Pest Management Assessment for Almonds

Reduced-Risk Alternatives to Dormant Organophosphate Insecticides

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This assessment complements the report entitled *Dormant Season Organophosphate Use in California Almonds* (Zhang et al. 2004). The report analyzes dormant OP and other pesticide use in almonds from 1992 to 2000.

Introduction

California law requires the Department of Pesticide Regulation (DPR) to consider and encourage the use of pest control products and practices that reduce risks to human and environmental health. Since the early 1980s, California almond growers have commonly used organophosphate pesticides (OPs) in the dormant season to control several key pests. Dormant OPs were recommended as effective controls for over wintering pests because they were considered to be safer to human health and the environment and much less disruptive to beneficial insects than in-season sprays. More recently, dormant OP use has raised concerns in California due to their appearance in surface water. Consequently, DPR has established a program designed to encourage the development and use of reduced-risk alternatives to OPs. This assessment will review existing pest management practices, describe DPR's reduced-risk pest management program, and identify alternative pest management practices that can be used to decrease the use of OPs and reduce off-site movement to surface water.

Background

Dormant season OPs are sprayed in the winter on almond orchards to control several insect pests.[1] OPs, especially diazinon and to a lesser extent chlorpyrifos, have been detected in the Sacramento and San Joaquin River basins since the 1980s. Rain runoff during the winter carries these OPs to surface waters. Concentrations of diazinon in the Sacramento and San Joaquin River watersheds have been detected at levels high enough to be toxic to some aquatic organisms, thus threatening the health of downstream ecosystems. Therefore, regulatory agencies are interested in reducing or eliminating the levels of OPs in surface water. In addition, OPs used on almonds in the dormant season and in-season (i.e., growing season) pose a potential occupational hazard to pesticide handlers and other workers through dermal exposure, and an ambient air exposure to workers as well as to the general population. In California, the pesticides azinphos-methyl, chlorpyrifos, diazinon, DDVP, ethoprop, methidathion, methyl parathion, and naled are OPs of particular concern.[2]

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[1] For the purposes of this paper, dormant season is defined as 10 December through 20 March (and includes bloom spray) in order to be consistent with other studies (Epstein et al. 2001; Hendricks 1995; Zhang et al. 2003).

[2] DPR lists these compounds as high priority and is developing or has completed risk characterizations for them under the Birth Defect Prevention Act or the Toxic Air Contaminants (TAC) Act. Ethyl and methyl parathion have been listed as TACs; ethyl parathion is no longer registered. The U.S. Environmental Protection Agency (EPA) lists OPs as its first priority as it implements the Food Quality Protection Act.

State and federal laws prohibit the discharge of toxic substances into surface water because the restoration and maintenance of the chemical, physical, and biological integrity of the nation's waters are primary goals. The State Water Resources Control Board (SWRCB) and the Regional Water Quality Control Boards (RWQCB) have established a narrative water quality objective designed to prevent aquatic toxicity. In addition, the Central Valley Regional Water Quality Control Board (CVRWQCB) amended its Basin Plan to establish a Total Maximum Daily Load (TMDL) for diazinon in the Sacramento River and Feather River watersheds.

To further protect surface water quality, the CVRWQCB imposed new regulations that require all dischargers of waste to file a report of waste discharge with a RWQCB. A Regional Board is then required to prescribe waste discharge requirements (WDRs) or waive the WDR. Since 1982, the CVRWQCB has had categorical waivers for "irrigation return water" and "storm water runoff." All waivers terminated on January 1, 2003, in accordance with Senate Bill 390 (Chapter 686, Statutes of 2000); individual WDRs or new conditional waivers were then necessary. In December 2002, the CVRWQCB adopted a new waiver for irrigated lands. Lands where water is applied for the purpose of producing crops are considered irrigated lands and include commercial nurseries, nursery stock production, and managed wetlands. The conditional waiver's conditions encouraged the development of watershed groups (also known as coalition groups) that consist of dischargers and other parties, and) farm-level water quality management plans. The goal of the waiver program is compliance with water quality objectives within 10 years.

Runoff from dormant OP spray has been detected in the Sacramento River and San Joaquin River watersheds. Some OP levels in waterways have been high enough to cause toxicity to aquatic organisms. Consequently, DPR established its Dormant Spray Water Quality Program in 1996. The program has conducted extensive monitoring of surface waters to characterize pesticide residues in surface water bodies, to identify the sources of contamination, and determine the mechanisms of off-site movement of pesticides to surface water.

Under a settlement agreement between the Sacramento Valley Toxics Campaign, the SWRCB, and the RWQCBs, DPR committed to address water quality problems caused by dormant sprays. If, after five years, dormant sprays were to continue to cause toxic conditions in the Sacramento and San Joaquin Rivers, then DPR would use its authorities to reduce concentrations to acceptable levels. Concentrations still periodically exceed target levels aimed at preventing toxicity to aquatic organisms. Therefore, DPR placed dormant sprays containing the active ingredient diazinon into reevaluation, instructing registrants to provide information on processes by which diazinon is transported to surface waters and to demonstrate the effectiveness of management practices in reducing diazinon levels. DPR also announced its intent to propose regulations affecting the application of all dormant sprays.

Pesticide Use Report analysis for the period 1992 to 2000 shows dormant OP use has decreased while the use of two alternatives, dormant pyrethroids[3] and no dormant insecticides, increased in the last nine years. The trends were the same when measured by pounds of OPs used per acre planted, percentage of total planted acres treated, or numbers of growers who applied dormant OPs. The reduction in dormant OP use appeared in all major almond-growing counties. Several factors may be responsible for this reduction such as cost of pesticides, weather conditions, level of pest pressure, and interest in reduced-risk farming practices.

Conventional Pest Management Practices

About 6,000 growers in California produce three-quarters of the world's almonds on an estimated 530,000 bearing acres that extend from Chico to Bakersfield. Almond growers have relied on OP and pyrethroid insecticides to control the crop's key pests, San Jose Scale (SJS), peach twig borer (PTB) and navel orange worm (NOW). The conventional practice to control PTB, SJS, and over wintering mites has been to spray an OP (mixed with narrow-range [superior] oil) during the dormant season (UC IPM 1985). The oil is added to improve the effectiveness of the OP in controlling PTB and because the oil itself controls SJS and over wintering mites very effectively by suffocating them. The spray can be applied whenever the grower can get into the field between leaf fall and the green tip stage of almond development. Sprays are applied by ground using a tractor-driven air blast sprayer, and must provide good coverage. Sprays also are applied by air, particularly in wet years when spray equipment cannot enter the fields

OPs are applied in-season as well as during the dormant season to control NOW, PTB, SJS and ants. These insecticides are usually applied in May after bloom or in July at hull split.

Alfalfa, almonds, nectarines, peaches, plums, and prunes accounted for about 60% to 80% of the dormant season OP use from 1991 to 2000 (Tables 1A and 1B).[4] Historically, use of OPs in the dormant season has been highest in almonds. Several studies have shown that almond and stone fruit orchards are a significant source of OPs in surface water in winter (Anderson et al. 1990, Bennet et al. 1998, Foe and Connor 1991, Kuivila 1993, McClure et al. 2002, Nordmark et al. 1998, Ross 1993, Shelton and Miller 1988, Spurlock 2002). Therefore, DPR focused its efforts on the use of dormant OPs in almonds to address these problems.

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[3] Pyrethroids are synthetic compounds produced to duplicate or improve on the biological activity of the active principles of the pyrethrum plant (e.g., pyrethrins). These compounds include: allethrin, alpha-metrin, barthrin, bioalletrhroin, bioresmethrin, biopermethrin, cismethrin, cyflulthrin, cypermethrin, deltamethrin, dimethrin, esbiol, fenothrin, fenpropanate, fenvalerate, flucythrinate, fluvalinate, furethrin, indothrin, permethrin, phthalthrin, resmethrin, tetramethrin, tralomethrin (Meister and Sine 2003).

[4] Most OP use in alfalfa is in March, although some use is reported during December through February (especially in 2000 and 2001). Most of the December through February use is in Imperial and Riverside counties. Although alfalfa may be treated with OPs during the dormant spray period as defined for this report, alfalfa is not dormant when treated; different pests are targeted; it is a field crop, not an orchard crop; different application methods are used; it is treated with OPs late in the dormant period, when likelihood of high rain runoff declines; and it uses different management practices to mitigate off-site movement of OPs. The relationship between OP use in alfalfa and surface water contamination in the watersheds in Imperial and Riverside counties is not known.

Almond growers select from among 15 OPs[5] to apply to dormant orchards during the winter. DPR and other agencies have sampled surface water for these OPs.[6] Among these OPs, diazinon, chlorpyrifos, and methidathion have been detected in surface waters in the Sacramento and San Joaquin River basins (Anderson et al. 1990, Bennett et al. 1998, Foe and Connor 1991, Kuivila 1993, Ross 1993, Nordmark et al. 1998, Shelton and Miller 1988, Spurlock 2002). Applications during the winter are considered less disruptive to non-target organisms, such as natural enemies, than applications during the spring and summer because most organisms are less active during the winter (Klonsky et al. 1990, UC IPM 2002b). However, detection of significant amounts of these pesticides in surface water indicate that routine dormant applications may need to be reduced or discontinued and replaced by alternative pest management strategies for control of PTB, scales, and mites.

DPR's Reduced-Risk Pest Management Program

Based on legislative mandate [FAC section 11501(f)] and strategic policy, the Pest Management Analysis and Planning (PMAP) program, within the Pest Management and Licensing Branch of DPR, conducts a reduced-risk pest management program. This program promotes the voluntary development and increased adoption of pest management practices that reduce potential human health and environmental risks from the use of pesticides. The program is part of a broader objective by the California EPA to encourage pollution prevention.

One element of PMAP's reduced-risk program is the Pest Management Alliance Grants. Grant funds, when available,[7] are awarded to prevent environmental and human health problems associated with pesticide use by forming a regional or statewide effort to implement reduced-risk practices for a particular commodity or urban site. This program funds projects that create a collaborative, interdisciplinary team that uses a systems approach—the assumption is that team members have already identified reduced-risk practices that solve pest problems through applied research. The Alliance is part of a problem-solving continuum, taking the data collected from research and preparing for the next stages—education through demonstration and, ultimately, implementation.

[5] Azinphos methyl, chlorpyrifos, DDVP, diazinon, dimethoate, disulfoton, ethoprop, fenamiphos, malathion, methidathion, methyl parathion, naled, parathion, phosalone, and phosmet (Zhang et al. 2002). The UC Pest Management Guidelines for Almonds (2002b) list diazinon, chlorpyrifos, methidathion, naled, and phosmet for control of PTB. Of these, growers use diazinon, chlorpyrifos and methidathion the most; diazinon is the OP most often detected in surface water at levels of concern. Ethoprop and fenamiphos are nematicides used in the winter; however, their use is small and presumably not for over wintering insects. Although ethyl parathion has not been registered for several years, its use is still reported. This is likely an error in reporting (for example, most of these uses may be methyl parathion). DDVP use is minor and reported as "non-production agriculture."

[6] DPR has sampled for all 15 OPs plus tribufos (Bennet et al. 1998, Nordmark et al. 1998). Most of these OPs are not surface water contaminants; however, the OP screen routinely analyzes for them.

[7] Due to recent budget cuts, funds are no longer available. They may be reinstated in the future.

The Almond Board of California was awarded one of the original Alliance grants. The Almond Pest Management Alliance (PMA), managed by PMAP, was formed in 1998 to address two major concerns of the almond industry:

- Growing public concern over water quality standards in the San Joaquin River and Sacramento River watershed, with possible links to rain runoff of dormant sprays of pesticides, including OPs, used by almond growers, and
- Implementation of the federal Food Quality Protection Act (FQPA) with possible loss of some traditional crop protection tools (e.g., OPs). [8]

The PMA is composed of growers, UC researchers, pest control advisers and others. The group prepared an Almond Pest Management Evaluation[9] and then developed a work plan to address areas of concern. The Almond PMA consists of three regional field sites located in Butte, Stanislaus, and Kern counties. Project orchards consist of a conventional treatment, reduced-risk treatments, and a control where no treatment is applied. The local UC Cooperative Extension farm advisor manages these plots that are set in commercial orchards. By December of 2003, DPR will have funded this PMA for five years.

To date, the Almond PMA has produced four years of results and activities, including the following findings and outreach:

- Reduced-risk practices, including no insecticide treatment, appear to be controlling pests below economic damage levels (levels where controls must be used to avoid economic crop damage).
  Examples of reduced-risk practices:
  1. Dormant application with oil alone to control SJS and other scales and mite species that over winter in the orchard as eggs.
  2. In-season spray at bloom with reduced-risk products[10] such as spinosad[11], or *Bacillus thuringiensis* (Bt) to control PTB. The timing and coverage of Bt is essential to get adequate control. Because timing the application is so critical, Bt use has fallen out of favor with some growers.
  3. In-season spray in May with reduced-risk products[12] such as spinosad, tebufenozide,[13] or Bt to control PTB and NOW.
  4. Extensive orchard monitoring is the key to success of a reduced-risk program.
  5. The important elements of a successful PMA program include a thorough and scientific evaluation of alternative versus conventional methods of pest control, proper pest identification, and timing crop protection activities using carefully considered monitoring and weather data.

- Outreach activities

[8] Funding: 1998, $99,000; 1999, $98,976; 2000: $98,756; 2001, $100,000; 2002, $79,487.
[9] Evaluation grants provided funding for an appraisal of a pest management system. This was the first step in the preparation of a Pest Management Alliance proposal.
[10] As designated in the Crop Protection Handbook (Meister and Sine 2003).
[11] Success®
[12] See footnote 10.
[13] Confirm®

1. Almond PMA field days coinciding with the traditional pesticide spray season (dormant and in-season) are very successful in an outreach campaign to growers.
2. The Coalition for Urban/Rural Environmental Stewardship published a booklet on orchard practices for protecting surface water (CURES 2002). The Almond Board distributed this booklet to all almond growers statewide. Best management practices for preventing runoff include:
    - Planting cover crops or managing resident vegetation
    - Maintaining vegetative buffers around the orchard
    - Maintaining vegetative filter strips between the orchard and water bodies
    - Planting permanent strips of perennial vegetation perpendicular to the slope of the field
    - Planting vegetation in water channels or waterways
    - Planting or maintaining trees and shrubs adjacent to water bodies
    - Constructing wetland areas at tile outlets to degrade pesticides
    - Planting hedgerows of trees or shrubs in or around fields.

3. The Agricultural Implementation Group (AIG), which includes members of the Sacramento River Watershed Program (SRWP)/Organophosphate Pesticide Focus Group (OPFG), coordinates with the Almond PMA whenever possible on education and outreach efforts. A primary objective of the AIG is to raise the awareness level of growers in the Sacramento River watershed about pest management strategies, pesticide application methods, and on-site practices that can reduce runoff.

Reduced-Risk Pest Management Alternatives for Almonds

Based on the work of the Almond PMA, the following alternatives represent effective practices in a successful reduced-risk program:

- Monitoring for pests and beneficial insects. Orchard pest monitoring is essential for the success of a reduced-risk program. The Almond PMA monitoring program used in Stanislaus County includes PTB pheromone traps, SJS pheromone traps, sticky tape traps for SJS crawlers, and NOW egg traps. PTB and NOW traps are checked twice weekly while SJS pheromone traps are monitored bi-weekly throughout the season (March through September). In addition, mites and mite predators are monitored bi-weekly with the presence/absence leaf sampling technique. Ants are monitored twice yearly or in-season using hotdog bait. In the dormant period, spurs are sampled to monitor SJS populations.

- Apply oil without other chemicals as a dormant spray. Adding a chemical with narrow range oils is not always necessary to get effective control, especially for SJS and over wintering mites. The Almond PMA has shown that oil alone can reduce SJS populations by 80 to 90% when applied at the rate of six gallons of oil in 250 gallons of water per acre. Oils affect SJS primarily by blocking the air holes through which they breathe, thus suffocating them. However, oil alone does not control PTB, brown mite, or European red mite.

- Apply in-season (i.e., bloom, May, or hull split)[14] sprays using reduced-risk pesticides, e.g., spinosad, Bt, or tebufenozide to control PTB. Spinosad is identified as a reduced-risk pesticide and has been shown to be less toxic to beneficial insects. It effectively controls PTB when applied during the dormant season or in-season as a bloom spray at ~ 30% emergence. Bt is known for its low toxicity to humans, non-target organisms, and the environment. Applications during bloom are effective for control of PTB (Barnett et al. 1993, Bryant 1994). The timing and coverage of the application is critical to get adequate control and has been an obstacle for some growers. Tebufenozide (Confirm®) can be used as a May spray or at hull split and has been shown to be particularly effective in controlling NOW, while maintaining populations of beneficial insects.

- Minimum or zero insecticide applications. Over the last two years, the Butte County Almond PMA project successfully demonstrated that pest damage levels were not higher in the PMA blocks, that had no insecticide applications, than occurs in the conventional blocks, which had dormant OP sprays.

- Winter sanitation program. Over wintering nuts (mummies) harbor NOW larvae. Removing and destroying mummies is an effective practice to reduce the need for in-season insecticide treatments, including OPs, to control NOW. This practice is essential to any reduced-risk program. Along with dormant oil treatment for SJS and bloom time treatment for PTB, adequate winter sanitation in conjunction with early harvest can greatly decrease the need for most in-season OP treatments.

In summary, growers in the Almond PMA have successfully demonstrated that reduced-risk practices exist that can replace diazinon and chlorpyrifos. Reduced-risk practices can reduce the overall use of OPs in almond-producing regions (and thus reduce OPs that could end up in the surface waters of the State) and can be used in situations where pest resistance is an issue. The lower costs of not using OPs (oils only or no insecticide) could help offset the increased costs of monitoring. Reduced-risk practices are not equally effective or economically viable in all almond-growing regions of the state. Additional reduced-risk applications may be necessary if pest pressure increases or secondary pests reach damaging levels due to the elimination of OP applications.

Pest Management Analysis and Planning Activities to Address Surface Water Concerns

Information from the Almond PMA and PUR data is being used to develop outreach materials promoting reduced-risk practices, identify high pesticide use areas by watershed, assess the causes of changes in pest control methods, and predict impacts from adoption of different reduced-risk practices, particularly in relation to vulnerable areas for surface water runoff.

[14] This event happens close to the time when almond hulls start to split usually during early July. The synchrony between PTB egg hatch and hull split is one of the most important factors that determine the level of damage to the almonds. Although *Integrated Pest Management for Almonds* (UC IPM 2002a) states that sprays at hull split are not recommended, this is one of the most commonly used applications.

Current PMAP projects include:

- Pesticide Environmental Stewardship Program (PESP) grant with the California Almond Board, U.S. EPA Region 9, and UC Cooperative Extension to develop an outreach program, with specified deliverables, to help growers make informed pest management decisions and comply with pending dormant spray regulations. In addition, information on development of TMDLs and WDRs will be provided at outreach workshops, field days and other events.
- PUR analysis to identify high pesticide use, particularly diazinon, by watershed. Information will be used in the PESP project to develop outreach for regions where OP use is particularly high.
- Contract with Dr. Karen Klonsky, a UC Davis researcher, to develop a general methodology to assess the causes of changes in pest control methods. Although the methodology can be used for any crop or pest issue, Dr. Klonsky will use the dormant OP issue in almonds as the test case.
- Modeling project with DPR's Surface Water Program that looks at pesticide use and surface water pesticide concentrations on a watershed level to predict impacts from adoption of different reduced-risk practices and to assess areas particularly vulnerable to surface water runoff.
- PUR analysis with DPR's Surface Water Program to determine more clearly the relationship between dormant OP use and the occurrence of OPs in surface water (e.g., this will involve analyzing use at various distances from relevant water bodies, timing of applications relative to significant rains, and types of OPs used).
- Partnership with the Natural Resources Conservation Service (NRCS) to provide input to revision of the NRCS Pest Management Practice Standard and to assist in development of a certification program for U.S. Department of Agriculture's Technical Service Providers in California.

Environmental Monitoring Branch Activities to Address Surface Water Concerns

Although these projects may be conducted primarily in dried plum orchards, the results also will apply to management practices in almonds and other fruit orchards. Currently Environmental Monitoring has several studies to:

- Determine the runoff potential of esfenvalerate, a pyrethroid, in dried plum orchards with managed floors;
- Determine if esfenvalerate and permethrin can be detected in surface waters in small watersheds where dormant season use is relatively high and, if so, the range of concentrations; and characterize further winter runoff of OP insecticides and selected herbicides (this study is not specific to dried plum orchards);
- Evaluate the effectiveness of vegetative buffer strips and post-treatment tillage as means to reduce runoff of diazinon from treated dried plum orchards;
- Oversee in coordination with the Pesticide Registration Branch technical elements of DPR's reevaluation of agricultural use products containing diazinon that are used as dormant sprays; and

- Consult with the CVRWQCB as it develops its regulatory framework for protecting water quality from the adverse effects of diazinon. The framework will include TMDLs, water quality objectives and implementation plans, and waivers for WDRs.

In conclusion, DPR is committed to collaboratively solving water quality problems in partnership with the almond industry through the Almond PMA. Dormant spray issues are being addressed through DPR's Dormant Spray Water Quality and Reduced-Risk Pest Management Programs, the almond industry and the University of California Cooperative Extension. The PMA has been shown to be effective in its outreach efforts to demonstrate reduced-risk alternatives to OP insecticides (Heintz, 2003b). These outreach efforts collectively have combined to raise industry and public awareness of the PMA and its role in solving surface water quality problems. Due in large part to the efforts of the Almond PMA, a baseline of awareness has been established within the almond industry resulting in less reliance on OP insecticides.

Table 1A. Pounds of all OPs used during each dormant season (from 10 December to 20 March) in crop production agriculture. The uses during December are summed with the results for the following year.

CROP	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ALFALFA	353,292	353,493	325,992	361,594	503,497	364,700	363,712	338,450	306,718	310,902
ALMOND	439,431	492,413	380,026	348,286	214,242	264,912	185,087	230,682	228,476	102,710
PEACH	99,901	106,284	118,086	112,541	104,785	94,383	81,312	71,971	65,825	68,439
PRUNE	96,731	117,518	107,945	88,351	98,957	85,646	69,056	62,162	51,940	48,890
PLUM	78,258	69,081	74,239	79,835	72,839	66,828	53,691	46,019	46,988	41,063
NECTARINE	55,187	62,368	67,923	73,863	72,287	64,359	58,763	52,536	47,298	47,387
BROCCOLI	33,884	39,376	37,069	43,590	42,557	41,483	34,759	27,030	36,542	29,474
GRAPE	8,100	14,521	6,527	12,904	13,769	30,039	64,943	77,088	63,203	58,513
APPLE	26,459	33,070	34,311	35,717	36,954	38,828	39,828	38,469	33,613	25,384
LETTUCE, HEAD	24,410	29,087	27,717	39,559	30,822	41,123	41,668	30,442	33,219	26,427
WHEAT	19,648	20,614	18,717	17,835	20,945	45,183	30,499	25,595	12,273	12,953
APRICOT	18,161	17,664	17,293	21,565	19,249	15,658	14,033	14,296	9,109	7,698
CANTALOUPE	30,980	12,851	10,845	15,275	14,526	12,963	13,613	12,750	17,055	10,647
CAULIFLOWER	15,571	17,540	15,106	16,773	10,676	10,644	10,847	6,477	7,702	8,193
POTATO	9,041	10,451	14,693	14,129	10,504	15,494	13,234	8,248	9,868	8,359
CHERRY	4,321	7,794	7,551	9,671	6,692	7,329	7,846	13,444	11,108	7,819
LETTUCE, LEAF	3,513	5,989	4,592	8,596	9,874	9,028	6,535	5,354	7,034	10,704
SUGARBEET	13,715	7,121	5,528	13,075	6,908	3,270	5,044	4,549	3,277	909
PEAR	5,997	6,767	5,491	4,797	5,607	4,453	6,316	9,281	5,533	8,421
ONION, DRY	2,756	4,668	5,522	5,982	7,363	5,310	8,506	3,296	6,286	6,018
STRAWBERRY	5,696	4,306	4,719	5,905	5,741	6,526	6,720	4,977	5,204	3,795
CABBAGE	5,369	5,783	3,721	7,742	4,901	4,377	5,007	3,257	4,776	4,109
N-OUTDR PLANTS IN C(	2,842	6,047	2,262	4,291	3,876	5,202	3,649	4,019	5,878	5,698
GRAPE, WINE	688	1,161	2,259	1,090	1,949	3,451	4,836	6,468	8,302	11,092
COTTON	3,067	2,777	3,291	2,335	4,343	2,902	5,783	6,125	5,797	3,710
SPINACH	2,901	2,779	2,328	5,644	4,227	4,465	3,083	2,964	4,245	2,620
CELERY	3,957	3,944	3,955	3,645	2,981	1,924	3,732	2,881	3,462	3,798
CORN, HUMAN CONSUI	388	1,354	2,354	2,671	2,265	3,820	3,565	3,757	2,999	4,280
N-GRNHS FLOWER	3,063	3,671	2,335	3,354	2,752	2,667	3,005	2,008	1,898	1,444
MELON	4,026	2,484	1,633	3,716	2,321	3,859	2,357	836	2,470	1,267
ASPARAGUS	609	957	729	2,164	2,868	3,549	5,387	2,348	1,976	4,134
OTHERS	29,489	38,691	39,178	43,622	33,294	30,928	40,074	30,702	34,081	29,102
Grand Total	1,401,453	1,502,623	1,353,937	1,410,118	1,374,571	1,295,304	1,196,487	1,148,482	1,084,154	915,960

Table 1B. Percent of total OPs (measured in pounds) during each dormant season (from 10 December to 20 March) in crop production agriculture. The uses during December are summed with the results for the following year.

CROP	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ALFALFA	25	24	24	26	37	28	30	29	28	34
ALMOND	31	33	28	25	16	20	15	20	21	11
PEACH	7	7	9	8	8	7	7	6	6	7
PRUNE	7	8	8	6	7	7	6	5	5	5
PLUM	6	5	5	6	5	5	4	4	4	4
NECTARINE	4	4	5	5	5	5	5	5	4	5
ALL OTHERS	= 6 for all years; most values are zero or 1.									
Grand Total	100	100	100	100	100	100	100	100	100	100

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