ALTERNATIVES TO CHLORPYRIFOS AND DIAZINON DORMANT SPRAYS

FRANK G. ZALOM, MICHAEL N. OLIVER, AND DAVID E. HINTON

STATEWIDE IPM PROJECT, WATER RESOURCES CENTER, AND ECOTOXICOLOGY PROGRAM UNIVERSITY OF CALIFORNIA, DAVIS

FINAL REPORT
SEPTEMBER 1999

THIS PROJECT WAS FUNDED THROUGH A CONTRACT WITH THE CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

ACKNOWLEDGEMENTS

This report and the efforts it summarizes are largely the result of the efforts and contributions of several persons representing communities from research, state agencies, and agricultural commodities. The project focused on three main tasks: identifying current knowledge about alternatives to organophosphate dormant sprays; assessment of the viability of these alternatives for purposes of extending knowledge and encouraging an awareness of the need for alternatives; and to highlight new research needed to fill in the gaps of our current knowledge about alternative practices.

In order to more effectively address the tasks, a steering committee was initially formed to advise the authors on sources of information about current alternatives, and to inform us of the level of current knowledge within the agricultural pesticide user communities. Additionally, the committee served as a peer review body for interim and final products of the project. Our sincere appreciation is extended to the members of the steering committee as follows:

CHRIS HEINTZ
ALMOND BOARD OF CALJFORNIA

PHILIP OSTERLI
UC COOPERATIVE EXTENSION STANISLAUS CO.

ANNEE FERRANTI
CALIFORNIA TREE FRUIT AGREEMENT

ROGER DUNCAN
UC COOPERATIVE EXTENSION STANISLAUS CO.

RICHARD RICE
KEARNEY AGRICLJLTURAL CENTER
UNIVERSRIY OF CALJFORNIA

VICTOR DEVLAMING
STATE WATER RESOURCES CONTROL BOARDDIVISION OF WATER QUALITY

CHRISTOPHER FOE
CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD

WALTER BENTLEY
KEARNEY AGRICULTURAL CENTER
UNIVERSITY OF CALIFORNIA

GARY OBENAUF
CA PRUNE ADVISORY BOARD

JAMES MELBAN
CA CLING PEACH ADVISORY BOARD

DAVID M. SUPKOFF
EPA
DEPAR OF PESTICIDE REGLTLANON

JENNY BROOME
UC SAREP PROGRAM

The steering committee provided much of the review of the database on alternatives that was compiled for the purpose of ultimately identifying those practices deemed most viable in terms of efficacy, cost, and environmental safety.

In addition to the steering committee, we wish to thank those who offered review and comment on the draft that preceeded this final report (see Appendix 2) as follows:

Bill Jennings, DeltaKeeper
Max Stevenson, CAFF
Bob Bugg, UC SAREP Program
Jerry Bruns, CA Regional Water Quality Control Board
Lonnie Hendricks, UC Cooperative Extension
Charles Goodman, Department of Food and Agriculture
Susan Kegley, Pesticide Action Network
Frank Limacher, State Water Resources Control Board

ALTERNATIVES TO CHLORPYRIFOS AND DIAZINON DORMANT SPRAYS

ABSTRACT

Movement of organophosphate pesticides (OPs) into surface waters from any source presents an ecological risk, and if water quality standards are exceeded is also illegal. OPs have many uses, both agricultural and urban. Growers cannot control urban uses, but they can take the leadership in reducing the risk of movement into water by using a number of alternative practices identified as being viable. Several of the practices, particularly those targeting peach twig borer, are quite effective. In many cases, the application of oil alone can adequately control scale pests, but in-season sprays may still occasionally be needed. Control of aphids in plums and prunes without dormant sprays is problematic as the most feasible current alternative is monitoring and use of in-season sprays which can be disruptive to natural enemy populations. In general, most of the practices identified are more expensive and complex to use than the conventional OP dormant sprays, but the percent increase in total cost of production is generally low. Best management practices (BMPs) are assumed to reduce the potential for pesticide contamination of surface waters and should be practiced wherever pesticides are applied. Many of the alternative pest control practices described in this report are already being widely practiced, and indications are that the use of OPs on almonds during the dormant season in the Central Valley decreased as much as 50-65% during the period 1992-97.

ALTERNATIVES TO CHLORPYRIFOS AND DIAZINON DORMANT SPRAYS

SECTION 1: PURPOSE

The intent of this document is to identify and contrast alternatives to the use of organophosphate (OP) pesticides as dormant sprays. These alternatives were identified as a result of an extensive review of research on this topic (as listed in the references section of this report). The summary document of research information was subsequently reviewed for accuracy and completeness by various researchers and interest groups.

This document is not intended to be a detailed review of the literature on pest control practices, but rather an overview of information elucidated by our review of this subject. Details on applying the practices can be found in other publications. Neither is it the intent of this document to suggest elimination of OP dormant sprays as options for growers. To the contrary, we believe that it may be possible to use OPs effectively where sound environmental safeguards are assured. Such safeguards include use only in areas where there is typically no surface runoff, where spray and associated drift has no potential for contaminating surface waters, and/or where various other best management practices (BMPs) offer high assurance of OPs being retained on site.

SECTION 2: BACKGROUND

Organophosphates, especially diazinon and chlorpyrifos, have been routinely detected in winter water quality monitoring projects coincident with storm events which follow their application to dormant orchards in the Sacramento and San Joaquin River watersheds. These studies have been conducted by both federal and state agencies, and indicate that small invertebrates are killed when exposed for even short periods to OP levels measured in the two watersheds during winter. These invertebrates are indicators of the health of aquatic food chains and serve as primary food for many larval and juvenile fish. Published and unpublished data demonstrate that rain runoff from orchards are a source of OPs detected in tributaries and rivers. The magnitude and duration of the insecticide-caused toxicity following the mid-winter storm events is such that it is a violation of the Central Valley Water Quality Control Board Basin Plan water quality standard for toxicity. In 1998, the State of California placed the Sacramento River and the San Joaquin River, as well as the associated Delta/Estuary on the Clean Water Act 303(d) list of impaired waterways in part because of elevaated levels of diazinon and chlorpyrifos from dormant spray orchard runoff. These listings necessitate the development of Total Maximum Daily Loads (TMDLs). TMDLs will restrict the quantities of the OPs coming off of specific areas. Diazinon and chlorpyrifos are widely used in California for a variety of urban as well as other agricultural applications, and all uses are subject to restrictions stemming from the TMDL limitations. Additionally, OPs in general are primary targets of the Food Quality Protection Act of 1996 (FQPA).

Because levels of chlorpyrifos and diazinon detected by recent monitoring studies are toxic to the EPA aquatic test species, Ceriodaphnia dubia, and in light of the 303(d) listings and the TMDL development, the California Department of Pesticide Regulation (DPR) has the authority to impose regulatory restrictions on these pesticides at any time. Selecting pest control options that reduce aquatic concentrations of OPs sufficiently to prevent toxicity may prevent regulatory action to restrict or eliminate the use of these materials.

SECTION 3: THE OPTIONS

Dormant sprays have been likened to a light switch that controls all of the lights in a room. The alternative to a single switch is multiple switches for controlling the lights. Similarly, traditional OP dormant sprays prevent occurrence of a number of different pests while alternatives to OP dormant sprays may require several switches to control all of the target pests, making the decision process more complicated and possibly more expensive.

The practices identified in **Table 1** represent those considered to be most viable and worthy of higher consideration. Except for alternate year OP dormant spraying (Option #3), all of these options have been the subject of University of California research; sufficient data exist to substantiate their viability. Viable, for our purposes, refers to practices which, when compared to conventional OP dormant sprays, offer favorable levels of pest control efficacy with comparable ranges of cost while affording a reduced risk of aquatic toxicity. Note that these alternatives can also be variously combined to fit the needs of individual growers and pest situations. As an example, Option #3 is essentially a combination of Options #1 and #2 and intuitively should be viable. Details are also provided in Table 1 for the range of production costs associated with each option as well as the potential for additional costs associated with that practice. Costs associated with potential environmental damage are not discussed. Also listed are the crops suited for treatment with each of the products associated with the alternative practices: almond (Al), apricot (Ap), cherry (C), nectarine (N), peach (P), plum (Pl), and prune (Pr).

SECTION 4: PEST MANAGEMENT PRACTICES CONSIDERED TO BE MOST VIABLE

OPTION #1: CONVENTIONAL DORMANT OP AND OIL SPRAY

It has long been recognized that the best time to use an OP insecticide (diazinon, chlorpyrifos, methidathion, phosmet and others) and oil mixture for treating peach twig borer (PTB), San Jose scale, and aphids on almonds and a variety of stonefruits is during the orchard dormancy period. Beneficial arthropods are less affected during the dormant period and certain other pests can also be controlled at that time. There is also better coverage of the bark for control of the overwintering larvae, scale, and eggs and less conflict with other cultural practices. Further, because there is no crop on the tree, no residue will be deposited on the fruit.

OPTION #2: NO DORMANT TREATMENT WITH IN-SEASON SPRAYS AS NEEDED

It may be possible to skip organophosphate dormant sprays in some years with adequate monitoring of peach twig borer and San Jose scale abundance. This is possible if your orchard has not had a recent history of peach twig borer or scale problems, and will be less of a risk in almonds than other tree crops. If you are growing plums or prunes, aphids can present a problem and skipping a dormant spray without applying an in-season spray is only advisable if there is no recent history of aphid problems.

If no dormant spray is applied, you should monitor for peach twig borer larvae associated with blooms or emerging shoots as well as twig strikes resulting from feeding by the emerging larvae. If larvae are observed associated with blooms or emerging shoots, *Bacillus thuringiensis* (Bt) can be applied during bloom as mentioned later. Once strikes are observed, it is probably too late for bloom time Bt sprays to be effective. If several twig strikes are seen on each tree by mid-April, in-season sprays should be applied for peach twig borer control timed to pheromone trap catches and the phenology model for peach twig borer. Spring sprays (usually applied in May), if needed, would be directed at the first generation peach twig borer larvae using pheromone traps and degree-day calculations. Place 1 trap per 20 acres (but never less than 2 traps in smaller orchards) by March 20 in the San Joaquin Valley and April 1 in the Sacramento Valley. The traps should be hung 6 to 7 feet high in the northern quadrant of the tree, 1 to 3 feet from the outer canopy. Traps should be monitored twice a week and the lure replaced according to manufacturer's directions. Using a 50° F lower threshold and an 88° F upper threshold the optimum timing for first generation larvae is between 400 and 500 degree-days (DD) after the first male is trapped. A degree-day generator is found on the UCIPM Internet site (http://www.ipm.ucdavis.edu) and is also available as a microcomputer program, DDU, available from the UC IPM Project. More detailed information on timing in-season sprays as well as how to identify twig strikes is provided in the *UC Pest Management Guidelines for Almond, Peaches and Nectarines, and Plums and Prunes* available on the UC IPM Internet site and through county UC Cooperative Extension offices, as well as in the UC publications *Integrated Pest Management for Almonds* and *Integrated Pest Management for Stone Fruit.*

If an organophosphate dormant spray is not applied, you should also monitor for San Jose scale in all tree crops, and for the presence of aphids in prunes and plums during the spring. Orchards can be monitored for San Jose scale during the dormant season by inspecting prunings from the treetops, twigs with attached leaves, and loose bark on older trees for the presence of scales. Pheromone traps for male scale, or double-sided sticky tape for crawlers, are used to monitor scale development in the spring. Traps should be placed 6 to 7 feet high in the north or east side of trees by February 25 in the San Joaquin Valley and by March 15 in the Sacramento Valley. Using a 51° F lower threshold and 90° F upper threshold, optimum treatments are timed at 600-700 DD after the beginning of the male flight or 200 DD after crawler emergence begins. Scale parasites can be detected on the traps in March and April. Due to the damage potential of San Jose scale, particularly to stone fruit, annual oil sprays during the dormant or delayed dormant period should be considered to maintain populations at low levels if it is found chronically in an orchard. Dormant oil sprays without an insecticide can also control the eggs of European red mite and brown mite. It is important to use high label rates of oil especially if an insecticide is not included with the spray. If scale populations increase or are already high, insecticides can be applied in May as described above, and in the following dormant season. Some action will probably need to be made in fresh fruit orchards, and when scales are present. Naturally occurring parasites of the San Jose scale will control populations unless they have been disrupted by nonselective pesticides applied during the season. Aphids can be exceptionally damaging in plums and prunes. Monitoring guidelines are described in the *UC Pest Management Guidelines for Plums and Prunes*, and in the UC publication *Integrated Pest Management for Stone Fruit.*

Before dormant sprays were recommended for insect control, many growers applied in-season sprays with residual insecticides for the target pests, often on a calendar basis. This was not favored because the practice was disruptive of naturally occurring biological control programs, and often required a greater number of applications in a season for efficacy. Also, pesticide residues on fruit can be a consideration for in-season sprays, while it is not an issue for dormant sprays. Longer residual pesticides are no longer available or are more restricted, so in-season sprays must be well timed for greater efficacy. If biological control of key or secondary pests is disrupted by in-season sprays, additional sprays may be required for these pests.

OPTION #3: ALTERNATE YEAR DORMANT APPLICATION

In concept, alternate year application of conventional dormant pesticides should reduce potential environmental risks by one-half assuming a mechanism were developed to restrict applications in a given year to half of the orchards on which a dormant spray might be applied. Also, alternate year applications should maintain populations of insect pests at densities lower than would be anticipated in the absence of dormant sprays. In years when conventional pesticides are not applied in the dormant season, monitoring and in-season sprays can be used as described in the previous section. No study has been conducted to conclusively demonstrate that this concept will in fact allow pest populations to be managed below economic levels or if it can reduce levels of overall aquatic contamination sufficient to fall below established regulatory toxicity standards.

OPTION #4: BLOOMTIME SPRAYS FOR PEACH TWIG BORER

Peach twig borer can be controlled during bloom with well-timed treatments of Bt, but this treatment will not control the other pests like San Jose scale that are normally controlled by the dormant spray. Over 100,000 acres of California orchards now use this approach. In many almond and prune orchards, the bloomtime Bt sprays may provide satisfactory control without further in-season treatments, but additional treatments will probably be necessary in peach and nectarine orchards. Guidelines for using Bt at bloom are available in the *UC Pest Management Guidelines for Almond, Peaches and Nectarines,* and *Plums and Prunes.* If this approach is used, dormant prunings should be examined annually to determine if scale populations are increasing and if naturally occurring parasites are providing control. No scale outbreaks were observed in a three year study of almond and prune orchards throughout the San Joaquin and Sacramento Valleys where only bloomtime Bt sprays for peach twig borer control were applied. One prune orchard using this approach which was not part of the study was confirmed to have had an outbreak with no observed scale parasitism present. Oil sprays alone applied during the dormant season will provide control of European red mite, brown mite and low populations of San Jose scale. Oil sprays alone have minimal impact on overwintering peach twig borer larvae.

OPTION #5: SPINOSAD AS A DORMANT SPRAY

Spinosad (Success) is a newly registered reduced-risk pesticide that has been shown to control peach twig borer as effectively as OPs when used as a dormant spray. However, like Bt it does not control scales or aphids, so these pests must be monitored as previously described. Because it is not labeled on all tree crops, always check the label before considering its use.

OPTION #6: CONVENTIONAL NON-OP PESTICIDES

Pesticides belonging to chemical classes other than organophosphates, including pyrethroids (permethrin and esfenvalerate) and carbamates (carbaryl), have been used for control of peach twig borer in the delayed dormant or dormant season. Specific label restrictions preclude the use of certain of these products on some crops and sites, so it is necessary to examine the label carefully to see if it is possible to apply a given product to a specific crop.

The pyrethroids are not as effective as OPs in controlling scales, and another approach should be considered if scales are present in orchards. Pyrethroid use has been increasing during the 1990's with a corresponding decrease in the amount of OPs applied. Residues of the pyrethroid insecticides permethrin and esfenvalerate persist on bark and may impact naturally occurring predator mites for extended periods of time after dormant season and in-season applications. Mite outbreaks that result from the use of pyrethroids will require additional pesticides (miticides) to be applied for their control.

While the pyrethroids remain effective for control of peach twig borers in most areas, greatly increased tolerance of the peach twig borer to pyrethroids has been identified in the Sacramento Valley, raising the possibility of resistance. In general, insects become resistant to pyrethroids more rapidly than for the other classes of pesticides registered for this use.

Some registered products have not become widely used in the dormant season because of possible effects on non-target organisms or because of label restrictions. For example, carbaryl can not be used in orchards where honeybees are present, and endosulfan use is restricted near water or wetlands.

All of these conventional pesticides can affect nontarget organisms in water, but the potential for offsite movement from runoff has not been well studied. If any conventional pesticides are applied as dormant sprays, they should be applied so as to prevent their movement into surface waters.

OPTION #7: PHEROMONE MATING DISRUPTION

Mating disruption with sex pheromones is a relatively new method for control of peach twig borer. It has been shown to be effective against peach twig borer in almond, peach and nectarine orchards, with a few exceptions. Mating disruption is most effective in orchards with lower endemic moth populations and orchards that are not close to other, untreated, peach twig borer hosts which can be sources of mated females. It is also most effective when used on an areawide basis. Other factors that reduce efficacy of mating disruption include small orchard size, uneven terrain, reduced pheromone application rates and improper treatment timing. Cost of the material and its application is high relative to pesticide treatments, and has been a limiting factor to more widespread use. The cost of this approach can be reduced in peaches and nectarines when it is applied coincident with mating disruption for the oriental fruit moth. Because scales and aphids are not controlled by mating disruption, these pests must be monitored as previously described.

SECTION 5: BEST MANAGEMENT PRACTICES

Best Management Practices (BMPs) aimed at protecting water quality have been identified which are intended to mitigate the use of OPs specifically, but their use might also help prevent offsite movement of the other conventional pesticides as well. The continued availability of many pesticides like OP dormant sprays depends on their being used wisely and in conjunction with alternative pest control practices. In 1996, several manufacturers of OPs which are used as dormant sprays collaborated with one another and with the Department of Pesticide Regulation to produce a publication, *Best Management Practices for Protecting Water Quality in California*, which identifys several practices which may contribute to protecting surface waters. More recently, the Coalition for Urban/Rural Environmental Stewardship (CURES) has produced a series of publications detailing the methods and importance of best management practices. Among the BMPs are detailed suggestions for proper mixing and loading of pesticides, sprayer calibration, spray drift avoidance, and container and waste water disposal. BMP cultural tactics include planting vegetation strips along waterways and creating berms to contain water on site. Maintaining an orchard floor vegetation cover may also be beneficial to reducing water movement offsite.

SECTION 6: PRACTICES IDENITFIED BUT NOT CONSIDERED VIABLE

A number of pest management options have been studied to control the target pests, and these were also identified by our research review. Some of the options were not considered viable due to issues arising from one or more selection criteria as previously described i.e. economic implications, efficacy of treatment, and risk to aquatic resources. Options that were considered to have promise, but which were not included among those described as viable include:

- -Use of OPs and carbamates as a dormant spray at standard and reduced rates without applying BMPs (high potential for environmental impact)
- -Use of crop covers to enhance biological control (variable efficacy for target pests, more research needed)
- -Decreased nitrogen fertilization (variable efficacy for target pests)
- -Use of potassium nitrate (variable efficacy for target pests)
- -Parasite and predator releases (variable efficacy for target pests)
- -Delayed application of oil sprays for aphid control on plums and prunes (variable efficacy, more research needed)
- -Use of insect growth regulators (not registered for use, unknown environmental impact)
- -Use of cryolite (not registered for use, only applicable for PTB, unknown environmental impact)

TABLE 1. CONVENTIONAL DORMANT SPRAYS AND OPTIONS: COMMENTS ON ECONOMICS, EFFICACY, AND ENVIRONMENTAL RISK.

Pest Management Options	**Economic Implications:** **Ranges of Cost Scenarios with Most Likely Cost (MLC). Range Determined by Options and Additional Costs Selected (refer to Appendix I for details)**	**Pest Control Efficacy and Risks for Growers**	**Risk to Aquatic Resources**
Option #1 Conventional dormant OP and oil spray.	Cost includes cost of monitoring. Range = $64.60 – 131.40/acre MLC= $85.40/acre	Effective for PTB and aphids. Effective in most areas for San Jose Scale but some resistance identified in Central San Joaquin Valley.	High risk if there is runoff or drift into surface waters.
Option #2 No dormant OP treatment and in-season sprays only as needed. Dormant oil spray applied.	Pest monitoring is recommended. Variable cost of in-season treatment as applications can vary from zero (low scenario) to multiple (high scenario) depending on results of monitoring. Additional costs of treating for secondary pests if disrupted by in-season sprays. Low = $58.65 – 80.65/acre MLC= $75.65/acre Moderate I = $80.60 – 263.85/acre $110.45/acre Moderate II = $111.90 – 258.42/acre $145.73/acre High I= $124.50 – 630.25/acre $180.05/acre High II = $218.40 – 613.96/acre $285.89/acre	Effective for PTB, San Jose scale, and aphids depending on the pesticide used in season as pesticides have different levels of efficacy for different species. May result in secondary pest outbreak depending on the pesticide used, which could induce secondary outbreaks of spider mites and other pests requiring additional in-season treatments. Careful monitoring of pests is necessary to decide if an in-season pesticide application is needed.	High risk (for OP), moderate risk (for non-OP) if used in close proximity to water or irrigation drains or if late season rains occur.
Option #3 Alternate year dormant applications. Dormant oil spray applied yearly.	Same comments as for Option 2. Low = $61.63 – 106.03/acre MLC= $80.53/acre Moderate I = $72.60 – 197.63/acre $87.93/acre Moderate II = $88.25 – 194.91/acre $115.57/acre High I = $94.55 – 380.83/acre $132.73/acre High II = $141.50 – 372.68 $178.40/acre	Same comments as for Option #2 PTB, scale, and aphid populations are reduced in years when dormant oil and OP spray is applied so that there would presumably be less pest preswsure during the year when the spray has not been applied, however no research has been conducted to test this. The same comments as for Option #2 apply to the alternate years when the dormant spray is not applied.	High risk from dormant spray if there is runoff or drift into surface waters. High risk from in-season sprays if used in close proximity to water or irrigation drains or if late season rains occur.
Option #4 Bloomtime Bt sprays. Dormant oil spray applied.	Requires two or more Bt applications for control of PTB only. Cost of two applications similar to a dormant OP application if applied at same time as fungicides to reduce application costs. Pest monitoring may indicate that in-season sprays are needed. Low = $50.25 – 91.90/acre MLC= $67.25/acre Moderate I = $80.25 – 121.90/acre $97.25/acre Moderate II = $103.05 – 283.10/acre $132.05/acre High = $148.65 – 605.50/acre $201.65/acre	Effective against PTB, and with sufficient oil applied at high volume in the dormant season is effective against moderate populations of scales. Will not control aphids, so in-season spray for this pest may be necessary in prunes and plums.	Low risk.
Option #5 Spinosad + oil as a dormant spray.	Pest monitoring recommended and may indicate that in-season sprays are needed (moderate and high scenarios). Low = $58.65 – 80.65/acre MLC= $75.65/acre Moderate I = $88.65 – 110.65/acre $105.65/acre Moderate II = $111.45 – 271.85/acre $140.45/acre High = $157.05 – 594.25/acre $210.05/acre	Effective against PTB, and with sufficient oil applied at high volume in the dormant season is effective against moderate populations of scales. Will not control aphids, so in-season spray for this pest may be necessary in prunes and plums.	Low risk.
Option #6 Conventional Non-OP Pesticides as dormant sprays.	Costs include cost of monitoring. Cost of pesticide depends on material chosen. Low I = $63.65 – 110.41/acre MLC= $80.65/acre Low II = $86.45 – 271.61/acre $115.45/acre Moderate I = $134.70 – 419.62/acre $180.53/acre Moderate II = $132.05 – 594.01/acre $185.05/acre High = $276.80 – 1038.04/acre $380.29/acre	Pyrethroids are not as effective as OPs for scale control. Effective in most areas for PTB control, but some resistance identified in the Sacramento Valley. May have to treat in-season for San Jose scale and/or mites based on pest monitoring. Pyrethroid residues have been found to persist on tree bark and can disrupt predators of spider mites thereby requiring application of in-season miticide sprays.	Pyrethroids are quite toxic to fish, but are considered low risk due to presumably low potential for runoff. Carbamates are considered medium risk.
Option #7 Pheromone mating disruption. Dormant oil spray applied.	Cost of application and possibly for the pheromone itself can be reduced for peaches and nectarines if applied with pheromone mating disruption for oriental fruit moth. Pest monitoring recommended. Additional costs may be incurred for in-season sprays for other pests if needed. Low = $147.95 – 169.95/acre MLC= $164.95/acre Moderate = $177.95 – 199.95/acre $194.95/acre High I = $200.75 – 361.15/acre $229.75/acre High II = $246.35 – 683.55/acre $299.35/acre	Variable results for PTB and dependent on pest densities, formulation and application of pheromone, and environmental factors. Sufficient oil applied at high volume in the dormant season is effective against moderate populations of scales. Will not control aphids, so in-season sprays may be necessary in prunes and plums.	Low risk .

SECTION 7: IMPORTANT ECONOMIC IMPLICATIONS

Most data on alternative strategies have been developed for almonds, peaches and prunes. However, many similarities exist in pests controlled during the dormant season by organophosphate and oil dormant sprays for apricots, cherries, nectarines and plums. Most of the organophosphates applied to orchard crops during the dormant season are applied to these crops. Dormant sprays are also applied to apples, pears and walnuts, but the majority of these orchards are not treated in the dormant season. Peach twig borer is not a pest of apples, pears and walnuts as it is on the other orchard crops, and sprays that are applied to these crops usually target several species of scales. High rate applications of Supreme oil alone are generally regarded as sufficient to control scales on apples and pears, but some pear orchards occasionally receive an OP application with the oil depending on scale species present and level of infestation present. Walnuts can not be treated with oil in the dormant season, and when a dormant spray is applied for scales the recommended material is methidathion (Supracide).

No cost study comparing conventional organophosphate dormant sprays to alternative practices has been published. Table 1 presents a summary of costs associated with the application of conventional organophosphate and oil dormant sprays and 6 other feasible options that could be substituted for the organophosphate and oil dormant spray on almond, apricot, cherry, nectarine, peach plum and prune. The table also presents summaries of pest control efficacy and risks to growers, and risk estimates to aquatic resources for each option. Details of specific costs and how costs associated with each of the options were derived are presented in Appendix 1. Where a specific chemical is registered on fewer than all of the target crops, the crops for which the chemical is registered are identified. Apples, pears and walnuts are not considered because the use of dormant season organophosphates on these crops is limited.

Costs associated with the organophosphate dormant spray and feasible practices considered may include the cost of materials applied (including Supreme oil), pesticide application(s), and monitoring by a Pest Control Adviser (PCA). The range of costs vary dramatically for most options due to variation in costs for the dormant season pesticides and their application, in-season pesticides and their application that might be warranted if sufficient pest populations are found to exist, and employing a pest control advisor to monitor orchards. Costs will also vary by farm size, so all costs presented are standardized for a 100 acre orchard. Costs of chemicals are based on average retail prices obtained from the Department of Agricultural and Resource Economics at UC Davis, John Taylor Fertilizers and Hughson Chemicals. Application costs are based on average prices obtained from the Department of Agricultural and Resource Economics at UC Davis, and from Richard Coviello, UC Cooperative Extension Entomology Farm Advisor in Fresno County who obtained estimates from two different applicators. Monitoring costs were obtained from two private pest control advisers, and represent the average per acre contract cost for almonds and for stone fruits.

Several scenarios are presented for each option as some costs are fixed because the practices are required while others are variable because a practice may be desirable but not essential. Monitoring is one example of such a nonessential cost, but one that is strongly recommended. The conventional organophosphate and oil dormant spray as well as non-organophosphate dormant sprays are typically applied by growers without paying for monitoring. However, it can be argued that better monitoring of pest populations is a cost effective strategy since damage by a range of pests can be prevented and better control decisions made through increased monitoring. Therefore, for Option 1, costs of the conventional organophosphate and oil dormant spray are presented with monitoring costs included. Additional scenarios are presented which depend on the number of in-season sprays that might be warranted based on pest monitoring results. Although the need for in-season applications can not be predicted, the number of in-season sprays needed for pests that can also be controlled in the dormant season will range from 0 to 3.

There exists a range of costs for each scenario, and the highest and lowest costs are presented in **Table 1.** Pesticide prices are the major contributor to this variability, although application costs also differ depending on if they are applied as concentrate or dilute applications, if they are applied by the grower or a custom applicator, or by air instead of ground. Pesticide products are considered if they are registered for use on at least one of the crops, although several of the products are not commonly used. Although each grower's choice of products and services will depend on their individual situation, it is possible to make assumptions about which scenario is most likely to be adopted by most growers. These are also provided in **Table 1** and **Appendix 1**, and should not be considered absolute, but rather as point of references. Lowest and highest costs (including monitoring) of several of the scenarios are also presented on **Figure 1.**

The Department of Agricultural and Resource Economics at UC Davis, in consultation with UC Cooperative Extension Farm Advisors, develops production cost studies for several California crops. Table 2 presents the changes in pest control and total production costs expected from switching from conventional dormant OP+monitoring (Option #1) to alternative practices (Options #2-#6) for almonds, prunes, cling peaches and cherries grown in the Central Valley of California (based on 1998-99 cost of production data).

TABLE 2. CHANGES IN PEST CONTROL COSTS AND TOTAL PRODUCTION COSTS FOR ALTERNATIVE PRACTICES (OPTIONS #2-#6) VS. CONVENTIONAL DORMANT OP+MONITORING FOR ALMONDS, PRUNES, CLING PEACHES AND CHERRIES GROWN IN THE CENTRAL VALLEY OF CALIFORNIA. SEE TABLE 1 FOR DESCRIPTION OF OPTIONS AND ASSOCIATED RANGE OF COSTS.

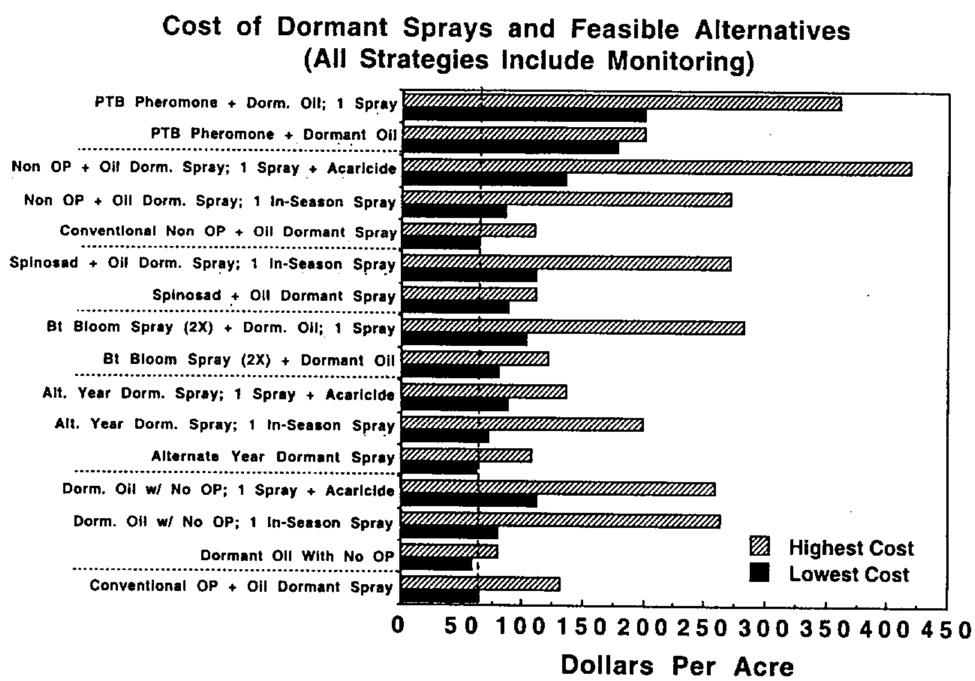
OPTION# AND SCENARIO CATEGORIES	MOST LIKELY COSTS	DIFFERENCE IN COST FROM OPTION #1	% DIFFERENCE IN PEST CONTROL COST	% DIFFERENCE IN TOTAL PRODUCTION COST[1]			
				ALMOND	PRUNE	CLING PEACH	CHERRY
2 LOW	75.65	-9.75	-11.4	-0.3	-0.3	-0.2	-0.1
2 MODERATE I	110.45	+25.05	+29.3	+0.9	+0.7	+0.6	+0.3
2 MODERATE II	145.73	+60.33	+70.6	+2.0	+1.8	+1.5	+0.6
2 HIGH I	180.05	+94.65	+110.8	+3.2	+2.8	+2.4	+1.0
2 HIGH II	285.89	+200.49	+234.8	+6.8	+5.8	+5.1	+2.1
3 LOW	80.53	-4.87	-5.7	-0.2	-0.1	-0.1	-0.1
3 MODERATE I	87.93	+2.53	+3.0	+0.1	+0.1	+0.1	0.0
3 MODERATE II	115.57	+30.17	+35.3	+1.0	+0.9	+0.8	+0.3
3 HIGH I	132.73	+47.33	+55.4	+1.6	+1.4	+1.2	+0.5
3 HIGH II	178.40	+93.00	+108.9	+3.2	+2.7	+2.4	+1.0
4 LOW	67.25	-18.15	-21.3	-0.6	-0.5	-0.5	-0.2
4 MODERATE I	97.25	+11.85	+13.9	+0.4	+0.3	+0.3	+0.1
4 MODERATE II	132.05	+46.65	+54.6	+1.6	+1.4	+1.2	+0.5
4 HIGH	201.65	+116.25	+136.1	+3.9	+3.4	+3.0	+1.2
5 LOW	75.65	-9.75	-11.4	-0.3	-0.3	-0.2	-0.1
5 MODERATE I	105.65	+20.25	+23.7	+0.7	+0.6	+0.5	+0.2
5 MODERATE II	140.45	+55.05	+64.5	+1.9	+1.6	+1.4	+0.6
5 HIGH	210.05	+124.65	+146.0	+4.2	+3.6	+3.2	+1.3
6 LOW I	80.65	-4.75	-5.6	-0.2	-0.1	-0.1	-0.1
6 LOW II	115.45	+30.05	+35.2	+1.0	+0.9	+0.8	+0.3
6 MODERATE I	180.53	+95.13	+111.4	+3.2	+2.8	+2.4	+1.0
6 MODERATE II	185.05	+99.65	+116.7	+3.4	+2.9	+2.5	+1.1
6 HIGH	380.29	+294.89	+345.3	+10.0	+8.6	+7.5	+3.1
7 LOW	164.95	+79.55	+93.1	+2.7	+2.3	+2.0	+0.8
7 MODERATE	194.95	+109.55	+128.3	+3.7	+3.2	+2.8	+1.2
7 HIGH I	229.75	+144.35	+169.0	+4.9	+4.2	+3.7	+1.5

[1] 1998 VALUES FOR TOTAL COST OF PRODUCTION PER ACRE ARE: ALMOND = $2,944; PRUNE = $3,437; CLING PEACH = $3,910; CHERRY = $9,370.
TOTAL COSTS = OPERATING COSTS+CASH COSTS+NON-OVERHEAD COSTS.
SOURCE: STUDIES DONE BY THE DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS, COOPERATIVE EXTENSION, UNIVERSITY OF CALIFORNIA, DAVIS.

Embedded within these costs are costs associated with pest control (Karen Klonsky, UC Cooperative Extension, Ag Economics). For almonds, dormant spray costs were estimated to be $66.00 per acre and in-season 'worm and mite' treatments as $90.00 per acre. For cherries, dormant spray costs were estimated to be $79.00 per acre and in-season sprays for 'worms', leafhoppers, and mites were estimated to be $144.00 per acre. For cling peaches, dormant spray costs were estimated to be $69.00 per acre, Bt bloom sprays as $108.00 per acre and in-season peach twig borer and oriental fruit moth sprays as $101.00 per acre. Oriental fruit moths are not controlled by the dormant spray as are peach twig borers, but conventional sprays applied during the season for either pest may also affect the density of the other. For prunes, dormant spray costs were estimated to be $38.00 per acre, and in season insecticide sprays to be $55.00 per acre. Except in the case of BT bloom sprays on cling peaches, these cost estimates are for the conventional pest management approach. The options other than conventional OP+Oil dormant sprays described in our study are not included in the aforementioned studies. Costs associated with potential environmental damage resulting from the use of any of the alternatives were not a consideration of this report.

An evaluation of economics should not discount the economics of environmental stewardship. Virtually every aspect of production agriculture carries with it a set of costs and risks. Costs are most evident when we think of the capital costs involved with producing a commodity i.e. labor, equipment, supplies, and taxes. Risks include the vagaries of weather and the outbreaks of pests. Less obvious are the costs and risks that accompany the constraints to production from forces outside of nature; constraints such as regulatory actions and/or consumer avoidance. In particular, we suggest that there are potential costs to the agricultural industry anytime its commitment to environmental stewardship is questioned. Acceptance of this assumption and a willingness to voluntarily adopt production practices which value environment costs as well as production costs can be an investment for which dividends far outweigh traditional bottom-line economic returns.

FIGURE 1:



SECTION 8: DEFINING RISK TO AQUATIC RESOURCES

In establishing relative risks to aquatic resources, we have considered only the active ingredients. Where data exist, we have considered laboratory toxicity assay results reported as that concentration at which 50% of the test organisms die during an 48 or 96 hr acute test (LC50, potential for off- site movement, and field samples of surface waters (water column only). For certain of the active ingredients, there are no water quality criteria. It is important to note that our considerations do not include sediment toxicity. For pyrethroids, these considerations warrant future research (see research needs section). For example, for organophosphates, off- site movement has been demonstrated and concentrations in receiving waters have been sufficient to cause toxicity in tests with Ceriodaphnia dubia; accordingly, these compounds were given a relative risk of **high**. For carbamates, the relative risk to aquatic resources was **medium**; reflecting less verification of off-site movement and less toxicity detects in receiving water toxicity tests. Pyrethroids were given a relative risk of **low** based on the lack of detection of water column toxicity tests which coupled with their increased usage suggest that they are not moving off-site. However, their acute toxicity to fish and invertebrates, when bioavailable (laboratory toxicity tests) suggest that these compounds should receive additional attention under field conditions (see research needs section). For these compounds when formation of mixtures of various agents could occur in receiving waters, we know little about possible interactions that could form a risk to aquatic resources.

It should also be noted that the "Risk to Aquatic Resources" column of **Table 1**indicates the risk for in-season use of OPs as being high. This is based on data that demonstrates high concentrations of OP pesticides in the San Joaquin River during several irrigation seasons. The precise source of these OPs is not known though it is assumed that they originate from agricultural use. Potentially, surface waters are as susceptible to spray drift and OPs in irrigation runoff during the in-season as they are to spray drift and rainfall runoff during the dormant season. Considering that flow rates of surface waters are much reduced during the in-season, the actual amount of OP material capable of causing high concentrations in these waters is less than when flow volumes are high.

RELATIVE RISK ESTIMATES

Ambush 25 SP - relative risk = low
Asana XL - relative risk = low
Bacillus thuringiensis (Bt) – relative risk = low
Pounce 3.2 EC - relative risk = low
Spinosad (Success) – relative risk = low
Sex pheromones – relative risk = low

Carbaryl - relative risk = medium
Carzol SP - relative risk = medium
Sevin – relative risk = medium

Diazinon - relative risk = high
Guthion - relative risk = high
Imidan - relative risk = high
Lorsban – relative risk = high
Supracide – relative risk = high

Agri-Mek 0.15 EC
Apollo SC
Kelthane 35
Omite 30 WP
Supreme Oil
Trilogy
Vendex

SECTION 9: RESEARCH NEEDS

In the course of our review of efficacy and environmental studies that have been done on organophosphate dormant sprays and other options for controlling the pests normally controlled by dormant sprays, several research needs were identified. We suggest the following research topics as "very high" and "high" priority, and recognize that this is not an exhaustive list. No doubt other alternative practices might well be identified given the benefit of funded research.

VERY HIGH PRIORITY

New pesticides for San Jose scale - insect growth regulators and other new classes of compounds that are not currently registered for use on crops that utilize dormant sprays may provide effective control. Efficacy studies need to be conducted. If proven effective, their registration through US EPA and CA DPR may need to be assisted through the IR-4 minor use process since companies producing the materials may not choose to register these products on the crops in question. Research to determine the effects of any potential new pesticide on aquatic organisms should be conducted.

Biological control for San Jose scale - San Jose scale is typically under good biological control in orchards. Research on causes of San Jose scale outbreaks and how native natural enemies can be more reliably enhanced in orchards to provide control is needed.

New pesticides for aphids on plums and prunes - imidachloprid and products from other new classes of compounds that are not currently registered for use on crops that utilize dormant sprays may provide effective control. Efficacy studies need to be conducted. If proven effective, their registration through US EPA and CA DPR may need to be assisted through the IR-4 minor use process since companies producing the materials may not choose to register these products on the crops in question. Research to determine the effects of any potential new pesticide on aquatic organisms should be conducted.

Biological control for aphids - importation of biological control agents for control of aphids on plums and prunes presents a potential option for reducing the need to spray for these pests.

Timing of winter applications- since most rainfall occurs during the period of January through March when most of the dormant sprays are applied, research could be conducted to determine the efficacy against target pests when treatments are moved to an earlier period of time such as mid December, when less rainfall is likely to occur and the rainfall that does occur is more likely to be absorbed into the soil instead of running off.

Pesticide budget - there are many mechanisms by which pesticides could potentially leave orchards, for example by runoff, volatilization, drift or on or in application equipment and containers. Research could be conducted to determine how much pesticide applied to an orchard remains in the orchard, and the pathways through which pesticide can leave the site of application. Such research could help identify opportunities for mitigation.

HIGH PRIORITY

Alternate year dormant spray applications - there is need to validate the efficacy of this approach over several years and at several sites as well as determine the potential for this approach to reduce toxicity to aquatic organisms.

Reduced rates - additional research is needed in different locations and at different pest population pressures to validate the efficacy of this approach as well as to determine the potential for this approach to reduce toxicity to aquatic organisms.

Pheromones - this approach holds promise for controlling peach twig borer, but additional research is needed to reduce the costs of production and application as well as to improve consistency of results.

Pest monitoring - research is needed to simplify monitoring for peach twig borer, San Jose scale and aphids to reduce the costs of monitoring and to more reliably decide on when dormant sprays and in-season are needed, reducing risks for growers.

Ground covers – studies are needed to validate the limited research on reduced runoff from orchards on which vegetation is growing. What is the impact of planted cover crops as opposed to maintaining weed cover during the winter? How much of the orchard floor needs to be covered?

The relative risk to aquatic resources is ranked after consideration of only the active ingredients. Given the number of different treatments and the multitude of active ingredients, some consideration of possible interaction of components in potential risk is needed.

For pyrethroids, the laboratory exposures indicate that aquatic organisms (fishes and invertebrates) are particularly sensitive to toxic effects of these compounds. Their persistence may mean that they will be transferred off site. If so, are they bioavailable to fishes in the water column, to invertebrates in the sediments? What is the sediment toxicity after pyrethroids are transferred?

In addition, so-called inert ingredients need to be evaluated for their potential to cause risk to aquatic resources.

We suggest that results from such studies could help alleviate the need for or impact of the traditional organophosphate and oil dormant sprays if the options identified prove economically viable and environmentally acceptable.

SECTION 10: CONCLUSIONS

Viable altemtives exist for pest control that can either reduce or replace the use of OPs in the dormant season, but more research is needed to address those pest situations which still may occur as a result of OPs not being used in the dormant season. In the absence of dormant OP treatments, some pest situations are currently still best addressed by in-season use of OPs. Interestingly, an examination of the pesticide use database of the California Department of Pesticide Regultion reveals that the number of acres of almonds treated with OPs during the dormant season dropped by 50-65% throughout the Sacramento and San Joaquin Valleys during the period of 1992-97 (Lynn Epstein, Plant Pathology UC Davis, personal communication). The decline in OP use appears to be the result of increased use of Bt and pyrethroid pesticides. The decline also cooincides with University of California research and Cooperative Extension activities which have tested and promoted the use of Bt and the other alternative practices described in this report. A subset of the many orchardists who have successfully switched to alternative practices include participants in the Biologically Integrated Orchard Systems (BIOS) program. Cooperating with growers in this effort are the University of California Sustainable Agriculture Research and Education Program, UC Statewide Integrated Pest Management Program, UC Cooperative Extension, the USDA's Farm Service Agency, the federal Natural Resources Conservation Service, the Community Alliance with Family Farmers (CAFF), and independent pest control advisors.

September 1999

APPENDIX 1. CONVENTIONAL DORMANT SPRAYS AND OPTIONS: COMMENTS ON EFFICACY, RISK TO AQUATIC RESOURCES, AND COSTS. COSTS BASED ON 100 ACRE APPLICATION.

1. CONVENTIONAL DORMANT OP AND OIL SPRAY

EFFICACY: Effective for PTB and aphids. Effective in most areas for San Jose Scale but some resistance identified in Central San Joaquin Valley.
RISK TO AQUATIC RESOURCES: High risk if there is runoff or drift into surface waters.
COSTS:

A. Supreme Oil @ 4 gal/acre	Al, Ap, C, N, P, Pl, Pr	$11.80/acre
plus		
B. Choose one of these organophosphates		
1. Lorsban 4 E @ 2 qt/acre		14.80
2. Diazinon 50 WP @ 4 lb/acre		18.60
3. Supracide 25 WP @ 8 lb/acre		59.60
plus		
C. Choose one of these application methods		
1. Ground application, grower, concentrate, 100 gal/acre		20.00
2. Ground application, custom, concentrate, 100 gal/acre		22.00
3. Ground application, grower, dilute, 400 gal/acre		25.00
4. Ground application, custom, dilute, 400 gal/acre		30.00
5. Aerial application		8.00
plus (possible additional cost - recommended)		
D. Monitoring, private PCA, $/acre/year.		30.00 (mid-range cost)
Almonds, 22-28		
Peaches, 30-40		

RANGE OF COST FOR SCENARIOS WITHOUT MONITORING= OIL+OP +APPLICATION

A+B1+C5 = **LOW**	11.80+14.80+8.00 =	**$34.60/acre**
A+B3+C4 = **HIGH**	11.80+59.60+30.00 =	**$101.40/acre**
A+B2+C1 = MOST LIKELY	**11.80+18.60+20.00 =**	**$50.40/acre**

RANGE OF COST SCENARIOS WITH MONITORING= OIL+OP+APPLICATION+MONITORING

A+B1+C5+D = **LOW**	11.80+14.80+8.00+30.00 =	**$64.60/acre**
A+B3+C4+D = **HIGH**	11.80+59.60+30.00+30.00 =	**$131.40/acre**
A+B2+C3+D = MOST LIKELY	**11.80+18.60+25.00+30.00 =**	**$85.40/acre**

2. DORMANT OIL SPRAY ONLY, NO DORMANT OP TREATMENT, MONITORING, IN-SEASON SPRAY AS NEEDED.

EFFICACY: Effective depending on the pesticide used in season. May result in secondary pest outbreak depending on the pesticide used.
RISK TO AQUATIC RESOURCES: High risk if used in close proximity to water or irrigation drains or if late season rains occur.
COSTS: Add cost of monitoring. Variable cost of in-season treatment as applications can vary from zero to multiple depending on results of monitoring. Additional costs of treating for secondary pests if disrupted by in-season sprays.

A. Supreme Oil, dormant spray @ 6-8 gal/acre	$20.65/acre (mid-range cost)
plus	
B. Choose one of these application methods for oil spray	
1. Ground application, grower, concentrate, 100 gal/acre	20.00
2. Ground application, custom, concentrate, 100 gal/acre	22.00
3. Ground application, grower, dilute, 400 gal/acre	25.00
4. Ground application, custom, dilute, 400 gal/acre	30.00
5. Aerial application	8.00
plus	
C. Monitoring, private PCA, $/acre/year.	30.00 (mid-range cost)
Almonds, 22-28	
Peaches, 30-40	

plus

D. Choose one of these in-season sprays IF NEEDED. Each will need to be applied 1-3 times based on results of monitoring.

1. Lorsban 4 E @ 2 qt/acre	Al	14.80
2. Guthion 50 WP @ 4 lb/acre	Al, Ap, N, P, Pl, Pr	45.44
3. Supracide 25 WP @ 8 lb/acre	Al	59.60
Footnote: Supracide has a long PHI and would only be applied once as an in-season spray.		
4. Spinosad (Success) @ 6 oz/acre	Al	30.00
5. Imidan 70 WP @ 4.25 lb/acre	Ap, N, P, Pl, Pr	29.96
6. Diazinon 50 WP @ 3 lb/acre	Ap, C, N, P, Pl, Pr	13.95
7. Trilogy 90 EC @ 2 gal/acre (2 or more apps)	Pr	139.20 (for 2 applications)
USE OF THE FOLLOWING IN-SEASON SPRAYS WILL LIKELY REQUIRE THE ADDITIONAL USE OF A MITICIDE, SO ALSO CHOOSE ONE FROM SECTION F BELOW		
8. Sevin 80 S @ 1.25 lb/acre + miticide	Al, Ap, C, N, P, Pl, Pr	7.43
9. Asana XL @ 4-6 oz/acre + miticide	N, P, Pr	5.00 (mid-range cost)
10. Carzol SP @ 0.125 lb/acre + miticide	Pr	5.38
11. Ambush 25 SP @ 12.8–25.6oz/acre+miticide	Al, P	29.76 (mid-range cost)
12. Pounce 3.2 EC @ 8 – 16 oz/acre + miticide	Al, P	22.95 (mid-range cost)

plus

E. Choose one of these application methods for in-season spray IF NEEDED

1. Ground application, grower, concentrate, 100 gal/acre	20.00
2. Ground application, custom, concentrate, 100 gal/acre	22.00
3. Aerial application	8.00

plus

F. Choose one of these miticides, if using D8-D12 above.

1. Vendex 50 WP @ 2 lb/acre	Al, C, N, P, Pl, Pr	56.42
2. Apollo SC @ 4 oz/acre	Al, Ap, C, N, P	58.28
3. Omite 30 WP @ 7.5 lb/acre	Al, C, N	45.08
4. Kelthane 35 @ 3.5 lb/acre	C, Pr	40.25
5. Agri-Mek 0.15 EC @ 20 oz/acre	Al	126.01
6. Supreme Oil @ 4 gal/acre (2 or more apps)	Al, Ap, C, N, P, Pl, Pr	44.60 (for 2 applications)

Footnote: We assume each miticide is tank-mixed with D8-D12 above. It is possible that the miticide could be applied separately from the in-season pesticide apray in which case additional application costs would apply.

RANGE OF LOW COST SCENARIOS = OIL+APPLICATION+MONITORING

A+B5+C = **LOW**	20.65+8.00+30.00 =	**$58.65/acre**
A+B4+C = **HIGH**	20.65+30.00+30.00 =	**$80.65/acre**
A+B3+C = MOST LIKELY	**20.65+25.00+30.00 =**	**$75.65/acre**

RANGE OF MODERATE COST SCENARIOS I = OIL+APPLICATION+MONITORING+ONE IN-SEASON TREATMENT+APPLICATION

A+B5+C+D6+E3 = **LOW**	20.65+8.00+30.00+13.95+8.00 =	**$80.60/acre**
A+B4+C+D7+2(E2) = **HIGH**	20.65+30.00+30.00+139.20+44.00 =	**$263.85/acre**
A+B3+C+D1+E1 = MOST LIKELY	**20.65+25.00+30.00+14.80+20.00 =**	**$110.45/acre**

RANGE OF MODERATE COST SCENARIOS II= OIL+APPLICATION+MONITORING+ONE IN-SEASON TREATMENT+APPLICATION+ONE MITICIDE TREATMENT

A+B5+C+D9+E3+F4 = **LOW**	20.65+8.00+30.00+5.00+8.00+40.25 =	**$111.90/acre**
A+B4+C+D11+E2+F5 = **HIGH**	20.65+30.00+30.00+29.76+22.00+126.01 =	**$258.42/acre**
A+B3+C+D9+E1+F3 = M. L.	**20.65+25.00+30.00+5.00+20.00+45.08 =**	**$145.73/acre**

RANGE OF HIGH COST SCENARIOS I = OIL+APPLICATION+MONITORING+THREE IN-SEASON TREATMENTS+THREE APPLICATIONS

A+B5+C+3(D6+E3) = **LOW**	20.65+8.00+30.00+3(13.95+8.00) =	**$124.50/acre**
A+B4+C+3(D7+2(E2)) = **HIGH**	20.65+30.00+30.00+3(139.20+44.00) =	**$630.25/acre**
A+B3+C+3(D1+E1) = M. L.	**20.65+25.00+30.00+3(14.80+20.00) =**	**$180.05/acre**

RANGE OF HIGH COST SCENARIOS II = OIL+APPLICATION+MONITORING+THREE IN-SEASON TREATMENTS+THREE APPLICATIONS+THREE MITICIDE TREATMENTS

A+B5+C+3(D9+E3+F4) = **LOW**	20.65+8.00+30.00+3(5.00+8.00+40.25) =	**$218.40/acre**
A+B4+C+3(D11+E2+F5) = **HIGH**	20.65+30.00+30.00+3(29.76+22.00+126.01) =	**$613.96/acre**
A+B3+C+3(D9+E1+F3) = M. L.	**20.65+25.00+30.00+3(5.00+20.00+45.08) =**	**$285.89/acre**

3. ALTERNATE YEAR DORMANT OP APPLICATIONS, DORMANT OIL SPRAY APPLIED YEARLY.

EFFICACY: Effective depending on the pesticide used in season. May result in secondary pest outbreak depending on the pesticide used.
RISK TO AQUATIC RESOURCES: High risk from dormant spray if there is runoff or drift into surface waters. High risk from in-season sprays if used in close proximity to water or irrigation drains or if late season rains occur.
COSTS: Add cost of monitoring. Variable cost of in-season treatment as applications can vary from zero to multiple depending on results of monitoring. Additional costs of treating for secondary pests if disrupted by in-season sprays.

Costs for this treatment option are calculated by adding first year costs as in #1 above, plus second year costs as in #2 above, and then dividing the total by two in order to yield a YEARLY AVERAGE cost. The Most Likely cost for each of the folllowing scenarios is calculated by dividing by 2 the sum of Most Likely High for Year 1 plus Most Likely Low, Medium or High costs for Year 2.

RANGE OF LOW COST SCENARIOS = THE SUM OF YEAR 1 PLUS YEAR 2 COSTS, DIVIDED BY 2

YEAR 1 = OIL+OP +APPLICATION+MONITORING (Logic dictates that consultants hired for monitoring will require yearly contracts).

A+B1+C5+D = LOW	11.80+14.80+8.00+30.00 =	$64.60/acre
A+B3+C4+D = HIGH	11.80+59.60+30.00+30.00 =	$131.40/acre

YEAR 2 = OIL+APPLICATION+MONITORING

A+B5+C = LOW	20.65+8.00+30.00 =	$58.65/acre
A+B4+C = HIGH	20.65+30.00+30.00 =	80.65/acre

LOW = (11.80+14.80+8.00+30.00+20.65+8.00+30.00)/2 = 123.50/2 = **$61.63/acre**
HIGH = (11.80+59.60+30.00+30.00+20.65+30.00+30.00)/2 = 212.05/2 = **$106.03/acre**
MOST LIKELY = (11.80+18.60+25.00+30.00+20.65+25.00+30.00)/2 = (85.40+75.65)/2 = $80.53/acre

RANGE OF MODERATE COST SCENARIOS I =THE SUM OF YEAR 1 PLUS YEAR 2 COSTS, DIVIDED BY 2

YEAR 1 = OIL+OP +APPLICATION+MONITORING

A+B1+C5+D = LOW	11.80+14.80+8.00+30.00 =	$64.60/acre
A+B3+C4+D = HIGH	11.80+59.60+30.00+30.00 =	$131.40/acre

YEAR 2 = OIL+APPLICATION+MONITORING+ONE IN-SEASON TREATMENT+APPLICATION

A+B5+C+D6+E3 = LOW	20.65+8.00+30.00+13.95+8.00 =	$80.60/acre
A+B4+C+D7+2(E2) = HIGH	20.65+30.00+30.00+139.20+44.00 =	$263.85/acre

LOW = (11.80+14.80+8.00+30.00+20.65+8.00+30.00+13.95+8.00)/2 = 145.20/2 = **$72.60/acre**
HIGH = (11.80+59.60+30.00+30.00+20.65+30.00+30.00+139.20+44.00)/2 = 395.25/2 = **$197.63/acre**
M. L. = (11.80+18.60+25.00+30.00+20.65+25.00+30.00+14.80+20.00)/2 = (85.40+110.45)/2 = $97.93/acre

RANGE OF MODERATE COST SCENARIOS II =THE SUM OF YEAR 1 PLUS YEAR 2 COSTS, DIVIDED BY 2

YEAR 1 = OIL+OP +APPLICATION+MONITORING

A+B1+C5+D = LOW	11.80+14.80+8.00+30.00 =	$64.60/acre
A+B3+C4+D = HIGH	11.80+59.60+30.00+30.00 =	$131.40/acre

YEAR 2 = OIL+APPLICATION+MONITORING+ONE IN-SEASON TREATMENT+APPLICATION+ONE MITICIDE TREATMENT

A+B5+C+D9+E3+F4 = LOW	20.65+8.00+30.00+5.00+8.00+40.25 =	$111.90/acre
A+B4+C+D11+E2+F5 = HIGH	20.65+30.00+30.00+29.76+22.00+126.01 =	$258.42/acre

LOW = (11.80+14.80+8.00+30.00+20.65+8.00+30.00+5.00+8.00+40.25)/2 = 176.50/2 = **$88.25/acre**
HIGH = (11.80+59.60+30.00+30.00+20.65+30.00+30.00+29.76+22.00+126.01)/2 = 389.82/2 = **$194.91/acre**
M.L.=(11.80+18.60+25.00+30.00+20.65+25.00+30.00+5.00+20.00+45.08)/2 =(85.40+145.73)/2 = $115.57/acre

RANGE OF HIGH COST SCENARIOS I = THE SUM OF YEAR 1 PLUS YEAR 2 COSTS, DIVIDED BY 2

YEAR 1 = OIL+OP +APPLICATION+MONITORING

A+B1+C5+D = LOW	11.80+14.80+8.00+30.00 =	$64.60/acre
A+B3+C4+D = HIGH	11.80+59.60+30.00+30.00 =	$131.40/acre

YEAR 2 = OIL+APPLICATION+MONITORING+THREE IN-SEASON TREATMENTS+THREE APPLICATIONS

A+B5+C+3(D6+E3) = LOW	20.65+8.00+30.00+3(13.95+8.00) =	$124.50/acre
A+B4+C+3(D7+2(E2)) = HIGH	20.65+30.00+30.00+3(139.20+44.00) =	$630.25/acre

LOW = (11.80+14.80+8.00+30.00+20.65+8.00+30.00+3(13.95+8.00))/2 = 189.10/2 = **$94.55/acre**
HIGH = (11.80+59.60+30.00+30.00+20.65+30.00+30.00+3(139.20+44.00))/2 = 761.65/2 = **$380.83/acre**
M. L.= (11.80+18.60+25.00+30.00+20.65+25.00+30.00+3(14.80+20.00))/2 = (85.40+180.05)/2 = $132.73/acre

RANGE OF HIGH COST SCENARIOS II = THE SUM OF YEAR 1 PLUS YEAR 2 COSTS, DIVIDED BY 2

YEAR 1 = OIL+OP +APPLICATION+MONITORING

A+B1+C5+D = LOW	11.80+14.80+8.00+30.00 =	$64.60/acre
A+B3+C4+D = HIGH	11.80+59.60+30.00+30.00 =	$131.40/acre

YEAR 2 = OIL+APPLICATION+MONITORING+THREE IN-SEASON TREATMENTS+THREE APPLICATIONS+THREE MITICIDE TREATMENTS

A+B5+C+3(D9+E3+F4) = LOW	20.65+8.00+30.00+3(5.00+8.00+40.25) =	$218.40/acre
A+B4+C+3(D11+E2+F5) = HIGH	20.65+30.00+30.00+3(29.76+22.00+126.01) =	$613.96/acre

LOW = (11.80+14.80+8.00+30.00+20.65+8.00+30.00+3(5.00+8.00+40.25))/2 = 283.00/2 = **$141.50/acre**
HIGH=(11.80+59.60+30.00+30.00+20.65+30.00+30.00+3(29.76+22.00+126.01))/2 = 745.36/2 = **$372.68/acre**
M. L. = (11.80+18.60+25.00+30.00+20.65+25.00+30.00+3(5.00+20.00+45.08))/2 = (85.40+285.89)/2 = $185.65/acre

4. BLOOMTIME BT SPRAYS, DORMANT OIL SPRAY APPLIED.

EFFICACY: Effective against PTB, and sufficient oil may be effective against moderate populations of scales. Will not control aphids, so in-season spray for this pest may be necessary in prunes and plums.
RISK TO AQUATIC RESOURCES: Low risk.
COSTS: Requires two or more Bt applications for control of PTB only. Cost of two applications similar to a dormant OP application if applied at same time as fungicides to reduce application costs.

A. Supreme Oil, dormant spray @ 6-8 gal/acre — Al, Ap, C, N, P, Pl, Pr — $20.65/acre (mid-range cost)

plus

B. Choose one of these application methods

1. Ground application, grower, concentrate, 100 gal/acre	20.00
2. Ground application, custom, concentrate, 100 gal/acre	22.00
3. Ground application, grower, dilute, 400 gal/acre	25.00
4. Ground application, custom, dilute, 400 gal/acre	30.00
5. Aerial application	8.00

plus

C. Choose a Bacillus thuringiensis (e.g. Biobit, Dipel, or equivalent)

1. Dipel @ 1 lb/acre for TWO applications	27.50
2. Dipel @ 1 lb/acre for THREE applications	41.25
3. Javelin @ 1 lb/acre for TWO applications	21.60
4. Javelin @ 1 lb/acre for THREE applications	32.40

Footnote 1: No application cost is required if the Bt is applied with the fungicide spray, but it will be required if it must be applied separate from fungicide spray.
Footnote 2: Two sprays are typically applied, but in years with extended emergence of PTB, three sprays may be necessary.

plus (possible additional cost)

D. Monitoring, private PCA, $/acre/year. — 30.00 (mid-range cost)
Almonds, 22-28
Peaches, 30-40

Footnote: This practice is recommended but not required.

plus (possible additional cost)

E. San Jose scale spray, IF NEEDED, choose one of these in-season sprays. Each will need to be applied 1-3 times

1. Lorsban 4 E @ 2 qt/acre	Al	14.80
2. Supracide 25 WP @ 8 lb/acre	Al	59.60

Footnote: Supracide has a long PHI and would only be applied once as an in-season spray.

3. Imidan 70 WP @ 4.25 lb/acre	Ap, N, P, Pl, Pr	29.96
4. Trilogy 90 EC @ 2 gal/acre (2 or more apps)	Pr	139.20 (for 2 applications)

Footnote: This treatment is only required based on monitoring results, and will likely be necessary on ≤ 10% of almond and prune acreage, and a higher but unknown amount of other stonefruit acreage.

F. Choose one of these application methods for in-season SJS spray IF NEEDED

1. Ground application, grower, concentrate, 100 gal/acre	20.00
2. Ground application, custom, concentrate, 100 gal/acre	22.00
3. Aerial application	8.00

RANGE OF LOW COST SCENARIOS = OIL+APPLICATION+BT

A+B5+C3 = **LOW**	20.65+8.00+21.60 =	**$50.25/acre**
A+B4+C2 = **HIGH**	20.65+30.00+41.25 =	**$91.90/acre**
A+B3+C3 = MOST LIKELY	**20.65+25.00+21.60 =**	**$67.25/acre**

RANGE OF MODERATE COST SCENARIOS I = OIL+APPLICATION+BT+MONITORING

A+B5+C3+D = **LOW**	20.65+8.00+21.60+30.00 =	**$80.25/acre**
A+B4+C2+D = **HIGH**	20.65+30.00+41.25+30.00 =	**$121.90/acre**
A+B3+C3+D = MOST LIKELY	**20.65+25.00+21.60+30.00 =**	**$97.25/acre**

RANGE OF MODERATE COST SCENARIOS II = OIL+APPLICATION+BT+MONITORING+ONE IN-SEASON TREATMENT+APPLICATION

A+B5+C3+D+E1+F3 = **LOW**	20.65+8.00+21.60+30.00+14.80+8.00 =	**$103.05/acre**
A+B4+C2+D+E4+F2= **HIGH**	20.65+30.00+41.25+30.00+139.20+22.00 =	**$283.10/acre**
A+B3+C3+D+E1+F1 = M. L.	**20.65+25.00+21.60+30.00+14.80+20.00 =**	**$132.05/acre**

RANGE OF HIGH COST SCENARIOS = OIL+APPLICATION+BT+MONITORING+THREE IN-SEASON TREATMENTS+THREE APPLICATIONS

A+B5+C3+D+3(E1+F3) = **LOW**	20.65+8.00+21.60+30.00+3(14.80+8.00) =	**$148.65/acre**
A+B4+C2+D+3(E4+F2)= **HIGH**	20.65+30.00+41.25+30.00+3(139.20+22.00) =	**$605.50/acre**
A+B3+C3+D+3(E1+F1) = M. L.	**20.65+25.00+21.60+30.00+3(14.80+20.00) =**	**$201.65/acre**

5. SPINOSAD + OIL AS A DORMANT SPRAY.

EFFICACY: Effective against PTB, and sufficient oil may be effective against moderate populations of scales. Will not control aphids, so in-season spray for this pest may be necessary in prunes and plums.
RISK TO AQUATIC RESOURCES: Low risk.
COSTS: Somewhat higher cost than conventional dormant sprays.

A. Supreme Oil, dormant spray @ 6-8 gal/acre — Al, Ap, C, N, P, Pl, Pr — $20.65/acre (mid-range cost)

plus

B. Spinosad (Success) @ 6 oz/acre — 30.00

plus

C. Choose one of these application methods

1. Ground application, grower, concentrate, 100 gal/acre	20.00
2. Ground application, custom, concentrate, 100 gal/acre	22.00
3. Ground application, grower, dilute, 400 gal/acre	25.00
4. Ground application, custom, dilute, 400 gal/acre	30.00
5. Aerial application	8.00

plus (possible additional cost)

D. Monitoring, private PCA, $/acre/year. — 30.00 (mid-range cost)
Almonds, 22-28
Peaches, 30-40

Footnote: This practice is recommended but not required.

plus (possible additional cost)

E. San Jose scale spray, IF NEEDED, choose one of these in-season sprays. Each will need to be applied 1-3 times

1. Lorsban 4 E @ 2 qt/acre	Al	14.80
2. Supracide 25 WP @ 8 lb/acre	Al	59.60
Footnote: Supracide has a long PHI and would only be applied once as an in-season spray.		
3. Imidan 70 WP @ 4.25 lb/acre	Ap, N, P, Pl, Pr	29.96
4. Trilogy 90 EC @ 2 gal/acre (2 or more apps)	Pr	139.20 (for 2 applications

Footnote: This treatment is only required based on monitoring results, and will likely be necessary on ≤ 10% of almond and prune acreage, and a higher but unknown amount of other stonefruit acreage.

F. Choose one of these application methods for in-season SJS spray IF NEEDED

1. Ground application, grower, concentrate, 100 gal/acre	20.00
2. Ground application, custom, concentrate, 100 gal/acre	22.00
3. Aerial application	8.00

RANGE OF LOW COST SCENARIOS = OIL +SPINOSAD+APPLICATION

A+B+C5 = **LOW**	20.65+30.00+8.00 =	**$58.65/acre**
A+B+C4 = **HIGH**	20.65+30.00+30.00 =	**$80.65/acre**
A+B+C3 = MOST LIKELY	**20.65+30.00+25.00 =**	**$75.65/acre**

RANGE OF MODERATE COST SCENARIOS I = OIL +SPINOSAD+APPLICATION+MONITORING

A+B+C5+D = **LOW**	20.65+30.00+8.00+30.00 =	**$88.65/acre**
A+B+C4+D = **HIGH**	20.65+30.00+30.00+30.00 =	**$110.65/acre**
A+B+C3+D = MOST LIKLEY	**20.65+30.00+25.00+30.00 =**	**$105.65/acre**

RANGE OF MODERATE COST SCENARIOS II = OIL +SPINOSAD+APPLICATION+MONITORING+ONE IN-SEASON TREATMENT+APPLICATION

A+B+C5+D+E1+F3 = **LOW**	20.65+30.00+8.00+30.00+14.80+8.00 =	**$111.45/acre**
A+B+C4+D+E4+F2 = **HIGH**	20.65+30.00+30.00+30.00+139.20+22.00 =	**$271.85/acre**
A+B+C3+D+E1+F1 = M. L.	**20.65+30.00+25.00+30.00+14.80+20.00 =**	**$140.45/acre**

RANGE OF HIGH COST SCENARIOS = OIL +SPINOSAD+APPLICATION+MONITORING+THREE IN-SEASON TREATMENTS+THREE APPLICATIONS

A+B+C5+D+3(E1+F3) = **LOW**	20.65+30.00+8.00+30.00+3(14.80+8.00) =	**$157.05/acre**
A+B+C4+D+3(E4+F2) = **HIGH**	20.65+30.00+30.00+30.00+3(139.20+22.00) =	**$594.25/acre**
A+B+C3+D+3(E1+F1) = M. L.	**20.65+30.00+25.00+30.00+3(14.80+20.00) =**	**$210.05/acre**

6. CONVENTIONAL NON-OP PESTICIDES [pyrethroids (permethrin, esfenvalerate), and carbamates (carbaryl)] AS DORMANT SPRAYS.

EFFICACY: Pyrethroids are not as effective as OPs for scale control.
May have to treat in-season for San Jose scale and/or mites.
RISK TO AQUATIC RESOURCES: Pyrethroids are especially toxic to fish.
COSTS: Cost of pesticide depends on material chosen.

A. Supreme Oil @ 6-8 gal/acre — Al, Ap, C, N, P, Pl, Pr — $20.65/acre (mid-range cost)

plus

B. Choose one of these dormant sprays. Each will likely require use of a miticide in-season. Choose a miticide from section G below.

1. Sevin 80 S @ 1.25 lb/acre	Al, Ap, C, N, P, Pl, Pr	7.43
2. Asana XL @4-6 oz/acre	Al N, P, Pr	5.00 (mid-range cost)
3. Ambush 25 SP @ 12.8–25.6oz/acre	Al, P	29.76 (mid-range cost)
4. Pounce 3.2 EC @ 8 – 16 oz/acre	Al, P	22.95 (mid-range cost)

plus

C. Choose one of these application methods

1. Ground application, grower, concentrate, 100 gal/acre	20.00
2. Ground application, custom, concentrate, 100 gal/acre	22.00
3. Ground application,.grower, dilute, 400 gal/acre	25.00
4. Ground application, custom, dilute, 400 gal/acre	30.00
5. Aerial application	8.00

plus (possible additional cost)

D. Monitoring, private PCA, $/acre/year. — 30.00 (mid-range cost)
Almonds, 22-28
Peaches, 30-40

plus (possible additional cost)

E. San Jose scale spray, IF NEEDED, choose one of these in-season sprays. Each will need to be applied 1-3 times

1. Lorsban 4 E @ 2 qt/acre	Al	14.80
2. Supracide 25 WP @ 8 lb/acre	Al	59.60
Footnote: Supracide has a long PHI and would only be applied once as an in-season spray.		
3. Imidan 70 WP @ 4.25 lb/acre	Ap, N, P, Pl, Pr	29.96
4. Trilogy 90 EC @ 2 gal/acre (2 or more apps)	Pr	139.20 (for 2 applications)

Footnote: This treatment is only required based on monitoring results, and will likely be necessary on ≤ 10% of almond and prune acreage, and a higher but unknown amount of other stonefruit acreage.

plus (possible additional cost)

F. Choose one of these application methods for SJS spray IF NEEDED

1. Ground application, grower, concentrate, 100 gal/acre	20.00
2. Ground application, custom, concentrate, 100 gal/acre	22.00
3. Aerial application	8.00

G. Choose one of these miticides, IF NEEDED. Each is applied 1-3 times.

1. Vendex 50 WP @ 2 lb/acre	Al, C, N, P, Pl, Pr	56.42
2. Apollo SC @ 4 oz/acre	Al, Ap, C, N, P	58.28
3. Omite 30 WP @ 7.5 lb/acre	Al, C, N	45.08
4. Kelthane 35 @ 3.5 lb/acre	C, Pr	40.25
5. Agri-Mek 0.15 EC @ 20 oz/acre	Al	126.01
6. Supreme Oil @ 4 gal/acre (2 or more apps)	Al, Ap, C, N, P, Pl, Pr	44.60 (for 2 applications)

Footnote: Miticide spray is only required if mites increase to damaging levels because of pyrethroid treatment. Percentage of acres treated with pyrethroids (Asana, Ambush, Pounce) that will have increased mite problems is not known.

H. Choose one of these application methods for miticide spray IF NEEDED

1. Ground application, grower, concentrate, 100 gal/acre	20.00
2. Ground application, custom, concentrate, 100 gal/acre	22.00
3. Aerial application	8.00

RANGE OF LOW COST SCENARIOS WITHOUT MONITORING = OIL+NON-OP+APPLICATION

A+B2+C5 = **LOW**	20.65+5.00+8.00 =	**$33.65/acre**
A+B3+C4 = **HIGH**	20.65+29.76+30.00 =	**$80.41/acre**
A+B2+C3 = MOST LIKELY	**20.65+5.00+25.00 =**	**$50.65/acre**

RANGE OF LOW COST SCENARIOS I = OIL+NON-OP+APPLICATION+MONITORING

A+B2+C5+D = **LOW**	20.65+5.00+8.00+30.00 =	**$63.65/acre**
A+B3+C4+D = **HIGH**	20.65+29.76+30.00+30.00 =	**$110.41/acre**
A+B2+C3+D = MOST LIKELY	**20.65+5.00+25.00+30.00 =**	**$80.65/acre**

RANGE OF LOW COST SCENARIOS II = OIL+NON-OP+APPLICATION+MONITORING+ONE SJS TREATMENT+APPLICATION

A+B2+C5+D+E1+F3 = **LOW**	20.65+5.00+8.00+30.00+14.80+8.00 =	**$86.45/acre**
A+B3+C4+D+E4+F2 = **HIGH**	20.65+29.76+30.00+30.00+139.20+22.00 =	**$271.61/acre**
A+B2+C3+D+E1+F1 = M. L.	**20.65+5.00+25.00+30.00+14.80+20.00 =**	**$115.45/acre**

RANGE OF MODERATE COST SCENARIOS I = OIL+NON-OP+APPLICATION+MONITORING+ONE SJS TREATMENT+APPLICATION+ONE MITICIDE TREATMENT+APPLICATION

A+B2+C5+D+E1+F3+G4+H3 =**L.**	20.65+5.00+8.00+30.00+14.80+8.00+40.25+8.00 =	**$134.70/acre**
A+B3+C4+D+E4+F2+G5+H2 =**H.**	20.65+29.76+30.00+30.00+139.20+22.00+126.01+22.00 =	**$419.62/acre**
A+B2+C3+D+E1+F1+G3+H1 =M.L.	**20.65+5.00+25.00+30.00+14.80+20.00+45.08+20.00 =**	**$180.53/acre**

RANGE OF MODERATE COST SCENARIOS II = OIL+NON-OP+APPLICATION+MONITORING+THREE SJS TREATMENTS+THREE APPLICATIONS

A+B2+C5+D+3(E1+F3) = **LOW**	20.65+5.00+8.00+30.00+3(14.80+8.00) =	**$132.05/acre**
A+B3+C4+D+3(E4+F2) = **HIGH**	20.65+29.76+30.00+30.00+3(139.20+22.00) =	**$594.01/acre**
A+B2+C3+D+3(E1+F1) = M. L.	**20.65+5.00+25.00+30.00+3(14.80+20.00) =**	**$185.05/acre**

RANGE OF HIGH COST SCENARIOS = OIL+NON-OP+APPLICATION+MONITORING+THREE SJS TREATMENTS+THREE APPLICATIONS+THREE MITICIDE TREATMENTS+THREE APPLICATIONS

A+B2+C5+D+3(E1+F3)+3(G4+H3) = **LOW =**

20.65+5.00+8.00+30.00+3(14.80+8.00)+3(40.25+8.00) = **$276.80/acre**

A+B3+C4+D+3(E4+F2)+3(G5+H2) = **HIGH =**

20.65+29.76+30.00+30.00+3(139.20+22.00)+3(126.01+22.00) = **$1038.04/acre**

A+B2+C3+D+3(E1+F1)+3(G3+H1) = MOST LIKELY =

20.65+5.00+25.00+30.00+3(14.80+20.00)+3(45.08+20.00) = $380.29/acre

7. PHEROMONE MATING DISRUPTION, DORMANT OIL SPRAY APPLIED.

EFFICACY: Variable for PTB and dependent on pest densities, formulation of pheromone, delivery system, coverage, temperature, humidity and precipitation. Sufficient oil applied during dormant season may be effective against moderate populations of scales. Will not control aphids, so in-season sprays may be necessary in prunes and plums.

RISK TO AQUATIC RESOURCES: Low risk.

COSTS: High cost for use in almonds and prunes. Moderate cost increase for stonefruits when applied with pheromone mating disruption for oriental fruit moth. Add monitoring cost.

A. PTB pheromone dispensers $107.80/acre (for 2 applications/year)

plus

B. Application cost 9.00-14.00/acre (for 2 applications/year) $11.50 (mid-range cost)

plus

C. Supreme Oil, dormant spray @ 6-8 gal/acre Al, Ap, C, N, P, Pl, Pr $20.65/acre (mid-range cost)

plus

D. Choose one of these application methods

1. Ground application, grower, concentrate, 100 gal/acre	20.00
2. Ground application, custom, concentrate, 100 gal/acre	22.00
3. Ground application, grower, dilute, 400 gal/acre	25.00
4. Ground application, custom, dilute, 400 gal/acre	30.00
5. Aerial application	8.00

plus (possible additional cost)

E. Monitoring, private PCA, $/acre/year. 30.00 (mid-range cost)

Almonds, 22-28

Peaches, 30-40

plus (possible additional cost)

F. San Jose scale spray, IF NEEDED, choose one of these in-season sprays. Each will need to be applied 1-3 times

1. Lorsban 4 E @ 2 qt/acre	Al	14.80
2. Supracide 25 WP @ 8 lb/acre	Al	59.60

Footnote: Supracide has a long PHI and would only be applied once as an in-season spray.

3. Imidan 70 WP @ 4.25 lb/acre	Ap, N, P, Pl, Pr	29.96
4. Trilogy 90 EC @ 2 gal/acre (2 or more apps)	Pr	139.20 (for 2 applications)

Footnote: This treatment is only required based on monitoring results, and will likely be necessary on ≤ 10% of almond and prune acreage, and a higher but unknown amount of other stonefruit acreage.

G. Choose one of these application methods for in-season SJS spray IF NEEDED

1. Ground application, grower, concentrate, 100 gal/acre	20.00
2. Ground application, custom, concentrate, 100 gal/acre	22.00
3. Aerial application	8.00

RANGE OF LOW COST SCENARIOS = DISPENSERS+APPLICATION+OIL+APPLICATION

A+B+C+D5 = **LOW**	107.80+11.50+20.65+8.00 =	**$147.95/acre**
A+B+C+D4 = **HIGH**	107.80+11.50+20.65+30.00 =	**$169.95/acre**
A+B+C+D3 = MOST LIKELY	**107.80+11.50+20.65+25.00 =**	**$164.95/acre**

RANGE OF MODERATE COST SCENARIOS = DISPENSERS+APPLICATION+OIL+APPLICATION+ MONITORING

A+B+C+D5+E = **LOW**	107.80+11.50+20.65+8.00+30.00 =	**$177.95/acre**
A+B+C+D4+E = **HIGH**	107.80+11.50+20.65+30.00+30.00 =	**$199.95/acre**
A+B+C+D3+E = MOST LIKELY	**107.80+11.50+20.65+25.00+30.00 =**	**$194.95/acre**

RANGE OF HIGH COST SCENARIOS I = DISPENSERS+APPLICATION+OIL+APPLICATION+ MONITORING+ONE SJS TREATMENT+APPLICATION

A+B+C+D5+E+F1+G3 = **LOW**	107.80+11.50+20.65+8.00+30.00+14.80+8.00 =	**$200.75/acre**
A+B+C+D4+E+F4+G2 = **HIGH**	107.80+11.50+20.65+30.00+30.00+139.20+22.00 =	**$361.15/acre**
A+B+C+D3+E+F1+G1 = M. L.	**107.80+11.50+20.65+25.00+30.00+14.80+20.00 =**	**$229.75/acre**

RANGE OF HIGH COST SCENARIOS II = DISPENSERS+APPLICATION+OIL+APPLICATION+ MONITORING+THREE SJS TREATMENTS+THREE APPLICATIONS

A+B+C+D5+E+3(F1+G3) = **LOW**	107.80+11.50+20.65+8.00+30.00+3(14.80+8.00) =	**$246.35/acre**
A+B+C+D4+E+3(F4+G2) = **HIGH**	107.80+11.50+20.65+30.00+30.00+3(139.20+22.00) =	**$683.55/acre**
A+B+C+D3+E+3(F1+G1) = M. L.	**107.80+11.50+20.65+25.00+30.00+3(14.80+20.00) =**	**$299.35/acre**

Footnote: Additional application expenses are not applicable on peaches only if it is applied at the same time as pheromone dispensers for oriental fruit moth.

Note: Mention of trade names or specific formulations does not represent an endorsement on behalf of the authors or the University of California.

REFERENCES

Information from the following references served as the basis for identifying the viable alternatives described in this report. This is not a list of references cited in this report.

[1] Brazzle, J. R.; Zalom, F. & W. Bentley, "Efficacy of Selected PTB *(Anarsia lineatella)* Insecticides: 1997,".

[2] Brazzle, J. R.; Zalom, F. & W. Bentley, "PTB *(Anarsia lineatella)* Project," 1996.

[3] Daane, K. M.; Glenn, Y.; Dlott, J. & W. Barnett, "Bionomics of Peach Twig Borer and Omnivorous Leafroller in Peach Orchards Using Mating Disruption for Oriental Fruit Moth.," California Tree and Fruit Agreement, Research 1991.

[4] Dibble, J.; Haire, S.; and S. Johnson. "San Jose Scale Control and It's Effect on Peach Twig Borer and Mite Suppression," California Tree and Fruit Agreement 1991.

[5] Dibble, J.; Haire, S.; and S. Johnson. "San Jose Scale Control and Its Effect on Peach Twig Borer and Mite Suppression," 1991 CTFA Progress Report 1991.

[6] Dibble, J. E. "Pest Aids for Insect and Mite Management: Entomology Notes from the Kearney Agricultural Center," Cooperative Extension, University of California, Parlier, California, Data Table 1982.

[7] Dibble, J. E. "Pest Aids for Insect and Mite Management: Entomology Notes from the Kearney Agricultural Center," Cooperative Extension, University of California, Parlier, California 1983.

[8] Dibble, J. E.; Bentley, W. and S. Haire, "Deciduous Tree Fruit Tests During 1984," University of California Kearney Agricultural Center, Western Orchard Pest & Disease Management Conference Report 1984.

[9] Dibble, J. E.; Bentley, W. and S. Haire, "Effect of Dormant Sprays on European Red Mite and San Jose Scale," University of California, Data Tables 1984.

[10] Dibble, J. E. and R. E. Rice, "Deciduous Tree Fruit Tests During 1980," University of California Kearney Agricultural Center, Western Orchard Pest & Disease Management Conference Report 1980.

[11] Dibble, J. E.; Rice, R. E.; Bentley, W.; Weakley, C. ; Haire, S. M. and R. A. Jones, "Deciduous Tree Fruit Tests During 1982," University of California Kearney Agricultural Center, Western Orchard Pest & Disease Management Conference Report 1982.

[12] J. Edstrom, "PTB Data from 1995", 1995.

[13] Fairchild, J. F.; Little, E. E. and J. N. Huckins, "Aquatic Hazard Assessment of the Organophosphate Insecticide Fonofos," *Archives of Environmental Contamination and Toxicology,* p. 375-379, 1992.

[14] Harper, L. L.; McDaniel, C. S.; Miller, C. E. and J. R. Wild, "Dissimilar plasmids isolated from *Pseudomonas diminuta* MB and *Flavobacterium sp.* (ATCC 27551) contain identical *opd genes.," Appl. Environ. Microbiol., vol.* 54, p.2586, 1988.

[15] Johnson, R. S.; Daane, K.; Prather, T. ; Michailides, T. ; Day, K. and H. Andris, "Developing an Integrated Peach & Nectarine Orchard Management System With Less Dependence on Synthetic Pesticides & Fertilizers.," CTFA, 1995.

[16] Johnson, R. S.; Daane, K.; Prather, T. ; Michallides, T. ; Day, K. and H. Andris, "Developing an Intefrated peach & Nectarine Orchard Management System With Less Dependence on Synthetic Pesticides & Fertilizers.," California Tree and Fruit Agreement 1995.

[17] Reil, W. 0. ; T. W. Johnson, J. C. Profita, L. W. Barclay, C. S. Davis, T. M. Aldrich, W. J. Bentley, L. C. Hendricks, and D. Rough, "Monitoring and Chemical control Trials for Peach Twig Borer in Almonds.," 1980.

[18] Rice, R. E., and R. A. Jones. Deciduous Tree Fruit Tests During 1983. University of California Kearney Agricultural Center, 1983.

[19] Rice, R. E., and R. A. Jones. California Tree Fruit Agreement 1994 Project Report. CTFA 1994 report, 1994.

[20] Rice, R. E., and R. A. Jones. Control of San Jose Scale. California Tree Fruit Agreement, 1996.

[21] Rice, R. E., and R. A. Jones, "Application and Efficacy of Paraffin Emulsions for Mating Disruption of Oriental Fruit Moth, Peach Twig Borer, and San Jose Scale.," California Tree Fruit Agreement 1995.

[22] Rice, R. E., and R. A. Jones, "Control and Management of San Jose Scale," *KAC Plant Protection Quarterly*, vol. 7, p. 10-, 1997.

[23] Roltsch, W. J., F. G. Zalom, J. W. Barry, G. W. Kirfman, and J. P. Edstrom. Ultra-Low Volume Aerial Applications of *Bacillus Thuringiensis* Variety *Kurstaki* for Control of Peach Twig Borer in Almonds Trees. *Applied Engineering in Agriculture* 11:25-30, 1995.

[24] Sibbett, G. S., W. B. Barnett, and W. Bentley. Effect of Alternate Year Dormant Phosphate/Oil Applications on San Jose Scale and Peach Twig Borer Control in French Prune. 1996 Prune Research Report., 1996.

[25] Wilson, B., W. Steinke, F. Zalom, M. Grismer, D. Hinton, H. Bailey, and T. Shibamoto. Reducing Dormant Sprays and Their Impact on the Environment. Prune Research Report, 1995.

[26] Wilson, B., W. Steinke, F. Zalom, M. Grismer, D. Hinton, T. Prichard, and T. Shibamoto. Reducing Dormant Sprays and their Impact on the Environment. Prune Research Report, 1996.

[27] Wilson, B., S. William, S. Takayuki, F. Zalom, and R. Coviello. Reducing Dormant Sprays and Their Impact on the Environment. Prune Commodity Board, 1994.

[28] Wilson, B. W., F. Zalom, M. Grismer, D. Hinton, T. Prichard, R. Coviello, and J. Brazzle. "Reducing the Rate and Volume of Dormant Orchard Sprays: Drift, Pest Control and Runoff.," USDA-CSREES, National Agricultural Pesticide Impact Assessment Program, Progress Report Project # 95-34050-1489 "I", November 26, 1996.

[29] Zalom, F. "Evaluating Management Options for Peach Twig Borer in Stone Fruit and Almonds.," USDA CSREES NAPIAP, Final Report September 30, 1997.

[30] Zalom, F. G., W. Barnett, W. Bentley, (and cooperators). "Insect and Mite Research," Almond Board of California, Annual Report,1991.

[31] Brazzle, J. R., M. Bartels, W. Bentley, and F. Zalom. "Evaluating Dormant Applications in Almonds: Impacts on primary and Secondary Pest Populations," , 1998.

[32] Barnett, W. W., J. P. Edstrom, R. L. Coviello, and F. G. Zalom. "Insect pathogen "Bt" controls peach twig borer on fruits and almonds.," *California Agriculture*, vol. 47, p. 4-6, 1993.

[33] Barnett, W. W. (and cooperators), "Managing Peach Twig Borer With Bacillus thuringiensis," California Tree and Fruit Agreement 1992.

[34] Barnett, W. W., "Managing Peach Twig Borer With Bacillus thuringiensis," California Fruit and Tree Agreement 1993.

[35] Barnett, W. W. (and cooperators), "Managing Peach Twig Borer With *Bacillus thuringiensis,"* California Tree Fruit Agreement Research Report 1991, Research 1991.

[36] Daane, K.M.; Yokota, G.Y. & J.W. Dlott. 1993. Dormant-Season Sprays Affect the Mortality of Peach Twig Borer (Lepidoptera: Gelechildae) and Its Parasitoids. J. Econ. Entomol. 86(6):1679-1685.

[37] Mills, N.J.; Etzel, L.; Pickel, C.; Olson, W.; Krueger, W.; Buchner, R; 1998. "Production, Release, and Evaluation of Parasitoids Attacking Prune Aphids." In: 1997 Prune Research Reports. **

[38] Olson, B.; Shawareb, N.; Elmore, C; 1998. "Potential for Cover Crops and Mulches to Provide Weed Control, Beneficial Insect Habitat and Improved Water Penetration." In: 1997 Prune Research Reports. **

[39] Olson, B.; Pickel, C.; Shawareb, N.; 1998. "Efficacy of Oil and Other 'Soft' Materials Sprays Applied at Different Rates for In-Season Control of Mealy Plum Aphid in Prune Orchards." In: 1997 Prune Research Reports. **

[40] Pickel, C; Olson, B; Drueger, B.; Buchner, R.; 1998. "Late Fall Prune Aphid Sampling." In: 1997 Prune Research Reports. **

[41] Krueger, B. & Z. Heath; 1998. "Differences in Insect Populations in Dormant Sprayed and Non-Sprayed Prune Orchards." In: 1997 Prune Research Reports.

[42] Sibbett, G. S.; Barnett,W. B. and W. Bentley; 1988 "Effect of Alternate Year Dormant Phosphate/Oil Applications on San Jose Scale and Peach Twig Borer Control in French Prune.," In 1997 Prune Research Reports. **

[43] Heimpel, G.E., Rosenheim, J.A.; 1996. "Improving biological control of San Jose scale using flowering cover crops." In 1996 Annual Report of the University of California Statewide IPM Project.

[44] Pickle, C; Hasey; Olson, W.H.; 1996. "Implementation of a complete mating disruption program for oriental fruit moth and peach twig borer in cling peaches." In 1996 Annual Report of the University of California Statewide IPM Project

[45] Weakley, C.V.; Kirsch, P.A.; Zalom, F.G.; 1990. Within-Orchard and WithinTree Distributions of Peach Twig Borer (Lepidoptera: Gelechiidae) Damage to Peaches. J. Econ. Entomol. 83(2):505-510.

[46] Rice, R.E.; Jones, R.A.; Black, J.H.; 1972. Dormant Sprays with experimental insecticides for control of Peach Twig Borer. California Agriculture, Jan. p. 14.

[47] Weakley,C.V.; Kirsch, P.; Zalom, F.G.; 1990. Distribution of peach twig borer damage in peaches. California Agriculture, Jan-Feb p. 9-11.

[48] Lichtenstein, E.P.; Katan, J.; Anderegg, B.N.; 1977. Binding of "Persisten" and Nonpersistent" 14C-Labeled Insecticides in an Agricultural Soil. J. Agric. Food Chem., Vol. 25, No. I p. 43-47.

[49] Schulbach,H.; Ewing, H.; Aldrich, T.M.; Joos, J.L.; Booher, L.J. & C.S. Davis; 1972. "NorAm Trials." In, Almond Field Tests. San Joaquin Valley Agricultural Research and Extension Center. Dibble, J.E.; 1981. Cooperative Extension, University of California. Parlier, CA. p. 15

[50] Dibble, J.E. & J.D Babcock, J.D.; 1974. "Almonds - Harvest Worm Evaluation. Peach Twig Borer & Navel Orangeworm, *Anarsia lineatella & Paramelois transitella."* In, Almond Field Tests. San Joaquin Valley Agricultural Research and Extension Center. Cooperative Extension, University of California. Parlier, CA. p. 58 & 114-115.

[51] Dibble, J.E.; 1975. "Almonds-Navel Orangeworm Chemical Control." In, Almond Field Tests. San Joaquin Valley Agricultural Research and Extension Center. Dibble, J.E.; 198 1. Cooperative Extension, University of California. Parlier, CA. p. 59-66.

[52] Dibble, J.E.; 1978. "Almonds-Navel Orangeworm *Paramyelois transitella.*" In, Almond Field Tests. San Joaquin Valley Agricultural Research and Extension Center. Dibble, J.E.; 198 1. Cooperative Extension, University of California. Parlier, CA. p. 59-66.

[53] Dibble, J.E.; 1980. "Almonds-Navel Orangeworm *Paramyelois transitella.*" In, Almond Field Tests. San Joaquin Valley Agricultural Research and Extension Center. Dibble, J.E.; 198 1. Cooperative Extension, University of California. Parlier, CA. p. 99-103.

[54] Rice, R.E. & F.M. Summers; 1970. "Almonds, Ne Plus Variety. Peach Twig Borer, *Anarsia lineatella.*" In, Almond Field Tests. San Joaquin Valley Agricultural Research and Extension Center. Dibble, J.E.; 1981. Cooperative Extension, University of California. Parlier, CA. p. 104.

[55] Dibble, J.E.; 1970. "Almonds-Peach Twig Borer." In, Almond Field Tests. San Joaquin Valley Agricultural Research and Extension Center. Dibble, J.E.; 1981. Cooperative Extension, University of California. Parlier, CA. p. 104.

[561 Dibble, J.E.; 1971. "Almonds-Peach Twig Borer Control." In, Almond Field Tests. San Joaquin Valley Agricultural Research and Extension Center. Dibble, J.E.; 198 1. Cooperative Extension, University of California. Palier, CA. p. 107.

[57] Hewitt, Jones, Rice coop.; 1972. "Summary of Peach Twig Borer Dormant Trial, Fresno, CA." In, Almond Field Tests. San Joaquin Valley Agricultural Research and Extension Center. Dibble, J.E.; 198 1. Cooperative Extension, University of California. Parlier, CA. p. 108.

[58] Rice, R.E. & L.T. Browne; 1972. "Almonds, Peach Twig Borer Dormant Trial, Sanger, CA." In, Almond Field Tests. San Joaquin Valley Agricultural Research and Extension Center. Dibble, J.E.; 1981. Cooperative Extension, University of California. Parlier, CA. p. 109.

[59] Dibble & Babcock; 1972. "Peach Twig Borer Control - Summer Brood. Almonds." In, Almond Field Tests. San Joaquin Valley Agricultural Research and Extension Center. Dibble, J.E.; 1981. Cooperative Extension, University of California. Paller, CA. p. 110.

[60] Dibble, Chaney & Post; 1972. "Summer Brood Twig Borer. Almonds." In, Almond Field Tests. San Joaquin Valley Agricultural Research and Extension Center. Dibble, J.E.; 198 1. Cooperative Extension, University of California. Parlier, CA. p. 111.

[611 Dibble, J.E.; Babcock, J.D. & R.E. Rice; 1974. "Almonds - Peach Twig Borer *Anarsia lineatella.*" In, Almond Field Tests. San Joaquin Valley Agricultural Research and Extension Center. Cooperative Extension, University of California. Parlier, CA. p. 112-113.

[62] Dibble, J.E; 1975. "Almonds - Ne Plus Variety. Peach Twig Borer, Fresno, CA." In, Almond Field Tests. San Joaquin Valley Agricultural Research and Extension Center. Cooperative Extension, University of California. Parlier, CA. p. 117.

[63] Dibble, J.E; 1975. "Almonds - 1975 Peach Twig Borer." In, Almond Field Tests. San Joaquin Valley Agricultural Research and Extension Center. Cooperative Extension, University of California. Parlier, CA. p. 118.

[64] "Almonds - 1976. Dormant treatments for San Jose scale and European red mite control and may sprays for two-spotted mite and NOW suppression." In, Almond Field Tests. San Joaquin Valley Agricultural Research and Extension Center. Cooperative Extension, University of California. Parlier, CA. p. 128.

[65] "Almonds - 1976. Dormant oil sprays. Their effect in a dry season and the resultant San Jose scale control." In, Almond Field Tests. San Joaquin Valley Agricultural Research and Extension Center. Cooperative Extension, University of California. Parlier, CA. p. 129.

[66] Summers, 95

[68] Olsen, B. 1998. Personal Communication.

[69] Rice, R.E. 1998. Personal Communication.

[70] Zalome, F. 1998. Personal Communication.

[71] Epstein, L. 1999. Personal Communication

** "not for publication, not to be cited w/o authorization by author(s)."

Toxicology References

[a] Merk Index 11th Ed. Budavari ed. 1989. Merck & Co. Inc., Lahway, NJ.

[b] California Fish & Game

[c] National Academy of Sciences

[d] US EPA

[e] Coats & O'Donnell-Jeffery (1979) (out of Smith & Stratton, 1986: [m])

[fl Holcombe et al. (1982) (out of Smith & Stratton, 1986: [m])

[g] Kumaraguru & Beamish (1981) (out of Smith & Stratton, 1986: [m])

[h] Mulla et. al. (1982) (out of Smith & Stratton, 1986: [m])

[I] Worthing & Walker (1983) (out of Smith & Stratton, 1986: [m])

[j] Schimmel et al. (1982) (out of Smith & Stratton, 1986: [m])

[k] Jolly et al. (1978) (out of Smith & Stratton, 1986: [m])

[l] Miyamoto (I 976) (out of Smith & Stratton, 1986: [m]) or (out of Bradbury & Coats, 1989: [w])

[m] Smith T.M. and Stratton G.W. (1986) Effects of synthetic pyrethrold insecticides on nontarget organisms. Residue Reviews 97:93-120.

[n] Linden et al. (1979) (out of Smith & Stratton, 1986: [m])

[o] Stratton & Corke (1981) (out of Smith & Stratton, 1986: [m])

[p] Anderson (1982) (out of Smith & Stratton, 1986: [m])

[q] NRCC (1986) (out of Bradbury & Coats, 1989: [w])

[r] McLeese et al. (1980) (out of Smith & Stratton, 1986: [m])

[s] Schimmel et al. (1983) (out of Smith & Stratton, 1986: [m])

[t] Mulla et al. (1978b) (out of Smith & Stratton)

[u] Spehar et al. (1983) (out of Bradbury & Coats, 1989: [w])

[v] Hansen et al. (1983) (out of Bradbury & Coats, 1989: [w])

[w] Bradbury, S.P. and J. R. Coats, "Toxicokinetics and Toxicodynamics of Pyrethrold Insecticides in Fish," *Environmental Toxicology and Chemistry, vol.* 8, pp. 373-380, 1989.

[x] Wan, M.T.; Watts, R.G.; Isman, M.B. & R. Strub. 1996. Evaluation of the Acute Toxicity to Juvenile Pacific Northwest Salmon of Azadirachtin, Neem Extract, and Neem Based Products. Bull. Environ. Contam. Toxicol. 56 (3): 432-439.

[y] Glickman, A.H.; Hamid, A.A.R; Rickert, D.E. & J.J. Lech. 198 1. Elimination and Metabolism of Permethrin Isomers In Rainbow Trout. Toxicol. Appl. Pharmacol. 57 (1): 88-98.

[z] Glickman, A.H.; Weitman, S.D. & J.J. Lech. 1982. Differential Toxicity of Trans-Permethrin in Rainbow Trout and Mice. Toxicol. Appl. Pharmacol. 66 (2): 153-161.

[al] EXTOXNET. Extension Toxicology Network, Pesticide Information Profiles. Revised June 1996. Cooperative Extension Offices of Cornell University, Oregon State University, the University of Idaho, and the University of California at Davis and the Institute for Environmental Toxicology, Michigan State University. Files maintained and archived at Oregon State University.

APPENDIX 2. REDRESS OF PEER REVIEW COMMENTS.

Early in the process of developing this report, an extensive review was conducted on research information available on the subject of alternative practices. The document derived from that review was submitted to various scientists and interest groups to ensure its accuracy and completeness.

When a draft of this report was completed, the State Water Resources Control Board sent a letter (Item #1) requesting review and comment of the report to sixty-eight persons (Item #2) who had special knowledge of this subject and/or who represented the views of various stakeholder groups. Only eight sets of comments were received by the date requested. Subsequently, the SWRCB reviewed the comments and sent the report authors a letter (Item #3) which identified six main themes of the comments and requested that these were the points that should be addressed, at a minimum. The reviewer comments in their entirety (Items #4) were also provided to the authors.

In addition to our providing copies of the above-mentioned items, we wish to explain how we have addressed the six themes representative of many of the reviewer comments.

Theme 1: The report would benefit from a summary or abstract which outlines the major conclusions.

We agreed with this comment and provided and abstract. Additionally, we included a final section on "Conclusions" as a summary of the main points of the report.

Theme 2: Cost/fiscal impacts and net profits of implementing alternatives MUST be over multiple years.

We disagreed with this comment. Two considerations affected our approach to addressing the issue. First of all, the data available on multiple years was irregular and not available from a single source nor calculated by standardized procedures. Secondly, we felt that comparing current costs of alternative practices to historic economic costs and profits was inappropriate and not indicative of the current economic atmosphere.

Theme 3: Costs of alternatives and OP dormant treatment MUST be normalized to total operating costs and/or net returns.

We agreed with this comment and decided to avoid presenting any information on profits due to the assumption that profits are a reflection of market trends and are therefore considerably less stable and predictable than costs associated with production. We chose to present the most recent total costs of production for four major crops and compare the increase (or decrease) in costs of alternatives (Options #2 - #6) to the costs of the traditional OP dormant treatment (Option #1+ monitoring). We compared only the Most Likely Costs (MLCs).

Theme 4: Address within the text that the costs of environmental damage were not considered and that pesticide manufacturers are not paying for the externalities associated with pesticide use.

We simply added text to indicate that "Costs associated with potential environmental damage resulting from the use of any of the alternatives were not a consideration of this report."

Theme 5: Address the purpose of the bibliography and the lack of references cited in the text.

In Section 1, we added additional clarification on the purpose of this report and noted that the alternatives presented were the result of extensive literature review. The "Bibliography" was renamed "References" with the explanation that "Information from the following references served as the basis for identifying the viable alternatives described in this report. This is not a list of references cited in this report."

Theme 6: Two reviewers contend that there is an error in Table 1, Option #2 with regards to potential for ecological risk of in-season use of OPs being "high".

We clarified the language in Table 1 and also addressed this comment in Section 8 as follows: "This is based on data that demonstrates high concentrations of OP pesticides in the San Joaquin River during several irrigation seasons. The precise source of these OPs is not known though it is assumed that they originate from agricultural use. Potentially, surface waters are as susceptible to spray drift and OPs in irrigation runoff during the in-season as they are to spray drift and rainfall runoff during the dormant season. Considering that flow rates of surface waters are much reduced during the in-season, the actual amount of OP material capable of causing high concentrations in these waters is less than when flow volumes are high."

State Water Resources Control Board

Division of Water Quality

901 P Street • Sacramento, California 95814 • (916) 657-0795
Mailing Address: P.O. Box 944213 • Sacramento, California • 94244-2130
FAX (916) 657-2388 • Internet Address: http://www.swrcb.ca.gov

Winston H. Hickox
Secretary for Environmental Protection

Gray Davis
Governor

ITEM #1

Greetings:

Organophosphorus (OP) insecticide movement off of dormant orchards into streams and rivers of the Central Valley has been identified by the Central Valley Regional Water Quality Control Board and the State Water Resources Control Board (SWRCB) as a threat to water quality and aquatic ecosystem health in these waterways. Because of these concerns, the SWRCB contracted with a multidisciplinary group at University of California, Davis, including Cooperative Extension, to identify possible alternatives to the conventional OP dormant orchard treatments. A focus was identification of alternative agricultural and irrigation practices designed to prevent or reduce offsite movement of pesticides into surface waters (the first priority being to reduce the offsite movement of pesticides applied to dormant orchards). Of particular concern was an evaluation of the economics and pest control efficacy of viable alternatives.

Enclosed you will find the draft final report for this contract--'Alternatives to Chlorpyrifos and Diazinon Dormant Sprays' by Frank Zalom, Mike Oliver, and David Hinton. Your comments and suggestion for modifications would be greatly appreciated. Please give special attention to the information on efficacy and economics. The quality and accuracy of the final report undoubtedly will benefit from your input. So that your comments and suggestions can be considered in drafting the final report, please be certain that I receive them no later than July 21, 1999. All comments received by July 21st will be reproduced as received and included in an appendix of the final report.

On behalf of the authors and the SWRCB, thank you for your time and efforts. Should you have questions, please do not hesitate to contact me at (916) 657-0795.

Regards,

Ch Foe (for)

Victor de Vlaming
Division of Water Quality
State Water Resources Control Board

Enclosure

1. Distribution list
2. Draft final report

ITEM #2

Distribution List

FirstName	LastName	Company	Address1	City	State	PostalCode
Kermett	Adams	Rhone-Poulenc Ag Co	434 Hillcrest Avenue	Fresno	CA	93720
Walt	Bentley	U.C. Kearney Ag Center	9240 South Riverbend Ave	Parlier	CA	93648
Jenny	Broome	Sustainable Ag Research & Education Program Department of Pomology	U.C. Davis	Davis	CA	95616
Rick	Buchner	UCCE Tehama County	3179 Bechelli Lane, Suite 206	Redding	CA	96002
Henry	Buckwalter	Uniroyal Chemical	5050 laguna Blvd, Suite 112-581	Elk Grove	CA	95758
Kati	Buehler	Western Crop Protection Association	3835 N. Freeway Blvd., Suite 140	Sacramento	CA	95834
Karen	Cain	Bayer, Ag Division	P.O. Box 4913	Kansas City	MO	64120-0013
John	Carlon	Sacramento River Partners	261 E. Third Street	Chico	CA	95928
Stacy	Carlson	Sutter County Ag Commissioner	142 Garden HWY	Yuba City	CA	95991
Joseph	Connell	UCCE Butte County	2279-B Del Oro Ave	Oroville	CA	95965
Rich	Coviello	UCCE Fresno	1720 South Maple Ave	Fresno	CA	93702
Donald	Crepe	Stanislaus County Ag Commissioner	725 County Center Three Ct	Modesto	CA	95355
Kimberly	Crum	CA Ag Production Consultants Assoc	1143 North Market Blvd, Suite 7	Sacramento	CA	95834
Jim	Davis	Rohm and Haas Company	Independence Mall West	Philadelphia	PA	19105
Tess	Dennis	CA Farm Bureau	1127-11th Street, Suite 626	Sacramento	CA	95814
Bill	Duckworth	Glenn County Ag Commissioner	PO Box 351	Willows	CA	95988
Roger	Duncan	UCCE Stanislaus County	733 County Center III Court	Modesto	CA	95355
Robert	Ehn	FMC Corporation	1508 Tollhouse Road, Suite D	Clovis	CA	93611
Paul	Feder	U.S. EPA Region 9	75 Hawthorne Street	San Francisco	CA	94105
Annee	Ferranti	CATree Fruit Agreement	975 I Steet	Reedley	CA	93854
Marcia	Gibbs	CAFF	P.O. Box 363	Davis	CA	95617
Charles	Goodman	CDFA	1220 N Street	Sacramento	CA	95814
Joseph	Grant	UCCE San Joaquin County	420 S Wilson Way	Stockton	Ca	95205
Roney	Gutierrez	NRCS	100 Sunrise Blvd., Suite B	Colusa	CA	95932
Lyn	Hawkins	DPR	830 K Street Mall	Sacramento	CA	95814-3510
Chris	Heintz	Almond Board of CA	1104 12th Street	Modesto	CA	95394
Lonnie	Hendricks	UCCE Merced County	2145 Wardrobe Ave	Merced	CA	95340
David	Higgins	Rhone-Poulenc Ag CO	P.O. Box 3375	Wickenburg	AZ	85358
Chuck	Ingles	UCCE Sacramento	4145 Branch Center Road	Sacramento	CA	95827-3898
John	Jachetta	DowElanco	9330 Zionsville Road	Indianapolis	IN	46268
Bill	Jennings	DeltaKeeper	3536 Rainer Avenue	Stockton	CA	95204

FirstName	LastName	Company	Address1	City	State	PostalCode
Susan	Kegley	Pesticide Action Network	49 Powell Street, Suite 500	San Francisco	CA	94102
Dennis	Kelly	Novartis Corporation	1380 Lead Hill Drive, Suite 201	Sacramento	CA	95661
Parry	Klassen	CURES	369 West Freemont	Clovis	CA	93612
Bill	Krueger	UCCE Glenn County	PO Box 697	Orland	CA	95963
Cindy	Lashbrook	Four Seasons Ag Consult	PO Box 338	Atwater	CA	95301
Marshall	Lee	DPR	830 K Street Mall	Sacramento	CA	95814-3510
Frank	Limacher	SWRCB	901 P Street	Sacramento	CA	94244
Rachael	Long	UCCE Yolo County	70 Cottonwood Street	Woodland	CA	95695-2593
Marie	Maks	E.I.Dupont de Nemours Co	P.O. Box 80038	Wilmington	DE	19880-0038
Paul	Marshall	CALFED	1416 Ninth Street, Suite 1155	Sacramento	CA	95814
Michael	McElhiney	NRCS	3800 Cornucopia Way Suite E	Modesto	CA	95358
Jim	Melban	CA Potato Research Advisory Board	531 D North Alta Avenue	Dinuba	CA	93618
Gary	Obenauf	CA Prune Advisory Board	3425 N First Street, Suite 101	Fresno	CA	93726
Bill	Olson	UCCE Butte County	2279 Del Oro Ave, Suite B	Oroville	CA	95965
Philip	Osterli	UCCE Stanislaus County	733 County Center III Court	Modesto	CA	95355
Lesley	Czochor	AgrEvo USA Co	2711 Canterville Road	Wilmington	DE	
Carolyn	Pickel	UCCE Sutter-Yuba Counties	142-A Garden HWY	Yuba City	CA	95991
Dennis	Pooler	Yuba County Ag Commissioner	938-14th Street	Marysville	CA	95901
Richard	Price	Butte County Ag Commissioner	316 Nelson Avenue	Oroville	CA	95926
Wilbur	Reil	UCCE Yolo County	70 Cottonwood Street	Woodland	CA	95695-2593
Dick	Rice	U.C. Kearney Ag Center	9240 South Riverbend Avenue	Parlier	CA	93648
Lisa	Ross	DPR	830 K Street Mall	Sacramento	CA	95814-3510
Jill	Slate	Zeneca Ag Products	1200 S. 47th Street	Richmond	CA	94804-4610
Ann	Stout	Gowan Company	P.O. Box 5569	Yuma	AZ	85366-5569
Bryan	Stuart	Dow AgroSciences	3835 N. Freeway Blvd., Suite 240	Sacramento	CA	95834
David	Supkoff	DPR	830 K Street	Sacramento	CA	95814-3510
Mike	Tanner	Merced County Ag Commissioner	2139 W. Wardrobe Ave	Merced	CA	95340
Angela	Tessier	Griffin LLC	P.O. Box 1847	Valdosta	GA	31603-1847
William	Thomas	Law Offices of William Thomas	770 L Street, Suite 1150	Sacramento	CA	95814-3325
Mumley	Tom	San Francisco Water Quality Control Bd	1515 Clay Street, Suite 1400	Oakland	CA	94612
Mark	Van Horn	Sustainable Ag Research & Education Program	U.C. Davis	Davis	CA	95616
Heidi	Walker-Hill	Tehama County Ag Commissioner	P.O. Box 38	Red Bluff	CA	96080
Ron	White	ThermoTrilogy Corp	9145 Guilford Rd, Suite 175	Columbia	MD	21046-1952

FirstName	LastName	Company	Address1	City	State	PostalCode
Barry	Wilson	UC Davis	3202 Meyer Hall	Davis	CA	95616
Dawit	Zeleke	Nature Conservancy	1330-21 St, Suite 103	Sacramento	CA	95814
		Apricot Producers of California	2125 Wylie Drive, Suite 2-A	Modesto	CA	95355
		CA Cherry Growers & Industries Foundation	33 East Oak	Lodi	CA	95240

/inston H. Hickox
Secretary for Environmental Protection

State Water Resources Control Board

Division of Water Quality
901 P Street • Sacramento, California 95814 • (916) 657-0795
Mailing Address: P.O. Box 944213 • Sacramento, California • 94244-2130
FAX (916) 657-2388 • Internet Address: http://www.swrcb.ca.gov

Gray Davis
Governor

ITEM #3

AUG 5 1999

Frank G. Zalom, Ph.D.
Statewide IPM Project
1 Shields Avenue
University of California
Davis, CA 95616

Dear Frank,

REVIEWERS' COMMENTS ON THE DRAFT FINAL REPORT TITLED 'ALTERNATIVES TO CHLORPYRIFOS AND DIAZINON DORMANT ORCHARD SPRAYS'

Enclosed are the comments received on the draft final report, 'Alternatives to Chlorpyrifos and Diazinon Dormant Sprays'. We had hoped for a greater number of responses, but such did not materialize. As we discussed in our last meeting, my letter requesting comments, the distribution list, and the comments received are to be included as an appendix in the final report.

There are some themes which run through several sets of comments. We request that you revise the draft final report to address, at a minimum, the following issues:

1. A summary or abstract which outlines your major conclusions is needed at the front of the document.

2. Costs/fiscal impacts and net profits of implementing alternatives **must** be over multiple years.

3. The costs of the alternatives compared to the 'traditional' OP treatment **must** be standardized/normalized (e.g., as a percent of) to total operating costs and/or to average net return. Please address the arguments that when 'normalized' in these ways, the 'traditional' treatment and alternatives are all fairly equivalent. Note, in this regard, the comments of the SWRCB economics unit.

4. Address, within the text, that the costs of environmental damage were not considered and that pesticide manufacturers are not paying for the externalities associated with pesticide use.

5. Please address the bibliography usage comment in the CAFF comments. Failure to include references in the text to document/substantiate facts was unpopular with some reviewers. Address the purpose of the bibliography in the text.

6. At least two of the reviews contend that there is an error in the Table 1 Option 2 with regards to potential for ecological risk.

The comments from the SWRCB economics unit, in particular, are thorough and deserve attention. We are looking forward to receiving the revised final report. Please advise me as to when you think we could review your revision. Ideally we would like to see the revision within 45 days or less, but if that period is not sufficient to adequately incorporate the necessary changes, please notify me.

That document will be useful to the Central Valley Regional Water Quality Control Board, the SWRCB, and several agricultural, as well as other, interests. If you have questions, please do not hesitate to call me at (916) 657-0795.

Regards,

Victor de Vlaming

Victor de Vlaming
Monitoring and Assessment Unit

Enclosures

cc: David E. Hinton, Ph.D.
Department of Anatomy, Physiology and
Cell Biology
VM:APC
1 Shields Avenue
University of California
Davis, CA 95616

Mike N. Oliver
University of California
Cooperative Extension
3800 Cornucopia Way, Suite A
Modesto, CA 95358

Max Puckett
34500 Coastal Route 1
Institute of Marine Science
Monterey, CA 93940

ITEMS #4

From:	Robert L. Bugg <rlbugg@ucdavis.edu>
To:	"Victor De Vlaming" <DE_VV@dwq.swrcb.ca.gov>
Date:	8/3/99 9:10AM
Subject:	Re: Additional Comments On Draft Report By Zalom et al.

Victor de Vlaming <de*vv@dwq.swrcb.ca.gov>

Dear Victor:

Thank you for the opportunity to review the draft report entitled "Alternatives to Chlorpyrifos and Diazinon Dormant Sprays" by Zalom et al.

In terms of content, although the report spells out 7 "options," it does not mention the many orchardists that have successfully eliminated winter dormant sprays of the targeted materials through participation in the Biologically Integrated Orchard Systems (BIOS) program, a cooperative effort of the UC and the Community Alliance with Family Farmers and various federal and state agencies. Although this group may be part of the 100,000 acres refered to as being under Bacillus thuringiensis use, there is more to BIOS than just input substitution. Moreover, BIOS has systematically and successfully addressed not only insecticide-based pollution, but also reductions in the use of synthetic nitrogen fertilizers, and chipping/spreading vs.burning of prunings. The BIOS demonstration and extension partnership has collected detailed data on pesticide use, pests, and yields since 1993. The authors should contact Max Stevenson of CAFF for more information. The relevant economic data on this same alternative farming system are available from Karen Klonsky of the Department of Agricultural Economics, UC Davis. BIOS has been underway since 1993, and should probably be considered in this report.

Data on reduction or elimination of dormant organophosphate insecticides in prunes are also available through Gary Obenauf of the California Prune Board and Dawit Zeleke of The Nature Conservancy. These data should certainly be consulted.

The Zalom et al. draft report makes no mention of recent grants from the Pest Management Allliance and CalFed, intended to support work on same theme as this draft report. Although these efforts are not funded through the SWRCB, the authors should clarify the relationships, complementarities, and differences among these projects.

It would be helpful to see Section 9 expanded to a more detailed discussion of research priorities, preferably on a crop-by-crop basis. The current version is not very detailed, e.g., the section on biological control of aphids that attack plums is too brief and does not give the reader a feel for the complexity of the issue, the past work, and the current efforts and prospects.

The current document is not referenced, in the sense of relating ideas expressed in the text to their sources. We assume the proper citation numbers will be inserted in the report rather than merely presenting the references at the end.

In terms of formatting and presentation, the report is not very accessible.

In particular, Appendix 1 appears to be a tabular summary of the literature review work and economic data and maybe it will be turned into an computer-based expert system or be accessed through an on-line interactive database. That might improve its accessibility. However, if the appendix is to stand alone, it might be helpful to consult the works of Edward Tufte on visualizing information and graphic presentation, to improve this aspect of the work.

Thank you again for the opportunity to comment on the draft report.

Sincerely,

Bob

Robert L. Bugg, Ph.D.
Assistant to the Director
U.C. Sustainable Agriculture Research and Education Program
University of California
One Shields Avenue
Davis, CA 95616-8716
U.S.A.
530-754-8549
530-754-8550 FAX
rlbugg@ucdavis.edu

Jenny

Jenny Broome, Ph.D.
Associate Director
University of California
Sustainable Agriculture Research and Education Program (SAREP)
One Shields Avenue
DANR Building - Hopkins Road
Davis, CA 95616
http://www.sarep.ucdavis.edu
jcbroome@ucdavis.edu
530-754-8547 phone
530-754-8550 FAX

Robert L. Bugg
Assistant to the Director
U.C. Sustainable Agriculture Research and Education Program
University of California
One Shields Avenue
Davis, CA 95616-8716
U.S.A.
530-754-8549
530-754-8550 FAX
rlbugg@ucdavis.edu

California Regional Water Quality Control Board

Central Valley Region

Steven T. Butler, Chair

ton H. Hickox
Secretary for Environmental Protection

Gray Davis
Governor

Sacramento Main Office
Internet Address: http://www.swrcb.ca.gov/~rwqcb5
3443 Routier Road, Suite A, Sacramento, California 95827-3003
Phone (916) 255-3000 • FAX (916) 255-3015

TO: Frank Zalom
Statewide IPM Coordinator

FROM: Jerry Bruns, Chief
Standards, Policies & Special Studies Section

DATE: 26 July 1999

SIGNATURE:

SUBJECT: COMMENTS ON REPORT ENTITLED, "ALTERNATIVES TO CHLORPYRIFOS AND DIAZINON DORMANT SPRAYS".

Thank-you for allowing the Regional Board to review the above report. Overall, I think the report was well done and particularly appreciate the obvious effort that went into developing the cost analysis of the recommended alternatives to the conventional dormant spray treatment. I have two major comments.

1. The readability of the report would be greatly improved by the addition of an abstract or summary section at the start of the report briefly outlining the major conclusions. Presumably these would include: (1) that alternatives have been identified to the present application of dormant O.P. sprays for control of peach twig borer, (2) that application of oil can adequately control scale in most cases (in-season sprays may occasionally be needed), (3) it is estimated that the average cost to the grower of implementing the alternatives will increase gross orchard production costs by 1 to 2 percent per acre per year or decrease net profits by x-y percent per acre per year. No good alternatives were identified for the control of aphids on prunes and plums. Development of better aphid controls for these commodities has been identified as a high priority research need.
2. The fiscal impact of implementing the alternatives on net orchard returns was analyzed by only considering 1998 data. Unfortunately, this was an El Nino year and the returns for most of California agriculture were highly unusual. This is apparent in Table 2 where the net returns for almonds and prunes, the two most common types of orchard in the Central Valley, were negative. No business can stay in production long with negative returns. I strongly recommend that the impact of the recommended alternatives on net profits be evaluated by considering the 5 or 10 year net average return per orchard.

Please call me at 916-255-3093 if you have any questions.

Winston H. Hickox
Secretary for
Environmental
Protection

State Water Resources Control Board

Office of Statewide Consistency
901 P Street • Sacramento, California 95814 • (916) 657-1832
Mailing Address: P.O. Box 100 Sacramento, California • 95812-0100
FAX (916) 657-2394 • Web Site Address: http://www.swrcb.ca.gov

Gray Davis
Governor

TO: 1. Barbara Evoy, Chief
Office of Statewide Consistency
State Water Resources Control Board

2. Victor de Vlaming
Division of Water Quality
State Water Resources Control Board

FROM: Frank Limacher, Economist
Economics Unit
OFFICE OF STATEWIDE CONSISTENCY

DATE: July 21, 1999

SUBJECT: COMMENTS ON "ALTERNATIVES TO CHLORPYRIFOS AND DIAZINON DORMANT SPRAYS"

The Economics Unit was requested to review the June 1999 draft of "Alternatives to Chlorpyrifos and Diazinon Dormant Sprays" ('Report') by Frank Zalom, Mike Oliver and David Hinton. We were requested to focus on economic aspects of the alternatives reviewed in the report.

The principal conclusions that can be drawn from the report are as follows:

- Under current practices, the annual cost of applying pesticides to orchards averages about $70 per acre.
- The costs of the alternatives discussed in the report range widely. It seems likely that growers would respond to restrictions on pesticide use by switching to one of the lower-cost alternatives. The median cost of the likely alternatives is about $115, representing an annual increase in production costs of about $35 per acre.
- An additional cost of $35 per acres is unlikely to affect fruit and nut production significantly. Gross receipts for Central Valley orchards are about $2,800 per acre. Total acreage in orchards is gradually increasing, indicating that margins are large enough to attract additional operators to fruit and nut production.

It should be noted that California crop production is the major factor in price determination for most orchard crops, since California orchards produce a dominant share of the national production in most fruit and nut crops. In terms of California's share of national production, sweet cherry production is about 15% of the national total, and pear production is about 35% and peach production is about 65% of the national total. For for the remainder of the orchard crops grown in the Central Valley, the California share is over 75% of the national total, and generally over 90%. Therefore, a region-wide increase in the cost of production would not be expected to negatively impact the competitive position of the growers.

Details of Analysis.

The Report reviewed a broad range of pesticide use practices for a broad range of orchard crops. The list of proposed alternatives in farming practices and chemical usage is very thorough, and the use of low-cost and high-cost scenarios provides a complete range of potential costs. A spot-check of prices of individual chemicals and rates of application affirmed the general accuracy of the costs quoted for the various scenarios. The Report did not include costs of some related farming practices that might also be factors to consider in the determination of chemical applications, such as the monitoring for proper irrigation schedules and the use of ground covers.

A cost that is included, however, in each of the "Feasible Alternatives" is $30 per acre per year in monitoring by a certified pest control advisor. This may be a redundant cost, already included in the per-acre cost of chemicals listed in the Report. In the farm chemical supply industry, quantity discounts are available, and individual growers may be charged different prices, depending on whether they utilize the pest control advisor service provided by the company. The prices listed in the beginning of the Report seem to include the per-acre service of advising and monitoring. This double-counting would result in an over-estimate of the increased cost.

The current cost of pesticides used in orchard crops appears to be about $70 per acre (halfway between the "low" and "high", under Option 1). The Feasible Alternatives shown in "Figure 1", presents a comparison of 16 of the 30 total scenarios, suggesting that these 16 are the "most probable" pest treatment scenarios. By taking the "most likely" value for these scenarios, it may be determined that the actual costs incurred by the growers will be increased from the current level of about $70 to a median "most likely" cost of about $115. However, this apparent conclusion is not explained anywhere in the Report. Also not mentioned is the reason that some alternatives become "Feasible", while others do not. It appears to be more than a simple matter of cost. (Included in the comparison in Figure 1 are Scenarios 1, 2a, 2b, 2c, 3a, 3b, 3c, 4b, 4c, 5b, 5c, 6b, 6c, 6d, 7b, and 7d. Not included are Scenarios 2d, 2e, 3d, 3e, 4a, 4d, 5a, 5d, 6a, 6e, 6f, 7a and 7c.)

Finally, the principal omission in this report is the lack of a review of the general affordability of increased costs of pest control. As mentioned above, the altered chemical usage and chemical application schedules will increase grower costs, under the most probable strategies, from a current level of about $70 per acre to about $115 per acre. This represents an increase of about 50% in pest control costs. Of course, for some growers the costs for insect treatment could nearly triple, to about $170 per acre. "Table 2" provides the only mention of the economic consequence of increased cultural costs, and implies that growers of almonds and prunes cannot afford any increased costs, while growers of peaches and cherries could afford significant increased costs. Probably neither implication is correct.

Accurate per-acre values for agricultural costs and returns are extremely difficult to obtain. According to the 1997 US Census of Agriculture's California data (Geographic Area Series, Part 5), the average revenue for Central Valley orchards is about $2540 per acre. However, due to various reasons, this value probably understates the true value by about 10%. Under this assumption, the 1997 average revenue per acre of orchard was about $2800. The US Census of Agriculture does not provide specific cost data by crop category.

County-specific agricultural cost data is compiled by the Department of Agricultural and Resource Economics, Cooperative Extension, University of California at Davis. However, this data is often not corrected or standardized by the staff, and reflects only the values provided by individual growers, or groups of growers. Knowledgeable users of this data believe that costs are overestimated by 10 to 15 percent.

Consequently, the impression given by "Table 2" – that net returns from growing almonds and prunes are negative – is incorrect. In recent years, acreage increases for fruit and tree nuts indicates that returns are sufficient to attract additional operators to invest in growing these crops.

Furthermore, a comparison of the UC Extension cost data with the cost of the alternatives shows that the current $70 per-acre cost of pest control represents about 2.5% of the total operating cost, and an increase of $35 per acre represents an increase of about 1.25% in total costs. However, the actual impact would be significantly less, since a substantial portion of the total cost represents non-cash overhead costs. These costs include land rent, and return on investment for purchased land.

In most instances involving any kind of real property investment, an increase in any long-term cost category (or potential cost category) will eventually be reflected in the potential sale value of that asset. Thus, if the annual per-acre operating cost for an orchard were to be permanently increased, the sale value of that acre would eventually be reduced by an approximately equivalent amount. If the orchard is rented, whether on a cash or share-crop basis, the increase in operating cost can be reflected in the rental price.

The Report should include some mention of these long-term impacts, and the relative insignificance of the range of operating cost increases that have been proposed under the various scenarios of alternative pesticide use in orchards.

Attachment 1: Census summary of 1997 county-level revenue from orchards.
Attachment 2: Expansion of "Figure 1".

cc. Adrian Griffin

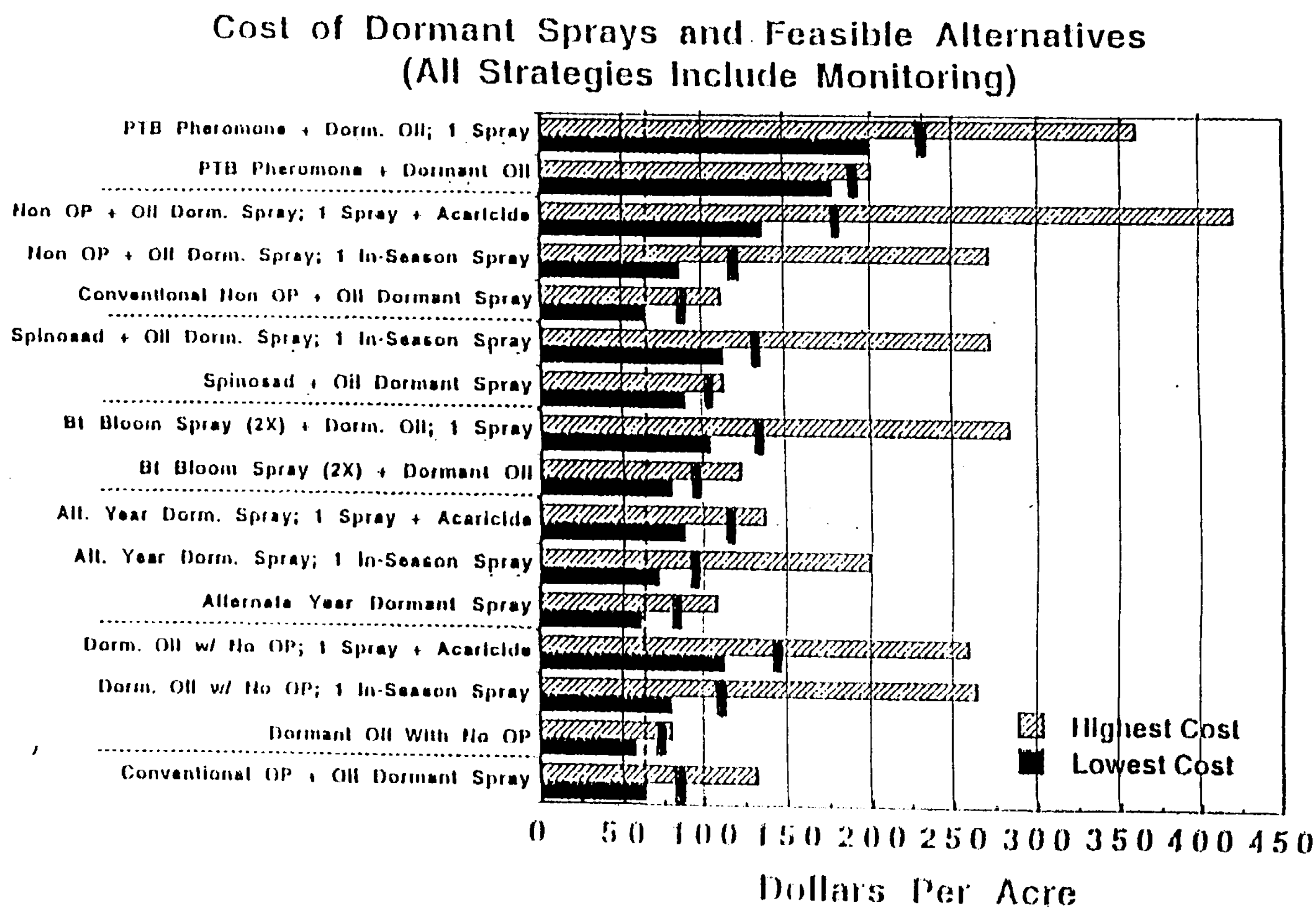
CALIFORNIA AGRICULTURAL CENSUS - 1997
PUBLISHED BY U.S. DEPT. OF COMMERCE
Acres of Fruits/Nuts/Berries, by county

Reduced List
Counties in Central Valley only

	F/N/B # of farms	orchards # of farms	orchards acres	F/N/B revenue (x $000)	revenue per acre
California - Fruits etc.	33,004	38,747	2,582,084	$7,822,769	$3,030
sales > $ 50,000	14,216			$7,579,651	
Sacramento	191	230	17,851	$63,171	$3,539
Kern	723	860	297,840	$1,023,113	$3,435
Tulare	3,689	4,182	305,384	$880,611	$2,884
San Joaquin	2,221	2,549	182,089	$486,553	$2,672
Tuolomne	14	29	292	$737	$2,524
Fresno	4,270	4,755	445,144	$1,098,446	$2,468
Yolo	327	402	32,064	$77,239	$2,409
Madera	999	1,103	179,586	$415,576	$2,314
Stanislaus	2,047	2,340	143,354	$327,794	$2,287
Merced	1,248	1,387	123,709	$278,626	$2,252
Solano	293	369	15,428	$34,302	$2,223
Kings	332	386	31,482	$69,546	$2,209
El Dorado	212	312	3,095	$6,258	$2,022
Butte	1,028	1,215	98,205	$187,830	$1,913
Yuba	220	265	34,701	$63,731	$1,837
Glenn	436	506	47,835	$83,209	$1,740
Colusa	243	293	34,398	$59,582	$1,732
Sutter	705	835	71,825	$123,194	$1,715
Tehema	571	662	36,956	$59,284	$1,604
Placer	141	225	3,348	$4,644	$1,387
Calaveras	61	78	1,136	$1,148	$1,011
Mariposa	17	35	169	$130	$769
Column total	19,988	23,018	2,105,891	5,344,724	$2,538
Pct of all-county	61%	60%	82%	68%	
all-county total	33,004	38,547	2,576,075	$7,821,969	$3,036
listed sum	33,004	38,747	2,582,084	$7,822,769	$3,030
page cited	CA 186-93	CA 170-77	CA 170-77	CA 186-93	

Economics Unit, OSC
TREE_ACR.XLS
7/23/99

FIGURE 1:


Cost of Dormant Sprays and Feasible Alternatives
(All Strategies Include Monitoring)
PTB Pheromone + Dorm. Oil; 1 Spray
PTB Pheromone + Dormant Oil
Non OP + Oil Dorm. Spray; 1 Spray + Acaricide
Non OP + Oil Dorm. Spray; 1 In-Season Spray
Conventional Non OP + Oil Dormant Spray
Spinosad + Oil Dorm. Spray; 1 In-Season Spray
Spinosad + Oil Dormant Spray
Bt Bloom Spray (2X) + Dorm. Oil; 1 Spray
Bt Bloom Spray (2X) + Dormant Oil
Alt. Year Dorm. Spray; 1 Spray + Acaricide
Alt. Year Dorm. Spray; 1 In-Season Spray
Alternate Year Dormant Spray
Dorm. Oil w/ No OP; 1 Spray + Acaricide
Dorm. Oil w/ No OP; 1 In-Season Spray
Dormant Oil With No OP
Conventional OP + Oil Dormant Spray
Highest Cost
Lowest Cost
0 50 100 150 200 250 300 350 400 450
Dollars Per Acre

STATE OF CALIFORNIA

GRAY DAVIS, Governor

DEPARTMENT OF FOOD AND AGRICULTURE
Office of Pesticide Consultation and Analysis
1220 N Street, Room 452
Sacramento, California 95814
Telephone: (916) 654-1765
Facsimile: (916) 657-5017

July 21, 1999

TO: Victor de Vlaming
Division of Water Quality
State Water Resources Control Board
901 P Street
Sacramento, CA 95814

FROM: Charles Goodman, Research Manager C.G.

RE: Comments on "Alternatives to Chlorpyrifos and Diazinon Dormant Sprays"

Thank you for the opportunity to review the draft report, "Alternatives to Chlorpyrifos and Diazinon Dormant Sprays." The draft provides a useful overview of the prospects and problems associated with making the transition to dormant season orchard insect pest management systems that are less dependent on conventional organophosphate (OP) treatments.

The report tellingly concludes that "most of the practices identified are more expensive and complex to use than the conventional OP dormant sprays," and outlines several avenues for additional research.

CDFA agrees that additional research is needed. For example, the report notes that bloom-time orchard peach twig borer (PTB) sprays using Bt are currently practiced on 100,000 acres, but this represents less than 15% of the total acreage (bearing and non-bearing) of the seven crops under discussion. One of the reasons dormant sprays have been a traditional means of controlling orchard pests is that a large window of opportunity exists to apply pesticides. Given the potentially increased costs and difficult logistics of "well-timed treatments of Bt" in larger orchards, the report would benefit from a more thorough discussion of the factors and conditions necessary for successful expansion of these Bt-based systems.

The report properly stresses the importance of empirical testing of the alternate year dormant spray option, and flags the need to better study the offsite movement of runoff from conventional non-OP pesticides for potential environmental Pandora's Boxes.

In fact, all of the draft's posited alternatives require more systematic field evaluation in order to reasonably determine the degree to which meaningful reductions in surface water pesticide levels are achievable without major disruptions to agricultural production systems. In this connection it is appropriate -- indeed more realistic -- to evaluate specific combinations of options in addition to analyzing them individually. Certain variations of options might also be examined, e.g., avoiding dormant sprays in two out of every three years, or three out of every four.

A successful transition away from OP dormant control could also be facilitated by the continued availability of OP's for limited dormant treatment of orchards when pest populations become unmanageable.

The SWRCB could greatly assist such efforts by providing: (1) reasonable guidance as to the desired magnitude of the reductions in environmental loading, and (2) additional support for more thorough empirical investigation of the most promising alternative strategies.

The report would also be strengthened by a more detailed analysis of the potential contribution of Best Management Practices to improving surface water quality.

Overall, the paper would benefit from a more thorough discussion of alternative practices and (though problematic), a discussion of which alternatives the authors believe have the most promise. Likewise, the list of research projects would be more useful if they were prioritized according to how they can best support a more holistic approach to pest management.

Finally, since the report's cost calculations are standardized for a 100-acre orchard, it would be appropriate to analyze to what extent economies of scale in larger orchards affect these calculations.

Thanks again for the chance to review the draft report.

cc: Tad Bell, Director of Policy & Forecasting

Pesticide Action Network

July 20, 1999

Dr. Victor deVlaming
Division of Water Quality
State Water Resources Control Board
901 P Street
Sacramento, CA 95814

Dear Dr. de Vlaming,

I am writing to comment on the draft final report "Alternatives to Chlorpyrifos and Diazinon Dormant Sprays" by Frank Zalom, Mike Oliver, and David Hinton.

The background information on the problem with OP pesticides and runoff is well-stated, highlighting the main points that:

- Dormant sprays are responsible for periodic acute toxicity to aquatic organisms in waterways during storm runoff, and
- These discharges of pesticides to surface waters are in violation of the Basin Plan.

Specific Comments:

1) The title of the document is somewhat misleading, since the overall tone of the document from the end of the first paragraph onward is defensive against any changes to present dormant spray practices. It is particularly instructive to note how the authors view the problem: "...their (diazinon and chlorpyrifos) continued availability for any purpose is genuinely threatened. Serious consideration should be given to options which exist..." This suggests that the authors view these pesticides almost like threatened species, with their consideration of alternatives driven solely by the threat of a ban on these substances. In fact, the real problem is that pesticide runoff from dormant orchard sprays causes our waterways to run toxic to aquatic invertebrates for many days at a time, exceeding chronic water quality criteria many fold. Consideration of alternatives should be conducted with the goal of protecting the ecosystem, not protecting a pesticide.

2) In Section 2, the last sentence states: "... their demonstrated use in such a manner as to avoid environmental damage is needed if they are to be preserved as a management option." We think this is better stated: "... it is necessary to demonstrate that reliance on these pesticides can be reduced or eliminated."

49 Powell Street, Suite 500 • San Francisco, CA 94102 • Tel (415) 981-1771 • Fax (415) 981-1991 • panna@panna.org • www.panna.org/panna

3) In Table 1, Option 2, the risk to aquatic life is said to be high for this option. We disagree with this ranking. Only if OPs are used as the in-season spray would this ranking be correct. If other insecticides were used, the risk to aquatic life could be low to moderate. Better yet, if biological controls were used, the risk to aquatic life would be almost non-existent.

4) In Table 2, the authors should explain that orchard growers do not depend on the profits for a single year, but rather look at income over multiple years. Table 2 is based on one year where average net returns for prunes and almonds were negative (losses). This could be misleading if one does not understand that returns are viewed in a multi-year framework.

5) In Section 6, the authors identify a number of practices that were not considered "viable." In fact, some of the options (or combinations of them) are now being used successfully by almond growers, particularly the use of cover crops and parasite and predator releases. The authors need to elaborate on these methods and their costs in more detail. In particular, there is a gaping hole in the draft report in that the successful BIOS program was not mentioned at all. BIOS integrates a number of pest control strategies, reserving the application of OP pesticides as a last-resort measure. In addition, the BIOS program has been very successful in working with growers, providing a network for exchanging information on the new methods associated with least-toxic pest management. This report is incomplete without a full description and economic analysis of the BIOS program.

6) In Section 10, the authors indicate that the conventional OP dormant sprays are less expensive than most other viable options. However, if the total per-acre costs of each option are put in the context of the total cost per acre for maintaining an orchard, then all treatments are quite similar, with pest management plans typically accounting for less than 13% of the total costs.

7) Finally, a serious failing of the draft report is that, in the economic analysis, the authors do not take into account any costs associated with environmental damage. While changes in farm management and pesticide use practices associated with reducing the inflow of pesticides into surface waters may cost a bit more for materials and labor than dormant sprays, the fact is that pesticide users are not presently paying the full cost of the externalities associated with pesticide use. These external costs include reduced invertebrate and fish populations in surface waters, poisonings of raptors that live near orchards, and human health effects associated with exposures during and after pesticide application. For example, if pesticide users were fined for each hour the concentrations of OP pesticides exceeded the water quality criteria, they would quickly find that dormant sprays of OP pesticides are quite expensive indeed. While we presently lack such monitoring and control

strategies, the exploration of alternatives should not ignore the costly externalities associated with the use of OP pesticides.

Sincerely yours,

Susan Kegley, Ph.D
Staff Scientist/ Program Coordinator

(415) 981-6205 x 316
Skegley@dnai.com

DeltaKeeper

A PROJECT OF SAN FRANCISCO BAYKEEPER

20 July 1999

Victor de Vlaming
State Water Resources Control Board
Division of Water Quality
901 P Street
P.O. Box 944213
Sacramento, CA 94244-2130

VIA FAX, Hardcopy to Follow

Re: Alternatives to Chlorpyrifos and Diazinon Dormant Sprays

Dear Dr. de Vlaming:

On behalf of DeltaKeeper and San Francisco BayKeeper (hereinafter DeltaKeeper), please accept the following comments regarding the draft final report; Alternatives to Chlorpyrifos and Diazinon Dormant Sprays (Report).

We are concerned that the Report suggests a pre-existing bias in favor of the traditional organophosphorus (OP) insecticides for the treatment of dormant orchards. Virtually all of the alternatives discussed or analyzed in the Report concern chemical application. However, there are a number of alternatives to current OP application practices (i.e. BIOS and other IPM approaches) that are both effective and economical. The Report fails to analyze these alternatives. Even so, the Report clearly demonstrates that reasonable alternatives to OPs exist that are efficient for pest control, economically equivalent with fewer adverse consequences for aquatic resources.

While the Report analyzes the economic costs to agriculture with respect to chemical alternatives, it inexplicably ignores the environmental economic costs of continuing to use OPs. The internalization of adverse costs is a fundamental tenet of our economic system. Externalizing the adverse consequences of OP usage undermines market efficiency and stifles progress.

Waterways and aquatic life are public trust assets belonging to all of the people. In a sense, these assets are a common property right. The public trust assets of our waterways have been seriously diminished by the widespread and indiscriminate usage of OPs. The authors should consult with environmental economists and evaluate costs to the environment and agriculture.

Our specific comments follow:

3536 Rainier Avenue
Stockton
CA 95204

Telephone: 209 464 5090
Facsimile: 209 464 5174
Hotline: 1 800 KEEPBAY

Page 1, Section 2:
It is suggested that there are costs and risks to the agricultural industry from constraints such as the potential of regulatory action of consumer avoidance. It is further suggested that there are potential costs to agriculture when questions arise as to commitments to environmental stewardship. We are concerned by the implication that agriculture is unique and should not be held accountable to environmental stewardship. Virtually all industries claim that environmental regulations are needlessly expensive.

Table 1, Option 2:
The risk to aquatic life is said to be high for this option. We disagree with this ranking. Only if OPs are used as the in season spray would this ranking be correct. If other insecticides listed in Appendix 1, Option 2 are used, the risk to aquatic life should be low to moderate.

Table 2:
The authors should explain that orchard growers don't depend on the profits from a single year, but rather look at income over multiple years. Table 2 is based on one year in which average net returns for prunes and almonds were negative (losses). This could be misleading if one doesn't understand that net returns must be viewed in a multi-year framework.

Section 10:
The authors claim that the conventional OP dormant sprays are less expensive than most other viable options. However, if the pesticide costs are made relative to (standardized to) total cost per acre for maintaining an orchard, then all of the treatments are relatively trivial (usually much less than 13% of the total) and not substantially different.

The authors state that growers cannot control urban uses. However, studies by Region 5 and DeltaKeeper demonstrate that atmospheric deposition of diazinon is a significant contributor to urban runoff.

Thank you for the opportunity to comment on the draft Report. If you have any questions, please don't hesitate to contact me at (209) 464-5090, Fax (209) 464-5174 or e-mail at deltakeep@aol.com.

Sincerely,

Bill Jennings

Bill Jennings, DeltaKeeper

cc: Michael Lozeau, San Francisco BayKeeper
Chris Foe, CVRWQCB

CAFF

COMMUNITY ALLIANCE WITH FAMILY FARMERS

P.O. Box 363
Davis, CA
95617-0363

Phone:
530.756.8518
Fax:
530.756.7857

E-mail:
caff@caff.org
Web site:
www.caff.org

June 24, 1999

Dear Victor De Vlaming,

Thank you for the opportunity to comment on the draft final report "Alternatives to Chlorpyrifos and Diazinon Dormant Sprays" by F. Zalom, M. Oliver, and D. Hinton.

This paper is an excellent review of the possible alternatives to a dormant OP spray. The list of alternative pest control strategies appears complete and detailed.

I have additional comments on four topics:

1. Identification of the "best" alternatives
2. Cover crops and runoff
3. Bibliography usage
4. Economics

1. Identification of the "best" alternatives

Overall, the authors have written in true scientific style. They have stated the facts and have avoided making recommendations or ranking of priorities. This style is appropriate in many cases, but I'm not sure if it is the best style to use in this case. Although I have not seen the original contract between the authors and the SWRCB, I would guess that the SWRCB would like to use this document as a guide for making policy decisions. The authors are recognized experts in their field and the SWRCB has turned to them for unbiased advice. Therefore, I would like to see an expanded "Section 10: Summary", in which the best alternatives to the dormant OP spray could be identified.

From a careful reading of the document the best alternatives can be identified, but they are not explicitly stated. In my role as the Biologically Integrated Orchard Systems (BIOS) Staff Scientist, I would like to take the liberty of identifying the best alternative here:

Alternative #4. Bloomtime Bt Sprays, Dormant Oil Applied: In almonds, this is the best alternative to a dormant OP spray. In almonds (grown on 570,000 acres in California) Alternative 4 is an effective and economical replacement for all dormant OP use in almonds. All almond pests controlled by the dormant OP spray can be controlled by other means and therefore the dormant OP spray can be eliminated in almond production. In prunes and plums, aphids can be a serious problem when the dormant OP is skipped. An in-season spray can then be used for aphid control, but this can cause additional outbreaks of pests. Aphid control in plums and prunes, when the dormant OP is skipped, could be a designated research priority in "Section 9: Research Needs".

2. Cover crops and runoff

The role of groundcover in reducing runoff was identified as a research need in Section 9. I know of an excellent, already completed, study from 1997, which I could not find in the bibliography and may be unknown to the authors, by Ross, et al., titled "Reducing dormant spray runoff from orchards". This study identifies certain cover crops that reduced runoff of pesticides (Diazinon, chlorpyrifos, and methidathion) by up to 74% compared to bare ground. The study described in the Ross, et al. 1997 report contains evidence that increased cover crop usage could possibly become a major factor for reducing the offsite movement of pesticides applied to dormant orchards, the "first priority" of the SWRCB contract with Zalom and colleges. Dr. Ross can be contacted at (916)324-4116.

3. Bibliography usage

The bibliography is extensive, but it appears to be a reading list that is also not in alphabetical order. I'm sure many of the cited source contain useful information, but since they are not discussed or referenced in the text, the references are substantially less useful to the reader. On page 2, the review of literature is described as "exhaustive", but also "not intended to be a detailed review". These two statement appear contradictory. Additionally, some of the citations are "personal communications", but since they are not referenced in the text, the reader does not know what the communications were about. I request that the bibliography receive substantial changes.

Alternatively, if the bibliography is a reading list, it could be made shorter, and only the most important or complete references retained. Perhaps an additional column could be added to table 1 titled "key references".

4. Economics

The economic section contains lots of data on the costs of different alternatives. It is very complete and a good analysis in terms of the range of costs of different alternatives.

However, to make useful economic comparisons, the benefits, or increase in income from a particular practice must be known also. Thereby the change in costs can be compared to the change in income. Unfortunately, the change in income (i.e.. efficacy) from these practices is not well known, as stated by the authors. Basically, a standard economic analysis requires both components, the costs and income. Without both, I'm not sure of the usefulness of the cost data, except as cost guides for farmers in planning, and when the income for the individual orchard is known. Perhaps the usefulness of cost data could be more fully explained in the report.

Conclusions

I sincerely hope my comments are taken as constructive criticism. I think the report is an excellent summary of the alternatives to the dormant OP spray. My main concern is that the recommendations of the authors may have become lost in the details. I'm sure the final version of the report will be well polished, as I am familiar with previous work of these authors.

Sincerely,

Max Stevenson, Ph.D.
BIOS Staff Scientist

Cooperative Extension
University of California
Merced County

2145 Wardrobe Avenue
Merced, California 95340-6496
Office 209-385-7403
4-H 209-385-7418
FAX 209-722-8856
Internet: cemerced@ucdavis.edu

July 6, 1999

VICTOR DE VLAMING
DIVISION OF WATER QUALITY
PO BOX 944213
SACRAMENTO, CA 94244-2130

Dear Mr. de Vlaming,

I have reviewed the manuscript "Alternatives to chlorpyrifos and diazinon dormant sprays" and I have only two suggestions for changes. These two suggestions are for page 2.

Under Option #2, second paragraph there is a statement "...lure replaced every two weeks." This is true for Trece septa, but not for others. We should suggest following manufacturers directions.

The next sentence has "...after the first male is trapped in April." This might mislead a person if the biofix should happen to be in March in a very warm year. A reader might think this means that only April moth catches need be considered.

These are my only suggestions, and the points are really quite minor.

Sincerely,

Lonnie C. Hendricks

Lonnie C. Hendricks
Farm Advisor