ALTERNATIVES TO CHLORPYRIFOS AND DIAZINON DORMANT SPRAYS

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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 whenever 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 elevated 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 50º F lower threshold and an 88º 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 51º F lower threshold and 90º 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 identifies 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 pressure 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 cannot 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 cannot 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

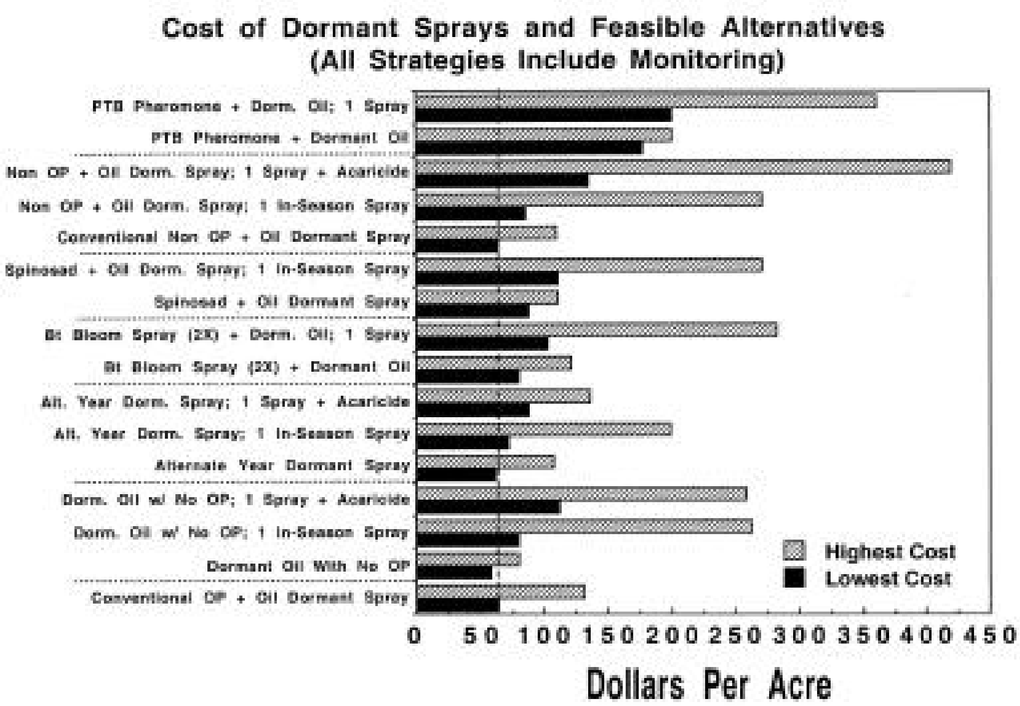
[1] 1998 VALUES FOR TOTAL COST OF PRODUCTION PER ACRE ARE: ALMOND = $2,944; PRUNE = $3,437; CLING PEACH = $3,910; CHERRY = $9,370.
TOTAL COSTS = OPERATING COSTS+CASH COSTS+NON-OVERHEAD COSTS.

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 alternatives 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 Regulation 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 coincides 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 spray 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 following 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,".

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