for codling moth
- Evaluate biological control techniques for all pear pests
- Evaluate reduced risk compounds for all pest categories in pears
- Evaluate new leaf roller management techniques
- Develop and evaluate new psylla management techniques
- Evaluate efficacy of materials for western flower thrips control
- Evaluate reduced risk insecticides for true bugs
- Study mechanism of codling moth detoxification as a part of resistance management
- Continue pheromone research, especially for attractants for monitoring codling moth
- Evaluate timing and efficacy of materials for eriophyid mite management

Diseases

- Evaluate new bactericides with differing modes of action for fire blight resistance control
- Evaluate and develop organically acceptable management techniques for fire blight
- Optimize compatible use of biologicals in fire blight programs
- Evaluate inoculum control for scab
- Develop model for pear scab
- Evaluate new copper formulations in relation to blight and russetting
- Study impacts of cultural practices to reduce inoculum of pear scab
- Generate data on use of copper as rotational product for fire blight control
- Evaluate oak root fungus and *Phytophthora* management techniques
- Evaluate new materials for oak root fungus
- Develop resistant rootstocks for *Armillaria*
- Develop scald management techniques
- Develop new techniques for application of postharvest fungicides

Weeds

- Evaluate organic herbicides
- Develop nonchemical weed controls (cultural, etc.)
- Develop improved herbicide application methods
- Evaluate glyphosphate, Simazine, 2,4-D alternatives
- Develop organic herbicides
- Identify willow brush management tools
- Evaluate non-chemical weed management approaches including carbon footprint-related issues

Other Areas

- Evaluate resistance status for insecticides, fungicides and herbicides used in pear pest management
- Evaluate improved cover crop management and techniques
- Evaluate delayed dormant blight treatments as to their ability to lower fire blight inoculum and provide measureable improvements for late season control
- Evaluate alternatives to be used with biologicals
- Evaluate new biocontrol techniques for all pest management systems
- 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
- Encourage registrants to develop residue data and export tolerances for new products prior to U.S. registration (Post Harvest)
- Develop orchard systems approach to pest and crop management alternatives, etc.

REGULATORY PRIORITIES

The pear industry needs new materials registered for codling moth control, particularly organophosphate replacement products and new chemistries for fire blight and pear scab control. 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. Policies limiting the use of antibiotics in plant based agriculture should be re-evaluated and the industry should coordinate data development and communications to insure these valuable products maintain registrations. Harmonization between Cal/EPA and US EPA should be encouraged to facilitate and hasten registrations, including coordination with appropriate regulatory officials in foreign countries to develop allowable maximum residue levels (MRLs).

Insects

- 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
- Allow the industry to maintain its post-harvest chlorpyrifos 24c for codling moth resistance management programs
- Enforce removal of abandoned orchards to aid in establishing area-wide pest management programs
- Maintain registrations of highly effective insecticides to use in conjunction with pheromone IPM systems in case of a severe pest outbreak, such as occurs at times near abandoned orchards
- Enforce abandoned orchard pest abatement
- Register products for psylla control (post harvest)
- Register ethephon or other materials to manage abandoned orchard related issues

Diseases

- Register alternative antibiotics for fire blight control
- Register fenhexamid and sodium ortho-phenylphenate (SOPP) for control of scald, *Botrytis*, and other post-harvest diseases
- Advance research and registration of difenoconazole as a premixture with fludioxonil through the IR-4 Program
- Maintain therapeutic use of antibiotics for plant agriculture
- Maintain availability of copper materials
- Expedite registration of new products

Weeds

- Maintain registration of Simazine
- Register glyphosate alternatives

Other

- Obtain approval by the California League of Food Processors/Del Monte Foods, Inc. for the use of PGRs Apogee® and Retain®
- Make sure resistance management information is included on new labels
- Develop and maintain an approved list of materials that can be used on pears; request that FAS maintain a current log of international MRLs
- Encourage registrants to establish export tolerances for new products prior to registration
- Harmonize registrations between the US EPA importing countries and USDA-APHIS
- 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 and avoid non-tariff trade barriers
- Secure registration for timing of lime sulfur and oil use as a post harvest treatment
- Increase awareness of compliance with secondary standards (e.g., Global Gap)
- Recognize genetic studies that show that some pests and diseases with the same nomenclature abroad as in the US may vary genetically
- Consider the effect of invasive species to IPM and reduced pesticide programs in risk assessments during trade negotiations

EDUCATIONAL PRIORITIES

Concerns remain about whether state and county budgets will be sufficient to support 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. Regulators and consumer groups must be educated about how Integrated Pest Management (IPM) in pears optimizes food production while minimizing risk to workers and the environment. 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. Fire blight and scab 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.

Insects

- Demonstrate new materials and techniques for codling moth control
- Educate growers, PCAs, and the community on the importance of removing abandoned orchards in establishing effective area-wide pest management programs
- Educate the public and buyers about the potential environmental benefits and lack of gene flow to market scions if these scions are produced on genetically modified rootstocks
- Educate growers and PCAs on the life cycles of the various species of true bugs and how this relates to effective management
- Increase public awareness of using integrated pest management tactics (e.g., pheromones) in California pear production
- Educate regulators and trade negotiators about the potential effect of invasive species and introduced genetic variants on IPM and reduced pesticide control programs

Diseases

- Inform the industry and the community of the benefits of removing abandoned orchards
- Inform stakeholders on the current use of fire blight models which support antibiotic use
- Train growers and PCAs on resistance management
- Educate regulators and trade negotiators about the potential effect of invasive species and introduced genetic variants on IPM and reduced pesticide control programs

Weeds

- Demonstrate alternatives to herbicide use
- Develop no till management practices
- Educate growers and PCAs on drift control issues with Roundup
- Educate growers and PCAs on size of weeds related to efficacy
- Educate growers and PCAs on importance of proper timing of herbicide applications
- Increase awareness of the need for university and USDA programs to support weed science programs (research and demonstration projects)

Other

- Insure that adequate levels of UCCE field staff are available to assist with research and extension needs
- Educate growers and PCAs on environmental and water impacts of organophosphate insecticides, antibiotics, and other materials used in pest control
- 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
- Develop a sustainability plan for California pear production
- Develop a "best management practices" document for pears
- Create a clearinghouse/summary of regulatory issues for pear growers
- Educate regulators on the challenges for growers to fully assimilate a myriad of regulations
- Educate legislators and congressmen about the intricacies of our markets, foreign and domestic, to minimize detrimental actions by government, i.e. Mexican regulatory tariffs
- Provide training to growers and PCAs on management practices to minimize off-site pesticide movement
- Educate urban users about pesticide use, particularly off-site movement
- Educate the public on pheromone issues
- Educate growers and PCAs on resistance management including importance of weed escapes
- Educate EPA on need for registrants to develop usable label language
- Increase awareness of compliance with secondary standards (e.g. Global Gap)
- Educate growers and PCAs about which materials are approved by export countries
- Educate and encourage registrants to develop MRLs in compliance with importing countries prior to full US registration (MRLs)
- Quantify the impact of increased pesticide use resulting from the potential spread of the brown marmorated stink bug into California for use as an example of invasive species introduction for regulators and trade negotiators.
- Evaluate the success/failure of codling moth predators introduced from Kazakhstan in becoming permanently established

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. In particular the Western Region IPM Center has been a valuable resource in the process of developing this document and providing assistance to California pear growers through this effort. We look forward to the valuable assistance provided by these agencies and institutions as we develop responses to the many issues facing our growers and the allied industry.

Funding for the original PMSP for California Pear Production was made available by the EPA Region 9 Agricultural Initiative and the USDA Cooperative States Research, Education, and Extension Service (CSREES) Pest Management Alternatives Program (PMAP). Additional support was received from the California Pear Advisory Board, the Western Region IPM Center at UC Davis and 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.

This project was funded by the Pear Pest Management Research Fund (PPMRF) with additional resources provided by the Western Region IPM Center at UC Davis.

We appreciate the support of these organizations and all individuals that have participated in this process to update the Pest Management Strategic Plan.

The California Pear Advisory Board (CPAB)
Pear Pest Management Research Fund (PPMRF)
California Specialty Crops Council (CSCC)
University of California Cooperative Extension (UCCE)

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A STRATEGIC APPROACH TO PEST MANAGEMENT IN PEARS

As a follow up to the first PMSP meeting in 2002, the California pear work group reconvened in March 2009 in Williams, California. The purpose of this meeting was to assess progress since the first PMSP document was created to reflect any changes due to new pest issues, regulatory actions, or resource issues of importance to the California pear industry. The session was attended by approximately 25 growers, PCAs, processors, extension personnel and researchers. The one-day session was facilitated by Rick Melnicoe and Diane Clarke of the Western IPM Center (UC Davis) and Lori Berger of the California Specialty Crops Council. Additional technical representatives and work group members were consulted after the meeting to obtain detailed information as follow-up to the discussions at Williams. The pear industry delayed completion of the document until pesticide use information was published by the CA Dept. Pesticide Regulation in December 2009. The draft document was circulated for review and finalized in late 2010.

OUTCOMES AND STATUS OF PRIORITY ITEMS IN ORIGINAL PMSP (2002)

The original pear PMSP identified critical issues for the industry to address including research, regulatory, or educational priorities. Key personnel and/or organizations were identified which could best address each of the objectives or needs; these included commodity groups, university, extension, and federal agencies (USDA-ARS, etc.). Progress was reevaluated as a part of the 2009/2010 revision process. These major outcomes and/or status of major priority areas identified in the original PMSP are summarized below. Note that "PPMRF" stands for Pear Pest Management Research Fund and "CPAB" stands for California Pear Advisory Board.

RESEARCH PRIORITIES

Priority	Entity	Outcome/ Status/ Comments
1. Develop organophosphate alternatives for codling moth	PPMRF/ CPAB/EPA	New, efficacious products (e.g., Dow – Delegate spinetoran; Dupont – Altacor, Rynaxypyr or Chlorantraniliprole) have been identified by the EPA/AZM transition committee as alternatives for managing codling moth. Because these products have different modes of action, they will work very well in a resistance management program.
2. Develop monitoring and ET techniques	PPMRF/ CPAB/EPA	Work continues through UC/UCCE programs.
3. Evaluate/develop reduced risk techniques for psylla, true bugs, and leaf rollers	PPMRF	Research continues into stinkbug aggregation for attract and kill devices. Jocelyn Millar of UC Riverside is also being funded for research in aggregation and pheromone with box elder bug colony. Research finds Delegate is effective for pear psylla management but may result in additional rust mite pressure and San Jose scale pressure.
4. Develop attract and kill	various	Determined attract and kill methods for CM need further refinement.
5. Evaluate and develop organically acceptable management techniques for codling moth	CPAB/ PPMRF	Efficacy studies for CM Granulosis virus, an organically acceptable product for CM management, supported successful registration. Two biological insecticides based on the virus are Cyd-X, a trademark product and Virosoft CP4. Virosoft CP4 was not registered in CA due to efficacy issues; Cyd-X by Certis USA is registered in CA.
6. Dev. New techniques and reduced risk products for control of fire blight and scab	CPAB/ PPMRF	Research by Jim Adaskaveg of UC Riverside supports registration of Kasugamycin for control of fireblight and scab. Kasugamycin belongs to the same class as Oxytetracycline and Streptomycin, but attacks different site in bacteria, but resistance can develop relatively quickly if over used. It is not used in animal or human medicine. Resistance to Strep has been documented and Jim Adaskaveg has found isolated incidences of Oxytet resistance. Doug Gubler has isolated Flint, Trifloxystrobin pear scab resistance in late variety districts in Mendocino and Lake counties. Tracking resistance to other pear scab fungicides is ongoing.
7. Eval. Resistance status for insecticides and fungicides used in pear IPM	CPAB/ PPMRF/ UC/ WSU	Identifying CM resistance mechanism is an ongoing global project due to the pest's potential for developing resistance to insecticides applied consecutively. Steve Welter, UC Berkeley and Washington State University researchers are keeping pear industry informed of developments in Western Orchard Pest and Disease Conference (WOPDMC) meetings and International IPM Conference.
8. Evaluate biocontrol techniques for all pest categories in pears	Various	Bio-control efforts for all pest categories in pears have stalled. Imported predator insects from Kazakhstan for CM control had limited success because of predator's susceptibility to reduced risk insecticides including

		Spinosad and insect growth regulators. Importation of predators has also become more heavily regulated for national security reasons as well as their potential to escape and become invasive species.
Research Priority <i>(continued)</i>	Entity	Outcome/ Status/ Comments
9. Evaluate reduced risk compounds for all pest categories in pears	PPMRF/CPAB	UC Berkeley Bob Van Steenwyk's work in evaluation of reduced risk insecticides on pear pests is ongoing and supported by growers and registrants. Fungicide evaluations also continue under Jim Adaskaveg for fireblight and Doug Gubler in pear scab.
10. Study the environmental impact of OPs and antibiotics	various	Study of environmental impact of organophosphates and antibiotics remains to be done. Exception is providing EPA product use information when they perform Registration Eligibility Documents. Participation in water coalitions, in order to receive waivers for ag water discharges, engages growers in efforts to protect water quality.

REGULATORY PRIORITIES

Priority	Entity	Outcome/ Status/ Comments
1. Register reduced risk codling moth materials	EPA/CDPR	Reduced risk products Delegate® and Altacore® are registered. Evaluation of a new CM control, which is still a numbered compound, is ongoing by Van Steenwyk.
2. Register reduced risk materials for psylla, true bugs, and leaf rollers	EPA/CDPR	Delegate, a registered reduced risk product may replace an application of abamectin if timed properly. True bugs, in adult stages are more difficult to control and dimethoate or pyrethroids may be required. Materials in use will control leafrollers.
3. Allow industry to maintain PH chlorpyrifos for codling moth resistance management programs	CPAB/PPMRF/registrant / EPA/CDPR	Continued registration of chlorpyrifos for post harvest use in CM resistance management programs must be defended when Registration Eligibility Document (RED) is due.
4. Enforce abandoned orchard removal	CPAB	CPAB-financed Pest Eradication Program of 2002 for removal of abandoned orchards was deemed successful. Efforts to continue similar program in Lake County is ongoing. The county's pear and grape growers have re-written the county abatement ordinance to allow county agriculture commissioner to bill owners for removal of abandoned trees or backyard hosts for CM. UC farm advisor Rachel Elkins and Lake County Pear Association and through funding from the Western IPM Center are developing an incentive program to encourage removal of potential CM hosts.
5. Register fludioxonil, fenhexamid	CPAB/PPMRF Postharvest	Post harvest treatment products fludioxonil and fenhexamid not registered. A Section 3 for fludioxonil was obtained as MRL in Canada was an issue. Request for use of fenhexamid preharvest stalled registration movement with Arysta.
6. Register pyrimethanil, and sodium ortho-phenylphenate (SOPP) for control of scald, botrytis, and other diseases	CPAB/PPMRF	Sodium orthophenylphenate (SOPP) for control of scald, botrytis and other diseases has been registered for use in Northwest. A Section 3 has been obtained for pyrimethanil.
7. Register alternative antibiotics for fireblight control	See fungicides and bactericides	Work continues through UC/UCCE programs.

EDUCATIONAL PRIORITIES

Priority	Entity	Outcome/ Status/ Comments
1. Demonstrate new materials and techniques for CM control	Bob Van Steenwyk, UCCE Steve Welter UCB	Demonstrate efficiency of pheromone meso-emitters for CM control. Research projects show they have less per-acre cost than pheromone ties and application costs are lower.
2. Inform industry of the benefits of removing abandoned orchards	CPAB/PPMRF	Public should be made aware of the reasons abandoned orchards should be removed. Educations should be ongoing as orchard abandonment continues.
3. Educate growers, PCAs, and the community on the importance of removing abandoned orchards in establishing area wide IPM	CPAB/PPMRF	Growers, PCAs and communities should be informed about the benefits of removing abandoned orchards when establishing area wide IPM programs.
4. Educate growers, PCAs, and the community on the environmental impacts of OPs, antibiotics, and other materials in pest control	CPAB/PPMRF	Work continues through UC/UCCE programs.
5. Train growers and PCAs on resistance management	CPAB/PPMRF	Yes. Research projects we have and are funding focus on resistance management on insecticides, fungicides and bactericides Resistance management research projects should include training component for growers and PCAs.
6. Document use of fireblight models to support antibiotic use	Jim Adaskaveg, UCR and Steve Lindow, UCB	All of our PCA use models to document use of antibiotic for fire blight control. I have copies of Broc's fire blight e-mails to his growers Fire blight model use should be documented to support antibiotic use.
7. Insure that UCCE field staffing meets research and education needs of pear industry	CPAB/PPMRF	Research and education needs of pear industry must be communicated to UCCE using contacts with California Specialty Crops Council, California Commodity Coalition, CA Agricultural Issues Forum and other influential groups.
8. Improve quality and quantity of field level monitoring with trained scouts	UC and CAPCA	Work continues through UC/UCCE programs
9. Continue/build availability of training materials in Spanish	CPAB	Would take place mostly through UC or the individual growers providing applicator and safety training on their ranch. The UC Train the Trainer programs are no longer funded by California and US EPA. Applicator and safety training materials for Spanish speaking workers now comes from UC or individual growers due to the loss of the Train the Trainer programs.
10. Educate the public on benefits of consuming pears	CPAB	Through our promotion program, 5-a Day and Buy California. Promotion programs 5-A Day and Buy California educate consumers about the benefits of eating pears.
11. Increase public awareness of how IPM is used in CA pear production	CPAB/PPMRF	Mainly in industry publications like Good Fruit Grower. Utilize the grower sustainable practices survey and information posted at www.calpear.com . Inform public, through industry publications, of how the pear industry uses IPM programs.

CALIFORNIA PEAR PRODUCTION OVERVIEW

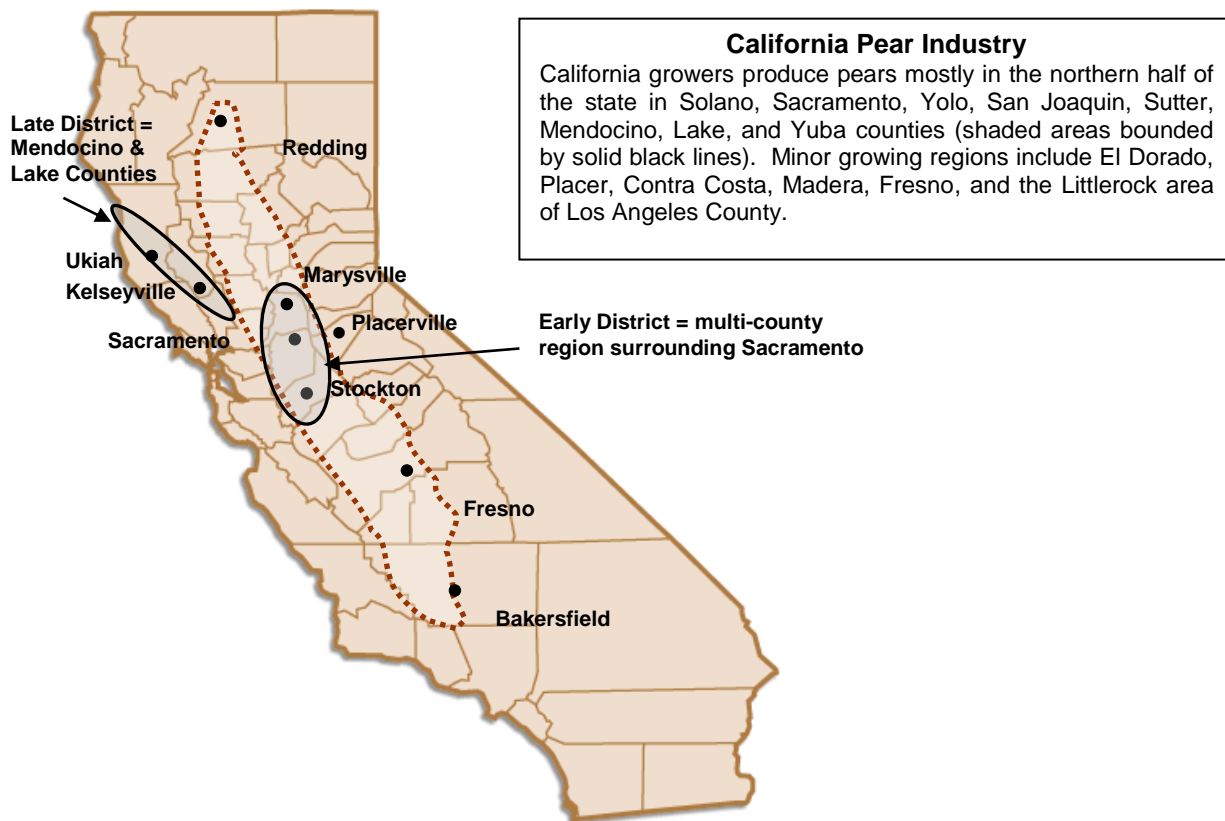
The majority of pears produced in California are found in the northern third of the state in the counties of Sacramento, Yolo, Solano, San Joaquin, Mendocino, Lake, El Dorado, Yuba, and Sutter (Figure 1). Pears are most productive on loam-textured, deep, uniform soil; however, many are planted on less 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 2009 was approximately 12,000 acres (of the U.S. total of about 65,000 acres) with a harvest value over \$60,000,000.
- Bartlett is the major summer variety (>98% acreage) in California, with minor varieties including Red Clapp Favorite, Rosie Red, Butirra Precocia Morettini, 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 54% of California Bartlett pears go to the processing market for canned fruit, juice concentrate, 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 40 % of the total pear crop is shipped to the fresh market.
- Fresh pear exports can be up to 30% of the total fresh pack. Canada and Mexico are the main export destinations; other markets include Costa Rica, Honduras, Guatemala, Brazil, Eastern Russia and others.
- Codling moth is the primary pest of pears in California. Other very important pests include pear psylla, surface feeding insects, eriophyid mites, fire blight, Oriental fruit moth, and scab disease. *Botrytis* and *Penicillium* are the most important post-harvest diseases of pears.
- Organic farms account for ~ 2% 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, often because of other pests such as katydids, true bugs and other Lepidoptera.
- 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) have allowed the reduction in the use of miticides. Pheromone based IPM has also required additional pesticide treatment for secondary pests that otherwise would be eliminated with broad spectrum pesticides.
- 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.
- A sustainability plan to identify best management practices for IPM, water use, energy conservation and resistance management practices is currently being funded.

California pear production areas are shown in Figure 1. Appendix 2 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 10,000 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 120,000 tons, about two thirds of California’s annual pear crop. The late district spans Mendocino, Lake, and El Dorado counties and produces approximately 55,000 tons of pears annually.

Early District:	~ 69% of total pear production
Late District:	~ 31 of total pear production

Characteristics of Major Pear Production Areas in California

CHARACTERISTIC	EARLY DISTRICT Sacramento Region	LATE DISTRICT Mendocino County	LATE DISTRICT Lake County
% of Total Acreage	69	12	19
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 Forelle
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 (relative)	Hottest	Coolest	Hot Days, Cool Nights

Note: Summary table based on "average" years

Pest 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 Red Clapp's Favorite, Rosie Red, Butirra Precocia 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), Forelle, and Taylor's Gold.

The above varieties are grafted onto rootstocks. Rootstock selection is based on cultivar compatibility, soil characteristics and drainage, pests (primarily fire blight, 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
Red Clapp's Favorite	< 1%	Early July-August
Butirra Precocia Morettini	< 1%	Late June
Max Red and Rosi Red	< 1%	July - August
Bosc	< 3%	Late July - September
Asian Pear varieties	< 1%	August - September

Pest Overview

Collaborative research by University of California, PCAs and growers over the past 37 years has been successful in transitioning the pear industry to a low input, biologically intensive system. Multiple sprays at a high cost to the grower are no longer the norm for the industry.

Efforts to control codling moth, the most economically damaging pear pest, evolved from heavy use of toxic materials to cost effective pest suppression. Judicious use of pesticides coupled with mating disruption tools are the foundation of an integrated pest management program adopted by nearly all California pear growers. Key to the pest management program has been advancing monitoring techniques and resistance management, which ensure the efficacy and availability of pest control materials. Biologically intensive integrated pest management has resulted in substantially fewer pesticide applications and risks associated with those materials.

As outlined in Patrick Weddle's History of IPM in California Pears (2009), challenges to the IPM program remain. Growers have adopted many of the new pest management techniques and materials but protecting and enhancing the availability of pesticides is vital to the industry. Invasive species, reduced funding for research, environmental regulations and securing knowledgeable pest control advisors in the future will present challenges.

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 California¹ 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 if under conventional pesticide management. 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 fenprothrin²), 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, campylocoma (*Campylomma verbasci*), several species of stink bug (*Pentatomidae*), boxelder bug, katydids, cucumber beetles 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 pear psylla, leafhoppers, leafminers, spider mites, pear aphid, spirea aphid, rosy pear aphid, woolly pear aphid, ten-lined June beetle, dock aphid, green peach aphid, pear slug, and pear sawfly

The occurrence of some pests in pear orchards has historically been infrequent or rare. Examples include grasshoppers, katydids, six-spotted cucumber beetle, pear sawfly, shothole borers, red-humped caterpillar, lesser appleworm, Oriental fruit moth (OFM), and pear slugs.. OP or carbamate insecticides used to control other pests have most likely kept these infrequent pests in a non-critical status until the recent adoption of mating disruption to control codling moth. Three pests of great importance to eastern U.S. pear growers, the plum curculio, brown marmorated stink bug 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, such as the brown marmorated stink bug, have the potential to become important pests of pear and other fruit crops in the west as they have recently become in the east after introduction from abroad.

Organophosphate (OP) insecticides have broad spectrum activity and formerly were the most widely used class of insecticides in pear orchards in California before the adoption of mating disruption for codling moth control. With the introduction of new reduced risk codling moth materials, however, OPs have diminished in their importance as compared to the previous decade. OPs are still critically important insecticides when insect populations reach high levels such as near abandoned orchards and where reduced risk insecticides will not control high populations. 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. Use of the new reduced risk Spinetoram (Delegate) for example has resulted in increased pressure from rust mites.

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: Tortricidae; John E. Dunley and Steven C. Welter

Diseases - The most important diseases of pears in California are fire blight, scab, pear decline, and blossom blast. In the spring, fire blight 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 fire blight infection and spread are rainy or humid weather following periods of temperatures ranging from 75°F to 85°F. Fire blight 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, fire blight may require 10 or more applications of pesticides, which results in three- to four-day spray cycles. Abandoned orchards can be an early source of inoculum in some seasons.

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 and resulting in unmarketable fruit. 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, lime sulfur, Mancozeb, Rubigan[®], Procure[®], Vanguard[®], Sovran[®], Scala[®], Topsin-M[®], wettable sulfur, Flint[®], or Syllit[®] may be made from March through May depending on weather conditions. No biological methods provide commercially acceptable control of pear scab. Abandoned orchards in an area assure that inoculum levels persist even through non scab favorable seasons.

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[®] and/or Goal[®]) 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[®] or Poast.

Nematodes - Nematodes are not generally considered pests of pears, since few, if any, new orchards are being planted. Species identified as most damaging are root lesion nematode, root knot nematode and dagger nematode. They feed on roots and affect the plant's nutrient and water uptake. Use of resistant or tolerant root stocks in combination with fumigation treatment for new trees usually provides sufficient protection against nematodes. Best management practices call for maintaining good tree vigor with proper irrigation and fertilization.

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 help to manage these pests; chemical options are strychnine and zinc phosphide baits. Vegetation management helps control infestations of several vertebrate pests; no biological controls are available.

SEASONAL 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 3 and 4.

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

DORMANCY and DELAYED DORMANCY (December through February)

Pears, being deciduous, shed their leaves and enter dormancy in late fall and early winter. That stage lasts until warmer temperatures bring on bud swelling in delayed dormancy. Dormancy and delayed dormancy is the period when chill hours accumulate. Chill hours are counted as the number of hours at or below 45 degrees F from approximately Nov. 1 through March 1.

Since research has shown that temperatures above 45 degrees can cancel out some of the hours, another method of totaling chill hours has been studied. The Dynamic Model as a means of calculating chill accumulation has been tested by UC researchers. The model calculates chilling accumulation as “chill portions” using a range of temperatures from 35-55 degrees F. It also accounts for chill cancellation caused by warmer temperatures. Chill hours vary much more than chill portions from place to place and year to year.

In some years, California pear production areas receive less than optimum chill accumulation during dormancy and delayed dormancy. For example, Bartlett and Bosc pears require between 1,000 and 1,200 hours of temperatures below 45 degrees F. Lack of adequate chill hours can result in poor bud break, spread out bloom, lack of bloom overlap for pollenizers, poor leaf out and weakened trees as well as floral bud death. Inadequate chilling can also affect timing of crop maturation and whether the crop matures over a short period or is spread out requiring multiple harvests.

Research into chill requirements has included a focus on rest-breaking agents to compensate for inadequate chill accumulations. Research also showed that timing of dormant oil spray by chill accumulation affected fruit size and yield with improvement after treatment at approximately 40 chill portions.

During Dormancy and delayed dormancy 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.

Worker Activities

<ul style="list-style-type: none">• Mowing• Scouting for psylla, mites, insect eggs, SJS, and rust mites• Pruning• Sanitation control of prunings on orchard floor	<ul style="list-style-type: none">• Herbicide application• Dormant oil applications• Irrigation (occasionally in the Early District when drought conditions exist)• Replant• Monitor winter weeds• Repair sprinklers and equipment
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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 inject toxin into the pear trees, produce honeydew, and vector pear decline disease, which is caused by a mycoplasma. 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 russetting on fruit and sooty mold on leaves, reducing photosynthesis. Pear decline can be a major problem if pear psylla populations are allowed to proliferate especially in abandoned pear orchards. When summer heat and lack of irrigation causes loss of vigor in abandoned orchards, pear psylla migrate to the more vigorous trees in farmed orchards.

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 preclude applications of dormant and delayed dormant treatments or otherwise favor pear psylla development, growers probably spend more money for control of it than for any other pear pest. Pear orchards receive one 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. Water quality is also an issue with pyrethroid use. 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, especially as practiced in combination with the enhancement of biological controls made possible through the adoption of mating disruption control of codling moth.

Horticultural mineral oil sprays are applied either post-harvest or, primarily, at the dormant/delayed dormant period to control over-wintering pear psylla adults before initial egg laying. These sprays reduce adults by about 80%. In addition, dormant oil spray delays egg production for at least four weeks, which makes post-bloom pear psylla control easier. Horticultural mineral oil has been used 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 at this time of the season.

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 such as is made possible through the adoption of mating disruption for the control of codling moth.

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 especially where mating disruption control for codling moth is not adopted.

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.

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, especially where the use of mating disruption control of codling moth has not been adopted.

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. Prior to the adoption of mating disruption for codling moth control, where climatic conditions favor spider mites, growers applied 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 to 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, bifentazate, hexythiazox, fenbutatin oxide, and pyridaben. However, some registered miticides have very limited use in some growing districts, due to resistance, disruption of predators, 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.

Blister mites have become an increasing problem, especially within a mile of abandoned orchards. Materials such as Thiodan included with dormant oil treatments in the past provided some suppression. However, this material and some others applied during the dormant season are detrimental to fish and the environment and are no longer able to be used. The inclusion of sulfur with dormant oil for blister mite suppression is currently being evaluated. The role of the predator mite, *Zetzalia mali* needs clarification and study of pesticide impacts.

Naturally occurring predators can also play an important role in regulating mite populations on pear. Important mite predators include brown lacewings, phytoseid mites, 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 in conventional pesticide managed orchards. The insecticides applied for pear psylla control often disrupt mite control. For instance, foliar sprays of abamectin or pyridaben may 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 the change to more selective pest control programs on pears facilitated by the use of mating disruption for the control of codling moth and avoidance of broad-spectrum pesticides, growers have been able to rely more on biological mite control. Unfortunately the transition to some of the more selective new codling moth materials have increased pressure from eriophyid mites while decreasing the need for spider mite treatments.

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. Due to the high reproductive capabilities of SJS, abandoned orchards pose a serious risk to neighboring commercial production areas. Unsprayed orchards can have 92 percent infested fruit rate over a three year period.

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 but is very disruptive to mite and pear psylla predators. 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. Water quality issues have led to a decrease in use with applications limited to one year out of three. Although Diazinon is not used often, it remains a critical tool in effective IPM. The use of the new selective material Delegate (spinetoram) is thought however to be somewhat disruptive to scale biological controls.

Work Group Recommendations for Insect Management during Dormancy

RESEARCH	<ul style="list-style-type: none"> • Evaluate new oils for psylla control, especially refined oils • Evaluate Box elder bug issues including status and management • Study effects of control materials in Riparian zones • Evaluate Landgard product for efficacy, commercial viability and availability • Evaluate sulfur + dormant oil treatments for blister mite control • The role of <i>Zetzalia mali</i> in eriophyid mite suppression in late season needs clarification
REGULATORY	<ul style="list-style-type: none"> • Address pyrethroid and water quality issues through mitigation • Address non-target issues through mitigation
EDUCATION	<ul style="list-style-type: none"> • Address pyrethroid issues, water quality issues and non-target issues. • Educate growers about Riparian zone issues • Communicate to regulators that OP use has dropped dramatically in pears • Report water quality improvements to all stakeholders

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.

Common Weeds in Pear Orchards

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

HERBICIDE RESISTANT WEEDS

Weed biotypes with resistance to several herbicide classes have been reported in California and around the world. Resistant weed populations often are first noticed after a single herbicide or herbicide family is used repeatedly over a period of years and the weed population becomes dominated by the resistant biotype. Effective resistance management strategies include using diverse weed control techniques such as rotating herbicide modes of action, using mixtures of herbicides with different modes of action, using full label rates of herbicides and using non-chemical weed management strategies such as tillage, mowing and hand weeding.

During November to February, weeds are controlled in the tree row with a dormant strip spray of residual and contact herbicides (Surflan[®], Karmex[®], simazine, Chateau, Solicam, Devrinol[®], 2,4-D, Roundup[®] and Gramoxone[®]). The middles are mowed to control weeds, frost, rodents, and to chop up prunings. Products used for orchard floor chemical mowing include a combination of one of the contact herbicides and a residual herbicide..

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 triazine products may limit its use and availability.

Solicam[®] is very expensive, but 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. Matrix and Poast are alternatives to Roundup.

Work Group Recommendations for Weed Management During Dormancy

Research	<ul style="list-style-type: none"> • Evaluate Glyphosate, Simazine, and 2,4-D alternatives. • Evaluate chemical mowing efficacy • Re-formulate all pesticides for low VOCs • Evaluate organic herbicides • Study willow weed products • Find non-chemical mechanical approaches for carbon footprint issues, etc. • Study use of cover crops to control weeds
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Regulatory	<ul style="list-style-type: none"> • Maintain registration of Simazine
Education	<ul style="list-style-type: none"> • Demonstrate alternatives to herbicide use • Discuss cover crop issues • Demonstrate no-till methods

DISEASES

Fire blight 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.

New materials and strategies to control fire blight are being developed. Population predictive models based on heat summation and the coincidence of warm temperatures and humidity or rainfall are widely and successfully used later during the bloom season. Surveys evaluating antibiotic efficacy found widespread resistance to streptomycin, one of two antibiotics used widely for many years to control fire blight. However, both streptomycin and terramycin resistant sub-populations of the fire blight pathogen were sensitive to kasugamycin, a new antibiotic submitted for registration in 2010. Kasugamycin, (e.g. Kasumin) has a different mode of action for protein synthesis of bacteria, but has been shown to quickly result in resistance when used frequently. No resistance to copper has been found in fire blight pathogen populations, although resistance has been found to copper in walnut blight.

Pear scab (*Venturia pirina*) 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 and models based on spore trapping in pears and temperature and wetness duration primarily in apples have been useful in the pre bloom, bloom and post bloom seasons. 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. After a bad scab year, fall foliar applications of urea have been useful in reducing primary spores. Lime sulfur applied with the dormant oils for psylla control provides some control of scab.

Widespread resistance, for example to Flint, has developed in pathogen populations of *Venturia pirina*. Resistance management strategies include multi site mode of action fungicides, rotations and mixtures of multi-site and single-site mode of action materials to start the season.

Copper and lime sulfur and/or wettable sulfur are options for organic growers; however, these products provide only fair control. Efficacy of lime sulfur combined with wettable sulfur is fair to good when applied prior to bloom. Fruit finish can be injured depending on temperature and application timing.

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

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.

Trapping and baiting are the primary techniques for vertebrate control. Fumigating, lethal control and habitat management are other options. Zinc phosphide helps to reduce vole (meadow mice) problems. Techniques used with variable success for vertebrate control are mainly trapping and baiting, then fumigating, lethal control, and habitat management. Zinc phosphide helps to reduce vole (meadow mice) problems. Strychnine effectively controls gophers when bait shanking machines are used regularly.

Management strategies for control of vertebrate pests include removal of trash from orchard floors, animal proof trenches, and mulching. Availability of suitable food and shelter are the key factors in vertebrate control, therefore sanitation is extremely important. Cover crops can provide a food source. Cover crops with fleshy roots, such as perennial clover, should be avoided for this reason.

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

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| <ul style="list-style-type: none">• Mowing• Scouting for codling moth, psylla, mite and insect eggs, SJS, and rust mites• Herbicide applications | <ul style="list-style-type: none">• Delayed dormancy oil and pyrethroid applications• Irrigation• Monitoring winter weeds |
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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. 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. Currently control has been less frequently based on chlorpyrifos use and more based on selective materials applied later in codling moth mating disruption orchards.

Organophosphates, as well as pyrethroids and herbicides found in surface water continue to be a concern of regulatory agencies and the public. Timing of insecticide and herbicide applications is critical in maintaining water quality

Watershed coalitions are currently an economic opportunity to avoid securing individual permits for water discharges. However, samples of surface water that exceed state and federal standards for clean water trigger a requirement for a discharge management plan. Those plans may impact pesticide and herbicide applications.

Mite management in pear orchards during delayed dormancy relies mostly on application of horticultural oils. Natural control by predators also is another management component if populations build slowly allowing trees to become conditioned to mite feeding.

Lygus and stink bugs are considered secondary pests and are generally suppressed by chemical mowing. Box elder bugs have become an increasing problem in the Late District 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.

Work Group Recommendations for Insect and Disease Management During Delayed Dormancy

RESEARCH	<ul style="list-style-type: none"> • Conduct research on the biology and management of Lygus ,box elder bugs and stink bugs • Conduct research on copper efficacy and phytotoxicity for fire blight control/management
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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

<ul style="list-style-type: none"> • Mowing • Frost protection (irrigation, wind machines, orchard heaters, Blightban[®] and/or Mycoshield[®]) • Fertilization • Irrigation • Pesticide applications 	<ul style="list-style-type: none"> • Scouting • Budding/grafting • Cutting holdover blight cankers • Pruning • Planting (interplants, replants etc.) • Pheromone applications/Setting insect traps and ties, puffers
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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 oriental fruit moths; degree day accumulations should be initiated at this time.

Please refer to earlier comments about psylla control. At this time of the season, pyrethroids and Danitol[®] provide good to excellent control of psylla and are especially effective on nymphs. Western flower thrips is also controlled by these treatments at this time. Low rate pyrethroid use against this pest only can minimize predator disruption. 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. Delegate, Intrepid[®], Entrust[®] (organic) and Success[®] are 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

True bugs and stink bugs) are considered secondary pests and are generally suppressed by chemical mowing. Box elder 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.

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.

San Jose Scale (SJS) – When dormant treatments are used, it is a minor issue; but periodic Esteem, Seize[®], or Ultor[®] use sometimes is necessary for augmentation of control.

True bugs (box elder, lygus, stink bugs) 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. True bugs (box elder, lygus, and stink bugs) are considered secondary pests and are generally suppressed by a pyrethroid. They have become an increasing problem in some orchards in which mating disruption is used because the use of organophosphate (OP) and carbamate insecticides has decreased or even been eliminated. Control of these pests can negate the development of predatory control of mites and psylla in these orchards.

Lygus and box elder bugs can be more important in the early part of the growing season, while stink bugs as well as box elder bug can cause damage late in the season when they invade the orchard from surrounding habitats. Box elder bugs are associated with riparian habitat that contains ash, maple and box elder trees.

True bugs are often invaders from open fields or permanent cover crop (lygus) or natural vegetation (box elder) surrounding pear orchards. Lygus can be a pest from bloom through harvest. Box elder bugs invade orchards in early spring and later, while stink bugs generally invade in late spring.

Many important predators within the orchard are true bugs (e.g. *Deraeocoris*, *Campylomma*, *Orius*, *Nabis* spp.). *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 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 box elder bugs and lygus, but does not perform well on stink bugs and is very harsh on beneficials. Dimethoate provides fair control at the labeled rate but has encountered increasing buyer use restriction. Danitol[®] controls lygus, stink bugs, and box elder bugs; if timing is coincidental to CM egg laying, it provides a measure of codling moth control. Provado[®] and Actara[®] both provide some 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. Water quality can be an issue with pyrethroid use at this timing.

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 russetting becomes visible only later in the spring and summer.

Blister mites have become an increasing issue within a mile of abandoned orchards. Treatment with sulfur or sometimes Diazinon + oil must be accomplished during a relatively narrow window in the late fall, however. The inclusion of sulfur in dormant oil treatments is currently being evaluated. In earlier times the inclusion of certain no longer advisable materials with dormant oils could provide suppression of this pest.

Carzol[®] provides excellent control of rust mites, but is very harsh on beneficials and is also expensive. Use of this product has declined and it is used primarily as a last resort rescue treatment. Applied at finger stage (pre-bloom), sulfur in wettable and micronized 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 where it is a regional pest. Damage from thrips feeding on fruit appears as silvering or russetting from oviposition. Asana[®], a pyrethroid, provides good control of thrips when applied at green tip prior to bloom; this timing is also less disruptive to beneficials. It can be used at a low rate with good control. Success[®] is newly registered for use on pears for thrips control, but it has not been used, partially due to its high cost. It has little contact activity and must be ingested to be toxic. Resistance management must be a concern for maintaining its use for as long as possible.

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

RESEARCH	<ul style="list-style-type: none"> • Evaluate new leaf roller management techniques • Develop attract-and-kill techniques for true bug control - for true bug monitoring • Develop and evaluate new psylla management techniques • Develop Western Flower thrips control • Study reduced risk pesticides for true bugs
REGULATORY	<ul style="list-style-type: none"> • Expedite registrations of new products • Make sure resistance info included on new labels • Include resistance management in new EPA design of labels
EDUCATION	<ul style="list-style-type: none"> • Advise against multiple applications of materials with the same or similar chemistries. Don't expose multiple generations of a pest in the same year to the same mode of action. Vary chemical applications for different pest generations. Continue resistance management education • Make sure everyone understands the life cycles of the various species of true bugs (they're not all the same). • Resistance management education • Educate EPA to ensure registrants place resistance management information on the label

WEEDS

During this season some pre-emergence herbicides are still being applied. Products used are the same as in dormancy with the exception of Diuron, Goal® and Chateau. Contact herbicide applications may occur also. 2,4-D is not used after bud break of important broadleaf neighboring crops such as grapes. 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. Poast is being used where Glyphosate resistant ryegrass is present. California requires that a closed mixing system be used with Gramoxone use..

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

Monitoring weeds should be done when they are in the seedling stage as they are easier to control with chemical or mechanical tools when small. Resident vegetation must be managed through repeated mowing or judicious use of chemicals.

Work Group Recommendations for Weed Management
During Green Tip through Petal Fall

RESEARCH	<ul style="list-style-type: none"> • Evaluate efficacy of materials in relation to size of weeds. • Evaluate weeds for glyphosate resistance.
REGULATORY	<ul style="list-style-type: none"> • Expedite registration of glyphosate alternatives
EDUCATION	<ul style="list-style-type: none"> • Understand the role of weed escapes related to resistance management. • Educate glyphosate users on drift control • Show how size of weeds impacts herbicide efficacy • Recognize importance of timing of chemical applications • Recognize value of weed science program support

DISEASES

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

Fire blight, *Erwinia amylovora* is the most important disease of pears. New materials and strategies to control fire blight are being developed. Population predictive models based on heat summation and the coincidence of warm temperatures and humidity or rainfall are widely and successfully used during the bloom season. 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. Terramycin resistance was found and documented for the first time at one location in 2007. 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 fire blight, but can cause russetting on the fruit; Kocide 3000 has less russetting potential. However, in wet springs, fresh packers have complained that Bartlett shows russetting when treated repeatedly with Kocide 3000. Blight Ban[®] A506, *Pseudomonas fluorescens* and Bloomtime Bio[®] *Pantoea agglomerans* are naturally occurring bacterial organisms. They assist in controlling fire blight, frost injury, and russetting by acting as a competitive exclusion agent. Blight Ban was the first biological agent for disease control registered, and the pear industry funded a portion of its initial development. 3 apps sprayed on the flowers starting at about 15-20% bloom, *P. fluorescens* prevents the fire blight 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[®] Max is currently unknown; test results have been erratic.

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. Unfortunately, the heavy resistance development experienced in the North Coast Counties has relegated the strobilurins to non use in the late districts and a one time application in a multi fungicide program in the early districts. Syllitt[®] (dodine) provides good control with some curative properties and is widely used, but is suspected as a cause of russet when applied under wet conditions. Procure[®] is a good, but expensive, fungicide used as a curative before petal fall. Rubigan is used after petal fall as a curative treatment. EBDC fungicides work as preventatives when used in combination with other products; however, they wash off easily and its performance is weather-related. Also, Gerber Inc. does not allow use of these products on pears that they purchase for use in baby food. Vanguard[®] 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 but is widely used. 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. Scab is most prevalent during wet springs and models based on spore trapping in pears and temperature and wetness duration primarily in apples have been useful in the pre bloom, bloom and post bloom seasons.

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

RESEARCH	<ul style="list-style-type: none"> • Evaluate streptomycin replacements for fire blight control • Evaluate alternatives to be used with biologicals • Optimize compatible use of biologicals in FB programs • Evaluate inoculum control for scab • Conduct research on the stabilization of Mycoshield[®] • Evaluate new bio- controls • Develop model for pear scab • Evaluate new copper formulations relation to blight and russetting • Study biology of pear scab and cultural practices to reduce inoculum • Seek data on use of copper as rotational product
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REGULATORY	<ul style="list-style-type: none"> • Maintain therapeutic use of antibiotics for plant agriculture • Maintain availability of copper materials • Register Kasugamycin for fire blight control
EDUCATION	<ul style="list-style-type: none"> • 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

<ul style="list-style-type: none"> • Mowing or cultivating • Frost protection • Fertilization • Irrigation • Scouting/leaf sampling for nutrient levels 	<ul style="list-style-type: none"> • Pesticide applications, including hormone sprays • Blight cutting/Pruning • Pheromone applications/Setting traps and ties, puffers • Harvest
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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 conventionally pesticide managed 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.

Codling moth control has entered a new phase with the introduction and adoption of mating disruption materials, but loss of a primary organophosphate to suppress CM near abandoned orchards and in cases of high populations is a concern.

Azinphos-methyl has been the most commonly used OP for codling moth control and still occasionally supplements mating disruption pheromone tactics to keep CM populations within grower acceptable infestation levels. AZM also controls leaf roller and other pear pests, but many beneficial insects have developed tolerance to this insecticide. Examples include *Typhlodromus occidentalis* (western predatory mite), *Prigalio flavipes* (an important parasite of leafminer) and green lacewings. Softer insect growth regulators (IGRs) like spinetoram, tebufenozide, spinosad, methoxyfenozide and chlorantriliniprole are currently used more frequently to augment mating disruption for CM control.

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 95% 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 and to control occasional pests formerly controlled by continued use of broad spectrum pesticides.

Mating disruption pheromones are dispensed in orchards via aerosol puffers or ties. Ties are more labor intensive, but preferred over puffers in windier districts. They are also routinely used as edge augmentation treatments in puffer orchards. Using MD alone for CM control is feasible where population levels are low, however, fruit damage has been documented along orchard borders, especially without augmenting the border concentration of pheromones as described.

Maintaining acceptable levels of CM control also becomes difficult when production areas are adjacent to abandoned orchards. Local ordinances that address abandoned groves are becoming vital in pear growing districts to keep infestations suppressed.

As OP products are lost due to environmental concerns, growers have turned to softer insect growth regulator products to augment mating disruption for CM control. These products have varying degrees of efficacy in addition to resistance issues. Imidan is only partly effective against CM and more expensive than AZM. 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, but can cause mite flare ups. Care must be taken to avoid development of resistance. Sevin has a short post harvest interval, but poor control of CM.

Grant programs to study AZM alternatives are a priority for the pear industry.

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

Cultural controls of CM mainly involve sanitation. Infested bins stored adjacent to orchards may contribute to problems with CM management. Post-harvest sanitation using 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.

Advances are being made with new products for CM control. Two relatively new reduced risk insecticides Altacor[®] (chlorantraniliprole) and Delegate[®] (spinetoram) have been evaluated for codling moth (CM) control in pears over the past five years and have become favored in use to augment insect control in mating disrupted orchards during the last two. These insecticides have proven to provide superior CM control to that of the grower standard treatment of Guthion[®], Imidan[®], Assail[®] and/or Warrior[®]. In addition, Delegate[®] has also provided control of pear psylla. These materials have very low mammalian toxicity and will have minimal personal protection equipment requirements and short re-entry intervals. Altacor[®] and Delegate[®] have excellent eco-toxicological profiles and are gentle on beneficial insects and mites, although Delegate has been shown to increase the pressure from rust mites and San Jose scale. They have unique modes of action that will allow for the development of a stable resistance management program. Future pear resistance management control programs should consist of pheromone mating disruption combined with one or two in-season insecticide applications. The insecticide applications should alternate between various modes of action. For example the 1A or 1B CM application could be Delegate[®] while the 2A application could be Altacor[®]. In addition, Intrepid[®], Assail[®] or Imidan[®] could be worked into the resistance management program so that CM populations are never exposed to the same mode of action more than once a year. Altacor[®] proved to be most effective when applied prior to CM oviposition. In addition, Altacor[®] applied before oviposition at 20 ppm was more effective than applied after oviposition at 100 ppm. Because Delegate[®] has excellent pear psylla activity, Delegate could be used as an alternative to Agri-Mek[®] or as a supplemental application to Agri-Mek[®]. This strategy would help delay the development of pear psylla resistance.

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, however, they are not used as much. 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 OP's and pyrethroids may cause mite flare-ups.

Pear rust mites are only an occasional damaging pest, but are an increasing problem to be treated in mating disruption orchards when miticide use is reduced or eliminated and Delegate is used. 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 is harmful to fish. Pyramite® is a new miticide; its efficacy for rust mite control in California pears is unknown.

Pear leaf blister mites have become an increasing issue in codling moth mating disrupted orchards, especially within one mile of abandoned orchards. However, nothing can be done in regard to control of this pest at this time of the year. Sulfur treatments in the late post harvest season are used.

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. Delegate looks very good, Assail, Actara, Provado provide good control. If you stay away from materials disruptive to natural enemies, spiders are very effective. Management of true bugs can upset beneficial balance.

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 Success®, Intrepid, Delegate, Assail and Altacor 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. Assail is the first neonicotinyl registered on apples and pears. Resistance issues with Assail limit the number of applications in a season.

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. These are not considered a serious pest, are seldom specifically treated and Psylla treatments usually help manage leaf hopper issues that emerge.

True bugs can be managed using several available chemicals. Thiodan® is not much used, because can be it is harmful to fish and provides only fair control of box elder bugs, lygus, and stink bugs. On the other hand, Carzol® provides good control of box elder bugs and lygus, but does not perform well on stink bugs and is very harsh on beneficials. Danitol® or dimethoate are currently the insecticides of choice. Management of true bugs can be disruptive for beneficials. Danitol is the principle material used because dimethoate has processor issues and Thiodan presents water quality issues.

Dimethoate provides a fair level of true bug control at the labeled rate and may not be used (if allowed at all) less than 28 days before harvest. Provado® and Actara® provide some 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.

Secondary pest infestations have historically been infrequent or rare. Carbamate or OP insecticides used to control other insect pests have kept secondary pests in check in conventional pesticide orchards. However, currently Katydid, cucumber beetles and pear slugs are on this list in mating disrupted orchards. There is concern with introduction and establishment of pests of foreign origin, such as the brown marmorated stink bug in the east. Several species have the potential to become important pests of pear and other fruit crops.

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

RESEARCH	<ul style="list-style-type: none"> • Evaluate and develop reduced risk control techniques for psylla, true bugs, and leaf rollers • Evaluate and develop OP alternatives for codling moth control; understand new alternatives, plus resistance management • Understand mechanism of CM detoxification as a part of resistance • 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
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REGULATORY	<ul style="list-style-type: none"> • 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
EDUCATION	<ul style="list-style-type: none"> • 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 and the community 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 • Educate the public about use of pheromone mating disruption

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. Cultivation and mowing are typically used to control weeds during fall. Johnsongrass and bindweed are targeted weeds for post emergence herbicides.

RESEARCH	<ul style="list-style-type: none"> • Evaluate cultivation practices and new post emergent controls • Evaluate solarization for weed control • Evaluate weed cloth for weed control • Study alternatives to Roundup
REGULATORY	<ul style="list-style-type: none"> • Seeking post emergence product for nutsedge
EDUCATION	<ul style="list-style-type: none"> • Weed control is very site specific • Post harvest cultivation can't be done because of psylla

DISEASES

Fire blight 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 Blight Ban[®], provides acceptable levels of control. Mycoshield[®] provides moderate levels of control. Application timing is critical to product performance. New materials and strategies to control fire blight are being developed. Population predictive models based on heat summation and the coincidence of warm temperatures and humidity or rainfall are widely and successfully used during the bloom season until hot weather is predicted to curtail the population. There can be seasons in the cooler parts of the early district when hot weather does not arrive to suppress the population until after the currently used preventative material's (Mycoshield) preharvest application interval (60 days) has passed, and nothing can be done during late infection periods..

Cultural controls include physical removal of the disease by cutting out fire blight infections. Because workers are needed in the field at this time, it 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. Proper irrigation management can be effective in minimizing this disease. Opening up crown below soil line helps minimize infection.

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

RESEARCH	<ul style="list-style-type: none"> • Evaluate oak root fungus and <i>Phytophthora</i> management techniques • Evaluate biological control techniques for all pear pests • Look at new materials for oak root fungus • Study Armillaria biology • Study Armillaria cultural controls • Evaluate resistant rootstocks for armillaria
REGULATORY	<ul style="list-style-type: none"> • 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 naphthalene acetic 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 and is unlikely to be registered. It could be used to reduce vegetative growth and limit the development of rattail blooms which become infected with fire blight.

There are no work group recommendations for plant growth regulators at this time.

POST- HARVEST

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. Research has shown the biological BioSave®, *Pseudomonas syringae*, is ineffective against both molds.

Mixtures of benzimidazoles and the products Scholar and Penbotec are effective. 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.

Work Group Recommendations for Post-Harvest Disease Management

RESEARCH	<ul style="list-style-type: none"> • Continue research on blue mold and <i>Botrytis</i> resistance management • Evaluate California requirements to register SOPP and ethoxyquin for use on California pears • Scald management
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POST-HARVEST ACTIVITIES IN THE ORCHARD (July through November)

Cultural and Worker Activities

<ul style="list-style-type: none"> • Fertilization • Irrigation • Cover crops • Cutting out blight • Tree removal 	<ul style="list-style-type: none"> • Tree hole fumigation (for replants) • Scouting • Pesticide applications • Pruning • Sanitation
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INSECTS AND MITES

Codling moth clean-up in pear orchards occurs at times in the early districts 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 in the early districts 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 provides good to excellent control. Oils alone also provide good control. Lime-sulfur and/or wettable sulfur also are good, 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 applied after late October in the late districts or in November in the early districts; or wettable sulfur alone, applied earlier in September. As temperatures cool in the late 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[®]. However the use of the latter material has decreased because of environmental concerns. Blister mites **must** be controlled during the late post harvest season with currently sulfur or Diazinon + oil. The timing is often best a little later than the optimal timing for rust mite control (and sometimes psylla control near abandoned orchards), so that there has been a tendency for blister mites to result in a need for an extra treatment, especially near abandoned orchards.

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

RESEARCH	<ul style="list-style-type: none"> • Study efficacy of psylla control materials • Evaluate timing for best use of lime sulfur and oil application
REGULATORY	<ul style="list-style-type: none"> • Register new materials to manage abandoned orchards and related pest issues

WEEDS

Cultural practices such as mowing and disking are typically used to control weeds during fall months. Post emergents are used in specific sites for perennial weeds. The use of Roundup at this time poses drift issues. Chemical products used are the same as those discussed previously in this document.

Biological control of weeds in pear orchards is limited because they are disturbed frequently by cultural operations or pesticide applications. Natural enemies of weeds cannot develop high enough populations to control weeds adequately.

There are no work group recommendations for fall weed management.

DISEASES

Fire blight management activities during the fall include cutting out and removing infected tissue.

Scab controls, such as lime-sulfur and urea, used at this time of year provide only very limited 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	<ul style="list-style-type: none"> Register ethephon; this is one of the most important current registration needs for pears
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INVASIVE SPECIES

Invasive species such as Light Brown Apple Moth (LBAM) and Venturia naschicola (scab) disease of Asian pears in China or brown marmorated stink bug could pose considerable challenges for pear production if they become established in commercial pear production areas. Weed species are not a problem at this time, but invertebrates such as Asian clams and Quagga mussels can clog irrigation system filters. Establishment could mean additional applications of crop protection materials which add to the potential for resistance as mentioned previously in this document.

The Invasive Species Council of California has appointed an advisory committee to recommend ways to mitigate non-native species effects on resources throughout the state including drafting an invasive species rapid response plan. The committee will take input from local government, tribal governments and federal agencies as well as environmental organizations, academic and science institutions, affected industry sectors and impacted landowners. Continuing dialogue with USDA's Animal Plant and Health Inspection Service is critical for the pear industry to explain the devastation to IPM and reduced use pesticide programs that introduction of invasive species and genetic variants would cause the California pear industry.

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 and established maximum residue levels (MRLs) for pesticides. Important pests that cause phytosanitary concerns in pears include internal feeders such as codling moth, and oblique-banded leaf roller (OBLR) and the suggestion that European grape vine moth (EGV) could be a pest of pears if established in California.

Work Group Recommendations Concerning International Trade

RESEARCH	<ul style="list-style-type: none"> Encourage registrants to develop residue data and export tolerances for new products prior to U.S. registration
REGULATORY	<ul style="list-style-type: none"> 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, importing countries, and USDA-APHIS 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. to avoid non-tariff trade barriers Explain to USDA-APHIS the devastation to IPM and reduced risk pesticide programs that would develop if invasive species or genetic variants are introduced.

EDUCATION	<ul style="list-style-type: none"> • 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 • Compliance with secondary standards (e.g., global gap)
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OTHER ISSUES

Water quality regulations have increased awareness of the potential for pesticide run-off by pear growers. Orchards near surface waterways typically use vegetated buffer zones to mitigate run-off or spray drift. Applicators must consider all factors in making their decisions about pesticide applications. Those include wind speed and direction, all weather conditions, and proximity of people and other crops.

New soil fumigant regulations have the potential to impact pear production where new orchards need effective products for successful establishment. However, longevity of pear trees and infrequent re-plant mean minimal need for fumigant products. Soil borne diseases, such as oak root fungus, can become a problem without effective products.

California pear production statistics for the past three years show an increase in fresh pear sales and a decrease in the amount of fruit moving to California canneries. Currently, three in-state canneries handle pears for processing. While the amount of pears moved for processing in California has declined from 133,347 tons in 2007 to 100,207 tons in 2009, there has been an increase in the pear tonnage sent to canneries in the Pacific Northwest. In 2009, 15,963 tons of California pears were processed in Pacific Northwest canneries.

APPLIED RESEARCH AND EXTENSION NEEDS OF THE CALIFORNIA PEAR INDUSTRY

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

The following areas of research and cooperative extension through the land grant university system are deemed essential to the successful widespread adoption of reduced risk pest management for the California pear industry.

TECHNICAL NEEDS	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 pome fruit production	Inform processors, regulatory agencies, retail buyers, etc. of the progress being made to reduce broad-spectrum pesticide use	Website 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, website with related links, orchard tours
Outreach to the non-farming public	Educational 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

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	<p><u>Insects</u></p> <ul style="list-style-type: none"> • 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 “attract and kill” techniques for true bug monitoring and control • Evaluate and develop organically acceptable management techniques for codling moth • Evaluate biological control techniques for all pear pests • Evaluate reduced risk compounds for all pest categories in pears • Evaluate new leaf roller management techniques • Develop and evaluate new psylla management techniques • Evaluate efficacy of materials for western flower thrips control • Evaluate reduced risk insecticides for true bugs • Study mechanism of codling moth detoxification as a part of resistance management • Continue pheromone research, especially for attractants for monitoring codling moth <p><u>Diseases</u></p> <ul style="list-style-type: none"> • Evaluate new bactericides with differing modes of action for fire blight resistance control • Evaluate and develop organically acceptable management techniques for fire blight • Optimize compatible use of biologicals in fire blight programs • Evaluate inoculum control for scab • Develop model for pear scab • Evaluate new copper formulations in relation to blight and russetting • Study impacts of cultural practices to reduce inoculum of pear scab • Generate data on use of copper as rotational product for fire blight control • Evaluate oak root fungus and <i>Phytophthora</i> management techniques • Evaluate new materials for oak root fungus • Develop resistant rootstocks for <i>Armillaria</i> • Develop scald management techniques • Develop new techniques for application of postharvest fungicides <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Evaluate organic herbicides • Develop nonchemical weed controls (cultural, etc.) • Develop improved herbicide application methods • Evaluate glyphosphate, Simazine, 2,4-D alternatives • Develop organic herbicides • Identify willow brush management tools • Evaluate non-chemical weed management approaches including carbon footprint-related issues <p><u>Other Areas</u></p> <ul style="list-style-type: none"> • Evaluate resistance status for insecticides, fungicides and herbicides used in pear pest management • Evaluate improved cover crop management and techniques • Evaluate delayed dormant blight treatments as to their ability to lower fire blight inoculum and provide measureable improvements for late season control • Evaluate alternatives to be used with biologicals • Evaluate new biocontrol techniques for all pest management systems • 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 • Encourage registrants to develop residue data and export tolerances for new products prior to U.S. registration (Post Harvest) • Develop orchard systems approach to pest and crop management alternatives, etc.
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CRITICAL ISSUES FOR THE PEAR INDUSTRY – Regulatory Needs

	<p><u>Insects</u></p> <ul style="list-style-type: none"> • Register reduced risk insecticides for codling moth – the key insect pest of pears
EDUCATION	<p><u>Insects</u></p> <ul style="list-style-type: none"> • Demonstrate new materials and techniques for codling moth control • Educate growers, PCAs, and the community on the importance of removing abandoned orchards in establishing effective area-wide pest management programs • Educate the public and buyers about the potential environmental benefits and lack of gene flow to market scions if these scions are produced on genetically modified rootstocks • Educate growers and PCAs on the life cycles of the various species of true bugs and how this relates to effective management • Increase public awareness of using integrated pest management tactics (e.g., pheromones) in California pear production <p><u>Diseases</u></p> <ul style="list-style-type: none"> • Inform the industry and the community of the benefits of removing abandoned orchards • Inform stakeholders on the current use of fire blight models which support antibiotic use • Train growers and PCAs on resistance management <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Demonstrate alternatives to herbicide use • Develop no till management practices • Educate growers and PCAs on drift control issues with Roundup • Educate growers and PCAs on size of weeds related to efficacy • Educate growers and PCAs on importance of proper timing of herbicide applications • Increase awareness of the need for university and USDA programs to support weed science programs (research and demonstration projects) <p><u>Other</u></p> <ul style="list-style-type: none"> • Insure that adequate levels of UCCE field staff are available to assist with research and extension needs • Educate growers and PCAs on environmental and water impacts of organophosphate insecticides, antibiotics, and other materials used in pest control • 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 • Develop a sustainability plan for California pear production • Develop a “best management practices” document for pears • Create a clearinghouse/summary of regulatory issues for pear growers • Educate regulators on the challenges for growers to fully assimilate a myriad of regulations • Educate legislators and congressmen about the intricacies of our markets, foreign and domestic, to minimize detrimental actions by government, i.e. Mexican regulatory tariffs • Provide training to growers and PCAs on management practices to minimize off-site pesticide • Educate urban users about pesticide use, particularly off-site movement • Educate the public on pheromone issues • Educate growers and PCAs on resistance management including importance of escape • Educate EPA on need for registrants to develop usable label language • Increase awareness of compliance with secondary standards (e.g. Global Gap) • Educate growers and PCAs about which materials are approved by export countries • Educate and encourage registrants to develop MRLs in compliance with importing countries prior to full US registration (MRLs) • Explain to USDA-APHIS the devastation to IPM and reduced risk pesticide programs that would develop if invasive species or genetic variants are introduced

CRITICAL ISSUES FOR THE PEAR INDUSTRY – Educational Needs

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<http://www.calpear.com>

National Agricultural Statistical Service of the USDA
<http://www.nass.usda.gov>

Pear Pest Management Guidelines – UC IPM
<http://www.ipm.ucdavis.edu/PMG/selectnewpest.pears.html>

Regional IPM Centers
<http://www.ipmcenters.org>

Washington State University Tree Fruit Research and Extension Center
<http://www.tfrec.wsu.edu>

Western IPM Center at UC Davis
<http://www.wrpmc.ucdavis.edu>

Western Orchard Pest and Disease Management Conference
<http://www.entomology.tfrec.wsu.edu/wopdmc/index.html>

APPENDICES

1. California Pear Production 2007-2009

Classification	2007 (Actual)		2008 (Actual)		2009 (Actual)	
	36 lb boxes	Tons	36 lb boxes	Tons	36 lb boxes	Tons
Total Fresh	4,188,863	75,399.53	4,427,165	79,689	4,696,951	84,545
Bartlett	3,580,383	64,446.89	3,771,842	67,893	3,792,548	68,266
Sunsprite	36,107	649.93	25,786	464	37,652	678
Reds	80,539	1,149.70	112,091	2,197	123,536	2,223
Bosc	412,672	7,428.10	192,269	3,461	160,020	2,880
Golden Russet Bosc			243,318	4,380	497,524	8,955
Comice	39,763	715.73	42,444	764	23,523	423
Seckel	21,124	380.23	14,462	260	36,330	654
Forelle	10,156	182.81	4,551	82	4,444	80
French Butter	5,035	90.63	10,032	181	10,742	193
Other	3,084	55.51	388	7	10,632	191
Cannery, California		113,347		103,475		100,207
Cannery, Northwest		9,475		14,101		15,963
Processed, Other		14,982		19,340		14,971
Total Crop		213,203.53		216,605		215,686
Bartlett Total	3,580,383	202,250.89	3,771,842	204,809	3,792,548	199,407
Variety Total	608,480	10,952.64	655,323	11,796	904,403	16,279

Source: California Pear Advisory Board

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												

Source: 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												
Blister mite												
Diseases	J	F	M	A	M	J	J	A	S	O	N	D
Fire blight												
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												

Source: Collective field observations and experiments

4. Efficacy of Insecticides

Rating Scale: E = Excellent, G = Good, F = Fair, P = Poor-to-None, R = Known Resistance, NT=Not Tested

PRODUCT	TRADE NAME	Codling Moth	Leaf Rollers	Green Fruitworm	Stink bugs	Cutworms	San Jose Scale	Fruit Tree Leaf Roller	Lygus Bug	Thrips	Leafhoppers	European Red Mite	Spider Mites	Pear Psylla	Pear Rust Mites	Box elder Bug	Grape mealybug	Blister Mite
Abamectin	Agri-Mek®	P										F	F		F			
Acetamiprid	Assail®	G												F		F		
Azadirachtin	Remix®	P												F			P	
Azinphos-methyl	Guthion®	G-E	E-R		P	F	P			F-G	P-F			P				
<i>B. thuringiensis</i>	Various BTs	P	G														N	
Bifenazate	Acramite®												G					
Carbaryl	Sevin®	G									E				G			
Chlorantraniliprole	Altacor®	E																
Chlorpyrifos	Lorsban®	G	G-E			E	G-E				F							
Clofentezine	Apollo®											F-E			P			
Clothianadin	Clutch®				F	G					G			G				
Diazinon	diazinon	F	P			E			G		F				F			G
Diflubenzuron	Dimilin®	F												F	P		N	
Emamectin	Proclaim®	G																
Endosulfan	Thiodan®		F		G-E		G-E		E	F	G-E			G	G	G		G
Esfenvalerate	Asana®	E	E				G-E		E		G-E			F-G				
Fenbutatin oxide	Vendex®											PE	FG		G			
Fenproxymate	Fujimite®												G		F			
Fenpropathrin	Danitol®	G			G	E					E		E		P		P	
Formetanate	Carzol®						G-E			G	E		F		G			
Hexythiazox	Savey®											F-E			P			
Imidacloprid	Provado®	NT												E			E	
Kaolin	Surround®	F					F-P							F			P	
Indoxacarb	Avaunt®	P																
Lime-sulfur	various													G	E			
Methomyl	Lannate®					E						G-E						
Methoxyfenozide	Intrepid®	G																
Naled	Dibrom®	F-G									F-G	F-G	F-G	G	G			
Neem Oil	Trilogy®									F		F	FG					
Oil – dormant	oil	G-E				G	G-E		E		E			F-E				
Oil - summer	oil	G-E	P															
Permethrin	Pounce®											E	F-G	G				
Pheromones	Isomate®	F-G				E								G				
Phosmet	Imidan®	F-G	F-R															
Pyridaben	Pyramite®																	
Pyriproxyfen	Esteem®	F	F											F			N	
Soaps	M-pede®																	
Spinosad	Success®	P-F												L			N	
Spinetoram	Delegate®	E												G				
Sulfur	Sulfur														G			G
Tebufenozide	Confirm®	P												N			N	
Thiamethoxam	Actara®	NT						F		G			E		F	E		
Thiocloprid	Calypso®	G			F	G					F		F			G		

Source: Collective field observations and experiments

5. Efficacy of Unregistered Insecticides

Rating Scale: E = Excellent, G = Good, F = Fair, P = Poor/None, R = Known Resistance, NT = Not Tested

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	Grape mealybug
Buprofezin	Applaud [®]	NT											F			F
Chlorfenapyr	Alert [®]	P	P													
Clothianidin	V-10066									G			P			
Diofenolan	CGA-59205	P				E							G			
Fenoxycarb	Comply [®]	G-E	G-E			G										
Granulosis virus	Carpovirusine	F-G														
Indoxacarb	Avaunt [®]	NT	P										NT			NT
Milbemectin	Fury [®]										F	F				
NPV	various	P														
Pirimicarb	Primor [®]															
Pymetrozine	Fulfill [®]															
Thiacloprid	Calypso [®]	E											E			E

Source: Collective field observations and experiments

6. Efficacy of Non-Chemical Insect Management

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

NON-CHEMICAL TOOLS	Codling Moth	Green Fruitworm	Leaf Rollers	Stink bugs	Cutworms	San Jose Scale	Fruit Tree Leaf Roller	Lygus Bug	Thrips	Leafhoppers	European Red Mite	Spider Mites	Pear psylla	Pear Rust Mites	Box elder Bug	Grape mealybug
Cover Crops				F G				F G	F G						F G	
Monitoring/Use of Action Thresholds	G E	G E	G E	G E	G E	G E	G E	G E	G E	G E	G E	G E	G E	G E	G E	
Natural Enemies	P F	F	F			G	F G			F G	G	G	F G	F G		
Nutrition	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	
Sanitation/ Weeding				G				G	G			G			G	
Soil/Dust Management											G	G				
Use of Models	G E															
Water Management												G				
Trap Crops				G				G							G	
Pheromones (Mating Disruption)	G		G													
Pheromones (Population Monitoring)	G		F			F										
Predatory Mites											F G	G				

Source: Collective field observations and experiment

7. Relative Toxicities of Insecticides and Miticides to Beneficial Organisms

Rating Scale: H = high, M = moderate, L = low, — = unknown

COMMON NAME (Trade Name)	TRADE NAME	SELECTIVITY	PREDATORY MITES	GENERAL PREDATORS	PARASITES
Abamectin	Agri-Mek [®]	moderate	H	L	M - H
Acetamiprid	Assail [®]	—	L	M	L
Azadirachtin	Neemix [®]	broad	—	L	L
Azinphos-methyl	Guthion [®]	broad	L/M	H	H
<i>Bacillus thuringiensis</i>	BT	narrow	L	L	L
Bifenazate	Acramite [®]	narrow	L	L	L
Buprofezin	Centaur	narrow	L	L	L
Carbaryl	Sevin [®] 50, 80	broad	L/H	H	H
Chlorantranliiprole	Altacor [®]	Narrow	L	L	L
Chlorpyrifos	Lorsban [®]	broad	M	H	H
Clofentezine	Apollo [®]	narrow	L	L	L
Clothianadin	Clutch	narrow	L	M	L
Cypermethrin	Ammo [®]	broad	H	H	H
Diazinon-foliar	diazinon	broad	L	H	H
Diflubenzuron	Dimilin [®]	narrow	L	L	L
Dimethoate	dimethoate	broad	H	H	H
Emamectin benzoate	Proclaim [®]	narrow	L	L	L
Esfenvalerate	Asana [®]	broad	H	M	H
Fenbutatin oxide	Vendex [®]	narrow	L	L	L
Fenpropathrin	Danitol [®]	broad	H	H	H
Fenproximate	FujiMite [®]	Narrow	L	L	L
Formetanate HCL	Carzol [®]	broad	L/H	H	H
Hexythiazox	Savey [®]	narrow	L	L	L
Imidacloprid	Provado [®]	narrow	L	L	L
Indoxacarb	Avaunt [®]	narrow	L	L	L
Insecticidal soap	M-Pede [®]	broad	M	M	M
Lime sulfur	Lime sulfure	narrow	L/H	L	H
Methodathion	Supracide [®]	broad	H	H	H
Mehoxyfemnozide	Intrepid [®]	narrow	L	L	L
Neem Oil	Trilogy [®]	broad	L	L	L
Petroleum Oil	oil	broad	L	L	L
Phosmet	Imidan)	broad	H	H	H
Pyriproxyfen	Esteem [®]	narrow	L	H	L
Spinosad	Success [®]	narrow	L	L	L
Spinetoram	Delgate [®]	Narrow	L	L	M
Sulfur	sulfur	narrow	L/H	L	H
Tebufenozide	Confirm [®]	narrow	L	L	L
Thiamethoxam	Actara [®]	moderate	—	—	—
Thiocloprid	Calypso [®]	narrow	L	M	L

Adapted from UC IPM Guidelines for California Pears; list includes some products with pending registrations.

8. List of Unregistered Insecticides/Miticides

COMPANY	TRADE NAME, CHEMICAL NAME, or NUMBER	POTENTIAL TARGET PEST(S)	COMMENTS (Chemistry or Mode of Action, Registration Status, Selectivity, etc.)
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
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	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	Fulfill [®] , pymetrozine, CGA-215944	Aphids	Pyridine azomethine; registration for apples anticipated/obtained; selective to natural enemies
Sankyo	milbemectin	Spider mites Pear psylla Leafminer	Same mode of action as abamectin
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

Source: Collective field observations and experiments

9. Efficacy of Herbicides

Rating Scale: 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 [®]	F-G			
Carfentrazone-ethyl	Shark [®]	P			
Dichlobenil	Casaron [®]		G		
Diuron	Karmex [®]	F-G	G		
Glyphosate	Roundup [®]	E	F-G	G	F-G
Flumioxazin	Chateau [®]		G	F-G	
Isoxaben	Gallery [®]	F-G			
MSMA	various		F-G		
Napropamide	Devrinol [®]	F	P-F	P	P
Norflurazon	Solicam [®]	F-G	F-G		
Oryzalin	Surflan [®]	G	G	P	P
Oxyfluorfen	Goal [®]	P	E	P	F
Paraquat Dichloride	Gramoxone [®]	E	G-E	P-F	F
Pelargonic Acid	Scythe [®]	F-G	F-G		
Pendimethalin	Prowl [®]	G	G-E	P	P
Proanamide	Kerb [®]		F-G		
Pyraflufen-ethyl	Venue [®]	G			
Saflufenacil	Treevix [®]	G			
Simazine	Princep [®]		P		
Non-Chemical Tools					
Cultivation		G	G	G	G
Hand Weeding		G	G	G	G
Mowing		G	G	G	G
Burning		P	P	F	F

Source: Collective field observations and experiments

10. Efficacy of Fungicides and Bactericides

Rating Scale: 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
Tebuconazole/Trifloxystrobin	Adament	P	P	E-R	P	P	P	P	P
Triadimefon	Bayleton®	P	P	P	P	P	P	P	P
Captan (Preharvest – Apples Only)		P	P	F	P	P	P	P	P
Copper	various	G	P	F	P	P	P	P	P
Cyprodinil	Vanguard®	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®, Penncozeb®, Manzate®	P	P	F	P	P	P	P	P
Oxytetracycline	Terramycin®, Mycoshield®, Flameout®	G-R	P	P	P	P	P	P	P
Myclobutanil	Rally®	P	P	E	P	P	P	P	P
Pyrimethanil	Scala®	P	P	G	P	P	P	P	P
Streptomycin Sulfate	Agri-mycin®, Firewall®, Agricultural Streptomycin®	G-R	P	P	P	P	P	P	P
Sulfur	various	P	P	F	P	P	P	P	P
Thiram	Thiram Granuflo	P	P	F	P	P	P	P	P
Trifloxystrobin	Flint®	P	P	E-R	P	P	P	P	P
Triflumizole	Procure®	P	P	E	P	P	P	P	P
Thiophanate-methyl	Topsin-M®, T- Methyl®, Thiophanate Methyl	P	P	G-R	P	P	P	P	P
Ziram		P	P	F-G	P	P	P	P	P

Source: Collective field observations and experiments

11. Efficacy of Disease Management Tools

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

TOOL	Fire blight	Pear Decline	Scab	Bacterial Blossom Blast	<i>Phytophthora</i> Root and Crown Rot	<i>Dermatophora</i> Root Rot	Oak Root Fungus	Viruses
Models*	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

Source: Collective field observations and experiments

* e.g. disease forecasting

12. Efficacy of Vertebrate Management Tools

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

PRODUCT	TRADE NAME	Gophers	Ground Squirrels	Voles
Chemical				
Strychnine		G-E	G	E
Diphacinone and chlorophacinone		F	E	G
Zinc Phosphide				E
Fumigation				
Gas cartridges		P	G	
Aluminum phosphide		E	E	F
Non-Chemical				
Exclusion		F	P	F-G
Trapping		G	F	P
Baits		G-E	G-E	G
Repellants		P	P	P
Frightening		P	P	P
Shooting (Lethal Control)		P	F-G	P
Explosive Devices		F	F	
Owl Boxes		P	P	P
Predators		P	P	P

Source: Collective field observations and experiments

13. Efficacy of Plant Growth Regulators (PGRs)

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

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

Source: Collective field observations and experiments

* Note: MCP has MRL issues in Canada.

14. Efficacy of Post-Harvest Pest Management Materials

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

PRODUCT	TRADE NAME	Blue-Green Mold	Gray Mold	Rhizopus Rot	Mucor Decay	Bull's-Eye Rot
Sodium hypochlorite*	Bleach	F	F	F	F	
Thiabendazole TBZ Group 1	Mertect®	R-F	R-F	P	P	
Fludioxonil Group 12	Scholar®	E	E	E	E	
Fenhexamid** Group 17	Elevate®	P	E	P	P	
Pyrimethanil Group 9	Penbotec®	E	E	P	P	
Difenoconazole*** Group 3		E	P	?	?	E

Source: Collective field observations and experiments

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

** Fenhexamid is currently registered for preharvest application only

***Difenoconazol going through the IR-4 registration process in 2010

Note: all fungicides listed are registered with exception of difenoconazole

15. Common Organic and Synthetic Pesticides Useful in Pear Production

TECHNICAL NAME	TRADE NAME(S)
2,4-D, DIETHANOLAMINE SALT	2,4-D
2,4-D, DIMETHYLAMINE SALT	2,4-D
ABAMECTIN	Agri-Mek [®] , Ardent
ACETAMIPRID	Assail [®]
ALUMINUM PHOSPHIDE	aluminum phosphide
AMMONIUM NITRATE	ammonium nitrate
AMMONIUM PROPIONATE	ammonium propionate
AMMONIUM SULFATE	ammonium sulfate
AZADIRACHTIN	Remix [®]
AZINPHOS-METHYL	Guthion [®]
BACILLUS SUBTILIS	Serenade [®] MAX
BACILLUS THURINGIENSIS	BT
BETA-CYFLUTHRIN	Tempo [®] , Leverage 360
BIFENAZATE	Acramite [®] , Floramite [®]
BIFENTHRIN	Capture [®] , Allectus, Talstar [®]
BOSCALID	Pestanal [®]
BUPROFEZIN	Applaud [®] , Turismo [™] , Vetica [™]
CARBARYL	Sevin [®]
CARFENTRAZONE-ETHYL	Rage [™] , Shark [®]
CHLORANTRANILIPROLE	Rally [®]
CHLORPYRIFOS	Lorsban [®]
CITRIC ACID	citric acid
CLOFENTEZINE	Apollo [®]
CLOTHIANIDIN	Aloft [®] , Arena [®]
CODLING MOTH GRANULOSIS VIRUS	Cyd-X [®]
COPPER	copper
COPPER HYDROXIDE	copper
COPPER OXIDE (OUS)	copper
COPPER OXYCHLORIDE	copper
COPPER OXYCHLORIDE SULFATE	copper
COPPER SULFATE	copper sulfate
COTTONSEED OIL	oil
CYHALOFOP BUTYL	Clincher CA [®]
CYPRODINIL	Vanguard [®]
DIAZINON	diazinon
DIFLUBENZURON	Dimilin [®]
DIMETHOATE	dimethoate, Agrisolutions dimate 4E
DIURON	Karmex [®]
DODINE	Syllit [®] LF
E,E-8,10-DODECADIEN-1-OL	CheckMate [®] Puffer CM, Cidetrak [®] CM
E-8-DODECENYL ACETATE	CheckMate [®] CM-OFM, Cidetrak [®] OFM
ESFENVALERATE	Asana [®]
ETHEPHON	Ethrel [®] , ethephon
ETOXAZOLE	TetraSan [™] 5WDG, Zeal [®] miticide
FATTY ACIDS, METHYL ESTERS	Compadre [®] , First Choice Preserve [™]
FATTY ACIDS, MIXED	Fasten, Ad-Here [®] XL, Activator 90, LI 700 [®]
FENARIMOL	Rubigan [®]
FENBUTATIN-OXIDE	Vendex [®]
FENPROPATHRIN	Danitol [®] , Tame [®]
FENPYROXIMATE	Fujimite [®] 5EC, Hivastan [®]
FLUMIOXAZIN	Valor [®] , Broadstar [™]
FOSETYL-AL	Aliette [®] , Autograph [®]
GLYPHOSATE	Roundup, Alecto, Honcho [®]
GLYPHOSATE, ISOPROPYLAMINE SALT	Roundup [®]
GLYPHOSATE, POTASSIUM SALT	Roundup [®]
GLYPHOSATE-TRIMESIUM	Roundup [®]
HEXYTHIAZOX	Savey [®]
IMIDACLOPRID	Provado [®]

Source: CA Dept. Pesticide Regulation, 2009 Pesticide Use Report (PUR)

Table continued on next page...

15. Pesticide List (continued)

TECHNICAL NAME	TRADE NAME(S)
INDOXACARB	Avaunt [®]
KAOLIN	kaolin, Surround [®]
KEROSENE	kerosene
KRESOXIM-METHYL	Cygnus [®]
LAMBDA-CYHALOTHRIN	Karate [®] , Demand [®] CS
LIME-SULFUR	lime-sulfur
MALATHION	malathion
MANCOZEB	Dithane [®] , Penncozeb [®]
METHIDATHION	Supracide [®]
METHOXYFENOZIDE	Intrepid [®]
METHYL BROMIDE	methyl bromide
METHYLATED SOYBEAN OIL	oil
MINERAL OIL	oil
MYCLOBUTANIL	Rally [®]
MYRISTYL ALCOHOL	Isomate [®] -CTT, Isomate [®] - C Plus
MYROTHECIUM VERRUCARIA	DiTera [®] DF
NAA, AMMONIUM SALT	Fruit Fix [™] Concentrate
NEEM OIL	Trilogy [®]
NORFLURAZON	Solicam [®]
OIL OF JOJOBA	oil
ORYZALIN	Surflan [™]
OXYFLUORFEN	Goal [®]
OXYTETRACYCLINE HYDROCHLORIDE	Bacastat [™] , Fireline [™] 17WP
OXYTETRACYCLINE, CALCIUM COMPLEX	Mycoshield [®] agricultural terramycin
PARAQUAT DICHLORIDE	Gramoxone [®] , Drexel, Firestorm [®] Quik-Quat [™] , Helmquat 3 SL
PENDIMETHALIN	Prowl [®] , Stomp
PERMETHRIN	Ambush [®] 25W, Pounce [®]
PETROLEUM DISTILLATES	oil
PETROLEUM DISTILLATES, REFINED	oil
PETROLEUM OIL, PARAFFIN BASED	oil
PETROLEUM OIL, UNCLASSIFIED	oil
PHOSMET	Imidan [®]
PHOSPHORIC ACID	phosphoric acid
PSEUDOMONAS FLUORESCENS	Blight Ban [®] A506, Frostban B
PYRACLOSTROBIN	Headline [®] , Pageant [®]
PYRETHRINS	Buhach, Firmotox [®] , Parexan [®] , Ofirmotox [®] , NA 9184
PYRIPROXYFEN	Esteem, Seize [®]
RIMSULFURON	Matrix [®] , Rimgro [™] , Steadfast [®]
SIMAZINE	Princep [®] , simazine
SOYBEAN OIL	oil
SPINETORAM	Delegate [™] WG
SPINOSAD	Success [®]
SPIRODICLOFEN	Envidor [®] 2 SC
STREPTOMYCIN	Agri-Mycin [®]
STREPTOMYCIN SULFATE	Firewall [®] 17WP, Agri-Mycin [®] 17 Agric'l Streptomycin
STRYCHNINE	strychnine
SULFUR	sulfur
TALL OIL	oil
TALL OIL FATTY ACIDS	tall oil fatty acids
TEBUFENOZIDE	Confirm [®]
THIABENDAZOLE	Arbotect [®] 20-5
THIACLOPRID	Calypso [®]
THIAMETHOXAM	Actara [®]
TRIFLOXYSTROBIN	Flint [®] , Adament [®]
TRIFLUMIZOLE	Procure [®]
Z-8-DODECENOL	CheckMate [®] Puffer CM-OFM
Z-8-DODECENYL ACETATE	Isomate [®] - M
ZINC PHOSPHIDE	zinc phosphide
ZINC SULFATE	zinc sulfate
ZIRAM	Ziram 76 DF

Source: CA Dept. Pesticide Regulation, 2009 Pesticide Use Report (PUR)

16. Pesticide Use in California Pears: Acres Treated

TECHNICAL NAME	TRADE NAME(S)	ACRES
OXYTETRACYCLINE, CALCIUM COMPLEX	Mycoshield [®] agricultural terramycin	44,458
MINERAL OIL	oil	28,696
STREPTOMYCIN SULFATE	Firewall [®] 17WP, Agri-Mycin [®] 17 Agric'l Streptomycin	20,992
MANCOZEB	Dithane [®] , Penncozeb [®]	18,663
COPPER HYDROXIDE	copper	12,125
PETROLEUM OIL, UNCLASSIFIED	oil	11,591
ABAMECTIN	Agri-Mek [®] , Ardent	11,358
GLYPHOSATE, ISOPROPYLAMINE SALT	Roundup [®]	9,956
ESFENVALERATE	Asana [®]	9,457
NAA, AMMONIUM SALT	Fruit Fix [™] Concentrate	9,440
ZIRAM	Ziram 76 DF	7,965
E,E-8,10-DODECADIEN-1-OL	CheckMate [®] Puffer CM, Cidetrak [®] CM	7,477
SULFUR	sulfur	6,665
MYRISTYL ALCOHOL	Isomate [®] -CTT, Isomate [®] -C Plus	6,407
E-8-DODECENYL ACETATE	CheckMate [®] CM-OFM, Cidetrak [®] OFM	5,561
Z-8-DODECENOL	CheckMate [®] Puffer CM-OFM	5,561
Z-8-DODECENYL ACETATE	Isomate [®] -M	5,561
SPINETORAM	Delegate [™] WG	5,426
METHOXYFENOZIDE	Intrepid [®]	4,490
AMMONIUM SULFATE	ammonium sulfate	3,778
OXYFLUORFEN	Goal [®]	3,051
PHOSMET	Imidan [®]	2,596
GLYPHOSATE, POTASSIUM SALT	Roundup [®]	2,589
PHOSPHORIC ACID	phosphoric acid	2,575
LIME-SULFUR	lime-sulfur	2,364
CITRIC ACID	citric acid	2,055
AMMONIUM NITRATE	ammonium nitrate	2,010
CARBARYL	Sevin [®]	1,991
PSEUDOMONAS FLUORESCENS	Blight Ban [®] A506, Frostban B	1,793
CARFENTHAZONE-ETHYL	Rage [™] , Shark [®]	1,637
FENARIMOL	Rubigan [®]	1,613
LAMBDA-CYHALOTHRIN	Karate [®] , Demand [®] CS	1,591
DIAZINON	diazinon	1,369
GLYPHOSATE	Roundup [®]	1,110
AZINPHOS-METHYL	Guthion [®]	1,105
IMIDACLOPRID	Provado [®]	1,012
CHLORPYRIFOS	Lorsban [®]	959
OXYTETRACYCLINE HYDROCHLORIDE	Bacastat [™] , Fireline [™] 17WP	924
FATTY ACIDS, METHYL ESTERS	Compadre [®] , First Choice Preserve [™]	906
BIFENAZATE	Acramite [®] , Floramite [®]	904
ACETAMIPRID	Assail [®]	892
PETROLEUM DISTILLATES	oil	891
SIMAZINE	Princep [®] , simazine	875
FLUMIOXAZIN	Valor [®] , Broadstar [™]	857
DIFLUBENZURON	Dimilin [®]	851
2,4-D, DIMETHYLAMINE SALT	2,4-D	808
PYRIPROXYFEN	Esteem [®]	777
COPPER OXIDE (OUS)	copper	759
ETOXAZOLE	TetraSan [™] 5WDG, Zeal [®] miticide	695
DIURON	Karmex [®]	674
CLOFENTEZINE	Apollo [®]	666
SPINOSAD	Success [®]	656
CODLING MOTH GRANULOSIS VIRUS	Cyd-X [®]	646
FATTY ACIDS, MIXED	Fasten, Ad-Here [®] XL, Activator 90, LI 700 [®]	612
CHLORANTRANILIPROLE	Rally [®]	574
TALL OIL FATTY ACIDS	tall oil fatty acids	570
KAOLIN	kaolin, Surround [®]	547
FENPROPATHRIN	Danitol [®] , Tame [®]	515

Source: CA Dept. Pesticide Regulation, 2009 Pesticide Use Report (PUR)

Table continued on next page...

16. Product Use in Pears: Cumulative Acres Treated (continued)

TECHNICAL NAME	TRADE NAME(S)	ACRES
PENDIMETHALIN	Prowl [®] , Stomp	511
PETROLEUM OIL, PARAFFIN BASED	oil	507
DODINE	Syllit [®] LF	411
PARAQUAT DICHLORIDE	Gramoxone [®] , Drexel [®] Quik-Quat™, Helmquat 3 SL	399
TRIFLUMIZOLE	Procure [®]	345
BOSCALID	Pestanal [®]	311
PYRACLOSTROBIN	Headline [®] , Pageant [®]	311
COPPER OXYCHLORIDE SULFATE	copper	301
ZINC PHOSPHIDE	zinc phosphide	291
SPIRODICLOFEN	Envidor [®] 2 SC	290
FOSETYL-AL	Aliette [®] , Autograph [®]	289
STRYCHNINE	strychnine	287
ZINC SULFATE	zinc sulfate	230
THIABENDAZOLE	Arbotect [®] 20-5	219
NORFLURAZON	Solicam [®]	190
BIFENTHRIN	Capture [®] , Allectus, Talstar [®]	185
KEROSENE	kerosene	174
CYPRODINIL	Vanguard [®]	165
ORYZALIN	Surflan™	157
GLYPHOSATE-TRIMESIUM	Roundup [®]	156
THIACLOPRID	Calypso [®]	150
PETROLEUM DISTILLATES, REFINED	oil	123
FENPYROXIMATE	Fujimite [®] 5EC, Hivastan [®]	118
BUPROFEZIN	Applaud [®] , Turismo™, Vetica™	113
KRESOXIM-METHYL	Cygnus [®]	96
ETHEPHON	Ethrel [®] , ethephon	84
BACILLUS THURINGIENSIS	BT	78
RIMSULFURON	Matrix [®] , Rimgro™, Steadfast [®]	75
TALL OIL	oil	74
COPPER SULFATE	copper sulfate	72
COPPER OXYCHLORIDE	copper	71
BETA-CYFLUTHRIN	Tempo [®] , Leverage 360	69
METHIDATHION	Supracide [®]	60
METHYL BROMIDE	methyl bromide	58
THIAMETHOXAM	Actara [®]	54
AMMONIUM PROPIONATE	ammonium propionate	50
AZADIRACHTIN	Remix [®]	47
MYCLOBUTANIL	Rally [®]	42
PYRETHRINS	Buhach, Firmotox [®] , Parexan [®] , Ofirmotox [®] , NA 9184	42
METHYLATED SOYBEAN OIL	oil	39
FENBUTATIN-OXIDE	Vendex [®]	34
COPPER	copper	33
2,4-D, DIETHANOLAMINE SALT	2,4-D	30
CYHALOFOP BUTYL	Clincher CA [®]	27
TRIFLOXYSTROBIN	Flint [®] , Adament [®]	27
ALUMINUM PHOSPHIDE	aluminum phosphide	25
OIL OF JOJOBA	oil	17
TEBUFENOZIDE	Confirm [®]	17
CLOTHIANIDIN	Aloft [®] , Arena [®]	16
STREPTOMYCIN	Agri-Mycin [®]	14
SOYBEAN OIL	oil	11
DIMETHOATE	dimethoate, Agrisolutions dimate 4E	10
MALATHION	malathion	8
MYROTHECIUM VERRUCARIA	DiTera [®] DF	5
COTTONSEED OIL	oil	3
NEEM OIL	Trilogy [®]	2
PERMETHRIN	Ambush [®] 25W, Pounce [®]	2
HEXYTHIAZOX	Savey [®]	2
BACILLUS SUBTILIS	Serenade [®] MAX	1
INDOXACARB	Avaunt [®]	1

Source: CA Dept. Pesticide Regulation, 2009 Pesticide Use Report (PUR)

17. Pesticide Use in Pears: Pounds Active Ingredients Used

TECHNICAL NAME	TRADE NAME(S)	LBS
MINERAL OIL	oil	986,879
PETROLEUM OIL, UNCLASSIFIED	oil	247,210
LIME-SULFUR	lime-sulfur	75,214
SULFUR	sulfur	72,303
ZIRAM	Ziram 76 DF	66,005
MANCOZEB	Dithane®, Penncozeb®	53,240
KAOLIN	kaolin, Surround®	17,445
KEROSENE	kerosene	13,934
OXYTETRACYCLINE, CALCIUM COMPLEX	Mycoshield® agricultural terramycin	13,736
GLYPHOSATE, ISOPROPYLAMINE SALT	Roundup®	11,529
COPPER HYDROXIDE	copper	11,378
PHOSMET	Imidan®	9,365
CARBARYL	Sevin®	4,872
GLYPHOSATE, POTASSIUM SALT	Roundup®	3,434
STREPTOMYCIN SULFATE	Firewall®17WP, Agri-Mycin® 17 Agric'l Streptomycin	2,846
DIAZINON	diazinon	1,836
OXYFLUORFEN	Goal®	1,725
COPPER OXIDE (OUS)	copper	1,386
AZINPHOS-METHYL	Guthion®	1,327
SIMAZINE	Princep®, simazine	1,303
METHOXYFENOZIDE	Intrepid®	1,225
DIURON	Karmex®	1,223
E,E-8,10-DODECADIEN-1-OL	CheckMate®Puffer CM, Cidetrak® CM	1,213
FOSETYL-AL	Aliette®, Autograph®	1,123
PENDIMETHALIN	Prowl®, Stomp	1,108
COPPER OXYCHLORIDE	copper	1,065
PETROLEUM DISTILLATES, REFINED	oil	1,022
GLYPHOSATE	Roundup®	1,014
AMMONIUM SULFATE	ammonium sulfate	977
PETROLEUM DISTILLATES	oil	966
CHLORPYRIFOS	Lorsban®	854
NAA, AMMONIUM SALT	Fruit Fix™ Concentrate	781
DODINE	Syllit® LF	727
ESFENVALERATE	Asana®	589
SPINETORAM	Delegate™WG	512
2,4-D, DIMETHYLAMINE SALT	2,4-D	494
ORYZALIN	Surflan™	415
PARAQUAT DICHLORIDE	Gramoxone®, Drexel® Quik-Quat™, Helmquat 3 SL	402
PETROLEUM OIL, PARAFFIN BASED	oil	364
PSEUDOMONAS FLUORESCENS	Blight Ban® A506, Frostban B	357
BIFENAZATE	Acramite®, Floramite®	328
COPPER SULFATE	copper sulfate	317
PHOSPHORIC ACID	phosphoric acid	271
COPPER OXYCHLORIDE SULFATE	copper	266
FENARIMOL	Rubigan®	231
NORFLURAZON	Solicam®	223
DIFLUBENZURON	Dimilin®	213
ABAMECTIN	Agri-Mek®, Ardent	199
CITRIC ACID	citric acid	197
FENPROPATHRIN	Danitol®, Tame®	196
AMMONIUM NITRATE	ammonium nitrate	185
Z-8-DODECENYL ACETATE	Isomate® - M	184
BUPROFEZIN	Applaud®, Turismo™, Vetica™	151
ACETAMIPRID	Assail®	126
GLYPHOSATE-TRIMESIUM	Roundup®	126
MYRISTYL ALCOHOL	Isomate®-CTT, Isomate®- C Plus	126
TRIFLUMIZOLE	Procure®	119
FLUMIOXAZIN	Valor®, Broadstar™	118
IMIDACLOPRID	Provado®	106

Source: CA Dept. Pesticide Regulation, 2009 Pesticide Use Report (PUR)

Table continued on next page...

17. Pesticide Use in Pears: Lbs Active Ingredients Used (continued)

TECHNICAL NAME	TRADE NAME(S)	LBS
ETOXAZOLE	TetraSan™5WDG, Zeal® miticide	98
FATTY ACIDS, MIXED	Fasten, Ad-Here® XL, Activator 90, LI 700®	87
CLOFENTEZINE	Apollo®	87
ETHEPHON	Ethrel®, ethephon	84
OXYTETRACYCLINE HYDROCHLORIDE	Bacastat™, Fireline™ 17WP	79
SOYBEAN OIL	oil	78
PYRIPROXYFEN	Esteem®	72
BOSCALID	Pestanal®	67
METHIDATHION	Supracide®	60
SPIRODICLOFEN	Envidor® 2 SC	59
METHYLATED SOYBEAN OIL	oil	58
LAMBDA-CYHALOTHRIN	Karate®, Demand® CS	54
SPINOSAD	Success®	53
CHLORANTRANILIPROLE	Rally®	50
CARFENTRAZONE-ETHYL	Rage™, Shark®	42
BACILLUS THURINGIENSIS	BT	42
METHYL BROMIDE	methyl bromide	39
FENBUTATIN-OXIDE	Vendex®	38
CYPRODINIL	Vanguard®	35
PYRACLOSTROBIN	Headline®, Pageant®	34
THIACLOPRID	Calypso®	32
TALL OIL FATTY ACIDS	tall oil fatty acids	32
BIFENTHRIN	Capture®, Allectus, Talstar®	30
COPPER	copper	28
MYCLOBUTANIL	Rally®	25
MALATHION	malathion	19
ZINC PHOSPHIDE	zinc phosphide	16
FENPYROXIMATE	Fujimite® 5EC, Hivastan®	15
E-8-DODECENYL ACETATE	CheckMate® CM-OFM, Cidetrak® OFM	12
KRESOXIM-METHYL	Cygnus®	11
NEEM OIL	Trilogy®	11
MYROTHECIUM VERRUCARIA	DiTera® DF	9
THIABENDAZOLE	Arbotect® 20-5	7
OIL OF JOJOBA	oil	7
AMMONIUM PROPIONATE	ammonium propionate	7
DIMETHOATE	dimethoate, Agrisolutions dimate 4E	6
STRYCHNINE	strychnine	6
TALL OIL	oil	6
PYRETHRINS	Buhach, Firmotox®, Parexan®, Ofirmotox®, NA 9184	4
CLOTHIANIDIN	Aloft®, Arena®	4
TEBUFENOZIDE	Confirm®	4
THIAMETHOXAM	Actara®	4
CYHALOFOP BUTYL	Clincher CA®	3
TRIFLOXYSTROBIN	Flint®, Adament®	3
RIMSULFURON	Matrix®, Rimgro™, Steadfast®	3
Z-8-DODECENOL	CheckMate® Puffer CM-OFM	2
ZINC SULFATE	zinc sulfate	1
COTTONSEED OIL	oil	1
STREPTOMYCIN	Agri-Mycin®	1
BETA-CYFLUTHRIN	Tempo®, Leverage 360	1
AZADIRACHTIN	Remix®	1
ALUMINUM PHOSPHIDE	aluminum phosphide	1
BACILLUS SUBTILIS	Serenade® MAX	0
PERMETHRIN	Ambush® 25W, Pounce®	0
HEXYTHIAZOX	Savey®	0
2,4-D, DIETHANOLAMINE SALT	2,4-D	0
INDOXACARB	Avaunt®	0
CODLING MOTH GRANULOSIS VIRUS	Cyd-X®	0
FATTY ACIDS, METHYL ESTERS	Compadre®, First Choice Preserve™	

18. Industry Affiliations and Contact Information for the California Pear Working Group

(As available, the area of regional production is included in parentheses)

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