CALIFORNIA'S PESTICIDE USE REPORTS AND TRENDS IN PESTICIDE USE

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Keywords: Food Quality Protection Act, fumigants, fungicides, herbicides, insecticides, Integrated pest management

California has the most extensive reporting system for agricultural pesticide use in the world with approximately 2.4 million pesticide application reports per year (California Department of Pesticide Regulation, 2000). Here is an overview of the information in the California Department of Pesticide Regulation's (DPR) Pesticide Use Report (PUR) system, uses and limitations of the PUR database, trends in use of compounds of regulatory interest, and some implications of analyses for the goals of integrated pest management (IPM).

History of the PUR system

California had a limited amount of agricultural pesticide reporting by 1950 (Federighi, 2001). In 1970, growers were required to report applications of restricted use materials. In addition, commercial pest control operators, i.e., ground and aerial applicators for agriculture, structural applicators, and professional gardeners were required to report pesticide use. In the 1980's, grower groups and regulators in California recognized the need for data on agricultural pesticide use. For example, the U.S. Environmental Protection Agency (EPA) made risk calculations based on use of the maximum label rate on all planted acreage, which over-estimated risk. After the state's Food Safety Act of 1989 gave DPR the statutory authority to require reporting of all pesticide use, the current PUR system was started in 1990. The system is financed by a tax on pesticide sales, levied at the point of first sale in the state; in 2006, the tax was 2.1%. Individual PURs initially are filed with the grower's County Agricultural Commissioner (CAC); the CACs review and forward the reports to the DPR. Reporting of pesticide applications is required for all of the following: commercial agriculture, except livestock, but including postharvest; poultry and fish production; restricted pesticides; pasture, rangeland, parks, golf courses, cemeteries, and roadside and railroad right-of-ways. In addition, reports must be filed for any pesticide application made by a pest control operator, including structural applicators, professional landscape gardeners, and aerial and ground agricultural applicators. Finally, any outdoor applications of pesticides with a potential to pollute ground water must be reported. The PUR do not contain records for either livestock, home and garden use, or most industrial and institutional applications.

In addition to the PUR database, the DPR (www.cdpr.ca.gov) manages complementary databases: Ground Water Protection Area; Pesticide Illness Surveillance Program; Pesticide Information Portal Project (an interface for access to multiple databases); Pesticide Labels (registered and formerly registered products); Pesticide Regulation's Endangered Species Custom Realtime Internet Bulletin Engine; Pesticide Residues; Pesticide Sales; and Volatile Organic Compounds emanating from pesticide applications.

Data in the PUR database

Each individual report of agricultural use includes the following information: a unique grower identification code; the grower's identification of the treated field (site ID); the geographic location of the treated field to within a square mile, i.e., the meridian, township, range and section; the county; the name of the crop; the number of acres of the planted crop; the date and time of application; the number of acres (or other units) treated; the type of units, e.g., acres; the pounds of active ingredient applied; the pesticide product used; the pounds of product applied; whether the application was made aerially or on the ground; and whether the report was filed by a grower or a pesticide operator. Recently, and in increasing numbers, counties are recording boundaries of grower fields as GPS coordinates; although this information is not yet part of the PUR database, DPR and the CACs are in negotiation about replacing the PUR system with a Statewide Permit and Use Reporting System (SPURS) that would have spatially explicit data and on-line reporting, presumably with improved error-checking.

Currently, DPR has an error checking program, which returns individual records with either missing data or with some unacceptable values back to the CACs. In 1998, DPR started flagging records in which there were probable errors in over-reporting of the mass of active ingredient; typically less than one percent of the current records are flagged; values in flagged records are not included in the data summaries from 1993 to the present.

The PUR database is available as either individual records on CD-ROMs or as data summaries, which are now available on the World Wide Web (http://www.cdpr.ca.gov/dprdatabase.htm). PUR summarized

 DOI: 10.1564/17aug02

yearly data include, for each active ingredient, pounds applied, cumulative acres treated, and number of applications by crop for all of California and by county. The 2004 data were released in December 2005. The non-governmental organization Pesticide Action Network North America (PANNA) has an easy-to-use interface for PUR data (http://www.pesticideinfo.org/Index.html).

The DPR provides commentary when data are released. Historically, when mass of a pesticide increased, the change was attributed to increased pest pressure, but when it decreased, it was a "step in the right direction." Overall, although there are yearly fluctuations, pesticide use has been fairly constant, with some replacements of pesticides. For example, internationally, methyl bromide is being phased out as an ozone-depleting compound under the Montreal Protocol and subsequent agreements; in the U.S., the Montreal Protocol is implemented through the Clean Air Act. As a result of the phase-out, methyl bromide use declined from 7.6 million kg in 1994 to 3.2 million kg in 2004; its replacement 1,3 dichloropropene increased from less than one thousand kg in 1994 to 4 million kg in 2004 (Fig. 1). Both compounds are on the DPR's toxic air contaminants list. While methyl bromide is listed as "known to cause reproductive toxicity" (California's Proposition 65), 1,3 dichloropropene is listed as carcinogenic (California's Proposition 65) and as a B2 probable carcinogen by EPA. Indeed, DPR cancelled registration of 1,3 dichloropropene (telone) from 1991 to 1993 because of its carcinogenicity. Similar to methyl bromide, 1, 3 dichloropropene is used with chloropicrin, which is also increasing in use (Fig. 1). Chloropicrin also can be used as an initial treatment before metam sodium, which increased in use, largely between 1991 and 1995 when 1,3 dichloropropene lost its registration in California because of its carcinogenic listing. Metam sodium is listed as a reproductive toxin (California's Proposition 65), a carcinogen (California's Proposition 65) or probable B2 carcinogen (EPA), and a DPR toxic air contaminant. Starting in 2000, metam potassium (potassium n-methyldithiocarbamate), which is on DPR's toxic air contaminants list, has been used as a methyl bromide replacement. Consequently, while California has made some progress towards the goals of the Montreal protocol, 3.2 million kg of methyl bromide were still used in 2004, and the replacements have not reduced overall health risk to residents from fumigants (Table 1).

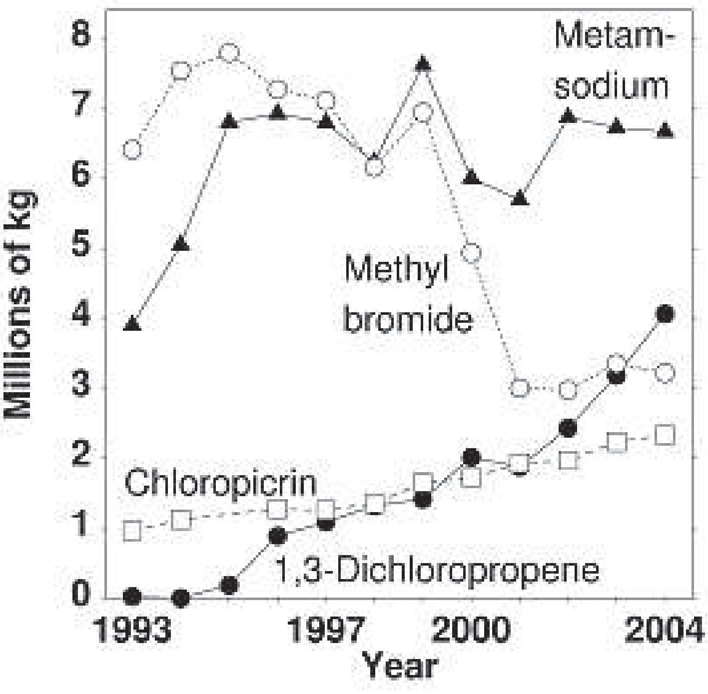

Figure. 1. **The decreased use of methyl bromide (○) in California and the increased use of other fumigants: 1,3 dichloropropene (●), metam sodium (▲) and chloropicrin (□). Data are from the California Department of Pesticide Regulation's Pesticide Use Report data summaries for all reported applications.**

Amongst the non-fumigants, California has made some progress in replacing compounds listed as health risks (Table 1) with those that are not listed. For example, organophosphate insecticides, which are targeted under the Food Quality Protection Act (FQPA), have been partly replaced with pyrethroids and neonicotinoids (Zalom *et al.*, 2005). Nonetheless, organophosphate use is still considerable. For example, chlorpyrifos use declined from 1.3 million kg in 1994, but 806 thousand kg were still used in 2004 (Table 1). Three fungicides on California's Proposition 65 carcinogen list have declined in use between 1994 and 2004: captan, which is also on the air toxics list, from 276 thousand kg to 168 thousand kg; chlorothalonil from 378 thousand kg to 259 thousand kg; and iprodione from 196 thousand kg to 118 thousand kg. Manufacturers discontinued the registration of some compounds, such as the fungicide benomyl, which is listed as a reproductive toxin. The herbicide cyanazine, a reproductive toxin, is no longer registered. However, use of some listed compounds increased. For example, use of the herbicide diuron, which is on DPR's lists for carcinogens and for groundwater protection, increased from 206 thousand kg in 1994 to 441 thousand kg in 2004.

Uses of the PUR database

The DPR uses the PUR for several purposes: to estimate dietary risk; to estimate worker exposure; to assist the CACs with making assessments regarding endangered species; and to assist in the determination of whether or not contamination of well water was the result of legal agricultural applications. Currently, California is not in compliance with the federal Clean Air Act for ozone. Volatile organic compounds (VOCs) contribute to ozone formation, and unless the state reduces VOCs from pesticides, California could lose federal highway funds and have a federal implementation plan imposed. In order to comply with the State Implementation Plan, DPR uses the PUR to estimate VOCs. VOCs are estimated from the mass of formulated product used, which includes both active ingredients and adjuvants, times the "product emission potential," an experimentally determined constant for each product. Manufacturers who either do not submit requested product information or who are unwilling to reformulate to reduce VOCs may have pesticide registrations cancelled. DPR also uses the PUR to guide sampling of pesticides in wells and streams (Maddy *et al.*, 1982).

Table 1. Pesticides of regulatory interest that were applied in a total quantity of greater than 227,000 kg and/or on more than 800 km^2 in either 1993 or in 2004 in California. Compounds that meet the criteria for both kg and km^2 are indicated with an * in the fourth column, but only the kg are reported.[a]

Agricultural use	Compound[b]	Chemical type	Application in California in 2004, in either kg or in km^2 [c]	Slope of a linear regression from 1993 to 2004 in either kg $year^{-1}$ or km^2 $year^{-1}$ as indicated in the previous column	Risk groups[d]
Fumigant	Metam sodium	Dithiocarbamate	6,666,222 kg	+135,982	A, C, R
Fumigant	1,3–Dichloropropene	Halogenated organic	4,061,096 kg	+337,814	C
Fumigant	Methyl bromide	Halogenated organic	3,218,797 kg	–467,127	A, R
Fumigant	Metam potassium	Dithiocarbamate	386,436 kg	+29,749	A
Fungicide	Benomyl	Benzimidazole	1003 kg*	–137,40	R
Fungicide	Captan	Thiophthalimide	854 km^2	–21	A, C
Fungicide	Chlorothalonil	Substituted benzene	259,428 kg*	–17,319	C
Fungicide	Iprodione	Dicarboximide	1,655 km^2	–132	C
Fungicide	Mancozeb	Dithiocarbamate	786 km^2	–41	A, C
Fungicide	Maneb	Dithiocarbamate	433,017 kg*	–1,495	A, C
Fungicide	Myclobutanil	Azole	2,654 km^2	–50	R
Defoliant	S,S,S–tributyl phosphorotrithioate	Organophosphate	81,579 kg*	–35,115	A, F
Herbicide	2,4–D	Chlorophenoxy	4,298,867 kg*	+331,017	A
Herbicide	Acephate	Organophosphate	857 km^2	–80	F
Herbicide	Bromoxynil octanoate	Hydroxybenzonitrile	658 km^2	–6	R
Herbicide, Defoliant	Cacodylic acid	Organoarsenic	0 km^2	–138	C
Herbicide	Cyanazine	Triazine	4 kg*	–29,934	R
Herbicide	Diuron	Urea	634,528 kg*	+8,754	C, W
Herbicide	EPTC	Thiocarbamate	82,739 kg*	–26,957	F, R
Herbicide	Molinate	Thiocarbamate	166,689 kg*	–45,094	F
Herbicide	Simazine	Triazine	331,124 kg*	–11,798	W
Herbicide	Thiobencarb	Thiocarbamate	236,800 kg	+11,161	F
Herbicide	Trifluralin	2,6–Dinitroaniline	464,500 kg*	–10,735	A
Insecticide	Aldicarb	N–Methyl carbamate	880 km^2	–44	F
Insecticide	Azinphosmethyl	Organophosphate	156 km^2	–101	F
Insecticide	Carbaryl	N–Methyl carbamate	108,992 kg*	–30,608	A, F
Insecticide	Carbofuran	N–Methyl carbamate	203 km^2	–139	F
Insecticide	Chlorpyrifos	Organophosphate	806,226 kg*	–62,467	F
Insecticide	Diazinon	Organophosphate	223,391 kg*	–33,963	F
Insecticide	Dimethoate	Organophosphate	150,747 kg*	–14,358	F
Insecticide	Malathion	Organophosphate	223,508 kg*	–9,122	F
Insecticide	Methamidophos	Organophosphate	157 km^2	–123	F
Insecticide	Methidathion	Organophosphate	183 km^2	–106	F
Insecticide	Methomyl	N–methyl carbamate	119,036 kg*	–19,177	F
Insecticide	Oxydemeton–methyl	Organophosphate	836 km^2	–16	F, R
Insecticide	Phosmet	Organophosphate	298,772 kg*	+12,416	F
Insecticide	Propargite	Unclassified	458,936 kg*	–36,670	C, R
Plant growth regulator	Ethephon	Organophosphate	289,291 kg*	–16,108	F

[a] Data are from the California Department of Regulation Pesticide Use Report data summaries for all reported applications in the database, and do not include records flagged as probable errors.

[b] Chlorine is not included because most use in the state is not in the database.

[c] *, compounds used in either 1993 or 2004 in a quantity greater than 227,000 kg and on more than 800 km^2.

[d] A, On California Department of Pesticide Regulation's (CaDPR) Toxic Air Contaminant list; C, on California State Proposition 65's "known to cause cancer" list and/or listed as a B2 carcinogen by the U.S. EPA; F, Organophosphate and carbamates that are cholinesterase inhibitors, and targeted by the U.S. Food Quality Protection Act; R, On California State Proposition 65's "known to cause reproductive toxicity"; W, CaDPR's groundwater protection list (part a).

The PUR data are used by federal agencies including the EPA and the USDA. The EPA uses the PUR as documentation of use of pesticides, including for section 18 registrations, pesticides under re-registration review, and pesticides submitted as organophosphate alternatives or reduced-risk materials. In the EPA's estimates of dietary exposure to pesticides, if the pesticide residue level is below the detection limit, EPA adjusts the estimate based on the percentage of crop treated, which, for California, is estimated from the PUR. Under FQPA, the USDA and EPA must assemble data on pesticide use, particularly of organophosphates, carbamates and possible carcinogens; the PUR are an important source because California produces more than half of the country's fruits, vegetables, and nuts and uses approximately 22% of the total agricultural pesticides in the nation. The USDA has been active in documenting benefits of pesticides. The Office of Pest Management Policy encourages groups including grower associations, pest managers, and Cooperative Extension Specialists to jointly develop Pest Management Strategic Plans for commodities by state or region; in California, as of 2005, there were approximately fifty profiles; the profiles contain PUR data, usually for all California.

The PUR data has been used to predict the impact of changes in pesticide regulations, actual or possible, on agricultural practice. Co-authors from the National Center for Food and Agricultural Policy (NCFAP), the University of Maryland, and the USDA used the PUR database to conclude that 1,3-dichloropropene (Telone), the probable methyl bromide replacement, will not be available to many growers because of air-quality and health hazard regulations, which limit pesticide use by township (Carpenter et al., 2001). Consequently, DPR doubled the limit to 82 thousand kg per year per township (approximately 94 km^2) if use between 1995 and 2002 was below the original cap. In a study of the impacts of possible loss of registration of organophosphates from FQPA, University of California (UC) economists, entomologists and cooperative extension personnel concluded that, overall, there would be little impact on either pest control, farm profits or food costs because there are alternative pesticides (Metcalf et al., 2002).

Perhaps the greatest use of the PUR database is for marketing of pesticides; the individual records have information on market, i.e., crop distribution and product used in a square mile, and potential market, i.e., competitors' products used in the same area. All of each year's individual records are sold for a nominal fee by DPR as text files on CD-ROMs.

The PUR database has been used for environmental quality studies. McConnell *et al.* (1998) associated PUR-documented pesticide use in California's Central Valley with pesticides in rain and snow collected downwind in the Sequoia National Park and Lake Tahoe basin. PUR data has also been used to associate historical pesticide use with human morbidity and species decline. Davidson (2004) associated upwind use of pesticides from 1974 to 1991, particularly of organophosphates, on amphibian decline. Multiple human diseases have known or suspected environmental causes, including cancers, asthma, and Parkinson's (http://www.catracking.com/). Mills and colleagues have been developing methods to quantify agricultural worker exposure, based partly on PUR records (Young et al., 2004). Complications of associating particular pesticides with particular diseases include the transience of many farm workers and the long asymptomatic period of diseases such as cancer.

The PUR database has been used to document trends in agricultural pesticide use that might cause problems in the future. Many organophosphates have been replaced by pyrethroids, which can be less expensive (Epstein *et al.* 2000; Metcalf *et al.* 2002). However, sustainable use of the alternative insecticides will require effective resistance management (Zalom *et al.* 2005).

Although copper is considered a safe fungicide and bacteriocide because it has low mammalian toxicity, it accumulates in topsoil and is toxic to beneficial microorganisms and sensitive crops (Epstein and Bassein, 2001). Based on the individual PUR records, we estimated that during the six year study period from 1993 to 1998, a walnut orchard with the mean copper application and a bulk density of 1.3 g per cm^3 would acquire 28 mg per kg dry weight soil in the upper 15 cm of soil. Moreover, 125 km^2 of walnut orchards, 17% of the area planted with walnuts in California would acquire 50 mg copper per kg dry weight in the upper 15 cm of soil. Although several soil factors affect toxicity, the following mg copper per kg soil are considered inhibitory to the following: beneficial mycorrhizal fungi, 34; soil respiration, 50; earthworms, 80 to110; and copper sensitive crops, 100 to 150. Thus, the PUR data suggest that copper usage in California, which is increasing and does not appear to be replacing other pesticides, could at some time in the future, decrease crop production in California.

While there have been numerous studies on the effect of IPM programs, for example, on growers' pest management practices, the studies are typically plagued by small sample sizes and the inclusion of participants who are self-selecting rather than random. I was interested in using the PUR database to ask questions about pesticide use because, in theory, the PUR is a census of a large population of growers. In collaboration with statistician Susan Bassein, we sought to transform individual records of the PUR into reasonably coherent pictures of growers' pesticide use practices. Some of our results are below.

Ultilization of the PUR database to evaluate various strategies for the reduction of pesticide use or risk

IPM has been promoted to the public as a strategy that will reduce pesticide use or risk. Both the US (US GAO, 2001) and the state of California, including the DPR and the UC Cooperative Extension Service promote IPM in this way. However, although IPM as defined by the USDA has been adopted by US growers, the goals of less pesticide use or risk have not been achieved (Ehler and Bottrell, 2000; Ehler, 2005; US GAO, 2001). Can the PUR database provide insight into why not?

1. The assumption is often made that if a grower adopts a new, non-pesticide alternative disease control measure, that

the alternative will be used instead of, rather than in addition to, the pesticide. The PUR includes applications of microbial biocontrol agents. *Pseudomonas fluorescens* A506 (Blight Ban) is used to control three pathogenic conditions on pears: fire blight, caused by *Erwinia amylovora*; blossom blast, caused by ice-nucleating strains of *Pseudomonas syringae*; and russetting, caused by various indole acetic acid-producing bacteria (Gardener & Fravel, 2002). In 1996, with financial support from the California growers' Pear Advisory Board, a research and extension program at UC introduced *P. fluorescens* with a stated goal of antibiotic replacement. While there was little use of *P. fluorescens* in 1995, by 1998 29% of the area planted with pears was treated with *P. fluorescens* (Epstein & Bassein, 2003). *P. fluorescens* can be used with or without antibiotics; indeed it can be tank mixed with streptomycin, which can even be used by organic growers. Growers who use the same site ID for the same parcel of land from year-to-year can be tracked over time; starting in 1994, this became increasingly common in some counties. Of those pear growers who could be tracked over the four year period (n=89), we divided them into three groups: those who made no applications in all four years (n=40) (Fig. 2 open circles); those who made no application in 1995 but at least one application in 1997 and in 1998 (n=15) (Fig. 2 dark circles); and those who did not fit into either category. Growers with the most intensive antibiotic use in 1995 were more likely to use *P. fluorescens* in the later years (P=0.012 by logistic regression). Of the growers in 1995 who used the median number of applications or less of antibiotics, only 17% used *P. fluorescens* in 1997 and 1998 whereas 60% of the more intensive antibiotic users used *P. fluorescens*. Thus, the most intensive pesticide users were most likely to try the biocontrol. However, they did not decrease their antibiotic use.

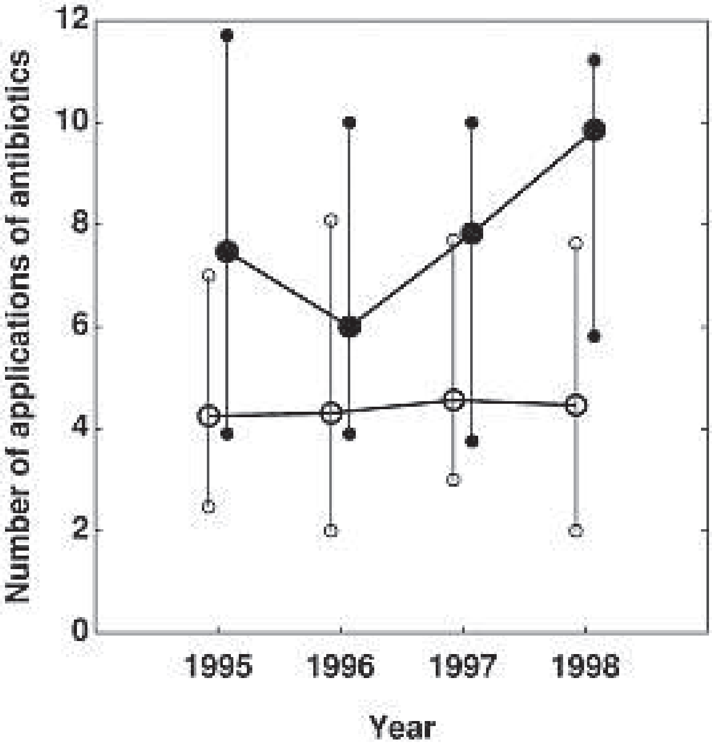

Figure. 2. **The larger circles show the median number of applications of antibiotics on pears by California growers that could be monitored from year-to-year with the Pesticide Use Reports; the smaller circles above and below show the first and third quartiles of use. The open circles show growers who never used the microbial biological control agent *Pseudomonas fluorescens* between 1995 and 1998; the dark circles show growers who applied at least one application of *P. fluorescens* in 1997 and 1998 (Epstein and Bassein, 2003). Reprinted, with permission, from the Annual Review of Phytopathology, Volume 43 ©2003 by Annual Reviews www.annualreviews.org.**

Selective leaf removal in grapevines controls Botrytis bunch rot on grapevines by increasing air flow and decreasing the hours that berries are wet. Leaf removal was implemented in the higher value, wine grape-growing areas on the California coast, largely because it improves fruit quality by increasing sunlight on the berries. Based on anecdotal reports, the media stated that growers' adoption of leaf removal resulted in decreased fungicide use. Diseases on grapevine provide useful case studies of pathogen management because there are a large number of growers and acreage; in 1995, there were 6,181 vineyards and a total of 1,645 km^2 and 1,343 km^2 of wine and non-wine grapes, respectively. In addition, one can make reasonable predictions on why applications were made, based on the active ingredient and the time of applications. Our analysis of PUR records indicated that the use of fungicides used to control bunch rot on wine grapes on the coast vacillated yearly but was overall stable between 1992 and 1997 (Table 2), a time period during which both UC IPM survey data and anecdotal reports indicated that leaf removal was increasing. These and other data led us to postulate that growers control programs are far more heterogeneous and far less dependent upon University of California (UC) recommendations than would be assumed from the literature.

Table 2. Percentage of the collective area of vineyards that were treated with chemicals used to control bunch rot on grapes in California between 1992 and 1997[a]

Region[b]	Type of grape	1992	1993	1994	1995	1996	1997
		Area treated, %					
North Coast	Wine	16	34	18	34	24	22
Central Coast	Wine	39	34	30	29	39	34
Northern SJV[c]	Wine	28	30	27	30	13	9
Southern SJV	Wine	17	24	21	23	15	8
Southern SJV	Non-wine	32	30	39	42	29	26

[a] Applications of benomyl, captan, dicloran, iprodione, mancozeb, or maneb between May 1 and November 30.

[b] Selective leaf removal or other forms of canopy management that increases aeration around the berries also controls bunch rot on grapes. This practice was widely implemented in the North Coast, there was some implementation in the Central Coast, and there was very little implementation in the San Joaquin Valley (SJV).

[c] SJV, San Joaquin Valley.

2. The assumption also is made that replacement of "calendar spray" pesticide programs with "environmentally driven" programs could reduce pesticide use in years with lower disease pressure. However, this assumes that the

majority of growers currently use a "calendar spray" program and that growers who use less than recommended by an environmentally-driven program would not increase their use. We examined control programs of growers for powdery mildew on grapevines (Bassein & Epstein, 2003) before introduction of an environmentally-driven program that extended the recommended interval between applications when temperatures were sub-optimal for the pathogen (Gubler *et al.*, 1999). Our data indicate that while there are a subset of growers who apparently use the calendar spray model, and consequently, could reduce their fungicide use, the majority of growers apparently have a third kind of spray schedule which is less than would be recommended by the environmentally-driven model. While these growers may conceivably have better disease control if they adopted the environmentally-driven model, if all growers convert to the environmentally-driven model, there will be a net increase of fungicide use on California grapevines (Bassein & Epstein, 2003). Overall, the data suggest that growers' control programs are more heterogeneous than often implied in the pest control literature and that the pest management literature may be biased towards the most intensive pesticide users.

Data limitations and data analysis issues

Information that would be useful for agricultural pesticide use analysis, but is not included in the PUR database, includes the following: the plant cultivar and its level of pest susceptibility; the pest for which the pesticide was applied; the intensity of pest pressure at the time of the application; the rationale for application, e.g., to meet export regulations, etc.; and the extent of pest control achieved.

The PUR is a large database with both idiosyncrasies, such as some varying crop classifications in different counties, and a variety of errors, including typographical mistakes and misidentification of amount of product used, e.g., gallons instead of ounces (Wilhoit, 2002). In our experience with the PUR, data quality was so poor in 1990 and 1991, that the data should not be used. Although there are some errors that result in over-estimation of pesticide use, e.g., duplicate records of applications on the same day in which area treated exceeds area planted on a single day, such errors can be removed. Overall, the PUR underestimates pesticide "load," particularly on the landscape level; the PUR does not include home, yard or garden use, which contributes to run-off in urban and suburban areas. Also, applications in most industrial and institutional settings, and on livestock, are not included. Although most experts consider compliance with PUR reporting requirements to be fairly high, particularly amongst the professionally managed farming operations, the amount of under-reporting is unknown. California has a black market for stolen pesticides, and these may not be reported in the PUR. Expert opinion is that "part-time" growers, often with small acreages, may under-report; in our analyses of fungicide use on grapes, for example, we excluded hobby growers by analyzing only those with plantings greater than 0.1 km^2. When the individual PUR records are used so that errors can be detected, researchers who are both knowledgeable about the PUR and pest management practices can select methods that minimize the impact of errors on their datasets (Epstein *et al.* 2001; Epstein & Bassein, 2003).

Conclusions

In theory, the PUR database is a census of pesticide use on crops and structures in California, essentially from 1992 or 1993 to the present. Currently, spatial resolution of the database is to a geographic section of 2.6 km^2. The database is used by state and federal regulators and for pesticide marketing. For pest management researchers, the PUR contains information on growers' practices that is not biased by small samples or self-selected participants. Data from the PUR indicates that growers try new products and substitute products, but overall, despite the promotion of integrated pest management, there has been no overall reduction in pesticide use and relatively little reduction in pesticide risk in California between 1992 and 2004.

Acknowledgements

I thank L. Ehler and S. Bassein for reviewing this manuscript, and Susan Bassein for her work on analysis of the PUR database.

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