Summary of
Pesticide Use Report Data
2018

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For information on obtaining electronic data files, see page ii.
This report is available on DPR's Web site <www.cdpr.ca.gov/docs/pur/purmain.htm>.
If you have questions concerning this report, contact <PUR.Inquiry@cdpr.ca.gov

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How to Access the Summary of Pesticide Use Report Data

The *Summary of Pesticide Use Report Data* issued by the California Department of Pesticide Regulation (DPR) for recent years can be found by clicking the link of the year of interest under the Pesticide Use Annual Summary Reports section at <www.cdpr.ca.gov/docs/pur/purmain.htm>. Past years (1989-current) can be requested by emailing <PUR.Inquiry@cdpr.ca.gov>. The tables in the Statewide Report and County Summary Reports list the pounds of active ingredient (AI) applied, the number of applications, and the number of acres or other unit treated. The data is available in two formats:

- *Indexed by chemical:* The report indexed by chemical shows all the commodities and sites in which a particular AI was applied.
- *Indexed by commodity:* The report indexed by commodity shows all the AIs that were applied to a particular commodity or site.

The following pesticide use report data can be downloaded from the Department's File Transfer Protocol (FTP) site at <ftp://transfer.cdpr.ca.gov/pub/outgoing/pur archives/>.

- *Annual Report Data:* The pesticide use report data used in the *Pesticide Use Annual Summary Reports* for 1989 to 2018. The files are in text (comma-delimited) format and do not include updates that occur after the year's Pesticide Use Annual Summary Report was released. For updated data, use the online California Information Portal (CalPIP) at <http://calpip.cdpr.ca.gov/main.cfm> or contact DPR at <PUR.Inquiry@cdpr.ca.gov> CalPIP data is usually refreshed once a year, while emailed queries return the most up-to-date data.
- *Pesticide Use Data 1974 - 1989:* Pesticide use data from 1974 to 1989 vary by year in the type and quality of data collected and are kept in a separate database from the more standardized "full-use" data collected since 1990. They are available as text files.
- *Microfiche Pesticide Use Data 1970 - 1973:* Files of summarized pesticide use data from 1970 to 1973 are available as PDF scans of microfiche.

Starting in 2016, the data from each figure or table in the annual report can be found at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Please direct any questions regarding the *Summary of Pesticide Use Report Data* to the Department of Pesticide Regulation, Pest Management and Licensing Branch, P.O. Box 4015, Sacramento, California 95812-4015, or you may request copies of the data by contacting <PUR.Inquiry@cdpr.ca.gov>.

Year in Summary

Overview: Reported pesticide use for California in 2018 totaled 209 million pounds of applied active ingredients (AIs) and 105 million cumulative acres treated. Since 2017, pounds of AIs increased by just over two and a half million pounds (1.3 percent) while the acres treated increased by around 859 thousand acres (0.8 percent). Pesticide use trends measured in pounds tend to be driven by pesticides with large application rates, such as sulfur, oil, or fumigants, while trends reported in cumulative "acres treated" focus more on widespread use weighted by the number of applications. Both measures taken together give a more nuanced understanding of how pesticide use changes over time.

Biopesticides and petroleum and mineral oils, which have been identified as likely to be low risk to human health and the environment, increased in both the pounds applied and the acres treated in 2018. Most oil pesticides used in California serve as alternatives to more toxic pesticides. Some highly refined petroleum-based oils are used by organic growers.

The cumulative acres treated with pesticides considered to be reproductive toxins, carcinogens, cholinesterase inhibitors, ground water contaminants, toxic air contaminants, and fumigants all decreased in 2018. The pounds of carcinogens, cholinesterase inhibitors, toxic air contaminants, and fumigants decreased as well.

The AIs with the highest total reported pounds were the fungicide/insecticides sulfur and petroleum and mineral oils, the fumigant 1,3-dichloropropene, the herbicide glyphosate, and the fumigant metam-potassium (potassium N-methyldithiocarbamate). (Fungicide/insecticide AIs have both fungicidal and insecticidal activity, although they may be used solely as a fungicide or an insecticide depending on the crop). The AIs with the highest reported cumulative acres treated were sulfur, glyphosate, petroleum and mineral oils, the miticide abamectin, and the insecticide lambda-cyhalothrin.

1 Introduction

History of pesticide use reporting in California

In the early 1880s, California passed legislation allowing counties to appoint horticultural commissioners to assist with pest management. These horticultural advisors were the forerunners of present-day County Agricultural Commissioners (CACs). During that early time period, many of these commissioners required agricultural pest control operators to submit some type of monthly report of pesticide use; however the exact requirements varied depending on the county. Most reports included details such as the location, date, crop, acres treated, pest, pesticide, and use rate. Unfortunately, many of these detailed records have been lost over time.

One of the first state-wide pesticide regulations was enacted in 1901. California passed a pesticide regulation law requiring product samples of Paris Green, an arsenic-based insecticide, to be submitted to University of California agricultural experiment stations in an effort to prevent consumer fraud from mislabeled and adulterated products. In 1911, California's State Insecticide and Fungicide Act furthered these protections by requiring labels identifying the component chemical amounts and information about the manufacturers.

In 1919, the California Department of Agriculture (CDA), now known as the California Department of Food and Agriculture (CDFA), was formed and began enforcing statewide pesticide laws. In 1921, the Economic Poisons Act was passed, giving the CDA the ability to regulate the manufacture, sale, and use of pesticides. From 1934 to 1956, the CDA produced a monthly Bulletin Report which included a summary pesticide use table. Starting in the early 1930s, the CDA began collecting statistics on aerial pesticide applications from the counties. In 1954, state regulators began requiring reports on ground application acreage as well, although these reports lacked detailed information about the pesticides used or commodities treated.

The 1960s brought increasing awareness about non-target effects of pesticides on the environment. At the federal level, congress passed numerous environmental statutes touching on pesticide regulation such as the Clean Water Act, the Clean Air Act, the Endangered Species Act, and the Occupational Safety and Health Act. In 1970, the U.S. EPA was created, taking over pesticide registration and residue tolerance functions from the U.S. Department of Agriculture (USDA) and the U.S. Food and Drug Administration (FDA). In addition, in 1972 and 2003, the 1910 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was overhauled with a stronger focus on protecting human health and the environment.

California also expanded many of its regulations during this time period, surpassing the requirements called for by FIFRA and other federal regulations. In 1970, pesticide use reporting requirements broadened to include all pesticide applications by pest control operators (PCOs) as well as all restricted pesticide applications by growers. In 1991, the California Environmental Protection Agency (CalEPA) was founded. As part of CalEPA, the California Department of

Pesticide Regulation (DPR) took over many pesticide regulatory roles, with a few exceptions: pesticide residue laboratory testing remained with CDFA, and local enforcement authority largely remained with the counties, overseen by the DPR Enforcement branch.

The Food Safety Act of 1989 (Chapter 1200, AB 2161) gave DPR statutory authority to require full reporting of agricultural pesticide use, which officially began in 1990. Full-use reporting required more detail than ever before about a wider variety of pesticide applications than previous requirements. CalAgPermits was developed in 2011 to meet demands for online access, and is still in use today (See *CalAgPermits*, p. 6).

California's broad definition of "agricultural use" requires reporting pesticide applications in production agriculture, parks, golf courses, cemeteries, rangeland, pastures, and along roadside and railroad rights-of-way. Production agricultural pesticide use is a subset of agricultural use, defined as use of a pesticide for the "production for sale of an agricultural commodity" or "agricultural plant commodity." Each application of pesticide on crops (production agriculture) must include the site name given to a location or field by the CAC as well as the one by one square mile section in which the application occurred. Most other uses are aggregated and reported by month with only the county identified. These other uses include rights-of-way applications, all postharvest pesticide treatments of agricultural commodities, structural applications by licensed applicators, all pesticide treatments in poultry and fish production, and some livestock applications. In addition, all applications made by licensed applicators and outdoor applications of pesticides that have the potential to pollute ground water must be reported. The primary exceptions to the reporting requirements are residential home and garden uses, veterinary uses, and most industrial and institutional uses.

In addition to requiring pesticide use reporting, California law (Food and Agricultural Code [FAC] section 12979) directs DPR to use the reports in setting priorities for monitoring food, enforcing pesticide laws, protecting the safety of farm workers, monitoring the environment for unanticipated residues, researching pest management practices, monitoring and researching public health issues, and similar activities. These activities help DPR with implementing another mandated activity: the continuous evaluation of currently registered pesticides (FAC section 12824). Information gathered during continuous evaluation is used to gauge the performance of DPR's regulatory programs and support additional measures, including development of new regulations or reevaluation or cancellation of pesticide registrations. California Code of Regulations Title 3, sections 6624 *et seq.* further describe pesticide use record keeping and reporting requirements.

Continuous Evaluation of Pesticides

The Pesticide Use Report (PUR) greatly increases the accuracy and efficiency of continuous evaluation of pesticides by providing details on each application, including date, location, site (e.g., crop), time, acres and units treated, and the identity and quantity of each pesticide product applied. These data allow scientists and others to identify trends in pesticide use, compare use locations with other geographical information and data, and perform quantitative assessments and evaluations of risks that pesticides may pose to human health and the environment. Prior to full reporting, the regulatory program's estimates of pesticide use frequently relied on maximum rates and applications as listed on the label, potentially overstating risks. Use of the PUR data allowed for much more accurate risk assessments and effective policy decisions. Over the years, these data have been used by a variety of individuals and groups, including government officials, scientists, growers, legislators, and public interest groups.

DPR uses the PUR throughout its pesticide regulatory programs in ways that can be broadly grouped as temporal (time), geospatial (place), and quantitative (amount), often combining elements of each.

Temporal analyses can pinpoint specific applications or span many years. Investigations into suspected worker illnesses, spray drift, fish or wildlife losses, or other enforcement inquiries frequently begin with a review of the PUR to see what applications were made in an area at a particular time. Protection of ground and surface waters, assessments of acute and chronic risks to human health, and allocation of monitoring and enforcement resources often include analyses of PUR data from numerous years to better evaluate pesticide use trends.

Geospatial analyses may be local or expansive. Local analyses are used to help set priorities for surface and ground water monitoring programs by determining pesticide use and runoff potential in specific watersheds or other defined areas. DPR scientists calculate contributions of smog-forming volatile organic compounds (VOCs) in the atmosphere from pesticide products using pesticide use data in combination with emissions potential data of products. DPR further refines the analyses to specific air basins that are particularly vulnerable to air pollution to determine whether pesticide-related VOC emissions are below required targets or whether additional restrictions on use may be warranted to protect air quality. More expansive analyses examine the proximity of pesticide use to endangered species habitat, resulting in the development of best use practices to protect these species. These analyses are invaluable when assessing regulatory responses or evaluating the performance of voluntary stewardship efforts.

Quantitative assessments are broadly used to model risks of pesticide use to humans and the environment. The quality and depth of the information provided in the PUR allows researchers to apply realistic assumptions when modeling pesticide exposure. PUR data have been used to model pesticide exposure of people who live near agricultural lands, workers in the field, handlers preparing and applying pesticides, and aquatic organisms inhabiting waterways that receive agricultural runoff. Analysis of the PUR enables well-informed and realistic assessments for risk management decisions.

Increases in the pounds, acres treated, or number of applications of pesticides do not necessarily correspond to higher risk to human health or the environment. However it is important to remember that risk is a function not only of the pesticide amount used, but also the toxicity of the AI to human health or the environment and the potential exposure to the AI. For example, kaolin clay was a large contributor to the total pounds of pesticides used in California in 2018, ranking 11th in the top 100 pesticides used by pounds. Kaolin clay is a fine-grained mineral that is sprayed on plants to form a particle film which acts as a fungicide, insecticide, or sunburn protectant. Although many pounds of kaolin clay were used during the year, kaolin is a biopesticide and considered a minimum risk chemical. Increased use of lower risk chemicals may serve to reduce overall risk if they are used as alternatives to higher risk chemicals.

In contrast, some AIs with high toxicity are only needed in very small amounts to be effective pest control agents, and therefore have low total pounds. However, if the toxicity, mode of action, and broad-spectrum nature of the AI can cause unintended harm to human health or the environment, then a small amount of an AI with high toxicity could pose a greater risk than a large amount of an AI with a lower toxicity.

In addition to toxicity, exposure plays a large role in determining potential human health or environmental risks. Minimizing exposure to an AI is generally thought to reduce risk of harm from the AI. Risk can therefore be mitigated through a number of tools and practices that minimize exposure, such as personal protective equipment (PPE), buffer zones, drift reduction practices and equipment, application timing with favorable environmental conditions to prevent off-site pesticide movement, vegetative filter strips, tailwater ponds, and many other innovative techniques. In summary, when using PUR data to assess risk from an AI, its toxicity and exposure potential should be considered in relation to the amounts of pesticide used.

The passage of the federal Food Quality Protection Act (FQPA) of 1996 launched the PUR into a more integral role as a tool for monitoring and achieving compliance with updated food safety regulations. The FQPA contained a new food safety standard against which all pesticide tolerances – amounts of pesticide residue allowed by federal law to remain on a harvested crop – must be measured. PUR data became increasingly important to commodity groups, University of California (UC) specialists, the U.S. EPA, and other interested parties as they reassessed tolerances and calculated dietary risks from pesticides based on actual reported uses.

PUR information such as pesticide types, use rates, geographical locations, crops, and timing of applications help researchers understand how various pest management options are implemented in the field. Analyses of these data are the basis for grant projects that DPR funds to promote the development and adoption of integrated pest management practices in both agricultural and urban settings.

The PUR data are used by state, regional, and local agencies, scientists, and public interest groups. The data are an invaluable tool for understanding pesticide use in order to protect human health and the environment while balancing the population’s need for quality food, fiber, shelter, and surroundings.

CalAgPermits

In 2011, the counties implemented CalAgPermits, a standardized, web-based system that greatly enhanced the efficiency of data entry and transfer, and thus the accuracy and integrity of the PUR database. In addition to helping CACs issue restricted-materials permits and operator IDs, it allowed individuals and businesses the option of reporting pesticide use electronically. The use of CalAgPermits also greatly enhanced data quality assurance by adding another level of automated data validation and error checking of submitted pesticide use reports in addition to what occurs after transmission to DPR. The many improvements in the ability to share data electronically between DPR and CACs have greatly improved the efficiency and effectiveness of quality control for the PUR.

Data Collection

Most pesticide use data required to be reported must be sent to the CAC in the county where the application took place. PURs can be submitted to the counties through individual CalAgPermit accounts, paper forms, or through third party software programs. After being sent to the CAC, the PUR is entered into the county CalAgPermit database and checked for a number of errors. The CAC then electronically sends required data to DPR, where additional validation and error checks take place. On average, DPR collects around three million pesticide use records a year. Currently the PUR database contains over 80 million pesticide use records, going back to 1990 (Earlier PUR records from 1974 to 1989 are kept in a separate database since these early records vary in the type and quality of data collected. PDF documents of scanned microfiche of pesticide records from 1970 to 1973 are also available).

Improving Data Quality

DPR checks the quality of PUR data many times between the initial data entry and before it is made available to the public. CalAgPermits checks for data entry errors, such as whether the pesticide applicator has the correct permits for any restricted materials reported or whether the pesticide product is allowed on the reported application site. Once the data have been received by DPR they undergo more than 50 different validity checks such as identifying missing data, invalid entries, and confirming that the reported pesticide unit of measurement corresponds to the pesticide's dry or wet formulation. The PUR database may include products that do not have an active registration since end-users are allowed to continue using stocks purchased prior to a product's registration becoming inactive. Records flagged for suspected errors are returned electronically to the county for resolution. If an error cannot be resolved, the record is transmitted to the database, but is logged as an error or outlier in a separate table, which is publicly available.

Additional data checks are performed to identify errors and outliers in pesticide use amounts. These checks are conducted via a complex, automated, statistical procedure that was originally developed by DPR in the late 1990s, and has continually been improved over time. If a reported use rate (amount of pesticide per acres treated) greatly exceeds typical use rates of that AI, it is flagged as an error and sent back to the CAC to confirm. If the county is unable to identify the correct rate, an estimated rate equal to the median rate of all other applications of the pesticide product on the same crop or site is used instead. Although less than one percent of the reports are flagged with this type of error, some errors are so large that if included, they would significantly affect the total cumulative amount of applied pesticides. For more information on errors and identifying outliers in the PUR, see <www.cdpr.ca.gov/docs/pur/outlier.pdf>.

Non-production-agricultural PUR records (for example, applications to structures, golf courses, landscapes, and rights-of-way) are difficult to statistically evaluate for errors due to the lack of information on the acres or area treated (See *Agricultural and Nonagricultural Pesticide Use*, p. 9, for more information about the differences between agricultural and non-production-agricultural pesticide use). Current regulations do not require reporting this information. While statistical algorithms can analyze whether the amount of pesticide used over a given number of acres seems to be a reasonable application rate for production-agricultural PUR records, the lack of an acres treated value creates problems for catching errors in non-production-agricultural PURs. For many of these non-production-agricultural PURs, a rate is calculated as the amount of pesticide per application rather than per acre. These rates are statistically evaluated against similar applications for validity, alongside algorithms that check the total amounts against high threshold values.

While the statistical algorithm currently in place detects many outliers in production agricultural pesticide use reports, its use for most structural pesticide applications is limited. In 2015, structural pesticide applicators were no longer required to report the number of applications. In addition, prior to 2015, there was a lot of variability in how the number of applications was interpreted, and reported, by the applicator. As a result, algorithms triggering errors when pesticide amounts are above high threshold values are used in conjunction with the statistical algorithms in an effort to catch very large errors. In addition, there has been a concerted effort by many DPR staff to manually identify exceptionally high structural PUR amounts and contact the applicators for verification - in many cases, these high amounts were mistakenly entered due to a misunderstanding that DPR wanted the diluted amount of pesticide rather than the undiluted amount. Many of these incorrect PURs have since been replaced by the correct, undiluted amounts. Future plans to further reduce errors in structural PURs include electronic warning flags that will notify CalAgPermit account holders if they enter an extremely high value, and remind them that undiluted amounts should always be reported.

Improving Access to the Data

There are several ways to access the PUR data. Annual reports serve as an accessible snapshot summary of the much larger PUR database. Before the late 1990s, summaries were available by request and were only hard copy. As use of online resources increased, DPR improved public access to the data by posting summary annually on its website <www.cdpr.ca.gov/docs/pur/purmain.htm>

(Contact <PUR.Inquiry@cdpr.ca.gov> to request summaries from years not available online). In addition, the PUR data used in each annual report from 1984 on can be downloaded using DPR's File Transfer Protocol (FTP) website <ftp://pestreg.cdpr.ca.gov/pub/outgoing/pur archives>. Data obtained from the FTP site does not include updates that may have occurred after the release of the annual report. Scans of the hard copy summaries from 1974 to 1989 are also available on the FTP site and are primarily a tabular summary of pesticide use data by county. Current annual reports are more detailed and analyze various pesticide use trends. In 2016, PDF files of scanned summary pesticide use reports on microfiche from 1970 to 1973 were added to the FTP site for download.

Starting in 1996, DPR scientists began analyzing critical crops and their pest problems as well as trends in the pounds of pesticides used, and the number of applications and acres treated. Each year, the annual report charts pesticide use over several years in specific categories:

- Reproductive toxins
- Carcinogens
- Organophosphorus and carbamate cholinesterase inhibitors
- Chemicals classified by DPR as ground water contaminants
- Chemicals listed by DPR as toxic air contaminants
- Fumigants
- Oil pesticides derived from petroleum distillation (many of which serve as alternatives to high-toxicity pesticides)
- Biopesticides (including biochemical pesticides that control pests by non-toxic mechanisms (for example, pheromones and bait attractants) and microbial pesticides. Biopesticides are considered to be less toxic and more selective than conventional pesticides)
- Crops (DPR analyzes pesticide use trends for around a dozen crops with the highest amount of pesticide used or acreage treated)

Pesticide use trend analyses can help regulatory agencies evaluate the success of their efforts to promote reduced-risk pest management strategies. Information on long-term trends also helps researchers better identify emerging challenges and direct research to finding solutions.

In 2003, DPR launched the web-based California Pesticide Information Portal (CalPIP) to increase public access to the PUR database. CalPIP provides pesticide use information including date, site or crop treated, pounds used, acres treated, pesticide product name, AI name, application pattern (ground, air, or other), county, ZIP code, and location where the application was made to within a one-square-mile area. Note that many of these data fields only apply to production agricultural pesticide use records (e.g. date, acres treated, application pattern, zip code, square mile section). DPR annually updates the previous few years of CalPIP data to account for any changes due to errors identified after the annual report has been released, so it is often a more up-to-date source of pesticide information than the annual report <http://www.cdpr.ca.gov/docs/pur/purmain.htm>.

Starting in 2016, text files of the data from all tables and figures in the annual reports can be accessed at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

2 Comments and Clarifications of Data

When analyzing the data contained in this report, it is important to consider the following:

Terminology

- *Product versus active ingredient (AI):* A pesticide product contains both active and inert ingredients. An AI is a component of a pesticide product that controls target pests. There can be more than one AI in a product. Inert ingredients are all the other ingredients of the product which do not target the pest but may enhance product performance and application. Specific products are reported in the pesticide use reports submitted to DPR. DPR identifies the AIs of these products for trend analysis.
- *Number of agricultural applications:* Number of applications of pesticide products used in production agriculture. More detailed information is given below under "Number of Applications."
- *Pounds applied:* Total pounds of AI summed over a given time period, geographic area, crop, or other category of interest. The pounds of AI in a single application is calculated by converting the product amount to pounds, then multiplying the pounds of product by the percent of the AI in the product.
- *Unit type:* The type of area treated with the pesticide:
    - A = Acreage
    - C = Cubic feet (usually of postharvest commodity treated)
    - K = Thousand cubic feet (usually of postharvest commodity treated) P = Pounds (usually of postharvest commodity treated)
    - S = Square feet
    - T = Tons (usually of postharvest commodity treated)
    - U = Miscellaneous units (e.g., number of nursery container plants, trees, tree holes, bins)
- *Acres treated:* Cumulative number of acres treated. More detailed information is given below under "Acres Treated."
- *Risk Analysis:* When using PUR data to analyze potential human health or environmental risks, the toxicity of the AI and the potential for exposure, in addition to the amount of pesticide used, should always be considered.

Agricultural and Nonagricultural Pesticide Use

Many pesticide licensing, sales, and use requirements are tied to California's definition of agricultural use. Pesticide labels differentiate between agricultural, industrial, or institutional uses.

California law (FAC section 11408) identifies agricultural use as all use except the following categories specifically identified as nonagricultural use:

- *Home:* Use in or around the immediate environment of a household. Licensed, professional pesticide applications are reported as nonagricultural use (usually "structural pest control" or "landscape maintenance"). Unlicensed, non-professional, residential pesticide applications around a home or garden are not required to be reported.
- *Industrial:* Use in or on property necessary to operate factories, processing plants, packing houses, or similar buildings or use for a manufacturing, mining, or chemical process. Postharvest commodity fumigations in buildings or on trucks, vans, or rail cars are normally considered industrial use. Industrial pesticide uses are not required to be reported unless the pesticide is a restricted material, has the potential to pollute ground water, or was applied by a licensed pest control operator. In California, industrial use does not include use on rights-of-way.
- *Institutional:* Use in or on property necessary to operate buildings such as hospitals, office buildings, libraries, auditoriums, or schools. Includes pesticide use on landscaping and around walkways, parking lots, and other areas bordering the institutional buildings. Institutional pesticide uses are not required to be reported unless the pesticide is a restricted material, has the potential to pollute ground water, or was applied by a licensed pest control operator. Note that the Healthy Schools Act of 2000 imposes additional pesticide use reporting requirements if the pesticide application takes place at a school or childcare center, regardless of whether or not the application was made by a licensed professional.
- *Structural:* Use by licensed structural pest control operators within the scope of their licenses
- *Vector control:* Use by certain vector control (e.g., mosquito abatement) districts
- *Veterinary:* Use according to a written prescription of a licensed veterinarian. Veterinary prescription pesticide use is not reported to the State.

Agricultural use of pesticides includes:

- *Production agricultural use:* Any pesticide used to produce a plant or animal agricultural product (food, feed, fiber, ornamental, or forest) that will be distributed in the channels of trade (Some requirements—most notably those that address worker safety and use reporting—apply only to plant product production.)
- *Non-production agricultural use:* Any pesticide used on watersheds, rights-of-way, and landscaped areas (e.g., golf courses, parks, recreation areas, and cemeteries) not covered by the definitions of home and institutional uses

The following specific pesticide uses are required to be reported to the CAC who, in turn, reports the data to DPR:

- Production of any agricultural commodity except livestock (where livestock is defined in FAC section 18663 as “any cattle, sheep, swine, goat, or any horse, mule or other equine, whether live or dead”)
- Treatment of postharvest agricultural commodities
- Landscape maintenance in parks, golf courses, cemeteries, and similar sites defined in the FAC as agricultural use
- Roadside and railroad rights-of-way
- Poultry and fish production
- Application of a restricted material
- Application of a pesticide listed in regulation as having the potential to pollute ground water when used outdoors in industrial and institutional settings
- Application by licensed pest control operators, including agricultural and structural applicators and maintenance gardeners

Growers must submit their production agricultural pesticide use reports to the CAC by the tenth day of the month following the month in which the work was performed, and pest control businesses must submit seven days after the application. Not all information submitted to the counties is transferred to DPR.

What must be reported:
Production agricultural pesticide use reports include the following:

- Date and time of application
- Geographic location including the county, meridian, township, range, and section Operator identification number or permit number (An operator identification number or permit number is issued by CAC to property operators. These numbers are needed to report pesticide use and, for permit numbers, to purchase restricted-use pesticides. DPR combines the reporting county code, the application year, the home county code, and the operator ID or permit number to form a data field called the “Grower ID”)
- Operator name and address (this information is not submitted to DPR)
- Site identification number (A site identification code must be assigned to each location or field where pesticides will be used for production of an agricultural commodity. This alphanumeric code is also recorded on any restricted material permit the grower obtains for the location.)
- Commodity, crop, or site treated
- Acres planted and treated (Not required for most nonagricultural PURs)
- Application method (e.g., by air, ground, or other means)
- Fumigation methods. Since 2008, fumigation applications in nonattainment areas that do not meet federal air quality standards for pesticide VOC emissions must be identified along with details on fumigation methods (for example, shallow shank injection with a tarp). This

information allows DPR to estimate pesticide VOC emissions, which contribute to the formation of atmospheric ozone, an important air pollutant.

- Product name, U.S. EPA Registration Number (or the California Registration Number if the product is an adjuvant), and the amount of product applied

All other kinds of pesticide use (mostly nonagricultural) are reported as monthly summaries that include the following information:

- Pesticide product name
- Product registration number
- Amount used of product over entire month
- Number of applications (except for structural applications, which were exempted from reporting number of applications in 2015)
- Application site (e.g., rights-of-way, structural)
- Month of application (rather than date and time)
- County (rather than square mile section location)

Site Codes

The site code refers to the site, commodity, or crop of the pesticide application. It is often referred to as the commodity code, although there are nonagricultural codes as well, such as a structural site code used for pesticide applications to buildings and other structures. DPR uses its product label database (<www.cdpr.ca.gov/docs/label/labelque.htm>) to verify that products listed in pesticide use reports are registered for use on the reported site. The product label database uses a coding system consistent with U.S. EPA official label information. To minimize errors, DPR developed a cross-reference table to link the different site code naming systems of the U.S. EPA, DPR's product label database, and the PUR database.

Certain commodities or sites may have more than one associated site code if different production methods or uses of the commodity result in different pesticide use. For example, greenhouse and nursery operations are divided into six different site codes: greenhouse-grown cut flowers or greens, outdoor-grown cut flowers or greens, greenhouse-grown plants in containers, outdoor-grown plants in container/field-grown plants, greenhouse-grown transplants/propagative material, and outdoor-grown transplants/propagative material.

Tomatoes and grapes are also separated into further subcategories because of public and processor interest in differentiating pesticide use. Tomatoes are assigned codes to differentiate between fresh market and processing categories. Grapes are assigned separate codes to differentiate table grapes and raisins from wine grapes.

Unregistered Use

The PUR database may contain records of pesticide use on a commodity or site for which the pesticide is not currently registered. Unregistered uses that are not detected by the error-checking process may be due to an error in the DPR product label database, where the product incorrectly lists a commodity or site as being registered. Other unregistered uses may be flagged as errors by the validation procedures, but left unchanged in the database. The error-checking process does not check whether the product was registered at the time of application. It is therefore possible that an application flagged as an error due to a recent change in registration may have been legally applied at the time of application. In addition, the law sometimes allows the use of existing stocks of a pesticide product following its withdrawal from the market by the manufacturer, or suspension or cancellation by regulatory authorities, since the safest way to dispose of small quantities of pesticides is often to use them as they were intended. Finally, some pesticide products do not list specific sites or commodities on their labels as they are designed to target specific pests across all sites, such as some soil fumigants, certain pre-plant herbicides, and rodenticides. In these cases, reporting an application of one of these types of pesticides on a specific commodity or site can result in an error. In 2015, an option was added in CalAgPermits that allows the user to designate any application as “pre-plant” and enter the commodity or site without generating any error messages.

Adjuvants

Use data on spray adjuvants (e.g., emulsifiers, wetting agents, foam suppressants, and other efficacy enhancers) were not reported before full-use reporting was required. Adjuvants are exempt from federal registration requirements but must be registered as pesticides in California. Examples of adjuvants include many alkyl groups and some petroleum distillates. Adjuvant product formulations are considered proprietary and are therefore confidential, however pesticide use totals for adjuvant AIs are included in the annual report.

Cumulative Acres Treated

The cumulative acres treated is the sum of the acres treated with an AI and is expressed in acres (applications reported in square feet are converted to acres). The cumulative acres treated for a crop may be greater than the planted acres of the crop since this measure accounts for a field being treated with the same AI more than once in a year. For example, if a 20-acre field is treated three times in a calendar year with an AI, the cumulative acres treated would be reported as 60 acres while the acres planted would be reported as 20 acres.

It is important, however, to be aware of the potential to over-count acreage when summing cumulative acres for products that have more than one AI. If a 20-acre field is treated with a product that contains three different pesticide AIs, the PUR record will correctly show that the *product* was applied to 20 acres, but that 20 acre value will also be attributed to each of the three AIs in any chemical summary reports. Adding these values across the AIs results in a total of 60 acres treated instead of the 20 acres actually treated. For more information on over-counting pesticide use data, see *Over-counting Pesticide Use*, p. 14.

Number of Applications

The number of applications is only included in the Annual Summary Report for production agricultural applications. Applicators are required to submit one of two basic types of use reports, a production agricultural report or a monthly summary report. The production agricultural report must include information for each application. The monthly summary report, required for all uses other than production agriculture, includes only monthly totals for all applications of pesticide product, site or commodity, and applicator.

The total number of applications in the monthly summary reports is not consistently reported, so they are no longer included in the annual totals. (In the annual PUR reports before 1997, each monthly summary record was counted as one application). On January 1, 2015, an amendment to section 8505.17 of the Business and Professions Code (BPC) brought about by the passage of Senate Bill 1244 (Chapter 560, Statutes of 2014), eliminated the requirement to report the number of applications made in monthly summary structural PURs.

Note that in the annual summary report arranged by commodity, the total number of agricultural applications for the site or commodity may not equal the sum of all applications of the listed AIs. Since the summary report is at the AI level rather than the product level, a single application of a product comprised of two AIs will result in the summary report assigning the single application to both AIs listed under the commodity heading. Summing the agricultural applications for these two AIs would result in an incorrect total of two applications. The total applications value at the bottom of each commodity section removes the possibility of over-counting applications for products with more than one AI, and is therefore a more accurate value. For more information on over-counting pesticide use data, see the following section, *Over-counting Pesticide Use*, p. 14.

Over-counting Pesticide Use

Pesticide products may be composed of one or more AIs (plus any confidential inert ingredients). The PUR database includes a wide assortment of information related to both the product and the AIs. Different types of analyses will use different subsets of information on the product, the AI, or both. Depending on the data subset chosen for analysis, one can unintentionally over-count pesticide use if the following three criteria are all true:

- Criteria 1: The chosen subset of PUR data includes **products with more than one AI.**
- Criteria 2: The chosen subset of PUR data **includes both product and AI information.**
- Criteria 3: The analysis sums **treated or planted acres, pounds or amount of product, or number of applications.**

The following two examples show two different hypothetical pesticide use analyses of a fictitious product, “Generic Bug Killer,” which has two AIs: chem1 and chem2. Both analyses sum pesticide use variables for the same three fictitious PUR records, however they use slightly different subsets of information from the PUR database. The second example over-counts certain pesticide use variables.

The first example (Table 1) does not meet all three criteria listed above, so it does not over-count pesticide use. Although Table 1 has PUR data for a product with two AIs (criteria 1) and is summing acres, product pounds, and applications (criteria 3), it does not include any information about chem1 and chem2, the two AIs (criteria 2). Since the second criteria is not met, the sums of acres treated (“Acres”), pounds of product (“Lbs Prod”), and number of applications (“Apps”) are correct.

Table 1: *Example of three PUR records for a fictitious product (Generic Bug Killer) with two AIs. Summing acres treated (Acres), product amount (Lbs Prod), or number of applications (Apps) from this table would be correct since the table does not contain AI information.*

Year	Use no	Product	Acres	Units	Lbs prod	Apps
2010	13322	Generic Bug Killer	5	A	20	1
2010	16609	Generic Bug Killer	10	A	30	1
2010	16610	Generic Bug Killer	15	A	40	2
2010	**Totals**	**Correct:**	**30**	**A**	**90**	**4**

In the second example (Table 2), there are two additional columns: the AI name (“AI”) and the pounds of AI (“Lbs AI”). The addition of AI information satisfies criteria 2. Now all three criteria are fulfilled and over-counting becomes an issue for acres treated, pounds of product, and number of applications. Although Table 2 shows the same three PUR records as Table 1 (as identified by unique year - use number (“Use no”) combinations), there are now six table rows instead of three: each PUR record has a row for each of the two AIs, chem1 and chem2. The values for Year, Use no, Product, Acres, Units, Lbs Prod, and Apps are repeated on both rows of each PUR record. Summing acres treated (“Acres”), product amount (“Lbs Prod”), or number of applications (“Apps”) from Table 2 now results in doubled amounts (The total pounds of AI (“Lbs AI”), however, is correct).

Table 2: *Example of three PUR records for a fictitious product (Generic Bug Killer) with two AIs. Summing acres treated (Acres), product amount (Lbs Prod), or number of applications (Apps) from this table would be incorrect since the table contains AI information and the product has two AIs. Summing the pounds of AI (Lbs AI), however, is correct.*

Year	Use no	Product	Acres	Units	Lbs Prod	Apps	AI	Lbs AI
2010	13322	Generic Bug Killer	5	A	20	1	chem1	5
2010	13322	Generic Bug Killer	5	A	20	1	chem2	10
2010	16609	Generic Bug Killer	10	A	30	1	chem1	7.5
2010	16609	Generic Bug Killer	10	A	30	1	chem2	15
2010	16610	Generic Bug Killer	15	A	40	2	chem1	10
2010	16610	Generic Bug Killer	15	A	40	2	chem2	20
2010	**Totals**	**Incorrect:**	**60**	**A**	**180**	**8**	**Correct:**	**67.5**

To avoid over-counting, it is important to identify individual PUR records by the unique combination of year and use number assigned to the record, and be aware of whether or not any data values are being repeated for PUR records that span multiple rows before performing any aggregations.

3 Data Summary

This report is a summary of 2018 data submitted to DPR as of September 17, 2019. PUR data are continually updated and therefore may not match later data from CalPIP or internal queries that contain corrected records identified after September 17, 2019.

Pesticide Use in California

In 2018, as in previous years, the region of greatest pesticide use was California's San Joaquin Valley (Table 3). The four counties in this region with the highest use were Fresno, Kern, Tulare, and San Joaquin. These counties were also among the leading producers of agricultural commodities.

Reported pesticide use in California in 2018 totaled 209 million pounds, an increase of just over two and a half million pounds (1.3 percent) from 2017. Much of the increase occurred in production agriculture, where use rose by 2.6 million pounds (1.4 percent). Structural, landscape maintenance, and postharvest pesticide use decreased by five, three, and 32 percent, respectively. Postharvest treatments are predominantly commodity fumigations, but can also include pesticide treatments to irrigation ditches and other parts of fields not planted in crops. The remaining assortment of nonagricultural pesticide uses increased as a whole by about nine percent. This group includes pesticide use for research purposes, vector control, pest and weed control on rights-of-way, and pest control through fumigation of non-food and non-feed materials such as lumber and furniture.

Table 3: *Total pounds of pesticide active ingredients reported in each county and their rank during 2017 and 2018. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

County	2017 Pounds Applied	2017 Rank	2018 Pounds Applied	2018 Rank
Alameda	372,190	37	285,779	38
Alpine	197	58	890	58
Amador	97,321	43	102,065	44
Butte	3,344,008	15	2,947,123	17
Calaveras	52,986	48	73,856	46
Colusa	2,831,076	18	2,903,505	18
Contra Costa	448,348	36	516,156	35
Del Norte	230,965	41	206,514	41
El Dorado	141,331	42	159,895	43
Fresno	32,972,545	1	35,682,274	1
Glenn	2,521,354	22	2,543,191	21
Humboldt	36,571	50	42,273	49
Imperial	5,276,292	12	5,088,287	11
Inyo	18,297	55	17,871	54
Kern	28,676,484	2	29,489,295	2
Kings	7,903,828	9	8,239,299	8
Lake	801,509	33	737,441	33
Lassen	65,186	47	90,953	45
Los Angeles	2,849,836	17	2,347,258	22
Madera	9,930,593	5	10,101,551	5
Marin	72,073	45	63,984	47
Mariposa	4,486	56	6,826	56
Mendocino	2,453,542	23	2,236,580	23
Merced	9,754,441	6	9,451,786	6
Modoc	89,418	44	172,037	42
Mono	35,652	51	14,301	55
Monterey	8,944,225	7	7,967,672	9
Napa	1,375,490	26	1,500,552	24
Nevada	70,920	46	56,542	48
Orange	1,062,405	31	1,424,825	26
Placer	301,142	38	433,453	37
Plumas	22,815	53	31,071	51
Riverside	2,701,555	20	2,821,202	19
San Benito	626,802	34	637,360	34
San Bernardino	456,779	35	482,273	36
San Diego	1,459,852	25	1,416,675	27
San Francisco	31,468	52	20,401	53

County	2017 Pounds Applied	2017 Rank	2018 Pounds Applied	2018 Rank
San Joaquin	13,559,718	4	13,514,919	4
San Luis Obispo	2,760,569	19	3,055,467	16
San Mateo	235,326	40	226,279	40
Santa Barbara	5,403,202	11	4,865,420	13
Santa Clara	830,376	32	899,679	32
Santa Cruz	1,551,410	24	1,251,897	30
Shasta	282,464	39	281,895	39
Sierra	1,238	57	3,465	57
Siskiyou	1,232,798	30	1,390,673	28
Solano	1,346,371	27	1,473,391	25
Sonoma	2,568,164	21	2,562,025	20
Stanislaus	8,217,714	8	8,790,919	7
Sutter	3,139,258	16	3,154,429	15
Tehama	1,327,245	28	1,318,439	29
Trinity	22,310	54	22,014	52
Tulare	19,703,081	3	19,132,300	3
Tuolumne	50,383	49	39,876	50
Ventura	6,327,158	10	6,110,556	10
Yolo	4,114,185	14	4,392,288	14
Yuba	1,311,485	29	1,121,594	31
Total	206,361,173	N/A	209,000,664	N/A

Table 4 breaks down the pounds of pesticide by general use categories: production agriculture, postharvest treatment, structural pest control, landscape maintenance, and all others.

Table 4: *Pounds of pesticide active ingredients, 1998 – 2018, by general use categories. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Year	Production Agriculture	Post-Harvest Treatment	Structural Pest Control	Landscape Maintenance	All Others	Total Pounds
1998	207,998,381	1,768,015	5,931,423	1,407,582	6,879,509	223,984,910
1999	189,339,531	2,072,525	5,674,180	1,412,279	7,936,292	206,434,807
2000	175,769,350	2,168,043	5,187,156	1,415,318	6,856,551	191,396,419
2001	142,763,823	1,462,507	4,922,610	1,290,244	6,325,521	156,764,705
2002	159,216,188	1,859,479	5,469,757	1,450,029	6,840,192	174,835,643
2003	161,056,091	1,785,861	5,177,132	1,975,913	7,527,645	177,522,642
2004	165,918,291	1,874,540	5,120,304	1,612,039	6,998,036	181,523,210
2005	178,372,742	2,267,314	5,625,436	1,775,723	8,517,944	196,559,159
2006	168,671,713	2,216,144	5,273,699	2,286,835	10,269,756	188,718,146
2007	157,485,086	2,279,837	3,967,384	1,672,457	7,346,123	172,750,886
2008	151,114,954	2,540,305	3,202,938	1,589,109	7,237,790	165,685,095

Year	Production Agriculture	Post-Harvest Treatment	Structural Pest Control	Landscape Maintenance	All Others	Total Pounds
2009	147,123,572	1,479,857	2,911,101	1,345,217	6,018,006	158,877,753
2010	160,494,346	2,164,741	3,699,144	1,734,598	8,026,210	176,119,038
2011	177,652,685	1,548,110	3,149,112	1,723,641	8,743,815	192,817,363
2012	172,060,715	1,233,600	3,464,623	1,555,544	9,297,146	187,611,628
2013	179,133,450	1,499,982	3,804,614	1,465,712	9,939,639	195,843,398
2014	174,861,617	1,333,933	3,714,895	1,619,076	8,902,204	190,431,725
2015	195,202,577	1,475,329	4,216,880	1,690,582	9,314,939	211,900,307
2016	192,063,419	1,790,306	3,932,611	1,735,995	10,349,069	209,871,401
2017	188,635,436	2,176,128	3,641,311	1,583,886	10,324,411	206,361,173
2018	191,232,587	1,483,994	3,452,219	1,537,444	11,294,419	209,000,664

4 Trends in Pesticide Use for Select Pesticide Categories

This report discusses three different measures of pesticide use: amount of AI applied in pounds, cumulative acres treated in acres (for an explanation of cumulative acres treated see page 13), and to a lesser degree, application counts. While most pesticides are applied at rates of one to two pounds per acre, some may be as low as a few ounces or as high as hundreds of pounds per acre. When comparing use among different AIs, pounds will emphasize pesticides used at high rates, such as sulfur, horticultural oils, and fumigants. In contrast, acres treated and application count use measures lack this bias toward pesticides with higher application rates. However, a summation of acres treated is only a partial representation of the total pesticide use reported: Only applications reported with units of acres or square feet are included in the total. Applications with volume units (cubic feet, tons, pounds, etc.) cannot be converted to acres, and area treated is not always reported for non-production-agricultural pesticide use reports, so these pesticide applications are excluded from cumulative acres treated totals. Application counts can also be a useful measure of pesticide use, however it has been inconsistently reported for non-production-agricultural use and is no longer required for structural use reporting, so it is not included as often in the annual report.

The contrast between measuring pesticide use by pounds or by acres can be seen by looking at the use of different pesticide types (Figures 1 and 2). Figure 1, the amount applied by weight (pounds), shows that pesticides with both fungicidal and insecticidal properties (fungicide/insecticides) such as sulfur had the highest use in 2018. The fungicide/insecticide category was followed by insecticides, fumigants, herbicides, fungicides, and finally, “Other” types of pesticides, which grouped all remaining types of pesticides that did not have large enough amounts used to warrant their own graph trend line. (“Other” pesticides include rodenticides, molluscicides, algaecides, repellents, antimicrobials, antifoulants, disinfectants, and biocides). In contrast, by cumulative area (acres) treated in Figure 2, insecticides, herbicides, and fungicides had the highest use, followed by fungicide/insecticides, “Other”, and, finally, fumigants.

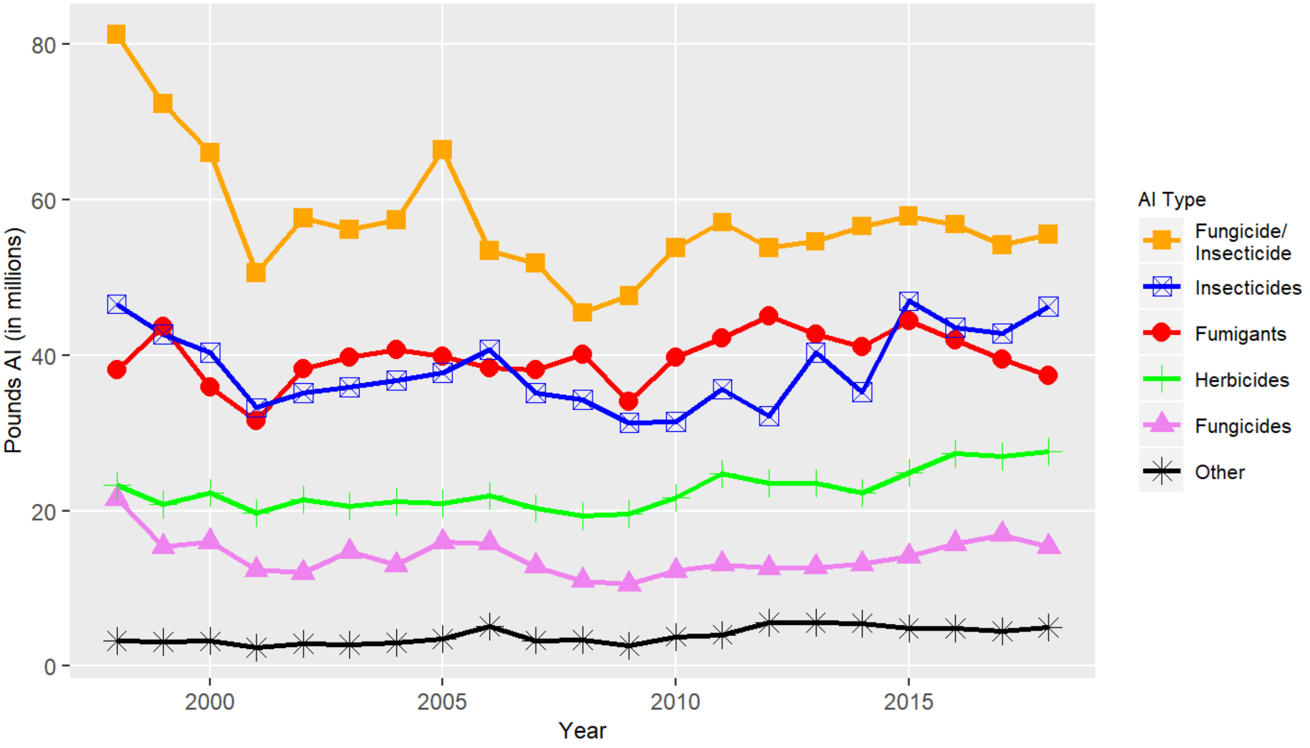

Figure 1: *Pounds of all AIs in the major types of pesticides from 1998 to 2018, where "Other" includes pesticides such as rodenticides, molluscicides, algaecides, repellents, antimicrobials, antifoulants, disinfectants, and biocides. Data are available at <ftp:// transfer.cdpr.ca.gov/ pub/ outgoing/ pur/ data/>*

The trends in use for a single AI will usually follow similar patterns of increases or decreases for both pounds and acres treated measures of pesticide use. However, when pounds and acres treated move in different directions for one AI, it is often due to non-production-agricultural uses of the AI which do not legally have to include acreage, or it could be from a change in use of products with higher or lower percentages of the AI. In contrast, when looking at cumulative totals of many AIs over a period of time or a region, it is quite common for the trends to diverge depending on what measure of pesticide use is analyzed, with pounds increasing while acres treated decreases, or vice versa.

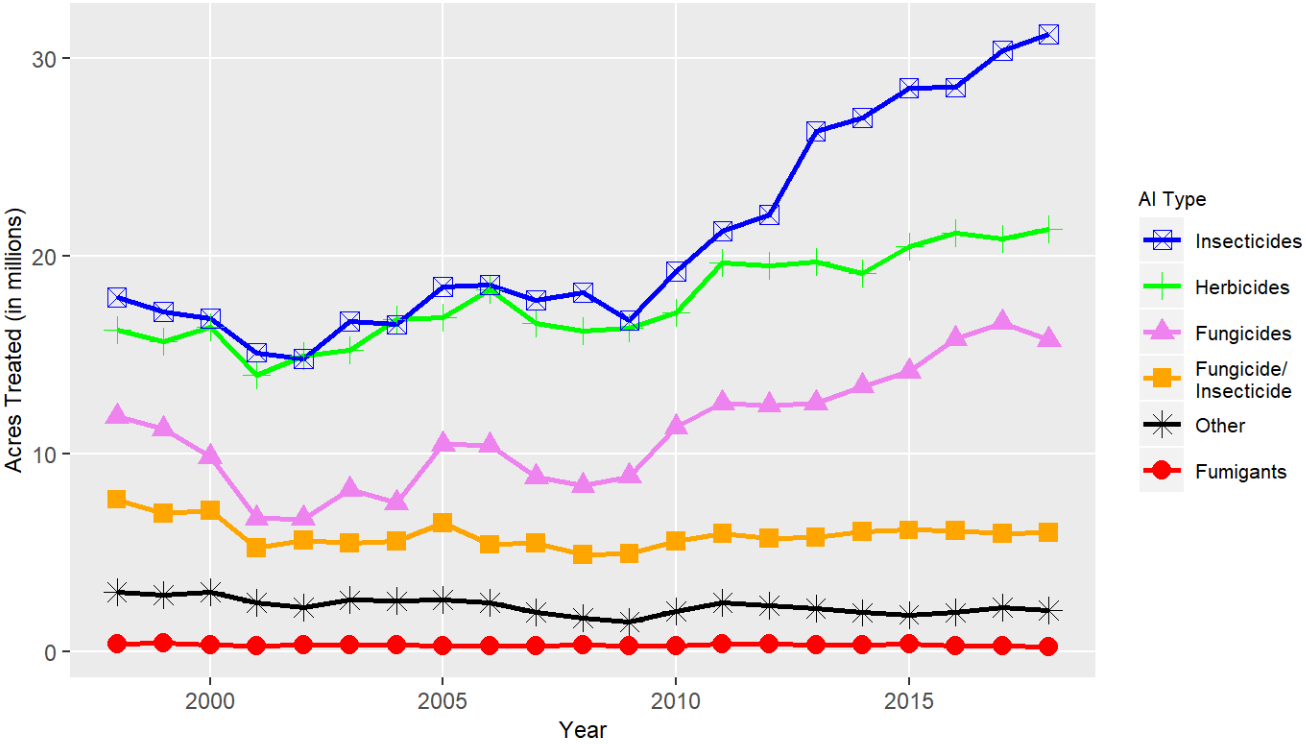

Figure 2: *Acres treated by all AIs in the major types of pesticides from 1998 to 2018, where "Other" includes pesticides such as rodenticides, molluscicides, algaecides, repellents, antimicrobials, antifoulants, disinfectants, and biocides. Data are available at <ftp:// transfer.cdpr.ca.gov/ pub/ outgoing/ pur/ data/>*

There were 209 million pounds of pesticides used in 2018, an increase of just over two and a half million pounds (1.3 percent) from 2017. The AIs with the highest total reported pounds were sulfur, petroleum and mineral oils, 1,3-dichloropropene, glyphosate, and metam-potassium (potassium N-methyldithiocarbamate). Sulfur accounted for 23 percent of total pesticide pounds in 2018.

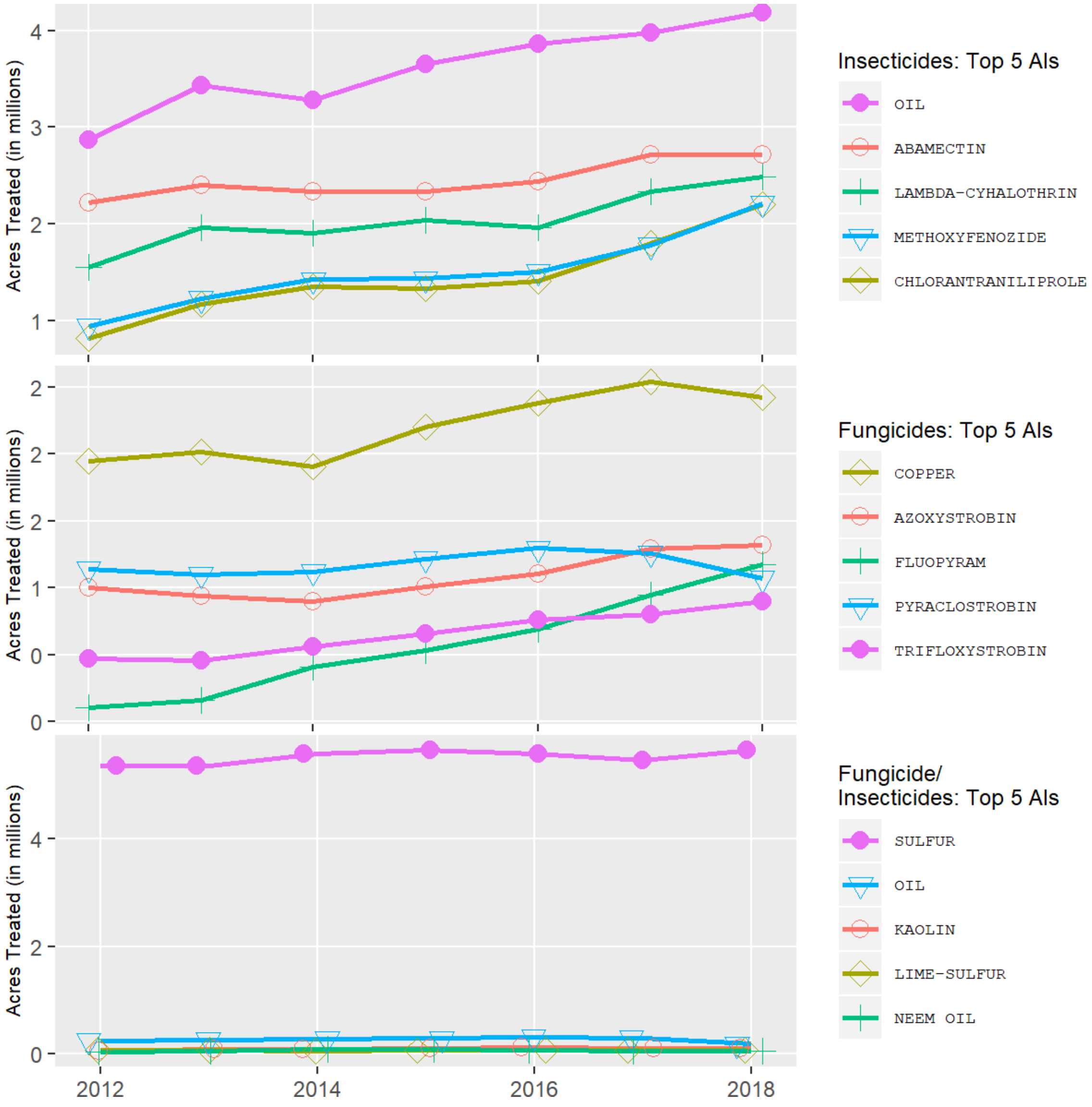

Figure 3: *Acres treated by the top five AIs in each of the major types of pesticides from 2012 to 2018. Data are available at <ftp:// transfer.cdpr.ca.gov/ pub/ outgoing/ pur/ data/>*

Reported pesticide use by cumulative acres treated in 2018 was 105 million acres, an increase of 859 thousand acres (0.8 percent) from 2017. The non-adjuvant pesticides applied to the greatest area in 2018 were sulfur, glyphosate, petroleum and mineral oils, abamectin, and lambda-cyhalothrin (Appendix figure A-1). For insecticides, the top AIs by acres treated included petroleum and mineral oils, abamectin, lambda-cyhalothrin, methoxyfenozide, and chlorantraniliprole. For fungicides, the top five AIs were copper, followed by azoxystrobin, fluopyram, pyraclostrobin, and trifloxystrobin. For AIs that could serve as either fungicides or insecticides, sulfur was by far the highest in acres treated, followed by petroleum and mineral oils, kaolin clay, lime-sulfur, and finally neem oil (Figure 3). Glyphosate topped the list for acres treated among herbicides, followed by oxyfluorfen, glufosinate-ammonium, paraquat dichloride, and pendimethalin. Fumigants had relatively low acres treated compared to other types of pesticides. Aluminum phosphide was applied to the largest number of cumulative acres compared to other fumigants, slightly above 1,3-dichloropropene when ranked by acres treated. Metam-potassium, chloropicrin, and zinc phosphide made up the remaining top five fumigants. The remaining "Others" category was largely comprised of plant growth regulators and harvest aids, with gibberellins leading in acres treated, followed by ethephon, mepiquat chloride, thidiazuron, and finally 2,4-D (when used as a harvest aid rather than an herbicide) (Figure 4).

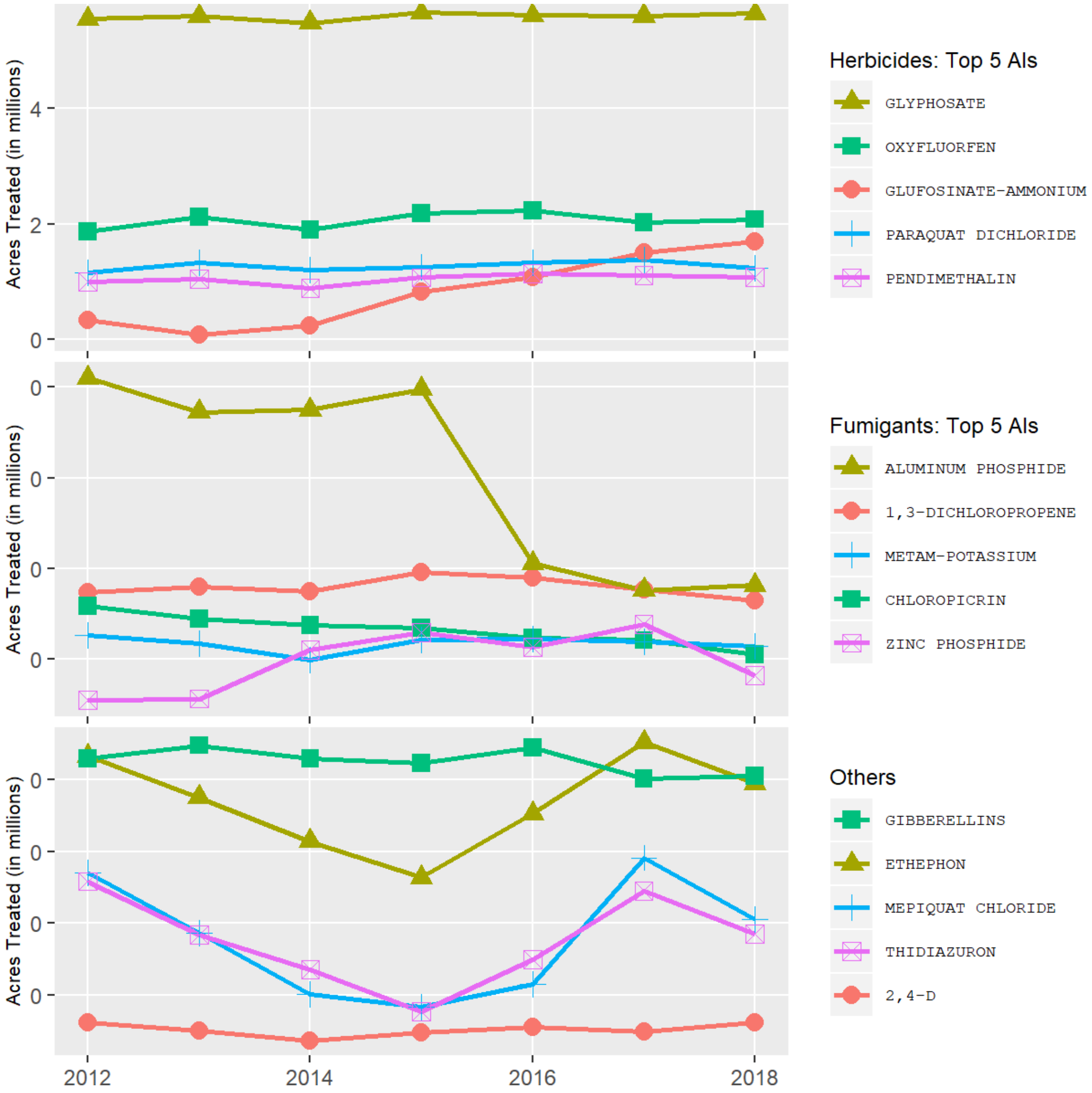

Figure 4: *Acres treated by the top five AIs in each of the major types of pesticides from 2012 to 2018. Data are available at <ftp:// transfer.cdpr.ca.gov/ pub/ outgoing/ pur/ data/>*

Since 1990, the reported pounds of pesticides applied and acres treated have fluctuated from year to year. These fluctuations can be attributed to a variety of factors, including changes in planted acreage, crop plantings, pest pressures, and weather conditions. An increase or decrease in use from one year to the next or in the span of a few years may not necessarily indicate a general trend in use, but rather variations related to changes in weather, pricing, supply of raw ingredients, or regulations. Regression analyses on use over the last twenty years do not indicate a significant trend of either increase or decrease in total pesticide use.

Pesticide use is summarized for eight different pesticide categories from 2009 to 2018 (Tables 5 – 20) and from 1998 to 2018 (Figures 5 – 12). These categories include reproductive toxicity, carcinogens, cholinesterase inhibitors, ground water contaminants, toxic air contaminants, fumigants, oils, and biopesticides. Changes from 2017 to 2018 are summarized as follows:

- *Reproductive toxins:* Chemicals classified as reproductive toxins increased in amount applied from 2017 to 2018 by 80 thousand pounds (one percent increase), but decreased by 406 thousand acres (eight percent decrease). The increase in amount applied was mainly due to an increase in use of the fumigant metam-sodium, which increased by 621 thousand pounds (20 percent increase). The reduction in acres treated was largely due to chlorpyrifos being used on 260 thousand fewer cumulative acres (38 percent decrease). Chlorpyrifos is an organophosphate that has been increasingly restricted in use since 2015. Its registration was cancelled and nearly all use will cease as of the end of December, 2020. Pesticides in this category are listed on the State's Proposition 65 list of chemicals known to cause reproductive toxicity.

- *Carcinogens:* The amount of pesticides classified as carcinogens decreased by 191 thousand pounds from 2017 to 2018 (0.5 percent decrease), and the acres treated decreased by 628 thousand acres (seven percent decrease). The decrease in amount applied was largely due to less use of the fumigant metam-potassium, which decreased by 413 thousand pounds (five percent decrease), and the fungicides mancozeb (13 percent decrease) and iprodione (57 percent decrease), which decreased by 204 thousand and 149 thousand pounds, respectively. The decline in acres treated was mostly due to less use of mancozeb (17 percent decrease) and iprodione (71 percent decrease), which were used on 142 thousand and 338 thousand fewer acres treated, respectively. The pesticides in this category are listed by U.S. EPA as A or B carcinogens or on the State's Proposition 65 list of chemicals known to cause cancer.

- *Cholinesterase inhibitors:* Use of organophosphorus and carbamate cholinesterase-inhibiting pesticides decreased from the previous year by 429 thousand pounds (10 percent decrease) and decreased by 360 thousand acres treated (11 percent decrease). Most of the reduction resulted from a drop in the use of the organophosphate insecticide chlorpyrifos, which decreased by 347 thousand pounds (37 percent decrease) and 260 thousand acres treated (38 percent decrease). Other organophosphates also declined in use, such as the insecticide dimethoate, which declined by 58 thousand pounds (26 percent decrease) and 63 thousand acres (13 percent decrease), and acephate, which dropped by 27 thousand pounds (14 percent decrease) and 19 thousand acres (11 percent decrease). The organophosphate plant growth regulator ethephon also significantly declined, decreasing by 52 thousand pounds (11 percent decrease) and 57 thousand acres (10 percent decrease).

- *Ground water contaminants:* The use of AIs categorized as ground water contaminants increased in amount applied by five thousand pounds (one percent increase), but decreased in acres treated by 60 thousand acres (11 percent decrease), mainly from changes in the use of the herbicide diuron. Diuron increased by nine thousand pounds (five percent increase), but was used on 56 thousand less cumulative acres treated (14 percent decrease). When pounds of a single active ingredient such as diuron increase but the acres treated decrease, it can be due to an increase in non-production-agricultural uses since these PURs typically do not report acreage. It can also be due to higher use of products that contain a larger percentage of the active ingredient.

- *Toxic air contaminants:* The use of AIs categorized as toxic air contaminants decreased in amount applied by nearly three million pounds (six percent decrease) and decreased in acres treated by 411 thousand acres (14 percent decrease). The 1.4 million pound decrease of the fumigant chloropicrin (15 percent decrease), the 663 thousand pound drop in sulfuryl fluoride (18 percent decrease), and the decline of metam-potassium by 413 thousand pounds (five percent decrease) accounted for much of the overall reduction in amount applied. The decrease in acres treated was due to 260 thousand fewer acres treated with the insecticide chlorpyrifos (38 percent decrease) and 142 thousand less acres treated with the fungicide mancozeb (17 percent decrease).

- *Fumigants:* The use of fumigant AIs decreased by two and a half million pounds (six percent decrease) and by 287 thousand acres treated (29 percent decrease). Much of the decrease was due to a reduction of 1.4 million pounds of chloropicrin (15 percent decrease), 663 thousand pounds of sulfuryl fluoride (18 percent decrease), and 413 thousand pounds of metam-potassium (five percent decrease). Cumulative acres treated declined largely due to 23 thousand less acres treated with the rodenticide fumigant zinc phosphide (41 percent decrease). Chloropicrin and metam-potassium are soil fumigants, while sulfuryl fluoride is used to control termites and other structural pests.

- *Oils:* Use of oil pesticides increased in amount by two and a half million pounds (seven percent increase), and increased in acres treated by 155 thousand acres (three percent increase). Only oil AIs derived from petroleum distillation are included in these totals. Although some oils are listed on the State’s Proposition 65 list of chemicals known to cause cancer, none of these carcinogenic oils are known to be used as pesticides in California. Most oil pesticides used in California serve as alternatives to more toxic pesticides. Some highly refined petroleum-based oils are used by organic growers.

- *Biopesticides:* Use of biopesticides and AIs considered to be lower risk to human health or the environment increased in amount by 257 thousand pounds (three percent increase) and by 46 thousand acres (less than one percent increase). The adjuvant vegetable oil increased by 159 thousand pounds (24 percent increase) and the fungicide/insecticide kaolin clay by 75 thousand pounds (two percent increase), while the adjuvant citric acid was applied to 28 thousand more acres (one percent increase) and the fungicide potassium phosphite was used on 23 thousand more acres (six percent increase). In general, biopesticides are derived from natural materials such as animals, plants, bacteria, and minerals. In some cases, they are synthetic mimics of these natural materials.

The summaries detailed above and the data presented in the following use category tables are not intended to serve as indicators of pesticide risks to the public or the environment. Rather, the data supports DPR regulatory functions to enhance public safety and environmental protection. (See Continuous Evaluation of Pesticides, p. 3.)

USE TRENDS OF PESTICIDES ON THE STATE’S PROPOSITION 65 LIST OF CHEMICALS THAT ARE “KNOWN TO CAUSE REPRODUCTIVE TOXICITY.”

Table 5: *The reported pounds of pesticides used that are on the State’s Proposition 65 list of chemicals that are “known to cause reproductive toxicity.” Use includes both agricultural and reportable nonagricultural applications. Values are rounded. N/A means there was not any reported pounds during that year.* *Data are available* at <*https://files.cdpr.ca.gov/pub/outgoing/pur/data/* >.

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1080	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
2,4-db acid	13,523	4,570	19	65	N/A	N/A	N/A	N/A	N/A	N/A
abamectin	16,640	19,384	28,160	33,008	40,413	38,651	40,067	45,260	53,880	52,990
amitraz	7	N/A	N/A	N/A	1,486	45	101	28	14	53
arsenic pentoxide	400	16,144	8,034	9,240	8,480	16,719	22,190	10,508	5,105	3,677
arsenic trioxide	<1	<1	<1	<1	N/A	<1	<1	<1	N/A	N/A
atrazine	23,260	28,937	22,654	32,173	23,419	20,896	17,912	21,282	21,175	17,103
benomyl	56	31	28	32	3	10	2	1	<1	145
bromacil, lithium salt	896	1,835	1,486	1,422	1,145	2,472	2,891	2,504	3,751	4,399
bromoxynil octanoate	50,396	43,643	47,817	56,495	49,699	44,247	52,458	45,187	49,993	38,696
carbaryl	136,104	113,983	74,890	113,845	117,252	131,744	155,525	221,095	107,453	128,623
carbon disulfide	<1	N/A	1	18	N/A	1	<1	<1	<1	N/A
chlordecone	N/A	N/A	<1	<1	<1	<1	<1	<1	<1	<1
chlorpyrifos	1,248,584	1,290,982	1,300,553	1,106,464	1,469,298	1,312,361	1,107,417	903,238	947,911	601,173
chromic acid	559	22,555	11,224	12,908	11,847	23,358	31,629	15,709	7,632	5,497
cyanazine	N/A	N/A	1	<1	N/A	1	3	<1	N/A	<1
cycloate	25,284	27,292	31,037	33,562	30,619	36,566	39,655	45,150	49,844	41,743
cycloheximide	N/A	N/A	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
dichlorophen	N/A	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A	N/A
diclofop-methyl	15	N/A	7	N/A	N/A	N/A	N/A	N/A	N/A	N/A
dinocap	2	N/A	<1	N/A	N/A	N/A	N/A	N/A	3	N/A
dinoseb	816	26	75	60	22	374	7	581	32	3
dioctyl phthalate	186	453	248	262	198	73	36	94	N/A	1
disodium cyanodithioimido carbonate	N/A	N/A	N/A	80	<1	N/A	101	280	N/A	N/A

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
endrin	N/A	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
eptc	128,993	118,509	125,932	168,665	187,349	235,271	237,983	255,431	259,784	218,451
ethylene dibromide	<1	N/A	N/A	6	N/A	N/A	<1	N/A	N/A	N/A
ethylene glycol	37,357	39,830	52,038	61,666	72,508	38,826	71,095	86,705	44,826	41,036
ethylene glycol monomethyl ether	2,257	5,187	4,333	3,782	6,202	5,601	7,601	7,645	6,530	3,506
ethylene oxide	7	N/A	N/A	8	N/A	<1	N/A	N/A	N/A	N/A
fenoxaprop-ethyl	11	<1	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A
fluazifop-butyl	21	11	8	6	17	43	16	23	98	76
heptachlor	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A	<1	<1
hydramethylnon	393	609	1,096	485	444	6,024	399	301	230	194
linuron	51,448	48,424	54,555	57,637	52,529	54,158	50,395	52,249	52,166	48,734
metam-sodium	9,359,224	11,428,913	10,895,290	8,427,548	4,846,423	4,297,539	3,606,650	3,297,827	3,144,356	3,765,705
methanol	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2	N/A	N/A
methyl bromide	5,623,692	4,809,340	4,055,208	4,017,075	3,529,577	2,963,143	2,655,355	2,602,823	1,798,430	1,682,989
metiram	N/A	N/A	15	34	17	13	<1	4	26	18
molinate	12,516	24	<1	3	<1	<1	<1	5	N/A	N/A
myclobutanil	59,057	65,604	65,538	64,425	61,076	65,056	61,036	59,152	56,704	49,186
nabam	8,963	10,518	13,358	13,485	22,187	16,535	9,357	18,414	18,854	11,257
nicotine	<1	<1	7	<1	N/A	N/A	<1	N/A	N/A	N/A
nitrapyrin	84	211	N/A	<1	2	N/A	5	2	N/A	16
oxadiazon	8,741	12,382	7,783	7,272	6,759	4,960	12,139	5,028	6,072	8,256
oxydemeton-methyl	68,576	71,290	26,017	17,562	10,656	8,407	6,610	3,764	1,533	1,460
oxytetracycline hydrochloride	147	1,356	208	81	266	15	45	7,223	7,837	6,433
oxythioquinox	45	6	<1	1	<1	1	N/A	1	N/A	<1
potassium dichromate	N/A	N/A	N/A	N/A	<1	N/A	<1	N/A	N/A	N/A
potassium dimethyl dithio carbamate	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
propargite	378,099	294,853	296,351	252,218	291,001	246,496	213,205	206,503	244,825	226,091
propazine	N/A	N/A	N/A	665	4	1	N/A	N/A	N/A	N/A
quizalofop-ethyl	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<1	N/A
resmethrin	211	206	122	46	19	188	4	146	67	54
simazine	420,004	378,661	425,870	368,621	300,394	242,895	179,321	163,707	127,182	117,877

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
sodium dichromate	N/A	N/A	N/A	N/A	N/A	2	N/A	N/A	N/A	N/A
sodium dimethyl dithio carbamate	8,963	11,053	13,358	13,485	22,187	16,535	9,357	18,414	18,854	11,257
streptomycin sulfate	3,233	4,040	4,651	4,054	4,795	5,161	4,737	15,265	10,355	10,152
sulfur dioxide	127,394	195,362	241,694	188,459	247,103	227,978	247,898	280,535	263,584	277,821
tau-fluvalinate	1,179	869	834	1,083	1,082	1,361	1,220	1,261	1,125	1,205
thiophanate-methyl	89,882	115,025	87,667	109,775	103,576	112,593	113,233	128,740	161,337	175,723
triadimefon	1,056	2,153	1,940	2,427	1,620	1,986	1,623	1,248	1,170	1,681
tributyltin methacrylate	N/A	N/A	N/A	N/A	1	N/A	N/A	N/A	N/A	N/A
trichloro ethylene	N/A	N/A	1	N/A	<1	N/A	N/A	N/A	10	<1
triforine	4	42	22	2	4	1	<1	<1	<1	<1
vinclozolin	476	217	328	467	151	219	149	125	81	39
warfarin	<1	1	2	2	1	1	<1	<1	<1	1
Total	17,908,763	19,184,532	17,900,466	15,180,678	11,521,832	10,178,527	8,959,432	8,523,458	7,472,829	7,553,324

Table 6: *The reported cumulative acres treated with pesticides that are on the State's Proposition 65 list of chemicals that are "known to cause reproductive toxicity." Use includes primarily agricultural applications (Most nonagricultural pesticide use reports are not required to report acreage). The grand total for acres treated may be less than the sum of acres treated for all chemicals because some products contain more than one active ingredient. Values are rounded. N/A means there was not any reported acres treated during that year.* *Data are available* *at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1080	67	176	127	<1	111	4	<1	4	22	77
2,4-db acid	21,629	6,980	51	190	N/A	N/A	N/A	N/A	N/A	N/A
abamectin	1,278,250	1,556,401	1,980,248	2,222,666	2,406,190	2,335,405	2,338,387	2,435,708	2,718,649	2,717,337
amitraz	74	N/A	N/A	N/A	351	316	88	450	101	1,153
arsenic pentoxide	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
arsenic trioxide	<1	<1	<1	<1	N/A	<1	<1	<1	N/A	N/A
atrazine	15,767	19,990	17,236	23,827	17,873	15,404	14,537	17,237	16,831	14,021
benomyl	163	1	26	19	1	<1	<1	<1	<1	2
bromacil, lithium salt	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
bromoxynil octanoate	146,561	125,926	139,567	153,503	132,257	118,306	133,826	119,794	121,745	110,827
carbaryl	107,934	81,683	68,394	97,229	96,647	108,805	136,319	116,667	106,737	99,446
carbon disulfide	<1	N/A	<1	<1	N/A	<1	<1	<1	<1	N/A
chlordecone	N/A	N/A	<1	<1	<1	<1	<1	<1	<1	<1
chlorpyrifos	935,588	1,098,958	1,188,543	1,056,026	1,297,150	1,108,317	829,304	641,561	690,834	431,218
chromic acid	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
cyanazine	N/A	N/A	4	<1	N/A	<1	<1	<1	N/A	<1
cycloate	12,058	13,799	14,895	17,565	16,045	19,124	21,037	23,173	23,962	20,953
cycloheximide	N/A	N/A	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
dichlorophen	N/A	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A	N/A
diclofop-methyl	30	N/A	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A
dinocap	7	N/A	1	N/A	N/A	N/A	N/A	N/A	73	N/A
dinoseb	304	111	427	81	55	450	67	<1	16	28
dioctyl phthalate	4,928	7,921	4,741	5,311	3,188	1,885	626	76	N/A	46
disodium cyanodithioimido carbonate	N/A	N/A	N/A	235	<1	N/A	300	831	N/A	N/A
endrin	N/A	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
eptc	49,708	44,289	47,770	56,872	69,989	89,126	91,512	100,883	104,151	91,178
ethylene dibromide	<1	N/A	N/A	<1	N/A	N/A	<1	N/A	N/A	N/A
ethylene glycol	104,574	146,961	199,569	249,378	286,255	158,378	202,923	245,859	145,270	115,874
ethylene glycol monomethyl ether	14,573	35,802	37,642	35,682	34,566	35,902	38,633	30,087	27,520	19,781
ethylene oxide	60	N/A	N/A	<1	N/A	<1	N/A	N/A	N/A	N/A
fenoxaprop-ethyl	143	<1	61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
fluazifop-butyl	2	80	<1	<1	40	3	180	<1	4	31
heptachlor	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A	<1	<1
hydramethylnon	1,280	4,689	1,514	6,876	1,376	1,653	5,307	6,854	5,877	3,170
linuron	68,750	68,058	77,062	81,958	73,493	76,353	70,944	74,469	72,510	70,648
metam-sodium	75,735	72,748	71,003	58,998	28,105	24,422	24,254	19,437	17,423	20,139
methanol	N/A	N/A	N/A	N/A	N/A	N/A	N/A	23	N/A	N/A
methyl bromide	40,250	32,293	47,050	30,147	26,359	16,578	12,753	11,031	6,051	5,602
metiram	N/A	N/A	<1	<1	<1	<1	<1	<1	<1	<1
molinate	2,942	6	<1	<1	3	<1	1	1	N/A	N/A
myclobutanil	512,918	588,750	569,584	574,436	537,469	564,796	544,947	527,995	477,718	420,638
nabam	3	13	<1	<1	<1	<1	<1	6	10	1
nicotine	<1	<1	<1	<1	N/A	N/A	<1	N/A	N/A	N/A

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
nitrapyrin	88	111	N/A	<1	1	N/A	<1	<1	N/A	34
oxadiazon	1,451	1,712	927	1,148	1,511	1,239	1,777	1,067	1,151	1,072
oxydemeton-methyl	82,368	86,131	27,447	18,204	12,163	9,096	7,355	7,883	3,555	3,111
oxytetracycline hydrochloride	815	8,644	1,125	364	1,417	1	<1	52,727	52,787	43,688
oxythioquinox	4	4	1	1	<1	<1	N/A	7	N/A	2
potassium dichromate	N/A	N/A	N/A	N/A	<1	N/A	<1	N/A	N/A	N/A
potassium dimethyl dithio carbamate	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
propargite	174,063	137,106	142,430	114,213	121,952	104,758	87,943	87,430	106,305	97,880
propazine	N/A	N/A	N/A	<1	<1	<1	N/A	N/A	N/A	N/A
quizalofop-ethyl	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<1	N/A
resmethrin	11	<1	6	4	436	18	7	3	<1	21
simazine	339,302	289,198	324,612	241,359	205,338	165,261	118,823	112,998	91,713	84,157
sodium dichromate	N/A	N/A	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A
sodium dimethyl dithio carbamate	3	13	<1	<1	<1	<1	<1	6	10	1
streptomycin sulfate	24,453	28,966	39,190	34,895	38,009	39,705	40,747	67,885	51,656	47,886
sulfur dioxide	2,503	256	45	1,323	218	535	777	400	1,396	546
tau-fluvalinate	5,015	4,583	5,048	4,996	5,398	5,363	5,195	5,577	4,590	4,098
thiophanate-methyl	92,429	122,563	85,810	124,162	120,629	134,968	119,789	129,749	183,873	201,666
triadimefon	1,007	1,172	2,469	1,341	907	1,282	2,042	1,208	1,529	1,897
tributyltin methacrylate	N/A	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A	N/A
trichloro ethylene	N/A	N/A	<1	N/A	<1	N/A	N/A	N/A	<1	<1
triforine	10	22	3	<1	<1	3	<1	<1	<1	<1
vinclozolin	85	86	100	33	11	5	10	6	18	13
warfarin	365	290	1,290	3,115	381	435	556	534	189	189
Total	4,118,266	4,586,476	5,096,041	5,216,135	5,535,893	5,137,894	4,850,966	4,839,621	5,034,194	4,628,430

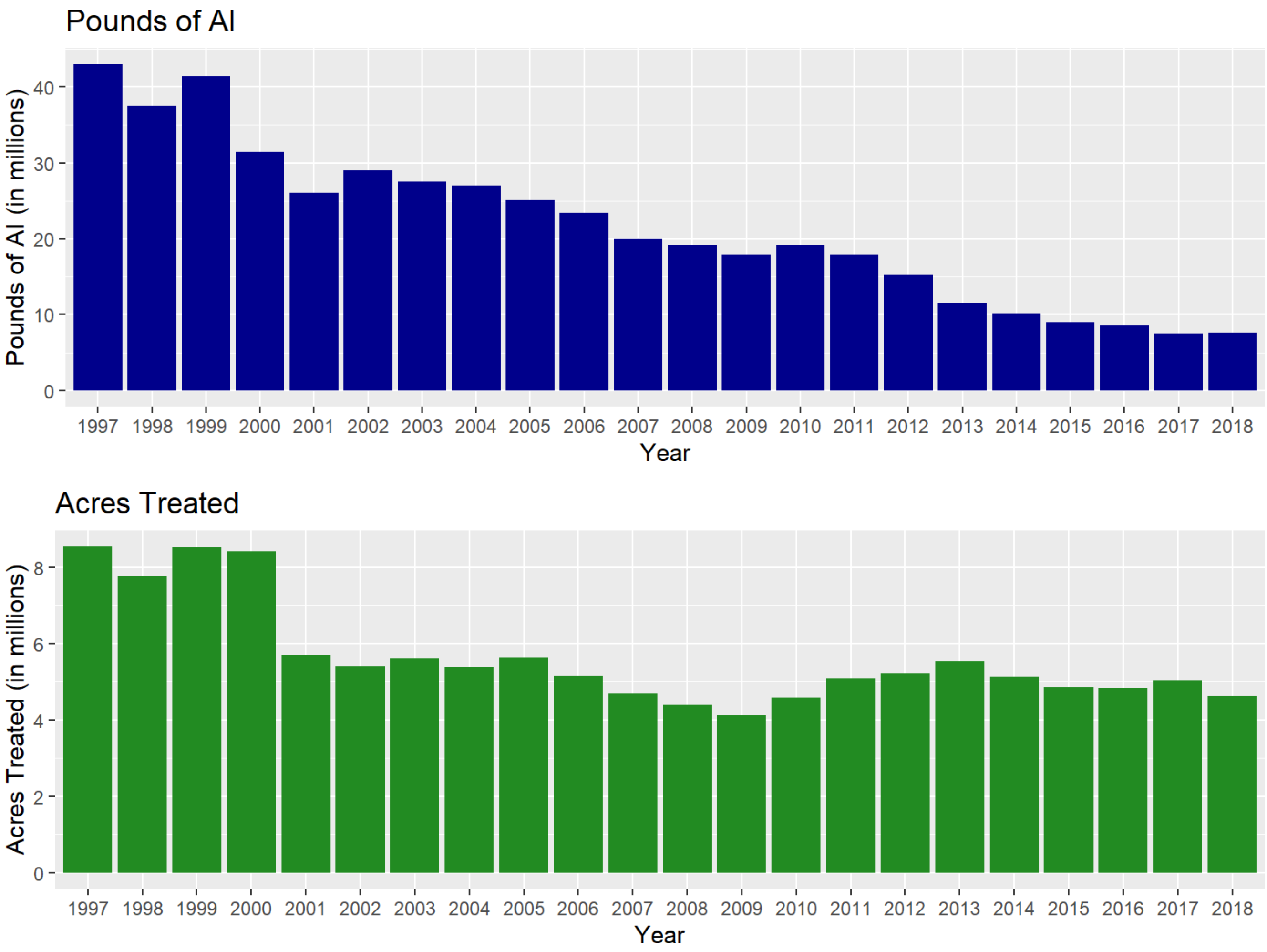

Figure 5: *Use trends of pesticides that are on the State's Proposition 65 list of chemicals that are "known to cause reproductive toxicity." Reported pounds of active ingredient (AI) applied include both agricultural and nonagricultural applications. The reported cumulative acres treated include primarily agricultural applications. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/ >.*

USE TRENDS OF PESTICIDES LISTED BY U.S. EPA AS A OR B CARCINOGENS OR ON THE STATE’S PROPOSITION 65 LIST OF CHEMICALS THAT ARE “KNOWN TO CAUSE CANCER.”

Table 7: *The reported pounds of pesticides used that are listed by U.S. EPA as A or B carcinogens or on the State’s Proposition 65 list of chemicals that are “known to cause cancer.” Use includes both agricultural and reportable nonagricultural applications. Values are rounded. N/A means there was not any reported pounds during that year. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/ >.*

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1,2-dichloropropane, 1,3-dichloropropene and related c3 compounds	N/A	N/A	N/A	6	N/A	1	N/A	N/A	N/A	N/A
1,3-dichloropropene	6,450,125	8,797,078	10,924,344	11,947,156	12,941,042	13,614,468	15,689,571	14,128,721	12,581,936	12,569,270
2,4-d	9,338	11,914	5,400	4,259	5,665	6,384	7,372	6,046	4,344	6,083
4-vinylcyclohexenediepoxide	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<1
acifluorfen, sodium salt	N/A	<1	N/A	<1	<1	<1	N/A	N/A	N/A	<1
alachlor	6,362	9,936	9,294	8,836	6,562	5,118	3,230	84	9	5
alpha-chlorohydrin	N/A	N/A	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
amitrole	5	4	4	6	N/A	N/A	N/A	2	N/A	N/A
arsenic acid	N/A	N/A	17	N/A	N/A	N/A	N/A	N/A	N/A	N/A
arsenic pentoxide	400	16,144	8,034	9,240	8,480	16,719	22,190	10,508	5,105	3,677
arsenic trioxide	<1	<1	<1	<1	N/A	<1	<1	<1	N/A	N/A
auramine	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
cacodylic acid	<1	3	<1	<1	N/A	<1	N/A	<1	<1	1
captan	329,747	450,225	376,597	403,224	349,430	370,136	511,177	638,401	561,769	413,622
carbaryl	136,104	113,983	74,890	113,845	117,252	131,744	155,525	221,095	107,453	128,623
carbon tetrachloride	<1	N/A	6	90	N/A	7	<1	<1	<1	N/A
chlordane	6	6	N/A	16	N/A	N/A	2	N/A	<1	<1
chlordecone	N/A	N/A	<1	<1	<1	<1	<1	<1	<1	<1
chlorothalonil	715,972	961,618	1,149,139	1,183,472	1,114,884	1,215,447	1,068,448	1,127,282	1,240,392	1,171,126
chromic acid	559	22,555	11,224	12,908	11,847	23,358	31,629	15,709	7,632	5,497
creosote	<1	N/A	N/A	N/A	3	N/A	1	N/A	N/A	<1
daminozide	6,570	9,361	8,441	8,250	8,560	8,427	8,959	7,585	8,063	6,819
ddvp	4,169	4,176	5,480	4,890	4,627	4,034	4,082	3,868	3,456	3,505
ddvp, other related	217	194	268	276	278	162	165	123	113	109
diclofop-methyl	15	N/A	7	N/A	N/A	N/A	N/A	N/A	N/A	N/A
diethanolamine	N/A	N/A	N/A	N/A	N/A	N/A	76	392	293	389
dioctyl phthalate	186	453	248	262	198	73	36	94	N/A	1

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
dipropyl isocinchomeronate	<1	1	1	<1	<1	<1	1	<1	<1	<1
diuron	623,001	588,905	675,024	554,583	413,291	325,345	317,328	248,331	179,467	188,274
ethoprop	20,793	5,645	7,475	2,077	2,502	3,076	1,820	2,023	2,134	5,848
ethyl acrylate	N/A	9	36	N/A	2	11	4	1	N/A	N/A
ethylene dibromide	<1	N/A	N/A	6	N/A	N/A	<1	N/A	N/A	N/A
ethylene oxide	7	N/A	N/A	8	N/A	<1	N/A	N/A	N/A	N/A
fenoxycarb	5	3	3	2	1	1	9	2	3	1
folpet	N/A	<1	N/A	<1	<1	<1	<1	<1	<1	N/A
formaldehyde	3,972	5,511	4,615	3,847	11,165	52,989	31,956	23,116	11,825	1,349
glyphosate	8,167	10,737	5,301	1,894	645	21	129	40	37	70
glyphosate, diammonium salt	34,032	11,987	11,468	2,428	2,989	3,673	1,019	897	112	28
glyphosate, dimethylamine salt	13,801	29,788	130,752	123,817	92,504	128,942	139,644	156,713	149,505	140,479
glyphosate, isopropylamine salt	4,736,643	5,617,241	5,912,962	4,985,453	5,008,332	4,877,876	4,859,287	5,147,133	5,368,052	5,766,081
glyphosate, monoammonium salt	31,567	24,675	22,748	11,921	36,553	21,965	12,387	18,724	9,033	7,098
glyphosate, potassium salt	2,400,139	3,074,103	4,711,137	5,403,813	5,306,770	5,613,513	6,517,467	6,424,021	6,267,885	6,109,802
glyphosate-trimesium	2,153	535	574	144	41	310	N/A	N/A	34	19
heptachlor	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A	<1	<1
imazalil	13,255	26,181	25,767	25,085	26,013	19,312	22,305	26,528	22,293	20,409
iprodione	249,157	349,532	353,707	297,788	260,152	240,455	220,086	297,614	260,566	111,587
kresoxim-methyl	27,338	32,107	38,587	26,276	26,213	28,346	23,915	22,905	23,565	19,944
lindane	8	18	1	N/A	2	N/A	6	N/A	N/A	N/A
malathion	532,321	561,398	512,004	405,353	446,743	502,997	443,128	355,053	334,893	360,906
mancozeb	282,587	757,664	1,045,594	1,130,998	1,149,091	1,282,145	1,273,707	1,436,008	1,519,480	1,315,141
maneb	657,090	370,333	54,024	6,260	1,383	1,274	286	1,275	2,224	59
metam-sodium	9,359,224	11,428,913	10,895,290	8,427,548	4,846,423	4,297,539	3,606,650	3,297,827	3,144,356	3,765,705
methyl eugenol	N/A	N/A	5	N/A	9	N/A	N/A	126	386	1,149
methyl iodide	N/A	N/A	1,157	21	N/A	N/A	N/A	N/A	N/A	N/A
methylene chloride	32	31	24	61	53	76	35	39	36	10
metiram	N/A	N/A	15	34	17	13	<1	4	26	18
naphthalene	N/A	1	<1	N/A	<1	N/A	N/A	N/A	<1	<1
nitrapyrin	84	211	N/A	<1	2	N/A	5	2	N/A	16
nitrofen	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ortho-phenylphenol	2,133	2,271	2,582	2,964	1,713	1,777	1,316	1,181	472	418
ortho-phenylphenol, sodium salt	2,294	2,129	5,192	3,586	4,375	3,611	4,815	2,261	N/A	N/A

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
oryzalin	529,892	602,291	768,869	686,197	584,071	582,736	510,680	316,178	338,029	297,679
oxadiazon	8,741	12,382	7,783	7,272	6,759	4,960	12,139	5,028	6,072	8,256
oxythioquinox	45	6	<1	1	<1	1	N/A	1	N/A	<1
para-dichlorobenzene	17	N/A	<1	18	<1	N/A	N/A	N/A	<1	<1
parathion	118	257	196	25	<1	1	836	41	3	3
pentachlorophenol	N/A	3	18	224	274	11	25	1	4	27
pirimicarb	2	1	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
potassium dichromate	N/A	N/A	N/A	N/A	<1	N/A	<1	N/A	N/A	N/A
potassium n-methyldithiocarbamate	4,128,181	4,832,615	5,673,722	8,320,255	9,484,467	7,798,703	10,252,596	9,343,192	8,940,720	8,527,736
propargite	378,099	294,853	296,351	252,218	291,001	246,496	213,205	206,503	244,825	226,091
propoxur	202	298	808	359	373	251	100	49	43	28
propylene oxide	111,609	300,008	449,037	389,070	410,360	400,719	396,191	368,260	255,702	213,681
propyzamide	73,811	51,384	49,678	47,404	42,022	42,662	41,902	93,849	107,248	114,447
pymetrozine	2,905	3,820	2,835	3,195	3,713	4,123	2,992	4,243	3,453	4,727
resmethrin	211	206	122	46	19	188	4	146	67	54
s,s,s-tributyl phosphorotrithioate	8,161	18,427	30,328	21,820	19,077	11,683	6,472	6,882	8,151	8,911
sedaxane	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<1	<1	N/A
sodium dichromate	N/A	N/A	N/A	N/A	N/A	2	N/A	N/A	N/A	N/A
spirodiclofen	45,521	31,085	22,729	28,358	52,050	49,054	34,540	42,285	47,321	52,286
terrazole	1,140	1,500	638	503	393	473	452	400	304	166
tetrachloroethylene	94	90	68	176	153	221	101	112	81	29
tetrachlorvinphos	1,306	1,086	912	665	2,660	629	173	66	55	109
thiodicarb	511	152	472	145	156	N/A	N/A	N/A	1	N/A
toxaphene	42	16	28	16	8	7	4	3	35	8
trichloro ethylene	N/A	N/A	1	N/A	<1	N/A	N/A	N/A	10	<1
vinclozolin	476	217	328	467	151	219	149	125	81	39
Total	31,950,664	39,448,277	44,294,361	44,871,135	43,103,520	41,944,486	46,452,332	44,009,100	41,769,155	41,577,418

Table 8: The reported cumulative acres treated with pesticides that are listed by U.S. EPA as A or B carcinogens or on the State's Proposition 65 list of chemicals that are "known to cause cancer." Use includes primarily agricultural applications (Most nonagricultural pesticide use reports are not required to report acreage). The grand total for acres treated may be less than the sum of acres treated for all chemicals because some products contain more than one active ingredient. Values are rounded. N/A means there was not any reported acres treated during that year. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/ >.

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1,2-dichloropropane, 1,3-dichloropropene and related c3 compounds	N/A	N/A	N/A	18	N/A	9	N/A	N/A	N/A	N/A
1,3-dichloropropene	38,849	54,209	59,065	69,422	71,794	69,656	78,332	75,735	70,641	65,635
2,4-d	22,422	22,913	7,565	7,749	10,773	11,041	13,243	12,019	8,704	10,917
4-vinylcyclohexenediepoxide	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<1
acifluorfen, sodium salt	N/A	<1	N/A	<1	<1	4	N/A	N/A	N/A	<1
alachlor	2,261	3,276	3,385	3,284	2,670	2,033	1,497	70	3	3
alpha-chlorohydrin	N/A	N/A	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
amitrole	<1	<1	<1	<1	N/A	N/A	N/A	70	N/A	N/A
arsenic acid	N/A	N/A	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
arsenic pentoxide	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
arsenic trioxide	<1	<1	<1	<1	N/A	<1	<1	<1	N/A	N/A
auramine	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
cacodylic acid	<1	<1	<1	<1	N/A	<1	N/A	<1	6	88
captan	173,133	245,464	209,979	209,406	187,988	211,312	212,100	246,074	220,620	218,301
carbaryl	107,934	81,683	68,394	97,229	96,647	108,805	136,319	116,667	106,737	99,446
carbon tetrachloride	<1	N/A	<1	<1	N/A	<1	<1	<1	<1	N/A
chlordane	8	<1	N/A	<1	N/A	N/A	<1	N/A	<1	<1
chlordecone	N/A	N/A	<1	<1	<1	<1	<1	<1	<1	<1
chlorothalonil	378,600	493,216	588,777	571,892	530,262	566,228	541,345	542,115	584,820	548,568
chromic acid	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
creosote	2	N/A	N/A	N/A	<1	N/A	<1	N/A	N/A	<1
daminozide	2,111	4,357	2,430	2,981	2,546	2,443	2,408	2,083	2,258	2,241
ddvp	2,685	1,880	5,184	6,530	5,593	3,307	6,282	3,317	787	12
ddvp, other related	2,017	410	1,945	5,442	5,537	3,301	5,149	3,287	703	10
diclofop-methyl	30	N/A	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A
diethanolamine	N/A	N/A	N/A	N/A	N/A	N/A	4,872	16,766	17,244	20,205
dioctyl phthalate	4,928	7,921	4,741	5,311	3,188	1,885	626	76	N/A	46
dipropyl isocinchomeronate	<1	19	<1	<1	<1	<1	1	<1	<1	<1

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
diuron	405,973	520,587	691,396	555,459	440,233	342,061	279,721	330,900	408,775	352,394
ethoprop	4,293	1,348	1,892	541	676	844	591	575	582	1,712
ethyl acrylate	N/A	72	88	N/A	24	222	<1	<1	N/A	N/A
ethylene dibromide	<1	N/A	N/A	<1	N/A	N/A	<1	N/A	N/A	N/A
ethylene oxide	60	N/A	N/A	<1	N/A	<1	N/A	N/A	N/A	N/A
fenoxycarb	353	100	107	110	37	58	15	33	76	20
folpet	N/A	<1	N/A	<1	<1	<1	<1	<1	3	N/A
formaldehyde	5	1	6	4	52	2	30	<1	<1	<1
glyphosate	1,708	1,741	1,808	508	451	<1	24	2	23	<1
glyphosate, diammonium salt	58,768	16,353	8,559	3,287	2,938	3,381	1,173	665	308	22
glyphosate, dimethylamine salt	897	3,847	6,291	9,406	9,707	25,463	34,323	36,507	35,727	37,632
glyphosate, isopropylamine salt	2,733,831	2,872,797	2,594,759	2,379,745	2,425,424	2,322,698	2,184,853	2,166,537	2,278,594	2,378,762
glyphosate, monoammonium salt	11,367	11,443	12,479	545	19,922	11,919	6,446	5,786	359	883
glyphosate, potassium salt	1,633,054	1,961,989	2,899,024	3,151,422	3,130,438	3,110,231	3,426,729	3,397,714	3,280,889	3,218,657
glyphosate-trimesium	2,023	295	431	172	43	450	N/A	N/A	90	30
heptachlor	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A	<1	<1
imazalil	<1	26	2	<1	<1	32	1	50	2	<1
iprodione	434,812	578,691	638,632	529,986	479,106	459,139	407,066	519,831	479,159	141,247
kresoxim-methyl	180,877	236,638	280,738	192,745	199,709	210,369	172,536	177,876	177,275	150,966
lindane	10	31	1	N/A	<1	N/A	28	N/A	N/A	N/A
malathion	277,706	434,717	281,044	271,627	289,749	285,266	266,825	218,282	204,397	216,638
mancozeb	146,402	433,887	634,712	678,932	675,754	711,031	740,602	830,305	857,513	715,654
maneb	471,837	290,266	40,588	4,559	1,524	1,006	425	987	1,286	75
metam-sodium	75,735	72,748	71,003	58,998	28,105	24,422	24,254	19,437	17,423	20,139
methyl eugenol	N/A	N/A	<1	N/A	<1	N/A	N/A	<1	<1	<1
methyl iodide	N/A	N/A	279	37	N/A	N/A	N/A	N/A	N/A	N/A
methylene chloride	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
metiram	N/A	N/A	<1	<1	<1	<1	<1	<1	<1	<1
naphthalene	N/A	3	<1	N/A	<1	N/A	N/A	N/A	<1	<1
nitrapyrin	88	111	N/A	<1	1	N/A	<1	<1	N/A	34
nitrofen	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ortho-phenylphenol	49	58	117	85	130	104	329	264	71	175
ortho-phenylphenol, sodium salt	<1	<1	<1	<1	<1	<1	<1	2	N/A	N/A
oryzalin	236,566	217,193	294,499	263,649	203,850	203,504	162,536	90,433	106,348	92,190
oxadiazon	1,451	1,712	927	1,148	1,511	1,239	1,777	1,067	1,151	1,072

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
oxythioquinox	4	4	1	1	<1	<1	N/A	7	N/A	2
para-dichlorobenzene	<1	<1	<1	<1	<1	N/A	N/A	N/A	<1	<1
parathion	195	56	68	15	<1	1	207	82	60	<1
pentachlorophenol	N/A	4	1	15	170	3	5	97	296	413
pirimicarb	<1	<1	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
potassium dichromate	N/A	N/A	N/A	N/A	<1	N/A	<1	N/A	N/A	N/A
potassium n-methyldithiocarbamate	38,277	41,444	44,079	50,361	46,861	39,708	48,504	49,022	47,542	45,459
propargite	174,063	137,106	142,430	114,213	121,952	104,758	87,943	87,430	106,305	97,880
propoxur	356	<1	3	<1	4	179	39	19	<1	25
propylene oxide	<1	<1	<1	288	9	<1	<1	<1	14	<1
propyzamide	102,176	69,328	61,014	57,625	51,921	51,307	49,022	110,588	122,543	122,108
pymetrozine	30,516	40,675	29,669	33,655	37,201	42,540	30,716	42,744	36,824	52,233
resmethrin	11	<1	6	4	436	18	7	3	<1	21
s,s,s-tributyl phosphorotrithioate	7,182	15,785	27,139	21,894	22,774	15,139	7,582	7,725	10,624	11,007
sedaxane	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<1	4	N/A
sodium dichromate	N/A	N/A	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A
spirodiclofen	148,338	99,851	72,318	83,110	135,077	124,024	97,629	107,825	121,796	120,400
terrazole	711	5,107	443	579	414	660	255	175	283	239
tetrachloroethylene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
tetrachlorvinphos	<1	5	5	8	4	3	1,044	5	3	<1
thiodicarb	680	192	656	206	247	N/A	N/A	N/A	<1	N/A
toxaphene	45	12	1	<1	<1	<1	<1	<1	2	<1
trichloro ethylene	N/A	N/A	<1	N/A	<1	N/A	N/A	N/A	<1	<1
vinclozolin	85	86	100	33	11	5	10	6	18	13
Total	7,887,826	8,962,971	9,774,534	9,438,331	9,218,941	9,056,480	9,021,670	9,198,413	9,228,984	8,600,552

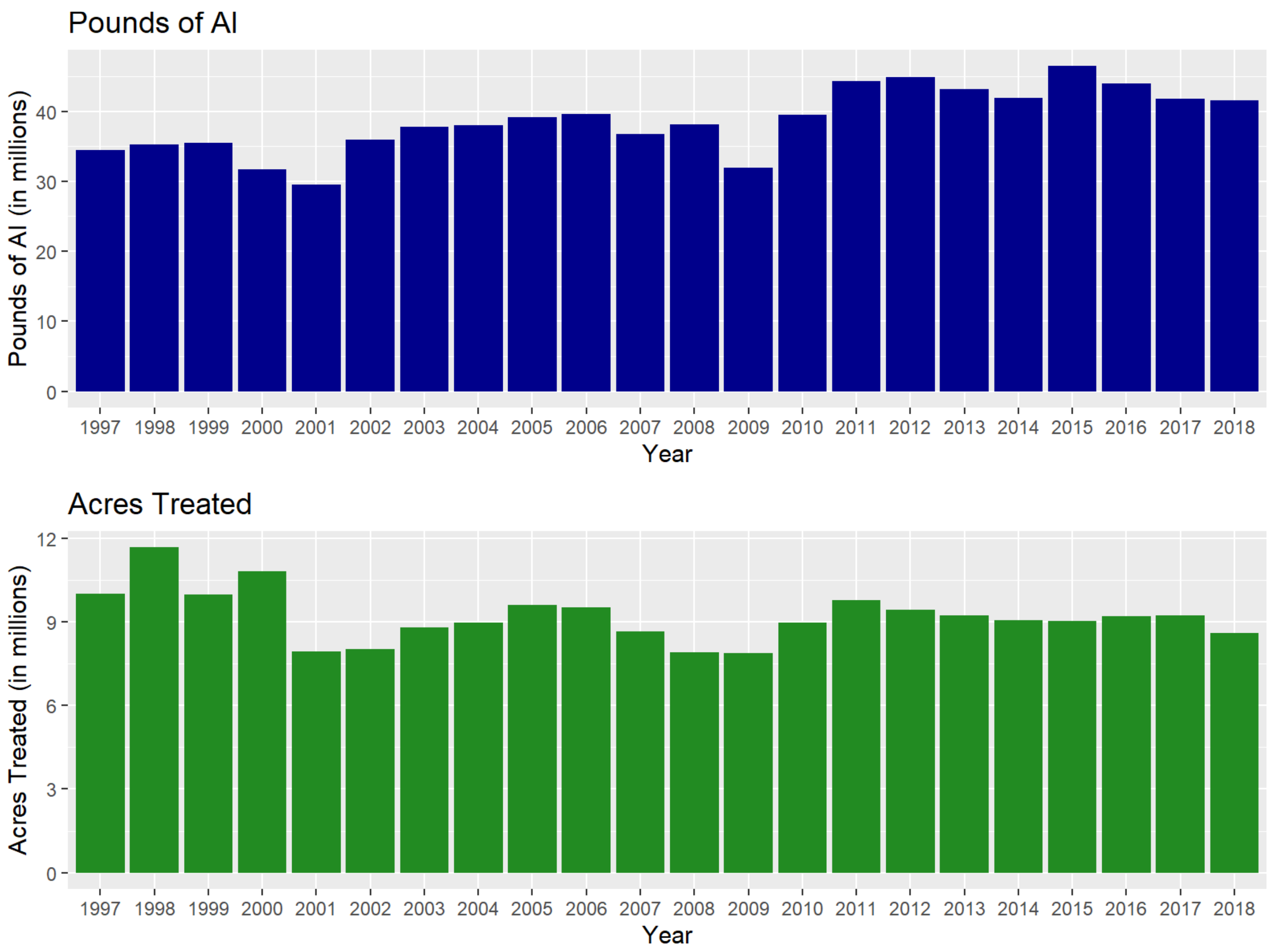

Figure 6: *Use trends of pesticides that are listed by U.S. EPA as A or B carcinogens or on the State's Proposition 65 list of chemicals that are "known to cause cancer." Reported pounds of active ingredient (AI) applied include both agricultural and nonagricultural applications. The reported cumulative acres treated include primarily agricultural applications. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/ >.*

USE TRENDS OF CHOLINESTERASE-INHIBITING PESTICIDES.

Table 9: *The reported pounds of pesticides used that are organophosphorus or carbamate cholinesterase-inhibiting pesticides. Use includes both agricultural and reportable nonagricultural applications. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/ >.*

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
acephate	112,562	134,993	152,610	130,470	185,130	144,555	170,759	159,353	192,134	164,830
aldicarb	31,579	64,626	24,167	1,489	1,487	126	N/A	N/A	N/A	N/A
azinphos-methyl	13,913	1,619	1,582	1,232	32	N/A	1	N/A	1	N/A
bendiocarb	<1	1	3	3	2	4	1	4	3	2
bensulide	247,735	271,835	288,435	267,050	285,471	319,400	346,137	293,204	285,292	311,544
butylate	N/A	299	N/A	N/A	88	53	N/A	10	N/A	N/A
carbaryl	136,104	113,983	74,890	113,845	117,252	131,744	155,525	221,095	107,453	128,623
carbofuran	10,117	4	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
carbophenothion	4	51	4	1,204	N/A	N/A	N/A	N/A	<1	N/A
chlorpyrifos	1,248,584	1,290,982	1,300,553	1,106,464	1,469,298	1,312,361	1,107,417	903,238	947,911	601,173
coumaphos	N/A	<1	3	3	14	N/A	1	N/A	<1	5
crotoxyphos	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<1	N/A	N/A
cycloate	25,284	27,292	31,037	33,562	30,619	36,566	39,655	45,150	49,844	41,743
ddvp	4,169	4,176	5,480	4,890	4,627	4,034	4,082	3,868	3,456	3,505
ddvp, other related	217	194	268	276	278	162	165	123	113	109
demeton	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
diazinon	142,061	126,804	86,647	78,523	61,224	61,126	52,665	48,991	72,612	33,489
dicrotophos	N/A	N/A	N/A	N/A	N/A	5	<1	N/A	N/A	N/A
dimethoate	251,926	210,431	226,434	183,201	270,156	334,563	288,376	243,736	223,288	164,880
dioxathion	<1	2	N/A	N/A	9	N/A	N/A	N/A	<1	N/A
dioxathion, other related	<1	1	N/A	N/A	4	N/A	N/A	N/A	<1	N/A
disulfoton	10,233	9,085	4,351	5,479	1,924	2,219	415	10	12	16
epn	N/A	528	13	8	20	425	1	2	<1	1
eptc	128,993	118,509	125,932	168,665	187,349	235,271	237,983	255,431	259,784	218,451
ethephon	207,894	375,561	548,700	484,377	397,059	348,653	319,307	399,159	485,572	433,459
ethion	28	72	1	44	N/A	<1	1	N/A	<1	N/A
ethoprop	20,793	5,645	7,475	2,077	2,502	3,076	1,820	2,023	2,134	5,848
fenamiphos	11,493	8,978	2,964	5,254	2,244	865	97	143	131	<1
fenthion	9	4	<1	N/A	N/A	<1	N/A	<1	N/A	N/A
fonofos	N/A	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
formetanate hydrochloride	32,670	30,313	20,952	20,446	26,912	28,333	31,172	42,037	36,709	40,164
malathion	532,321	561,398	512,004	405,353	446,743	502,997	443,128	355,053	334,893	360,906
merphos	N/A	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
merphos, other related	N/A	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
methamidophos	17,934	9,664	6,037	<1	55	N/A	N/A	N/A	1	<1
methidathion	47,319	51,343	29,545	23,396	6,375	3,614	245	146	11	140
methiocarb	3,093	3,506	2,708	3,786	3,675	3,722	3,371	2,810	2,803	2,485
methomyl	221,248	231,690	220,085	273,337	260,518	278,741	282,501	260,627	234,580	224,535
methyl parathion	25,770	21,512	22,970	25,408	21,520	481	182	24	5	2
methyl parathion, other related	1,355	1,132	1,195	1,334	1,131	<1	5	<1	N/A	N/A
mevinphos	9	24	118	3	<1	8	9	4	N/A	7
mevinphos, other related	6	16	79	2	N/A	5	6	3	N/A	5
mexacarbate	N/A	N/A	N/A	N/A	1	N/A	N/A	N/A	N/A	N/A
molinate	12,516	24	<1	3	<1	<1	<1	5	N/A	N/A
naled	162,530	175,118	199,203	153,116	218,690	225,285	288,473	316,868	283,944	330,719
oxamyl	48,994	121,725	136,967	52,984	72,993	65,785	17,236	2,466	38,302	78,737
oxydemeton-methyl	68,576	71,290	26,017	17,562	10,656	8,407	6,610	3,764	1,533	1,460
parathion	118	257	196	25	<1	1	836	41	3	3
parathion, other related	1	10	<1	<1	N/A	N/A	1	<1	N/A	N/A
phorate	17,686	14,775	46,430	61,545	30,909	32,683	19,519	20,378	29,897	25,477
phosacetin	N/A	N/A	N/A	N/A	<1	<1	<1	N/A	<1	<1
phosmet	132,647	115,008	95,781	53,587	60,903	44,344	19,278	28,971	16,869	22,595
phosphamidon	N/A	24	N/A	N/A	N/A	N/A	N/A	6	N/A	N/A
phosphamidon, other related	N/A	1	N/A	N/A	N/A	N/A	N/A	<1	N/A	N/A
pirimicarb	2	1	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
potassium dimethyl dithio carbamate	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
profenofos	N/A	1,552	N/A	58	N/A	N/A	N/A	N/A	N/A	N/A
propetamphos	352	213	139	170	127	3,047	5	2	<1	<1
propoxur	202	298	808	359	373	251	100	49	43	28
ronnel	N/A	N/A	2	N/A	1	1	112	16	12	N/A
s,s,s-tributyl phosphorotrithioate	8,161	18,427	30,328	21,820	19,077	11,683	6,472	6,882	8,151	8,911

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
sodium dimethyl dithio carbamate	8,963	11,053	13,358	13,485	22,187	16,535	9,357	18,414	18,854	11,257
sulfotep	2	N/A	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
temephos	83	99	34	17	8	10	5	3	4	2
tepp	N/A	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
tepp, other related	N/A	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
tetrachlorvinphos	1,306	1,086	912	665	2,660	629	173	66	55	109
thiobencarb	320,643	258,402	246,927	280,678	289,946	373,930	523,582	698,888	603,226	592,804
thiodicarb	511	152	472	145	156	N/A	N/A	N/A	1	N/A
triallate	N/A	879	2,671	3,752	4,530	5,886	4,830	5,217	1,568	3,796
trichlorfon	25	34	40	29	25	11	<1	<1	<1	4
Total	4,268,740	4,466,707	4,497,530	4,001,180	4,516,963	4,541,595	4,381,617	4,338,279	4,241,204	3,811,824

Table 10: The reported cumulative acres treated with pesticides that are organophosphorus or carbamate cholinesterase-inhibiting pesticides. Use includes primarily agricultural applications (Most nonagricultural pesticide use reports are not required to report acreage). The grand total for acres treated may be less than the sum of acres treated for all chemicals because some products contain more than one active ingredient. Values are rounded. N/A means there was not any reported acres treated during that year. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
acephate	115,063	144,134	150,268	132,424	183,239	122,616	163,104	172,589	177,380	158,440
aldicarb	31,977	66,192	29,363	1,451	1,882	166	N/A	N/A	N/A	N/A
azinphos-methyl	8,283	1,724	1,809	1,639	25	N/A	1	N/A	<1	N/A
bendiocarb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
bensulide	73,306	78,736	84,201	79,195	84,384	85,657	94,185	79,317	77,377	85,689
butylate	N/A	60	N/A	N/A	20	12	N/A	8	N/A	N/A
carbaryl	107,934	81,683	68,394	97,229	96,647	108,805	136,319	116,667	106,737	99,446
carbofuran	7,331	15	30	N/A	N/A	N/A	N/A	N/A	N/A	N/A
carbophenothion	15	107	12	31	N/A	N/A	N/A	N/A	1	N/A
chlorpyrifos	935,588	1,098,958	1,188,543	1,056,026	1,297,150	1,108,317	829,304	641,561	690,834	431,218
coumaphos	N/A	<1	<1	<1	1	N/A	62	N/A	<1	1
crotoxyphos	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<1	N/A	N/A
cycloate	12,058	13,799	14,895	17,565	16,045	19,124	21,037	23,173	23,962	20,953
ddvp	2,685	1,880	5,184	6,530	5,593	3,307	6,282	3,317	787	12
ddvp, other related	2,017	410	1,945	5,442	5,537	3,301	5,149	3,287	703	10
demeton	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
diazinon	140,620	104,443	71,156	48,594	35,069	32,862	27,004	24,353	24,579	17,932
dicrotophos	N/A	N/A	N/A	N/A	N/A	23	<1	N/A	N/A	N/A
dimethoate	499,991	436,845	532,891	422,176	594,369	725,261	626,623	531,217	499,453	436,002
dioxathion	37	<1	N/A	N/A	78	N/A	N/A	N/A	<1	N/A
dioxathion, other related	37	<1	N/A	N/A	78	N/A	N/A	N/A	<1	N/A
disulfoton	7,591	6,167	1,621	2,595	1,042	1,157	205	16	<1	<1
epn	N/A	135	<1	<1	2	<1	<1	2	<1	<1
eptc	49,708	44,289	47,770	56,872	69,989	89,126	91,512	100,883	104,151	91,178
ethephon	261,336	455,338	602,803	533,731	475,399	414,279	363,766	452,937	552,728	495,261
ethion	15	184	81	332	N/A	<1	306	N/A	30	N/A
ethoprop	4,293	1,348	1,892	541	676	844	591	575	582	1,712
fenamiphos	7,537	5,873	2,127	2,691	1,437	465	<1	<1	20	<1
fenthion	<1	<1	<1	N/A	N/A	<1	N/A	60	N/A	N/A
fonofos	N/A	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
formetanate hydrochloride	32,678	30,898	22,038	21,821	27,894	28,234	31,515	41,115	36,188	38,465
malathion	277,706	434,717	281,044	271,627	289,749	285,266	266,825	218,282	204,397	216,638
merphos	N/A	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
merphos, other related	N/A	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
methamidophos	20,408	10,731	6,465	<1	69	N/A	N/A	N/A	2	<1
methidathion	54,227	49,968	34,918	31,741	9,046	3,564	453	198	27	138
methiocarb	2,131	2,335	2,057	2,800	3,376	2,409	2,444	1,771	1,934	1,380
methomyl	377,954	410,186	396,484	473,037	439,612	450,025	453,825	431,681	386,649	375,018
methyl parathion	15,198	13,046	13,343	15,551	12,486	<1	298	60	<1	3
methyl parathion, other related	15,053	13,029	13,327	15,337	12,440	<1	36	18	N/A	N/A
mevinphos	69	11	108	3	<1	51	51	23	N/A	136
mevinphos, other related	69	11	108	3	N/A	51	51	23	N/A	136
mexacarbate	N/A	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A	N/A
molinate	2,942	6	<1	<1	3	<1	1	1	N/A	N/A
naled	128,415	145,673	163,486	109,008	160,907	139,823	164,576	175,205	175,253	190,102
oxamyl	59,118	138,801	150,265	61,931	83,561	75,324	21,033	3,301	40,943	90,621
oxydemeton-methyl	82,368	86,131	27,447	18,204	12,163	9,096	7,355	7,883	3,555	3,111
parathion	195	56	68	15	<1	1	207	82	60	<1
parathion, other related	49	54	<1	10	N/A	N/A	10	4	N/A	N/A
phorate	10,236	8,719	32,863	47,176	22,469	25,700	14,682	16,300	23,653	20,590

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
phosacetin	N/A	N/A	N/A	N/A	<1	<1	<1	N/A	1	3
phosmet	51,514	40,276	33,692	18,923	23,726	21,122	10,336	11,297	7,751	8,405
phosphamidon	N/A	72	N/A	N/A	N/A	N/A	N/A	35	N/A	N/A
phosphamidon, other related	N/A	72	N/A	N/A	N/A	N/A	N/A	35	N/A	N/A
pirimicarb	<1	<1	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
potassium dimethyl dithio carbamate	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
profenofos	N/A	1,635	N/A	155	N/A	N/A	N/A	N/A	N/A	N/A
propetamphos	<1	<1	<1	<1	<1	3,621	<1	<1	<1	<1
propoxur	356	<1	3	<1	4	179	39	19	<1	25
ronnel	N/A	N/A	110	N/A	11	<1	<1	<1	<1	N/A
s,s,s-tributyl phosphorotrithioate	7,182	15,785	27,139	21,894	22,774	15,139	7,582	7,725	10,624	11,007
sodium dimethyl dithio carbamate	3	13	<1	<1	<1	<1	<1	6	10	1
sulfotep	3	N/A	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
temephos	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
tepp	N/A	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
tepp, other related	N/A	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
tetrachlorvinphos	<1	5	5	8	4	3	1,044	5	3	<1
thiobencarb	83,567	75,172	71,824	79,689	84,726	107,636	148,349	197,836	178,307	172,814
thiodicarb	680	192	656	206	247	N/A	N/A	N/A	<1	N/A
triallate	N/A	867	1,854	2,715	2,998	3,918	3,221	3,665	1,064	2,525
trichlorfon	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total	3,472,056	4,006,991	4,068,608	3,636,104	4,058,823	3,883,027	3,492,728	3,263,135	3,328,994	2,968,755

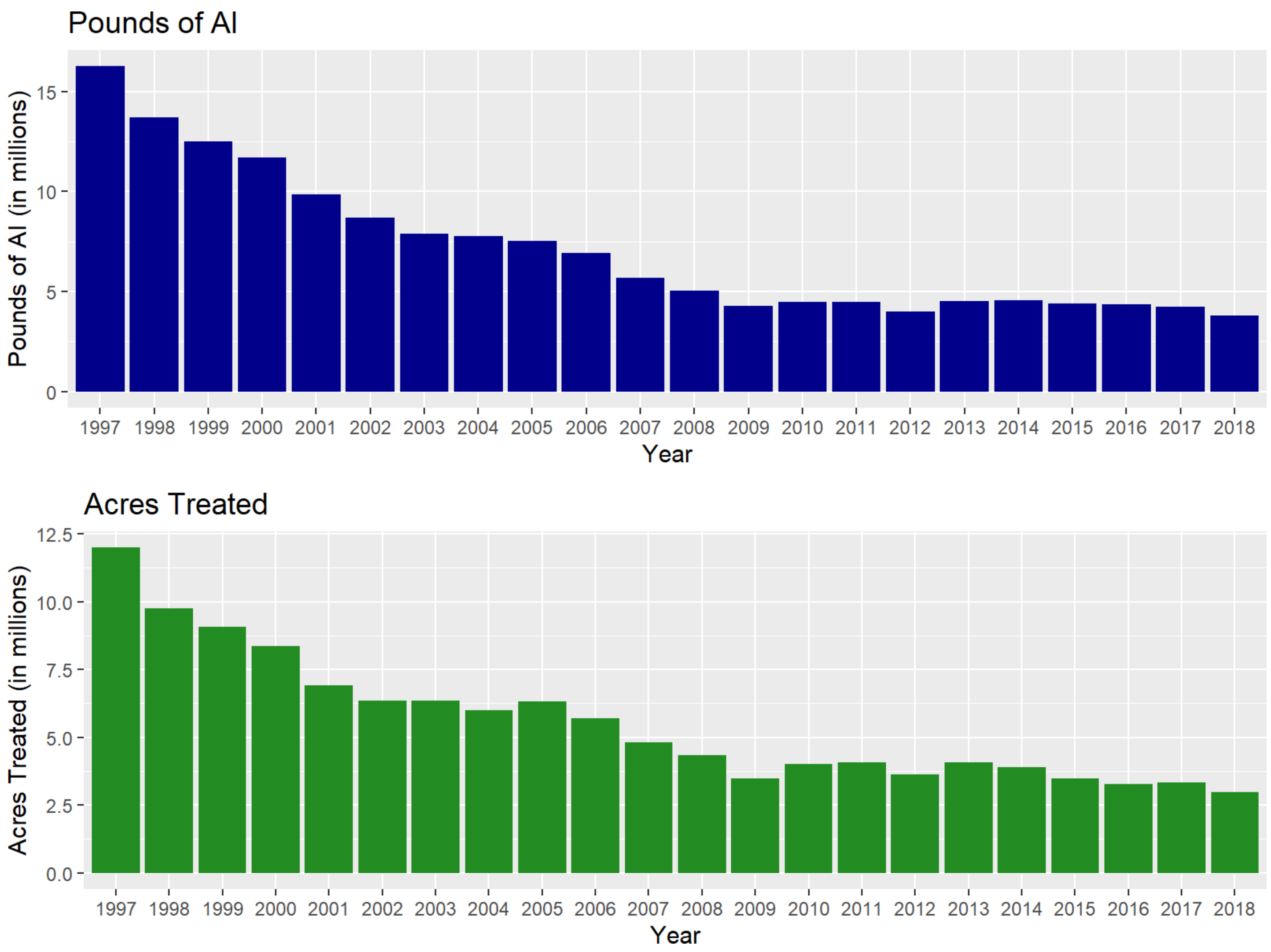

Figure 7: *Use trends of pesticides that are organophosphorus or carbamate cholinesterase-inhibiting pesticides. Reported pounds of active ingredient (AI) applied include both agricultural and nonagricultural applications. The reported cumulative acres treated include primarily agricultural applications. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/ >.*

USE TRENDS OF PESTICIDES ON THE “A” PART OF DPR’S GROUNDWATER PROTECTION LIST.

Table 11: *The reported pounds of pesticides used that are on the “a” part of DPR’s groundwater protection list. These pesticides are the active ingredients listed in the California Code of Regulations, Title 3, Division 6, Chapter 4, Subchapter 1, Article 1, Section 6800(a). Use includes both agricultural and reportable nonagricultural applications. Values are rounded. N/A means there was not any reported pounds during that year. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/ >.*

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
atrazine	23,260	28,937	22,654	32,173	23,419	20,896	17,912	21,282	21,175	17,103
atrazine, other related	482	607	475	676	480	434	375	445	440	349
bentazon, sodium salt	9,589	7,447	5,800	7,060	8,250	8,506	8,322	8,671	8,193	8,044
bromacil	52,049	67,784	92,437	82,485	68,294	61,793	37,484	30,002	19,290	22,606
bromacil, lithium salt	896	1,835	1,486	1,422	1,145	2,472	2,891	2,504	3,751	4,399
diuron	623,001	588,905	675,024	554,583	413,291	325,345	317,328	248,331	179,467	188,274
norflurazon	44,762	43,686	30,697	42,045	29,946	30,226	22,562	11,320	6,819	12,659
prometon	1	6	3	8	34	1	59	<1	1	<1
simazine	420,004	378,661	425,870	368,621	300,394	242,895	179,321	163,707	127,182	117,877
Total	1,174,044	1,117,868	1,254,447	1,089,073	845,254	692,569	586,253	486,262	366,319	371,311

Table 12: *The reported cumulative acres treated with pesticides that are on the "a" part of DPR's groundwater protection list. These pesticides are the active ingredients listed in the California Code of Regulations, Title 3, Division 6, Chapter 4, Subchapter 1, Article 1, Section 6800(a). Use includes primarily agricultural applications (Most nonagricultural pesticide use reports are not required to report acreage). The grand total for acres treated may be less than the sum of acres treated for all chemicals because some products contain more than one active ingredient. Values are rounded. N/A means there was not any reported acres treated during that year. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
atrazine	15,767	19,990	17,236	23,827	17,873	15,404	14,537	17,237	16,831	14,021
atrazine, other related	15,767	19,990	17,236	23,827	17,873	15,404	14,537	17,237	16,831	14,021
bentazon, sodium salt	6,424	6,258	4,846	6,539	7,467	7,956	6,823	7,320	6,743	6,882
bromacil	24,420	28,757	32,183	28,746	16,607	12,628	5,942	6,936	7,306	4,846
bromacil, lithium salt	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
diuron	405,973	520,587	691,396	555,459	440,233	342,061	279,721	330,900	408,775	352,394
norflurazon	44,503	45,638	30,601	31,693	23,306	25,112	17,343	9,790	5,471	12,102
prometon	3	20	<1	<1	234	<1	19	38	1	<1
simazine	339,302	289,198	324,612	241,359	205,338	165,261	118,823	112,998	91,713	84,157
Total	813,118	882,518	1,069,323	859,272	694,764	556,157	437,858	478,769	530,053	470,263

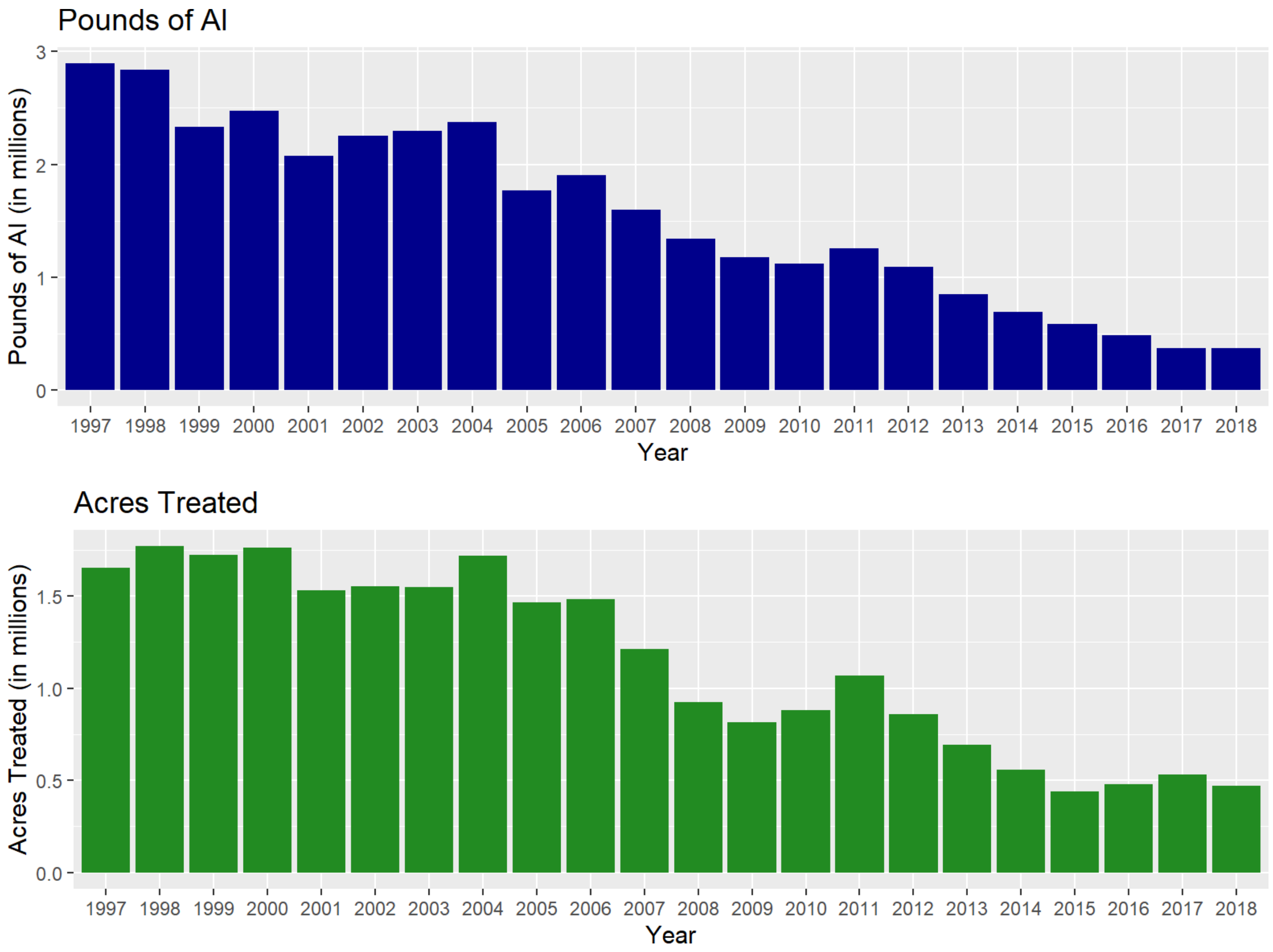

Figure 8: *Use trends of pesticides that are on the "a" part of DPR's groundwater protection list. These pesticides are the active ingredients listed in the California Code of Regulations, Title 3, Division 6, Chapter 4, Subchapter 1, Article 1, Section 6800(a). Reported pounds of active ingredient (AI) applied include both agricultural and nonagricultural applications. The reported cumulative acres treated include primarily agricultural applications. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/ >.*

USE TRENDS OF PESTICIDES ON DPR’S TOXIC AIR CONTAMINANTS LIST.

Table 13: *The reported pounds of pesticides used that are on DPR’s toxic air contaminants list applied in California. These pesticides are the active ingredients listed in the California Code of Regulations, Title 3, Division 6, Chapter 4, Subchapter 1, Article 1, Section 6860. Use includes both agricultural and reportable nonagricultural applications. Values are rounded. N/A means there was not any reported pounds during that year. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/ >.*

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1,3-dichloropropene	6,450,125	8,797,078	10,924,344	11,947,156	12,941,042	13,614,468	15,689,571	14,128,721	12,581,936	12,569,270
2,4-d	9,338	11,914	5,400	4,259	5,665	6,384	7,372	6,046	4,344	6,083
2,4-d, 2-ethylhexyl ester	15,113	74,398	25,795	27,639	25,647	21,655	26,985	31,914	19,382	20,818
2,4-d, alkanolamine salts (ethanol and isopropanol amines)	131	516	1	16	18	<1	201	21	82	204
2,4-d, butoxyethanol ester	2,751	1,368	1,757	1,798	2,483	2,318	1,791	893	1,325	2,105
2,4-d, butyl ester	2	3	4	7	26	N/A	129	N/A	50	N/A
2,4-d, diethanolamine salt	4,913	6,872	3,165	2,649	2,880	4,081	3,628	3,227	2,977	3,233
2,4-d, dimethylamine salt	448,024	489,475	408,926	371,759	352,024	329,058	361,610	368,389	305,705	326,899
2,4-d, dodecylamine salt	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10	N/A	N/A
2,4-d, isooctyl ester	4,446	4,214	5,361	4,623	1,421	779	1,026	899	361	630
2,4-d, isopropyl ester	13,123	11,682	19,072	13,527	11,766	10,440	11,488	14,951	12,738	13,543
2,4-d, propyl ester	99	57	N/A	N/A	6	N/A	N/A	N/A	N/A	N/A
2,4-d, tetradecylamine salt	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2	N/A	N/A
2,4-d, triethylamine salt	472	2,829	106	5	<1	23	10	137	2	<1
2,4-d, triisopropanolamine salt	1,930	2,092	2,741	1,746	1,588	2,439	1,945	1,675	534	1,412
2,4-d, triisopropylamine salt	1,941	1,655	1,971	770	1,263	1,871	1,372	1,139	749	264
acrolein	161,637	123,660	101,425	114,130	101,817	84,220	56,830	48,108	56,227	57,971
aluminum phosphide	108,084	108,406	157,006	148,903	142,903	113,910	90,314	160,806	299,641	123,527
arsenic acid	N/A	N/A	17	N/A	N/A	N/A	N/A	N/A	N/A	N/A
arsenic pentoxide	400	16,144	8,034	9,240	8,480	16,719	22,190	10,508	5,105	3,677
arsenic trioxide	<1	<1	<1	<1	N/A	<1	<1	<1	N/A	N/A
captan	329,747	450,225	376,597	403,224	349,430	370,136	511,177	638,401	561,769	413,622
captan, other related	7,374	10,002	8,395	8,904	5,967	4,717	4,030	4,837	4,158	3,853

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
carbaryl	136,104	113,983	74,890	113,845	117,252	131,744	155,525	221,095	107,453	128,623
chlorine	585,673	1,011,383	834,152	1,437,637	1,323,645	800,013	603,519	726,781	418,713	457,774
chloropicrin	5,693,356	6,398,482	7,307,900	8,931,248	8,220,135	8,994,608	8,514,720	8,641,553	8,788,404	7,436,425
chlorpyrifos	1,248,584	1,290,982	1,300,553	1,106,464	1,469,298	1,312,361	1,107,417	903,238	947,911	601,173
chromic acid	559	22,555	11,224	12,908	11,847	23,358	31,629	15,709	7,632	5,497
dazomet	65,725	60,539	59,245	39,229	63,920	58,652	83,058	53,928	47,513	25,948
ddvp	4,169	4,176	5,480	4,890	4,627	4,034	4,082	3,868	3,456	3,505
endosulfan	41,840	37,799	15,679	11,113	1,833	8,136	6,420	576	55	1
ethylene oxide	7	N/A	N/A	8	N/A	<1	N/A	N/A	N/A	N/A
formaldehyde	3,972	5,511	4,615	3,847	11,165	52,989	31,956	23,116	11,825	1,349
hydrogen chloride	3,976	2,240	504	336	395	412	553	589	1,573	3,958
lindane	8	18	1	N/A	2	N/A	6	N/A	N/A	N/A
magnesium phosphide	8,009	12,233	12,769	11,497	12,372	7,562	22,316	14,766	9,021	8,344
mancozeb	282,587	757,664	1,045,594	1,130,998	1,149,091	1,282,145	1,273,707	1,436,008	1,519,480	1,315,141
maneb	657,090	370,333	54,024	6,260	1,383	1,274	286	1,275	2,224	59
meta-cresol	<1	<1	1	2	7	<1	<1	1	4	<1
metam-sodium	9,359,224	11,428,913	10,895,290	8,427,548	4,846,423	4,297,539	3,606,650	3,297,827	3,144,356	3,765,705
methanol	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2	N/A	N/A
methidathion	47,319	51,343	29,545	23,396	6,375	3,614	245	146	11	140
methoxychlor	8	270	39	N/A	<1	N/A	<1	<1	3	N/A
methoxychlor, other related	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<1	N/A	N/A
methyl bromide	5,623,692	4,809,340	4,055,208	4,017,075	3,529,577	2,963,143	2,655,355	2,602,823	1,798,430	1,682,989
methyl iodide	N/A	N/A	1,157	21	N/A	N/A	N/A	N/A	N/A	N/A
methyl isothiocyanate	N/A	73	476	764	N/A	92	63	77	153	511
methyl parathion	25,770	21,512	22,970	25,408	21,520	481	182	24	5	2
methyl parathion, other related	1,355	1,132	1,195	1,334	1,131	<1	5	<1	N/A	N/A
naphthalene	N/A	1	<1	N/A	<1	N/A	N/A	N/A	<1	<1
para-dichlorobenzene	17	N/A	<1	18	<1	N/A	N/A	N/A	<1	<1
parathion	118	257	196	25	<1	1	836	41	3	3
pcnb	24,637	37,378	11,867	16,750	26,131	23,431	20,626	53,374	76,601	83,619
pcp, other related	N/A	<1	3	32	39	2	3	<1	<1	3
pcp, sodium salt	N/A	N/A	<1	N/A	N/A	<1	N/A	N/A	N/A	N/A
pentachlorophenol	N/A	3	18	224	274	11	25	1	4	27
phenol	2	N/A	N/A	N/A	5	3	1	41	3	<1
phenol, ferrous salt	N/A	N/A	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A
phosphine	29,527	11,291	125,469	51,259	20,855	11,399	28,397	19,247	21,699	49,832
phosphorus	<1	1	N/A	4	3	N/A	N/A	N/A	N/A	N/A

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
potassium n-methyldithiocarbamate	4,128,181	4,832,615	5,673,722	8,320,255	9,484,467	7,798,703	10,252,596	9,343,192	8,940,720	8,527,736
potassium permanganate	109	N/A	N/A	N/A	N/A	N/A	N/A	113	N/A	N/A
propoxur	202	298	808	359	373	251	100	49	43	28
propylene oxide	111,609	300,008	449,037	389,070	410,360	400,719	396,191	368,260	255,702	213,681
s,s,s-tributyl phosphorotrithioate	8,161	18,427	30,328	21,820	19,077	11,683	6,472	6,882	8,151	8,911
sodium cyanide	2,579	2,502	1,073	2,588	2,593	2,611	3,108	2,869	3,057	2,986
sodium dichromate	N/A	N/A	N/A	N/A	N/A	2	N/A	N/A	N/A	N/A
sodium tetrathiocarbonate	249,580	233,949	168,761	49,713	N/A	120	N/A	N/A	N/A	N/A
sulfuryl fluoride	2,184,823	2,728,977	2,359,006	2,663,898	3,061,470	2,801,523	3,042,482	3,300,334	3,654,817	2,991,914
trifluralin	533,307	473,502	502,198	505,585	508,617	513,766	471,559	387,921	346,848	352,310
xylene	517	1,070	282	372	1,181	1,712	668	556	167	160
zinc phosphide	20,898	1,745	2,543	2,249	2,287	3,598	4,001	3,721	4,197	4,328
Total	38,642,944	45,155,096	47,107,933	50,390,404	48,284,158	46,094,911	49,116,428	46,850,687	43,977,316	41,219,794

Table 14: The reported cumulative acres treated with pesticides that are on DPR's toxic air contaminants list applied in California. These pesticides are the active ingredients listed in the California Code of Regulations, Title 3, Division 6, Chapter 4, Subchapter 1, Article 1, Section 6860. Use includes primarily agricultural applications (Most nonagricultural pesticide use reports are not required to report acreage). The grand total for acres treated may be less than the sum of acres treated for all chemicals because some products contain more than one active ingredient. Values are rounded. N/A means there was not any reported acres treated during that year. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/ >.

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1,3-dichloropropene	38,849	54,209	59,065	69,422	71,794	69,656	78,332	75,735	70,641	65,635
2,4-d	22,422	22,913	7,565	7,749	10,773	11,041	13,243	12,019	8,704	10,917
2,4-d, 2-ethylhexyl ester	9,020	11,797	10,396	7,703	11,634	8,541	11,339	15,697	9,098	9,668
2,4-d, alkanolamine salts (ethanol and isopropanol amines)	270	172	1	36	26	<1	<1	2	59	28
2,4-d, butoxyethanol ester	5,110	2,542	1,206	1,054	990	1,775	813	1,000	1,438	1,508
2,4-d, butyl ester	6	<1	<1	7	<1	N/A	33	N/A	38	N/A

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2,4-d, diethanolamine salt	18,931	27,009	11,075	7,033	8,859	7,547	6,581	8,176	7,087	7,350
2,4-d, dimethylamine salt	529,920	520,477	446,062	378,249	351,869	311,534	329,376	331,889	264,633	290,467
2,4-d, dodecylamine salt	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<1	N/A	N/A
2,4-d, isooctyl ester	2,673	2,424	2,903	414	885	30	97	318	306	483
2,4-d, isopropyl ester	132,302	138,826	145,544	161,007	149,908	136,530	147,250	155,601	149,359	161,120
2,4-d, propyl ester	1,751	895	N/A	N/A	128	N/A	N/A	N/A	N/A	N/A
2,4-d, tetradecylamine salt	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<1	N/A	N/A
2,4-d, triethylamine salt	740	165	117	3	<1	10	45	<1	<1	<1
2,4-d, triisopropanolamine salt	541	720	623	308	524	936	861	209	45	125
2,4-d, triisopropylamine salt	<1	<1	25	37	653	585	238	<1	75	80
acrolein	1,497	12	45	56	68	306	432	79	34	47
aluminum phosphide	112,063	100,859	133,103	164,083	148,962	150,088	159,056	82,175	70,347	72,600
arsenic acid	N/A	N/A	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
arsenic pentoxide	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
arsenic trioxide	<1	<1	<1	<1	N/A	<1	<1	<1	N/A	N/A
captan	173,133	245,464	209,979	209,406	187,988	211,312	212,100	246,074	220,620	218,301
captan, other related	173,083	245,464	209,979	205,402	144,375	119,113	98,445	105,766	100,369	90,049
carbaryl	107,934	81,683	68,394	97,229	96,647	108,805	136,319	116,667	106,737	99,446
chlorine	24,644	88,144	24,253	24,097	<1	38,381	6,258	2,275	<1	323
chloropicrin	49,223	51,805	65,975	63,433	57,605	54,872	53,765	49,149	48,256	41,974
chlorpyrifos	935,588	1,098,958	1,188,543	1,056,026	1,297,150	1,108,317	829,304	641,561	690,834	431,218
chromic acid	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
dazomet	301	274	243	594	768	152	368	18	89	35
ddvp	2,685	1,880	5,184	6,530	5,593	3,307	6,282	3,317	787	12
endosulfan	48,639	48,023	19,812	11,134	1,856	8,331	6,561	644	106	13
ethylene oxide	60	N/A	N/A	<1	N/A	<1	N/A	N/A	N/A	N/A
formaldehyde	5	1	6	4	52	2	30	<1	<1	<1
hydrogen chloride	49	116	<1	5	1	155	100	<1	11	3
lindane	10	31	1	N/A	<1	N/A	28	N/A	N/A	N/A
magnesium phosphide	32	145	80	29	19	14	131	9	20	3
mancozeb	146,402	433,887	634,712	678,932	675,754	711,031	740,602	830,305	857,513	715,654
maneb	471,837	290,266	40,588	4,559	1,524	1,006	425	987	1,286	75

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
meta-cresol	108	79	145	857	614	6	128	690	1,218	253
metam-sodium	75,735	72,748	71,003	58,998	28,105	24,422	24,254	19,437	17,423	20,139
methanol	N/A	N/A	N/A	N/A	N/A	N/A	N/A	23	N/A	N/A
methidathion	54,227	49,968	34,918	31,741	9,046	3,564	453	198	27	138
methoxychlor	75	90	58	N/A	<1	N/A	<1	8	3	N/A
methoxychlor, other related	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8	N/A	N/A
methyl bromide	40,250	32,293	47,050	30,147	26,359	16,578	12,753	11,031	6,051	5,602
methyl iodide	N/A	N/A	279	37	N/A	N/A	N/A	N/A	N/A	N/A
methyl isothiocyanate	N/A	<1	<1	<1	N/A	<1	<1	<1	<1	<1
methyl parathion	15,198	13,046	13,343	15,551	12,486	<1	298	60	<1	3
methyl parathion, other related	15,053	13,029	13,327	15,337	12,440	<1	36	18	N/A	N/A
naphthalene	N/A	3	<1	N/A	<1	N/A	N/A	N/A	<1	<1
para-dichlorobenzene	<1	<1	<1	<1	<1	N/A	N/A	N/A	<1	<1
parathion	195	56	68	15	<1	1	207	82	60	<1
pcnb	1,400	4,429	879	331	605	1,365	811	2,084	3,561	3,333
pcp, other related	N/A	4	1	15	170	3	5	97	296	413
pcp, sodium salt	N/A	N/A	47	N/A	N/A	1	N/A	N/A	N/A	N/A
pentachlorophenol	N/A	4	1	15	170	3	5	97	296	413
phenol	15	N/A	N/A	N/A	114	315	170	557	65	35
phenol, ferrous salt	N/A	N/A	N/A	N/A	N/A	2	N/A	N/A	N/A	N/A
phosphine	50	643	824	687	110	2	25	3	93	112
phosphorus	<1	<1	N/A	74	109	N/A	N/A	N/A	N/A	N/A
potassium n-methyldithiocarbamate	38,277	41,444	44,079	50,361	46,861	39,708	48,504	49,022	47,542	45,459
potassium permanganate	5	N/A	N/A	N/A	N/A	N/A	N/A	<1	N/A	N/A
propoxur	356	<1	3	<1	4	179	39	19	<1	25
propylene oxide	<1	<1	<1	288	9	<1	<1	<1	14	<1
s,s,s-tributyl phosphorotrithioate	7,182	15,785	27,139	21,894	22,774	15,139	7,582	7,725	10,624	11,007
sodium cyanide	<1	<1	<1	<1	<1	<1	18	<1	<1	<1
sodium dichromate	N/A	N/A	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A
sodium tetrathiocarbonate	7,180	7,301	4,826	1,672	N/A	4	N/A	N/A	N/A	N/A
sulfuryl fluoride	361	130	537	532	63	585	153	<1	30	1
trifluralin	492,498	438,784	469,738	466,421	476,388	531,635	480,763	387,998	350,431	339,373
xylene	1,387	589	633	1,010	2,157	1,778	1,225	671	225	270
zinc phosphide	14,512	12,751	21,417	21,685	22,425	44,037	51,789	45,360	55,392	32,849

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total	3,518,176	3,839,221	3,743,166	3,592,148	3,675,434	3,578,879	3,331,339	3,060,614	2,967,389	2,556,162

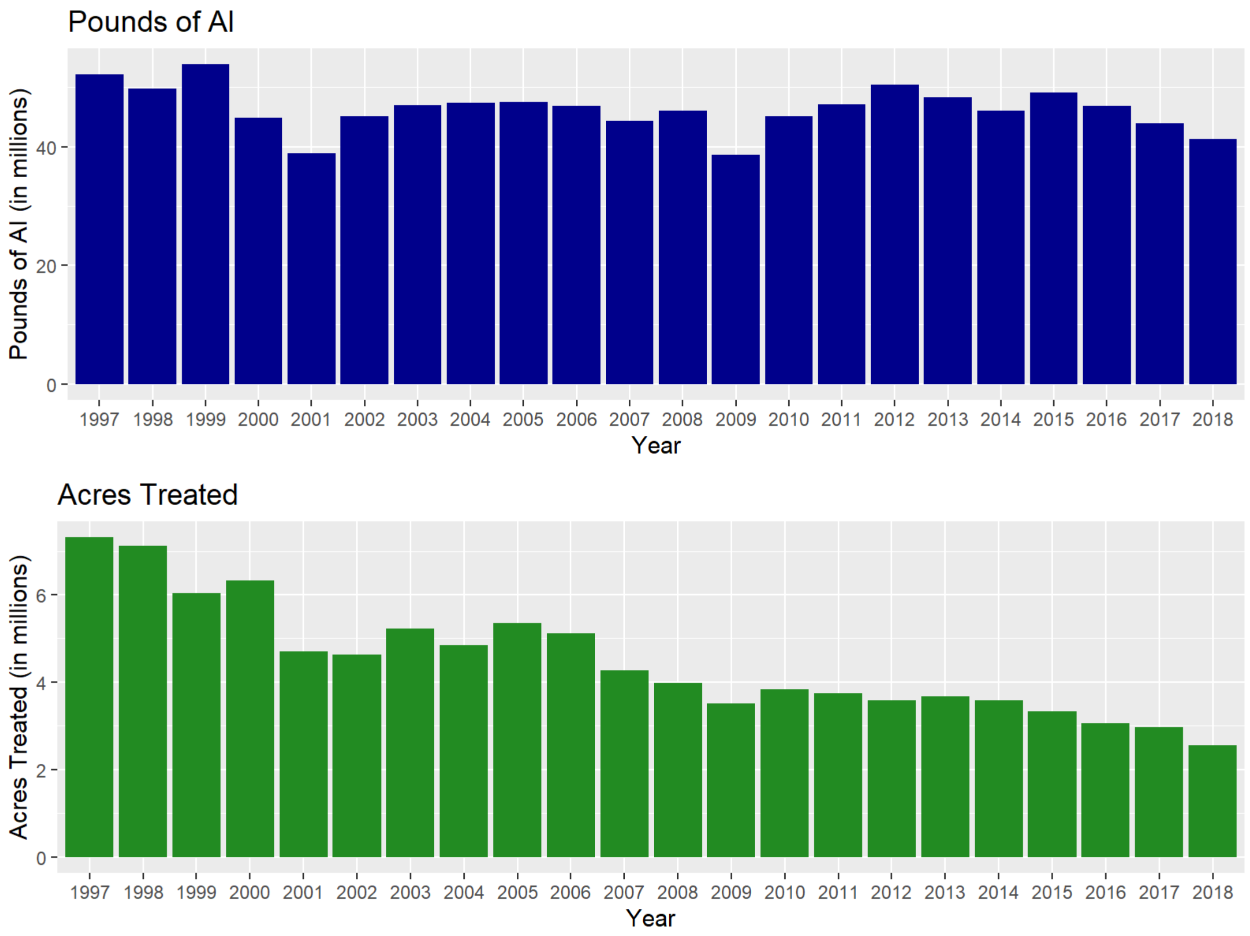

Figure 9: *Use trends of pesticides that are on DPR's toxic air contaminants list applied in California. These pesticides are the active ingredients listed in the California Code of Regulations, Title 3, Division 6, Chapter 4, Subchapter 1, Article 1, Section 6860. Reported pounds of active ingredient (AI) applied include both agricultural and nonagricultural applications. The reported cumulative acres treated include primarily agricultural applications. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/ >.*

USE TRENDS OF PESTICIDES THAT ARE FUMIGANTS.

Table 15: *The reported pounds of pesticides used that are fumigants. Use includes both agricultural and reportable nonagricultural applications. Values are rounded. N/A means there was not any reported pounds during that year. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/ >.*

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1,2-dichloropropane, 1,3-dichloropropene and related c3 compounds	N/A	N/A	N/A	6	N/A	1	N/A	N/A	N/A	N/A
1,3-dichloropropene	6,450,125	8,797,078	10,924,344	11,947,156	12,941,042	13,614,468	15,689,571	14,128,721	12,581,936	12,569,270
aluminum phosphide	108,084	108,406	157,006	148,903	142,903	113,910	90,314	160,806	299,641	123,527
carbon tetrachloride	<1	N/A	6	90	N/A	7	<1	<1	<1	N/A
chloropicrin	5,693,356	6,398,482	7,307,900	8,931,248	8,220,135	8,994,608	8,514,720	8,641,553	8,788,404	7,436,425
dazomet	65,725	60,539	59,245	39,229	63,920	58,652	83,058	53,928	47,513	25,948
ethylene dibromide	<1	N/A	N/A	6	N/A	N/A	<1	N/A	N/A	N/A
ethylene dichloride	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ethylene oxide	7	N/A	N/A	8	N/A	<1	N/A	N/A	N/A	N/A
magnesium phosphide	8,009	12,233	12,769	11,497	12,372	7,562	22,316	14,766	9,021	8,344
metam-sodium	9,359,224	11,428,913	10,895,290	8,427,548	4,846,423	4,297,539	3,606,650	3,297,827	3,144,356	3,765,705
methyl bromide	5,623,692	4,809,340	4,055,208	4,017,075	3,529,577	2,963,143	2,655,355	2,602,823	1,798,430	1,682,989
methyl iodide	N/A	N/A	1,157	21	N/A	N/A	N/A	N/A	N/A	N/A
phosphine	29,527	11,291	125,469	51,259	20,855	11,399	28,397	19,247	21,699	49,832
potassium n-methyldithiocarbamate	4,128,181	4,832,615	5,673,722	8,320,255	9,484,467	7,798,703	10,252,596	9,343,192	8,940,720	8,527,736
propylene oxide	111,609	300,008	449,037	389,070	410,360	400,719	396,191	368,260	255,702	213,681
sodium tetrathiocarbonate	249,580	233,949	168,761	49,713	N/A	120	N/A	N/A	N/A	N/A
sulfuryl fluoride	2,184,823	2,728,977	2,359,006	2,663,898	3,061,470	2,801,523	3,042,482	3,300,334	3,654,817	2,991,914
zinc phosphide	20,898	1,745	2,543	2,249	2,287	3,598	4,001	3,721	4,197	4,328
Total	35,215,697	40,954,020	43,432,770	46,066,464	44,141,190	42,319,661	45,410,010	42,784,488	40,446,834	37,974,923

Table 16: *The reported cumulative acres treated with pesticides that are fumigants. Use includes primarily agricultural applications (Most nonagricultural pesticide use reports are not required to report acreage). The grand total for acres treated may be less than the sum of acres treated for all chemicals because some products contain more than one active ingredient. Values are rounded. N/A means there was not any reported acres treated during that year. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/ >.*

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1,2-dichloropropane, 1,3-dichloropropene and related c3 compounds	N/A	N/A	N/A	18	N/A	9	N/A	N/A	N/A	N/A
1,3-dichloropropene	38,849	54,209	59,065	69,422	71,794	69,656	78,332	75,735	70,641	65,635
aluminum phosphide	112,063	100,859	133,103	164,083	148,962	150,088	159,056	82,175	70,347	72,600
carbon tetrachloride	<1	N/A	<1	<1	N/A	<1	<1	<1	<1	N/A
chloropicrin	49,223	51,805	65,975	63,433	57,605	54,872	53,765	49,149	48,256	41,974
dazomet	301	274	243	594	768	152	368	18	89	35
ethylene dibromide	<1	N/A	N/A	<1	N/A	N/A	<1	N/A	N/A	N/A
ethylene dichloride	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ethylene oxide	60	N/A	N/A	<1	N/A	<1	N/A	N/A	N/A	N/A
magnesium phosphide	32	145	80	29	19	14	131	9	20	3
metam-sodium	75,735	72,748	71,003	58,998	28,105	24,422	24,254	19,437	17,423	20,139
methyl bromide	40,250	32,293	47,050	30,147	26,359	16,578	12,753	11,031	6,051	5,602
methyl iodide	N/A	N/A	279	37	N/A	N/A	N/A	N/A	N/A	N/A
phosphine	50	643	824	687	110	2	25	3	93	112
potassium n-methyldithiocarbamate	38,277	41,444	44,079	50,361	46,861	39,708	48,504	49,022	47,542	45,459
propylene oxide	<1	<1	<1	288	9	<1	<1	<1	14	<1
sodium tetrathiocarbonate	7,180	7,301	4,826	1,672	N/A	4	N/A	N/A	N/A	N/A
sulfuryl fluoride	361	130	537	532	63	585	153	<1	30	1
zinc phosphide	14,512	12,751	21,417	21,685	22,425	44,037	51,789	45,360	55,392	32,849
Total	1,269,360	1,429,125	1,579,970	1,466,383	1,654,616	1,472,957	1,228,359	944,366	981,614	694,777

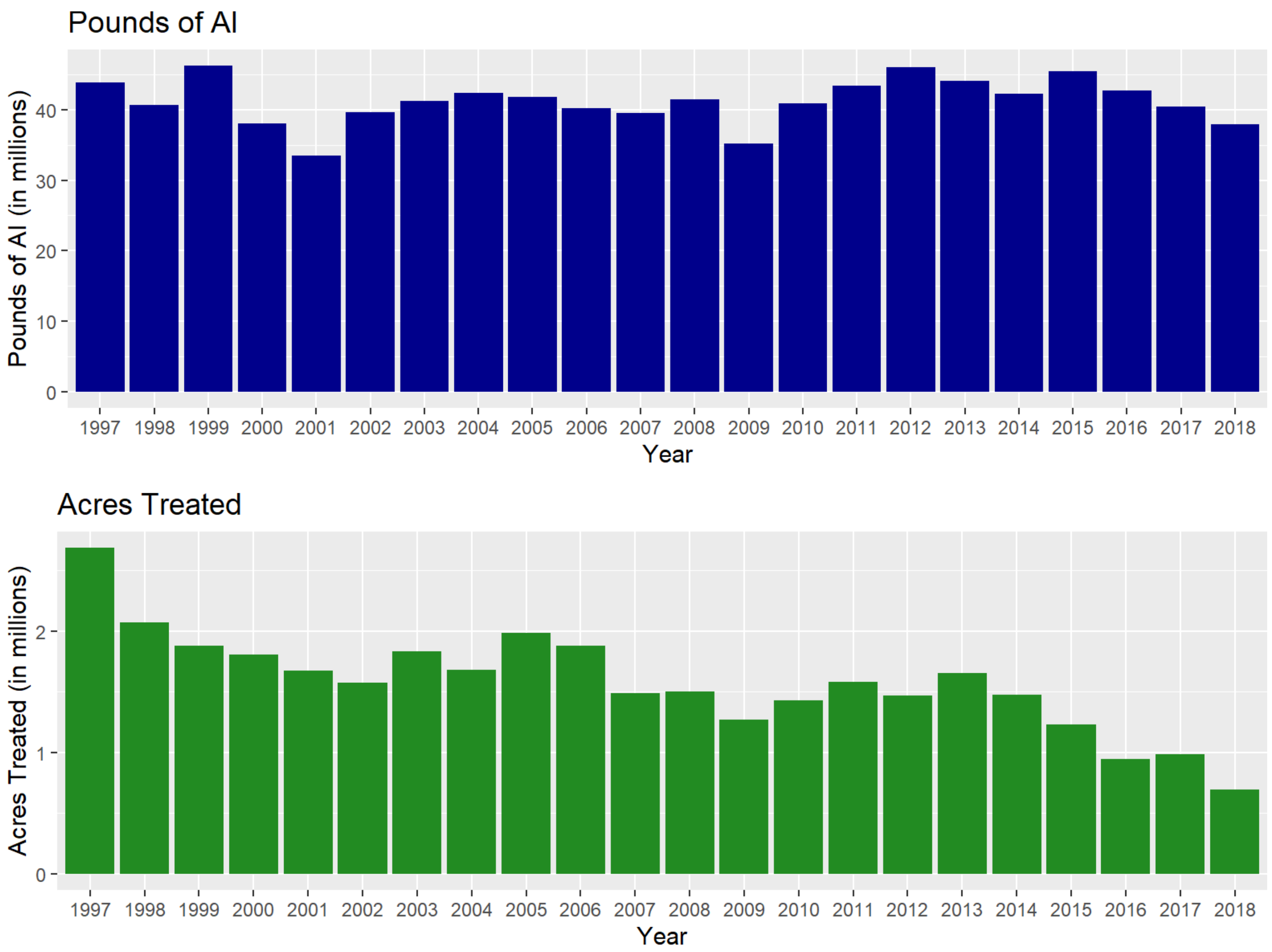

Figure 10: *Use trends of pesticides that are fumigants. Reported pounds of active ingredient (AI) applied include both agricultural and nonagricultural applications. The reported cumulative acres treated include primarily agricultural applications. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/ >.*

USE TRENDS OF OIL PESTICIDES.

Table 17: *The reported pounds of pesticides used that are oils. Although some oils and other petroleum distillates are on U.S. EPA's list of A or B carcinogens or the State's Proposition 65 list of chemicals "known to cause cancer," these carcinogenic oils are not known to be used in California as pesticides. Many oil pesticides used in California serve as alternatives to chemicals with higher toxicity. Use includes both agricultural and reportable nonagricultural applications. Values are rounded. N/A means there was not any reported pounds during that year. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/ >.*

Chemical	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
hydrotreated paraffinic solvent	248,774	224,458	248,359	240,650	229,203	264,564	260,497	265,667	306,659	363,825
isoparaffinic hydrocarbons	13,007	6,628	13,823	9,822	6,415	2,191	11,426	20,769	69,291	25,357
kerosene	4,930	3,888	4,690	4,504	221	24	74	N/A	10	1
low molecular weight paraffinic oil	N/A	N/A	376	1,032	1,588	2,583	264	122	39	10
mineral oil	13,896,451	13,083,940	12,427,770	12,646,344	18,255,400	17,091,840	27,944,415	25,138,306	26,744,409	29,611,582
mineral oil, petroleum distillates, solvent refined light	124	401	11	N/A	N/A	N/A	N/A	N/A	N/A	N/A
naphtha, heavy aromatic	N/A	N/A	N/A	N/A	<1	N/A	31	N/A	1	N/A
orchex 796 oil	54,864	44,658	41,408	61,963	121,278	75,668	26,462	12,485	3,138	1,728
petroleum derivative resin	1	N/A	<1	N/A	6	N/A	N/A	<1	<1	N/A
petroleum distillates	548,175	341,825	280,145	247,347	207,188	158,628	139,448	155,684	93,018	47,130
petroleum distillates, aliphatic	10,663	15,645	8,991	6,638	7,680	15,233	10,861	6,104	5,239	1,878
petroleum distillates, aromatic	119,480	127,456	135,891	148,867	146,904	119,990	129,363	173,651	183,218	203,100

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
petroleum distillates, refined	1,222,830	2,005,527	1,991,134	1,909,372	1,905,974	1,737,566	2,027,849	2,023,977	2,076,575	1,395,969
petroleum hydrocarbons	138	177	177	27	77	33	692	809	25	57
petroleum naphthenic oils	254	1,101	1,090	518	349	842	574	1,103	543	351
petroleum oil, paraffin based	1,049,428	618,900	759,355	899,673	1,188,762	976,615	995,001	542,615	456,455	589,747
petroleum oil, unclassified	10,197,661	10,973,702	15,777,980	12,356,333	13,855,918	9,825,513	10,150,353	10,191,938	7,478,250	7,734,445
petroleum sulfonates	N/A	N/A	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	27,366,779	27,448,309	31,691,200	28,533,090	35,926,963	30,271,289	41,697,310	38,533,230	37,416,871	39,975,180

Table 18: *The reported cumulative acres treated with pesticides that are oils. Although some oils and other petroleum distillates are on U.S. EPA's list of A or B carcinogens or the State's Proposition 65 list of chemicals "known to cause cancer," these carcinogenic oils are not known to be used in California as pesticides. Many oil pesticides used in California serve as alternatives to chemicals with higher toxicity. Use includes primarily agricultural applications (Most nonagricultural pesticide use reports are not required to report acreage). The grand total for acres treated may be less than the sum of acres treated for all chemicals because some products contain more than one active ingredient. Values are rounded. N/A means there was not any reported acres treated during that year. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
hydrotreated paraffinic solvent	232,299	227,415	260,234	247,830	236,841	275,904	286,913	434,876	506,569	599,730
isoparaffinic hydrocarbons	22,913	13,709	19,129	15,023	8,637	4,657	23,216	39,060	67,965	55,085
kerosene	8,442	8,007	9,349	9,064	380	48	138	N/A	50	<1
low molecular weight paraffinic oil	N/A	N/A	2,064	5,872	9,499	16,631	1,791	465	183	91
mineral oil	1,416,029	1,597,574	1,691,761	1,725,193	2,208,903	2,281,456	2,681,475	2,728,767	3,094,893	3,367,201

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
mineral oil, petroleum distillates, solvent refined light	850	1,255	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
naphtha, heavy aromatic	N/A	N/A	N/A	N/A	<1	N/A	<1	N/A	<1	N/A
orchex 796 oil	75,571	54,349	54,544	62,455	84,529	61,815	24,565	10,100	4,317	2,244
petroleum derivative resin	<1	N/A	<1	N/A	<1	N/A	N/A	<1	<1	N/A
petroleum distillates	277,893	238,831	219,270	175,514	175,473	131,336	115,976	132,499	67,329	31,281
petroleum distillates, aliphatic	30,995	58,342	75,134	32,428	36,156	34,352	44,341	51,513	34,767	22,140
petroleum distillates, aromatic	141,479	161,472	158,736	178,941	163,753	141,531	170,395	207,589	215,058	234,373
petroleum distillates, refined	258,026	273,923	256,383	244,544	258,843	274,445	289,791	309,264	298,212	184,100
petroleum hydrocarbons	309	159	35	5	75	80	173	156	90	8
petroleum naphthenic oils	22,435	44,879	65,430	27,369	30,539	21,280	35,826	46,936	30,584	20,825
petroleum oil, paraffin based	631,455	673,568	706,727	651,743	608,111	645,825	540,778	506,061	448,590	442,144
petroleum oil, unclassified	586,867	671,457	933,165	793,498	882,228	724,288	688,602	798,786	601,494	555,113
petroleum sulfonates	N/A	N/A	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	3,657,236	3,966,074	4,367,406	4,126,924	4,664,759	4,587,671	4,866,097	5,217,109	5,336,526	5,491,881

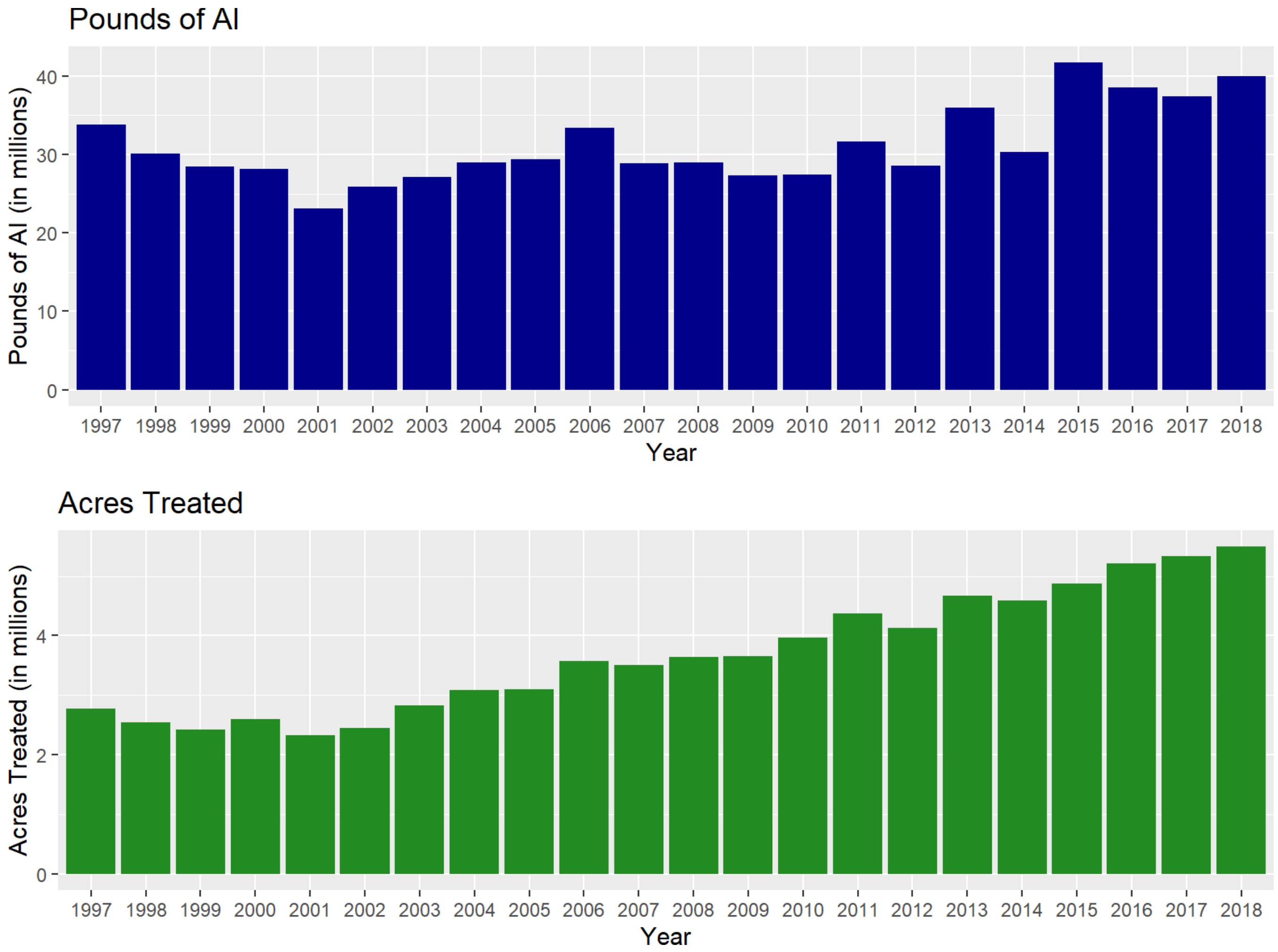

Figure 11: *Use trends of pesticides that are oils. Although some oils and other petroleum distillates are on U.S. EPA's list of A or B carcinogens or the State's Proposition 65 list of chemicals "known to cause cancer," these carcinogenic oils are not known to be used in California as pesticides. Many oil pesticides used in California serve as alternatives to chemicals with higher toxicity. Reported pounds of active ingredient (AI) applied include both agricultural and nonagricultural applications. The reported cumulative acres treated include primarily agricultural applications. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

USE TRENDS OF BIOPESTICIDES.

Table 19: *The reported pounds of pesticides used that are biopesticides. Biopesticides include microorganisms and naturally occurring compounds, or compounds similar to those found in nature that are not toxic to the target pest (such as pheromones). Use includes both agricultural and reportable nonagricultural applications. Values are rounded. N/A means there was not any reported pounds during that year. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/ >.*

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
(3s, 6r)-3-methyl-6-isopropenyl-9-decen-1-yl acetate	<1	N/A	N/A	<1	N/A	<1	N/A	<1	7	25
(3s, 6s)-3-methyl-6-isopropenyl-9-decen-1-yl acetate	<1	N/A	N/A	<1	N/A	<1	N/A	<1	7	25
(e)-4-tridecen-1-yl-acetate	80	96	N/A	N/A	N/A	23	N/A	N/A	N/A	<1
(e)-5-decen-1-ol	N/A	N/A	N/A	<1	<1	<1	1	8	1	2
(e)-5-decenol	1	1	<1	2	3	1	33	8	95	5
(e)-5-decenyl acetate	4	5	2	10	7	4	25	134	84	48
(e,e)-9, 11-tetradecadien-1-yl acetate	11	2	6	3	4	3	3	1	12	2
(e,z)-7,9-dodecadien-1-yl acetate	N/A	50	249	270	24	24	N/A	N/A	N/A	N/A
(s)-kinoprene	276	277	191	300	285	311	429	327	253	377
(s)-verbenone	N/A	N/A	N/A	55	N/A	N/A	781	633	28	5
(z)-11-hexadecen-1-yl acetate	681	N/A	1	N/A	N/A	N/A	N/A	<1	98	34
(z)-11-hexadecenal	N/A	N/A	N/A	N/A	N/A	N/A	1	1	98	33
(z)-4-tridecen-1-yl-acetate	3	3	N/A	N/A	N/A	1	N/A	N/A	N/A	<1
(z)-9-dodecenyl acetate	<1	<1	<1	<1	<1	<1	<1	N/A	N/A	N/A
(z,e)-7,11-hexadecadien-1-yl acetate	3	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(z,z)-11,13-hexadecadienal	N/A	<1	571	271	321	619	969	1,072	1,086	1,404

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
(z,z)-7,11-hexadecadien-1-yl acetate	3	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,4-dimethylnaphthalene	1,544	1,152	544	893	1,163	1,085	891	660	133	836
1,7-dioxaspiro-(5,5)-undecane	<1	<1	<1	<1	1	<1	1	N/A	N/A	N/A
1-methylcyclopropene	<1	<1	<1	1	1	<1	1	1	1	1
1-naphthaleneacetamide	32	25	20	20	19	22	18	14	11	17
2,4-decadienoic acid, ethyl ester, (2e,4z)-	N/A	N/A	N/A	N/A	N/A	<1	4	3	3	2
2-methyl-1-butanol	N/A	N/A	N/A	N/A	<1	<1	<1	<1	1	<1
3,13 octadecadien-1-yl acetate	N/A	1	12	N/A	<1	N/A	<1	142	N/A	N/A
3,7-dimethyl-6-octen-1-ol	5	23	12	28	54	42	49	72	95	98
acetic acid	79	1,732	73	601	43	62	20,806	9,111	5,357	4,248
agrobacterium radiobacter	142	124	507	28	230	271	137	2,561	64	59
agrobacterium radiobacter, strain k1026	1	<1	<1	<1	34	<1	<1	<1	N/A	N/A
allyl isothiocyanate	N/A	N/A	N/A	<1	N/A	N/A	N/A	<1	N/A	N/A
almond, bitter	<1	<1	<1	<1	<1	<1	<1	N/A	<1	<1
amino ethoxy vinyl glycine hydrochloride	543	1,024	1,194	1,368	1,444	1,757	2,011	1,380	1,296	2,532
ammonium bicarbonate	<1	9	14	7	51	34	42	N/A	N/A	N/A
ammonium nitrate	39,544	40,065	52,070	66,520	86,022	88,037	91,564	89,252	86,910	78,171
ammonium nonanoate	N/A	N/A	N/A	N/A	1,937	3,131	3,399	27,356	19,625	17,272
ampelomyces quisqualis	<1	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
aspergillus flavus strain af36	N/A	N/A	<1	4	4	8	9	14	15	16
aureobasidium pullulans strain dsm 14940	N/A	N/A	N/A	N/A	81	458	356	1,095	2,493	3,947
aureobasidium pullulans strain dsm 14941	N/A	N/A	N/A	N/A	81	458	356	1,095	2,493	3,947

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
azadirachtin	2,502	1,885	2,215	3,417	3,387	4,323	5,108	4,774	4,883	4,387
bacillus amyloliquefaciens strain d747	N/A	N/A	N/A	869	84,957	177,589	131,295	209,773	395,702	272,675
bacillus amyloliquefaciens strain mbi 600	N/A	N/A	N/A	<1	<1	N/A	N/A	15	79	275
bacillus firmus (strain i-1582)	N/A	N/A	N/A	N/A	N/A	42	190	170	212	160
bacillus mycoides isolate j	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,085	568
bacillus popilliae	N/A	N/A	N/A	N/A	<1	<1	<1	<1	N/A	<1
bacillus pumilus, strain qst 2808	6,987	6,783	7,558	6,752	6,245	7,957	8,123	7,889	9,239	7,551
bacillus sphaericus 2362, serotype h5a5b, strain abts 1743 fermentation solids, spores and insecticidal toxins	18,178	13,013	10,602	9,123	10,500	10,499	12,357	13,122	16,362	10,652
bacillus subtilis gb03	<1	<1	<1	1	1	2	3	3	4	3
bacillus subtilis strain iab/bs03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5
bacillus subtilis var. amyloliquefaciens strain fzb24	N/A	N/A	N/A	2	94	119	178	6	<1	N/A
bacillus thuringiensis (berliner)	4	6	26	18	11	4	29	21	14	17
bacillus thuringiensis (berliner), subsp. aizawai, gc-91 protein	27,539	20,397	11,666	17,042	13,265	18,776	16,771	18,882	34,097	44,961
bacillus thuringiensis (berliner), subsp. aizawai, serotype h-7	894	824	814	714	359	333	184	73	118	48
bacillus thuringiensis (berliner), subsp. israelensis, serotype h-14	17,202	11,401	22,640	12,632	9,269	11,779	15,761	15,839	17,733	14,132
bacillus thuringiensis (berliner), subsp. kurstaki strain sa-12	12,128	7,424	4,689	10,361	8,246	7,971	8,579	9,804	2,218	562

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
bacillus thuringiensis (berliner), subsp. kurstaki, serotype 3a,3b	402	150	244	234	53	41	18	34	76	83
bacillus thuringiensis (berliner), subsp. kurstaki, strain eg 2348	118	66	478	44	500	514	344	645	396	8
bacillus thuringiensis (berliner), subsp. kurstaki, strain eg2371	N/A	<1	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
bacillus thuringiensis (berliner), subsp. kurstaki, strain sa-11	80,565	75,074	115,679	52,421	77,932	80,401	80,953	74,963	96,271	118,790
bacillus thuringiensis (berliner), subsp. san diego	<1	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
bacillus thuringiensis subspecies kurstaki strain bmp 123	118	14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
bacillus thuringiensis subspecies kurstaki, genetically engineered strain eg7841 lepidopteran active toxin	42	1	75	298	116	65	3	43	3	1
bacillus thuringiensis var. kurstaki strain m-200	<1	N/A	N/A	N/A	N/A	N/A	<1	N/A	<1	1
bacillus thuringiensis var. kurstaki, genetically engineered strain eg7826	95	N/A	N/A	528	N/A	N/A	N/A	7	N/A	15
bacillus thuringiensis, subsp. aizawai, strain abts-1857	31,043	26,250	24,314	30,648	29,863	49,186	55,914	72,261	92,917	88,345
bacillus thuringiensis, subsp. aizawai, strain sd-1372, lepidopteran active toxin(s)	243	130	88	1	18	6	43	13	6	16

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
bacillus thuringiensis, subsp. israelensis, strain am 65-52	53,778	71,050	52,787	173,153	49,682	42,763	46,599	70,128	61,729	66,598
bacillus thuringiensis, subsp. kurstaki, strain abts-351, fermentation solids and solubles	69,620	96,988	83,048	95,294	83,409	111,388	95,431	117,645	134,263	120,926
bacillus thuringiensis, subsp. kurstaki, strain hd-1	3,747	3,589	2,549	3,187	2,323	1,928	1,916	441	646	536
bacillus thuringiensis, var. kurstaki delta endotoxins cry 1a(c) and cry 1c (genetically engineered) encapsulated in pseudomonas fluorescens (killed)	28	<1	<1	4	N/A	<1	N/A	<1	N/A	5
bacteriophage active against xanthomonas campestris pv. vesicatoria and pseudomonas syringae pv. tomato	N/A	N/A	<1	<1	<1	<1	N/A	N/A	<1	N/A
balsam fir oil	N/A	<1	N/A	<1	<1	<1	1	<1	N/A	<1
beauveria bassiana hf 23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	37	55	67
beauveria bassiana strain gha	378	357	622	1,220	1,796	2,749	3,511	2,850	5,688	7,031
beta-conglutin	N/A	N/A	N/A	N/A	N/A	N/A	6,762	6,099	7,383	4,314
buffalo gourd root powder	1	11	N/A	1	25	5	6	8	3	73
burkholderia sp strain a396 cells and fermentation media	N/A	N/A	N/A	N/A	N/A	2,829	58,593	53,655	115,528	216,044
butyl mercaptan	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A	N/A	N/A
canola oil	17	131	26	15	28	61	97	247	286	2,175
capsicum oleoresin	2	4	4	12	10	27	92	125	203	635
carbon dioxide	7,727	17,550	21,239	30,826	15,739	18,297	17,675	25,366	26,359	36,307
castor oil	21	7	<1	2	<1	8	<1	4	N/A	3

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
chenopodium ambrosiodes near ambrosiodes	20,367	10,336	7,897	10,231	20,261	17,504	12,828	10,207	8,300	387
chromobacterium subtsugae strain praa4-1	N/A	N/A	N/A	1,169	30,262	46,419	45,894	31,445	36,385	42,397
cinnamaldehyde	N/A	N/A	1	N/A	N/A	N/A	N/A	N/A	59	1
citral	N/A	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
citric acid	55,421	74,232	90,830	94,968	128,798	114,942	126,174	142,111	136,398	152,231
clarified hydrophobic extract of neem oil	106,271	115,931	71,139	77,254	119,298	197,351	222,694	166,062	173,094	137,951
codling moth granulosis virus	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
coniothyrium minitans strain con/m/91-08	127	80	176	245	611	641	786	657	665	424
corn syrup	2,891	3,026	4,377	4,766	3,216	3,344	4,342	4,850	14,767	22,753
cottonseed oil	79,268	153,038	318,868	114,610	105,083	132,464	87,451	55,082	45,678	35,072
coyote urine	N/A	<1	1	2	3	9	6	3	6	3
cytokinin (as kinetin)	N/A	N/A	<1	<1	<1	<1	<1	<1	<1	<1
diallyl disulfide	N/A	N/A	N/A	N/A	N/A	N/A	N/A	103	94	N/A
dihydro-5-heptyl-2(3h)-furanone	<1	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
dihydro-5-pentyl-2(3h)-furanone	<1	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
e,e-8,10-dodecadien-1-ol	4,978	1,942	1,376	1,995	2,276	1,395	1,445	1,079	5,420	1,209
e-11-tetradecen-1-yl acetate	312	100	172	133	142	61	73	32	294	40
e-8-dodecenyl acetate	606	898	195	283	273	224	769	390	1,712	270
encapsulated delta endotoxin of bacillus thuringiensis var. kurstaki in killed pseudomonas fluorescens	18	N/A	1	<1	N/A	N/A	N/A	N/A	N/A	N/A
essential oils	<1	<1	<1	1	<1	15	12	20	24	11
ethylene	N/A	97	1,018	954	1,359	1,333	1,683	1,299	1,248	953
eucalyptus oil	N/A	22	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
eugenol	N/A	N/A	N/A	1	<1	1	<1	1	<1	<1
farnesol	3	10	5	11	21	17	20	29	38	39

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
fenugreek	17	1	5	8	2	1	7	N/A	<1	10
ferric sodium edta	N/A	N/A	1,979	6,351	5,855	6,790	8,000	12,449	12,329	8,082
fish oil	N/A	N/A	1,657	5,466	4,114	N/A	N/A	1,078	N/A	N/A
formic acid	280	223	241	634	66	337	2,606	1,243	984	953
fox urine	N/A	<1	<1	2	1	4	3	1	4	2
gamma aminobutyric acid	177	118	40	133	28	15	15	N/A	N/A	N/A
garlic	36	423	29	1,905	2,832	1,392	667	849	529	1,126
geraniol	5	23	12	28	54	42	49	72	95	98
german cockroach pheromone	<1	<1	<1	<1	<1	<1	N/A	<1	<1	<1
gibberellins	22,917	21,536	22,687	23,214	41,103	27,422	27,409	23,142	27,103	28,619
gibberellins, potassium salt	N/A	<1	<1	5	N/A	N/A	N/A	N/A	1	N/A
gliocladium virens gl-21 (spores)	356	945	649	1,957	3,538	2,989	4,586	4,395	2,829	2,707
glutamic acid	177	118	40	133	28	15	15	N/A	N/A	N/A
gs-omega/kappa-hxtx-hv1a (versitude peptide)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<1	N/A	3
harpin protein	14	13	11	1	1	<1	N/A	<1	<1	N/A
heptyl butyrate	N/A	<1	<1	<1	14	6	4	3	13	4
hydrogen peroxide	21,750	69,179	59,387	36,302	47,236	49,826	74,419	130,417	312,058	345,059
hydroprene	1,664	6,382	11,261	3,948	7,352	5,734	6,456	3,920	3,155	2,913
iba	6	7	9	12	15	14	13	10	19	17
indole	N/A	N/A	N/A	N/A	<1	N/A	<1	<1	<1	<1
iron hedta	N/A	N/A	N/A	43	92	120	91	170	213	113
iron phosphate	1,435	2,351	2,874	2,327	2,119	2,007	2,071	2,250	3,477	2,835
kaolin	2,376,194	3,040,482	1,686,874	2,007,204	2,473,768	2,854,542	3,411,740	3,591,408	3,193,218	3,268,360
kinoprene	3	3	9	3	8	33	17	10	1	<1
lactic acid	N/A	N/A	N/A	N/A	N/A	N/A	2	3	12	10
lactose	9,191	7,984	9,285	6,554	7,143	6,616	7,855	8,501	8,889	7,903
lagenidium giganteum (california strain)	N/A	N/A	N/A	5	N/A	N/A	N/A	N/A	N/A	N/A
lauryl alcohol	432	736	497	755	449	293	501	319	2,566	309
lavandulyl senecioate	462	437	6,120	586	477	3,166	507	1,029	1,150	2,282
limonene	56,495	56,406	62,925	74,369	61,293	68,137	72,906	67,550	92,320	106,938
linalool	62	1,104	95	136	72	62	93	15	11	2
margosa oil	N/A	579	7,886	9,106	12,189	22,585	26,019	32,493	25,028	13,553
menthol	N/A	5	<1	N/A	20	N/A	N/A	N/A	N/A	N/A

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
metarhizium anisopliae strain f52	N/A	N/A	N/A	116	89	121	20	54	2	1
metarhizium anisopliae, var. anisopliae, strain esf1	N/A	<1	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
methoprene	1,568	1,492	1,809	1,304	1,350	3,556	1,390	1,271	1,064	763
methyl anthranilate	312	343	448	300	1,237	634	672	789	1,118	958
methyl eugenol	N/A	N/A	5	N/A	9	N/A	N/A	126	386	1,149
methyl nonyl ketone	<1	<1	N/A	N/A	<1	<1	<1	<1	<1	1
methyl salicylate	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<1	<1
muscalure	20	15	15	16	13	17	23	29	44	60
myristyl alcohol	88	150	102	155	91	60	102	65	520	63
myrothecium verrucaria, dried fermentation solids & solubles, strain aarc-0255	23,273	22,813	27,757	25,556	26,005	17,675	30,810	26,033	22,923	23,021
n6-benzyl adenine	168	217	129	168	183	184	230	221	161	198
naa	3	5	4	9	15	12	18	11	100	11
naa, ammonium salt	1,203	976	839	1,400	1,056	945	996	125	181	335
naa, ethyl ester	3	6	23	4	3	5	3	38	10,502	13,162
naa, potassium salt	N/A	N/A	N/A	N/A	53	15	2	934	1,017	607
naa, sodium salt	2	N/A	N/A	N/A	2	1	<1	<1	N/A	N/A
natamycin	N/A	N/A	N/A	N/A	<1	1	1	1	<1	N/A
nerolidol	6	24	12	28	54	42	49	72	95	98
nitrogen, liquefied	2,181	135	216	74	594	6	N/A	N/A	N/A	N/A
nonanoic acid	9,063	17,322	17,939	18,200	21,545	17,530	14,482	13,301	14,610	12,755
nonanoic acid, other related	477	912	944	958	1,134	923	762	700	769	671
nosema locustae spores	<1	<1	<1	1	<1	<1	<1	1	<1	<1
oil of anise	N/A	N/A	<1	<1	<1	<1	<1	<1	<1	<1
oil of black pepper	1	<1	<1	<1	1	1	<1	<1	<1	<1
oil of cedarwood	N/A	<1	N/A	N/A	N/A	N/A	<1	<1	N/A	N/A
oil of citronella	N/A	5	46	N/A	N/A	1	5	<1	1	<1
oil of geranium	N/A	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
oil of jojoba	3,418	4,176	1,232	507	135	376	44	19	2	N/A
oil of lemon eucalyptus	N/A	N/A	<1	3	N/A	N/A	N/A	N/A	N/A	N/A
oil of orange	N/A	N/A	N/A	N/A	N/A	N/A	198	386	1,360	479
oil of peppermint	N/A	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
oxypurinol	N/A	N/A	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A
paecilomyces fumosoroseus apopka strain 97	N/A	N/A	N/A	507	3,302	5,951	5,624	8,947	8,659	5,100
pantoea agglomerans strain e325, nrrl b-21856	33	4	1	1	1	N/A	N/A	N/A	N/A	N/A
phenylethyl propionate	500	822	423	535	701	712	185	96	140	34
phosphoric acid, monopotassium salt	12	6,984	9,079	3,927	1,918	374	9,585	15,002	11,445	10,125
piperine	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
polyhedral occlusion bodies (ob's) of the nuclear polyhedrosis virus of helicoverpa zea (corn earworm)	1	1	51	6	1	2	4	20	41	41
polyoxin d, zinc salt	397	1,296	3,513	4,738	6,731	7,412	8,613	10,306	10,431	11,333
potassium bicarbonate	180,858	275,648	358,255	228,900	239,609	223,547	318,099	462,830	488,686	349,173
potassium phosphite	141,395	287,730	279,896	281,601	390,300	708,940	666,576	952,539	1,167,365	1,203,727
potassium silicate	231	39	1,412	988	5,407	23,582	36,525	25,901	33,039	13,821
potassium sorbate	<1	65	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
propylene glycol	25,792	54,233	48,494	58,461	86,296	90,353	87,136	87,865	103,903	107,437
propyleneglycol monolaurate	7	12	N/A	N/A	203	44	N/A	N/A	N/A	N/A
pseudomonas fluorescens, strain a506	328	217	274	59	92	270	87	123	111	113
pseudomonas syringae, strain esc-10	N/A	<1	N/A	N/A	3	N/A	N/A	N/A	N/A	N/A
purpureocillium lilaciunum strain 251	N/A	252	515	840	4,073	5,031	6,408	6,273	5,463	3,805
putrescent whole egg solids	143	3	1	1	1	1	1	6	5	6
pythium oligandrum dv74	N/A	N/A	<1	<1	<1	N/A	N/A	N/A	N/A	N/A
qst 713 strain of dried bacillus subtilis	16,203	21,464	23,960	23,504	24,590	20,969	20,916	21,063	21,952	21,153
quillaja	410	682	1,081	785	1,040	775	829	1,027	1,385	1,445

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
reynoutria sachalinensis	179	8,996	14,844	14,803	15,354	16,105	18,358	23,508	23,610	19,946
s-abscisic acid	66	864	1,852	2,651	2,131	2,382	2,114	2,192	2,220	1,861
s-methoprene	3,285	3,921	2,313	2,324	2,331	2,524	2,781	3,220	3,133	4,069
sawdust	<1	1	N/A	4	4	N/A	N/A	1	N/A	N/A
sesame oil	851	1,309	1,327	15	<1	N/A	N/A	N/A	N/A	2
silver nitrate	N/A	<1	<1	<1	N/A	N/A	N/A	<1	<1	N/A
sodium bicarbonate	27	3	515	146	44	479	420	13,604	3,679	3
sodium carbonate peroxyhydrate	114,653	101,714	298,763	300,693	295,762	463,448	244,233	261,347	165,621	329,252
sodium chloride	3	2	169	111	119	211	216	128	81	110
sodium lauryl sulfate	146	96	458	884	431	570	1,749	507	1,200	1,329
sorbitol octanoate	2,007	N/A	35	N/A	N/A	N/A	N/A	N/A	<1	N/A
soybean oil	28,801	24,110	24,109	22,022	45,973	59,297	69,771	84,295	80,999	82,505
streptomyces griseoviridis strain k61	<1	<1	<1	<1	10	11	18	5	4	2
streptomyces lydicus wyec 108	1	2	1	2	3	3	3	4	3	2
sucrose octanoate	4,003	1,128	230	55	188	98	203	29	7	N/A
sugar	993	1,122	448	1,240	51	16	60	667	4	20
thyme	775	1,311	665	844	1,135	1,150	257	122	181	25
thyme oil	N/A	N/A	N/A	N/A	N/A	N/A	1	3	12	7
thymol	1,675	1,539	265	181	398	314	278	570	564	667
trichoderma harzianum rifai strain krl-ag2	11	504	129	158	186	86	65	112	63	86
trichoderma icc 012 asperellum	N/A	N/A	13	19	43	2	2	9	4	1
trichoderma icc 080 gamsii	N/A	N/A	13	19	43	2	2	9	4	1
trimethylamine	N/A	N/A	N/A	N/A	<1	N/A	<1	<1	<1	<1
ulocladium oudemansii (u3 strain)	N/A	N/A	N/A	N/A	29	792	516	155	34	2,131
vanillin	3	<1	1	1	<1	<1	1	N/A	<1	2
vegetable oil	196,078	323,401	514,884	276,278	315,218	267,446	485,628	517,951	666,055	824,829
xanthine	N/A	N/A	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A
yeast	926	470	1,165	818	80	32	86	14	4	12
yucca schidigera	169	634	1,649	7,147	12,327	5,652	2,565	3,130	2,173	5,733

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
z,e-9,12-tetradecadien-1-yl acetate	6,149	1	7	6	14	122	20	10	21	62
z-11-tetradecen-1-yl acetate	9	9	4	8	8	<1	<1	<1	<1	<1
z-8-dodecenol	106	157	34	48	44	38	98	60	201	47
z-8-dodecenyl acetate	9,262	13,964	3,010	4,005	3,467	3,248	4,461	4,300	6,457	4,138
Total	3,916,545	5,149,768	4,432,836	4,295,143	5,084,339	6,167,980	6,882,941	7,686,714	8,117,822	8,375,195

Table 20: The reported cumulative acres treated with pesticides that are biopesticides. Biopesticides include microorganisms and naturally occurring compounds, or compounds similar to those found in nature that are not toxic to the target pest (such as pheromones). Use includes primarily agricultural applications (Most nonagricultural pesticide use reports are not required to report acreage). The grand total for acres treated may be less than the sum of acres treated for all chemicals because some products contain more than one active ingredient. Values are rounded. N/A means there was not any reported acres treated during that year. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/ >.

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
(3s, 6r)-3-methyl-6-isopropenyl-9-decen-1-yl acetate	3	N/A	N/A	7	N/A	24	N/A	215	8,683	35,138
(3s, 6s)-3-methyl-6-isopropenyl-9-decen-1-yl acetate	3	N/A	N/A	7	N/A	24	N/A	215	8,683	35,138
(e)-4-tridecen-1-yl-acetate	3,982	3,995	N/A	N/A	N/A	1,074	N/A	N/A	N/A	<1
(e)-5-decen-1-ol	N/A	N/A	N/A	53	83	20	166	354	264	242
(e)-5-decenol	118	249	166	502	837	639	348	368	832	1,053
(e)-5-decenyl acetate	118	249	166	555	920	659	514	721	1,095	1,295
(e,e)-9, 11-tetradecadien-1-yl acetate	3	474	759	608	985	466	645	349	361	364
(e,z)-7,9-dodecadien-1-yl acetate	N/A	5,168	18,104	22,856	2,479	1,623	N/A	N/A	N/A	N/A
(s)-kinoprene	510	490	346	506	675	750	990	691	679	869
(s)-verbenone	N/A	N/A	N/A	100	N/A	N/A	<1	<1	3	1
(z)-11-hexadecen-1-yl acetate	1,622	N/A	49	N/A	N/A	N/A	N/A	26	2,994	1,807
(z)-11-hexadecenal	N/A	N/A	N/A	N/A	N/A	N/A	74	145	2,951	1,351

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
(z)-4-tridecen-1-yl-acetate	3,982	3,995	N/A	N/A	N/A	1,074	N/A	N/A	N/A	<1
(z)-9-dodecenyl acetate	123	74	1,814	392	555	1,966	950	N/A	N/A	N/A
(z,e)-7,11-hexadecadien-1-yl acetate	93	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(z,z)-11,13-hexadecadienal	N/A	763	11,336	17,283	20,591	38,681	61,037	66,068	67,233	89,479
(z,z)-7,11-hexadecadien-1-yl acetate	93	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,4-dimethylnaphthalene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,7-dioxaspiro-(5,5)-undecane	6	<1	<1	30	43	25	32	N/A	N/A	N/A
1-methylcyclopropene	61	3	1	17	21	14	10	6	13	5
1-naphthaleneacetamide	607	408	315	393	343	394	257	338	319	483
2,4-decadienoic acid, ethyl ester, (2e,4z)-	N/A	N/A	N/A	N/A	N/A	179	3,247	1,309	1,014	583
2-methyl-1-butanol	N/A	N/A	N/A	N/A	<1	<1	<1	<1	<1	<1
3,13 octadecadien-1-yl acetate	N/A	50	131	N/A	<1	N/A	10	25	N/A	N/A
3,7-dimethyl-6-octen-1-ol	349	1,531	788	2,220	3,939	3,545	3,111	4,331	5,936	5,749
acetic acid	226	110	162	3,165	3,114	10,301	15,775	10,437	18,729	13,906
agrobacterium radiobacter	215	362	507	852	622	664	806	613	99	570
agrobacterium radiobacter, strain k1026	5,086	81	19	4,947	9,016	754	745	<1	N/A	N/A
allyl isothiocyanate	N/A	N/A	N/A	<1	N/A	N/A	N/A	<1	N/A	N/A
almond, bitter	471	74	412	271	88	68	73	N/A	4	198
amino ethoxy vinyl glycine hydrochloride	5,611	10,179	11,108	14,991	16,371	17,666	20,248	14,254	13,067	25,478
ammonium bicarbonate	6	<1	<1	30	43	25	32	N/A	N/A	N/A
ammonium nitrate	679,859	726,842	817,316	867,336	1,085,302	953,176	988,164	882,572	829,331	742,539
ammonium nonanoate	N/A	N/A	N/A	N/A	239	284	452	459	320	455

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
ampelomyces quisqualis	22	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
aspergillus flavus strain af36	N/A	N/A	260	48,833	89,337	147,011	159,586	183,128	188,090	207,257
aureobasidium pullulans strain dsm 14940	N/A	N/A	N/A	N/A	254	2,823	1,569	5,376	8,675	18,077
aureobasidium pullulans strain dsm 14941	N/A	N/A	N/A	N/A	254	2,823	1,569	5,376	8,675	18,077
azadirachtin	82,722	71,707	70,228	98,803	113,960	159,292	193,929	175,608	175,645	150,779
bacillus amyloliquefaciens strain d747	N/A	N/A	N/A	2,337	29,684	41,678	38,545	57,375	90,603	68,085
bacillus amyloliquefaciens strain mbi 600	N/A	N/A	N/A	2	<1	N/A	N/A	165	1,607	4,793
bacillus firmus (strain i-1582)	N/A	N/A	N/A	N/A	N/A	12	45	41	43	29
bacillus mycoides isolate j	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11,591	5,455
bacillus popilliae	N/A	N/A	N/A	N/A	<1	<1	<1	<1	N/A	<1
bacillus pumilus, strain qst 2808	75,509	72,582	84,256	76,229	68,102	83,406	89,485	83,283	95,326	84,823
bacillus sphaericus 2362, serotype h5a5b, strain abts 1743 fermentation solids, spores and insecticidal toxins	<1	9	<1	231	38	110	118	233	542	<1
bacillus subtilis gb03	2	<1	6	<1	21	302	467	609	2,293	1,473
bacillus subtilis strain iab/bs03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,277
bacillus subtilis var. amyloliquefaciens strain fzb24	N/A	N/A	N/A	406	1,702	3,516	4,328	152	<1	N/A
bacillus thuringiensis (berliner)	82	127	877	292	248	91	249	247	573	186
bacillus thuringiensis (berliner), subsp. aizawai, gc-91 protein	48,842	40,395	18,657	25,262	22,511	28,611	26,155	25,221	48,924	53,734

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
bacillus thuringiensis (berliner), subsp. aizawai, serotype h-7	7,888	6,943	7,766	6,064	3,296	2,941	1,360	624	1,025	451
bacillus thuringiensis (berliner), subsp. israelensis, serotype h-14	501	1,873	337	773	1,107	1,254	1,713	334	836	149
bacillus thuringiensis (berliner), subsp. kurstaki strain sa-12	19,700	10,721	8,222	15,379	9,855	10,751	10,850	13,714	3,214	326
bacillus thuringiensis (berliner), subsp. kurstaki, serotype 3a,3b	7,807	2,269	3,063	1,973	818	453	145	274	777	1,274
bacillus thuringiensis (berliner), subsp. kurstaki, strain eg 2348	1,302	688	3,428	645	3,580	4,038	2,502	4,480	4,004	132
bacillus thuringiensis (berliner), subsp. kurstaki, strain eg2371	N/A	<1	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
bacillus thuringiensis (berliner), subsp. kurstaki, strain sa-11	101,522	111,746	84,061	81,574	95,890	111,634	108,411	95,637	120,980	134,836
bacillus thuringiensis (berliner), subsp. san diego	<1	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
bacillus thuringiensis subspecies kurstaki strain bmp 123	310	73	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
bacillus thuringiensis subspecies kurstaki, genetically engineered strain eg7841 lepidopteran active toxin	62	3	200	373	5	99	116	473	8	3
bacillus thuringiensis var. kurstaki strain m-200	<1	N/A	N/A	N/A	N/A	N/A	<1	N/A	1	<1

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
bacillus thuringiensis var. kurstaki, genetically engineered strain eg7826	250	N/A	N/A	1,320	N/A	N/A	N/A	9	N/A	37
bacillus thuringiensis, subsp. aizawai, strain abts-1857	41,724	37,209	35,300	41,720	36,837	68,895	70,582	86,966	111,201	104,319
bacillus thuringiensis, subsp. aizawai, strain sd-1372, lepidopteran active toxin(s)	2,136	1,057	640	4	113	47	306	120	77	118
bacillus thuringiensis, subsp. israelensis, strain am 65-52	270	758	1,052	1,305	793	2,524	2,009	1,419	1,088	8,064
bacillus thuringiensis, subsp. kurstaki, strain abts-351, fermentation solids and solubles	120,801	162,444	152,510	164,936	147,805	192,454	152,721	193,013	230,441	213,550
bacillus thuringiensis, subsp. kurstaki, strain hd-1	20,295	18,465	15,940	15,228	10,138	7,887	11,007	2,241	2,744	1,221
bacillus thuringiensis, var. kurstaki delta endotoxins cry 1a(c) and cry 1c (genetically engineered) encapsulated in pseudomonas fluorescens (killed)	52	2	<1	10	N/A	<1	N/A	<1	N/A	2
bacteriophage active against xanthomonas campestris pv. vesicatoria and pseudomonas syringae pv. tomato	N/A	N/A	11	25	21	12	N/A	N/A	1	N/A
balsam fir oil	N/A	<1	N/A	<1	<1	<1	<1	<1	N/A	<1
beauveria bassiana hf 23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	32	69	81
beauveria bassiana strain gha	2,188	1,686	2,706	4,011	6,857	10,900	14,356	11,145	16,947	17,959
beta-conglutin	N/A	N/A	N/A	N/A	N/A	N/A	9,032	12,422	15,510	9,584

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
buffalo gourd root powder	9	138	N/A	25	161	200	224	114	154	194
burkholderia sp strain a396 cells and fermentation media	N/A	N/A	N/A	N/A	N/A	196	5,531	6,816	17,303	35,064
butyl mercaptan	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A	N/A	N/A
canola oil	1,541	4,786	3,872	2,329	5,788	4,272	7,455	20,351	47,851	74,737
capsicum oleoresin	325	388	238	576	546	1,541	1,997	2,084	3,777	6,457
carbon dioxide	<1	<1	26	917	5	20	19	2	<1	<1
castor oil	12	<1	<1	<1	<1	<1	<1	<1	N/A	<1
chenopodium ambrosiodes near ambrosiodes	6,395	9,265	6,868	13,401	22,552	25,820	19,072	15,804	15,002	635
chromobacterium subtsugae strain praa4-1	N/A	N/A	N/A	1,424	38,138	61,191	62,467	43,369	48,863	54,929
cinnamaldehyde	N/A	N/A	<1	N/A	N/A	N/A	N/A	N/A	110	<1
citral	N/A	15	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
citric acid	903,198	1,204,981	1,332,600	1,389,801	1,542,524	1,686,317	1,923,049	2,202,219	2,158,303	2,186,430
clarified hydrophobic extract of neem oil	47,422	42,281	40,773	42,613	60,212	85,369	87,917	65,680	59,517	47,093
codling moth granulosis virus	1,139	984	3,468	3,431	4,339	4,530	3,683	2,938	4,426	4,707
coniothyrium minitans strain con/m/91-08	1,205	395	1,107	1,697	4,286	4,886	6,194	4,105	5,134	3,250
corn syrup	14,316	12,877	27,721	27,760	15,992	14,206	18,817	18,940	48,546	74,160
cottonseed oil	74,544	129,722	177,732	95,344	98,797	78,736	67,349	41,034	36,856	35,581
coyote urine	N/A	<1	12	<1	<1	<1	<1	<1	<1	<1
cytokinin (as kinetin)	N/A	N/A	199	2,409	352	3,290	1,966	1,910	3,506	5,052
diallyl disulfide	N/A	N/A	N/A	N/A	N/A	N/A	N/A	225	223	N/A
dihydro-5-heptyl-2(3h)-furanone	<1	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
dihydro-5-pentyl-2(3h)-furanone	<1	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
e,e-8,10-dodecadien-1-ol	15,309	15,283	17,872	15,879	18,241	16,548	10,763	12,918	17,123	15,845
e-11-tetradecen-1-yl acetate	5,592	5,405	1,701	4,485	4,396	489	696	369	1,000	421
e-8-dodecenyl acetate	46,757	49,591	45,667	49,300	47,640	41,405	42,645	39,638	38,080	41,944

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
encapsulated delta endotoxin of bacillus thuringiensis var. kurstaki in killed pseudomonas fluorescens	37	N/A	<1	<1	N/A	N/A	N/A	N/A	N/A	N/A
essential oils	<1	4	<1	<1	<1	<1	<1	181	61	169
ethylene	N/A	4	70	49	36	21	28	77	26	17
eucalyptus oil	N/A	2	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
eugenol	N/A	N/A	N/A	<1	<1	<1	<1	<1	<1	<1
farnesol	503	1,597	826	2,227	3,940	3,547	3,121	4,331	5,936	5,749
fenugreek	471	74	412	271	88	68	73	N/A	4	198
ferric sodium edta	N/A	N/A	3,049	8,428	8,038	10,540	12,522	13,115	13,697	14,347
fish oil	N/A	N/A	<1	382	252	N/A	N/A	66	N/A	N/A
formic acid	10	60	1	369	5	178	1,203	60	1	402
fox urine	N/A	<1	12	<1	<1	<1	<1	<1	<1	<1
gamma aminobutyric acid	1,786	835	542	1,811	385	314	287	N/A	N/A	N/A
garlic	374	1,123	1,369	12,410	14,485	8,509	4,767	7,185	3,819	6,613
geraniol	349	1,531	788	2,220	3,939	3,545	3,111	4,331	5,936	5,749
german cockroach pheromone	<1	<1	<1	<1	<1	<1	N/A	<1	<1	<1
gibberellins	514,164	493,034	509,758	529,744	548,185	530,086	523,059	544,711	501,836	505,422
gibberellins, potassium salt	N/A	34	150	795	N/A	N/A	N/A	N/A	58	N/A
gliocladium virens gl-21 (spores)	716	1,401	1,076	3,172	5,444	5,187	7,439	7,140	4,914	4,300
glutamic acid	1,786	835	542	1,811	385	314	287	N/A	N/A	N/A
gs-omega/kappa-hxtx-hv1a (versitude peptide)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A	1
harpin protein	1,562	1,631	1,582	115	95	1	N/A	112	<1	N/A
heptyl butyrate	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1
hydrogen peroxide	14,521	23,208	39,194	21,863	22,955	27,951	32,676	69,022	65,560	103,587
hydroprene	82	<1	<1	2	4	<1	<1	7	28	35
iba	150	227	1,156	1,283	962	940	489	808	1,437	527
indole	N/A	N/A	N/A	N/A	<1	N/A	<1	<1	<1	<1
iron hedta	N/A	N/A	N/A	<1	2	<1	<1	<1	2	<1
iron phosphate	4,561	6,345	5,477	6,519	6,286	8,109	8,618	13,322	11,965	9,264
kaolin	66,850	82,636	51,100	57,755	80,075	88,044	101,645	115,468	103,356	98,959
kinoprene	3	4	9	3	6	25	7	3	<1	6

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
lactic acid	N/A	N/A	N/A	N/A	N/A	N/A	38	59	225	3
lactose	80,355	81,164	91,936	68,442	80,242	61,764	81,390	77,746	74,127	70,016
lagenidium giganteum (california strain)	N/A	N/A	N/A	2	N/A	N/A	N/A	N/A	N/A	N/A
lauryl alcohol	4,705	5,495	6,443	6,652	7,807	5,681	5,725	4,718	4,354	4,765
lavandulyl senecioate	2,375	7,025	11,754	6,666	5,869	6,294	8,424	18,076	74,825	141,775
limonene	55,465	29,621	15,514	73,605	29,552	32,924	45,208	40,224	68,084	54,142
linalool	1	<1	<1	<1	<1	2	<1	<1	<1	<1
margosa oil	N/A	40	4,260	7,977	9,546	19,013	19,917	25,809	32,241	23,369
menthol	N/A	2	<1	N/A	20	N/A	N/A	N/A	N/A	N/A
metarhizium anisopliae strain f52	N/A	N/A	N/A	202	133	634	122	55	2	<1
metarhizium anisopliae, var. anisopliae, strain esf1	N/A	<1	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
methoprene	211	4	896	<1	<1	<1	<1	42	106	<1
methyl anthranilate	551	380	2,043	215	1,092	808	895	1,463	2,490	2,041
methyl eugenol	N/A	N/A	<1	N/A	<1	N/A	N/A	<1	<1	<1
methyl nonyl ketone	1	<1	N/A	N/A	<1	<1	<1	<1	<1	<1
methyl salicylate	<1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10	44
muscalure	739	300	68	40	50	139	41	19	178	125
myristyl alcohol	4,705	5,495	6,443	6,652	7,807	5,681	5,725	4,718	4,354	4,765
myrothecium verrucaria, dried fermentation solids & solubles, strain aarc-0255	5,331	4,840	5,136	4,274	4,456	3,637	8,775	6,473	4,075	5,037
n6-benzyl adenine	2,072	3,352	1,691	1,666	2,954	2,630	2,595	2,999	2,322	3,160
naa	47	38	219	655	293	109	210	84	84	17
naa, ammonium salt	9,024	9,140	9,075	11,922	10,611	9,703	9,966	778	671	2,792
naa, ethyl ester	1	23	396	384	112	189	37	45	7,899	8,232
naa, potassium salt	N/A	N/A	N/A	N/A	6	110	35	8,819	8,650	5,764
naa, sodium salt	257	N/A	N/A	N/A	153	85	55	11	N/A	N/A
natamycin	N/A	N/A	N/A	N/A	7	32	35	27	5	N/A
nerolidol	503	1,597	826	2,227	3,940	3,547	3,121	4,331	5,936	5,749
nitrogen, liquefied	<1	<1	<1	<1	<1	5	N/A	N/A	N/A	N/A
nonanoic acid	703	412	828	480	2,166	2,074	1,040	653	1,889	1,394
nonanoic acid, other related	701	412	828	460	2,166	2,074	1,040	653	1,219	619
nosema locustae spores	132	12	12	1,612	1,207	910	750	50	<1	1

Chemical	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
oil of anise	N/A	N/A	<1	<1	<1	<1	<1	<1	<1	<1
oil of black pepper	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
oil of cedarwood	N/A	15	N/A	N/A	N/A	N/A	<1	<1	N/A	N/A
oil of citronella	N/A	34	48	N/A	N/A	<1	<1	<1	<1	<1
oil of geranium	N/A	15	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
oil of jojoba	7,203	8,255	1,762	1,077	316	323	83	16	5	N/A
oil of lemon eucalyptus	N/A	N/A	<1	<1	N/A	N/A	N/A	N/A	N/A	N/A
oil of orange	N/A	N/A	N/A	N/A	N/A	N/A	21,472	37,651	66,215	53,652
oil of peppermint	N/A	15	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
oxypurinol	N/A	N/A	N/A	N/A	N/A	6	N/A	N/A	N/A	N/A
paecilomyces fumosoroseus apopka strain 97	N/A	N/A	N/A	2,109	12,822	18,487	19,076	31,000	26,577	15,462
pantoea agglomerans strain e325, nrrl b-21856	698	55	25	50	50	N/A	N/A	N/A	N/A	N/A
phenylethyl propionate	94	<1	<1	<1	<1	<1	<1	<1	<1	<1
phosphoric acid, monopotassium salt	<1	1,021	1,275	561	219	<1	1,837	3,142	2,284	2,025
piperine	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
polyhedral occlusion bodies (ob's) of the nuclear polyhedrosis virus of helicoverpa zea (corn earworm)	254	302	14,752	1,297	337	518	1,011	4,902	8,857	8,803
polyoxin d, zinc salt	1,299	19,082	69,674	95,645	143,483	165,601	191,654	231,736	242,630	261,976
potassium bicarbonate	69,155	101,283	118,642	75,356	85,844	85,701	112,047	156,452	162,321	124,850
potassium phosphite	36,665	92,671	82,323	115,741	131,552	214,917	199,571	299,256	387,605	411,056
potassium silicate	274	48	808	537	3,524	12,973	13,499	12,133	14,938	8,228
potassium sorbate	2	105	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
propylene glycol	381,957	591,332	662,523	676,470	974,665	1,069,976	1,107,603	1,122,784	1,209,430	1,171,518
propyleneglycol monolaurate	3	12	N/A	N/A	159	76	N/A	N/A	N/A	N/A
pseudomonas fluorescens, strain a506	2,463	1,472	1,281	372	431	1,178	376	601	524	533
pseudomonas syringae, strain esc-10	N/A	3	N/A	N/A	<1	N/A	N/A	N/A	N/A	N/A

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
purpureocillium lilaciunum strain 251	N/A	1,115	2,330	3,531	20,039	25,826	32,089	26,924	22,662	15,819
putrescent whole egg solids	33	2	<1	<1	<1	<1	<1	<1	<1	<1
pythium oligandrum dv74	N/A	N/A	2	2	63	N/A	N/A	N/A	N/A	N/A
qst 713 strain of dried bacillus subtilis	81,484	100,689	118,033	124,702	141,250	138,006	140,825	130,215	128,141	143,369
quillaja	22,595	22,949	30,225	22,907	28,538	30,232	31,107	53,339	53,857	68,592
reynoutria sachalinensis	1,297	70,363	90,750	94,114	96,188	95,988	105,535	128,066	124,832	111,531
s-abscisic acid	502	5,197	9,528	14,974	11,645	12,761	11,202	11,471	12,079	8,770
s-methoprene	47,350	65,114	62,628	87,637	49,491	53,371	102,129	76,961	53,963	71,084
sawdust	<1	<1	N/A	74	109	N/A	N/A	160	N/A	N/A
sesame oil	1,448	1,912	1,938	39	1	N/A	N/A	N/A	N/A	6
silver nitrate	N/A	<1	<1	5	N/A	N/A	N/A	<1	1	N/A
sodium bicarbonate	57	1	967	1,026	291	544	706	796	162	1
sodium carbonate peroxyhydrate	1,453	3,666	6,566	13,797	11,764	17,035	8,051	10,137	7,129	12,824
sodium chloride	<1	<1	2	73	207	135	66	134	144	42
sodium lauryl sulfate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
sorbitol octanoate	268	N/A	42	N/A	N/A	N/A	N/A	N/A	<1	N/A
soybean oil	4,557	6,845	3,636	3,302	4,524	6,275	5,476	7,018	7,910	18,418
streptomyces griseoviridis strain k61	<1	<1	1	<1	5	10	18	5	4	5
streptomyces lydicus wyec 108	4,009	6,998	6,404	10,367	16,071	14,050	16,546	20,474	15,963	10,132
sucrose octanoate	930	1,172	148	1	5	10	2	12	<1	N/A
sugar	4,507	1,527	5,807	4,843	1,062	1,427	452	504	86	212
thyme	68	<1	<1	<1	<1	<1	<1	<1	<1	<1
thyme oil	N/A	N/A	N/A	N/A	N/A	N/A	<1	<1	<1	<1
thymol	50	423	10	18	1	1	1,267	490	44	311
trichoderma harzianum rifai strain krl-ag2	320	7,253	871	1,088	994	2,497	2,346	2,207	2,244	2,404
trichoderma icc 012 asperellum	N/A	N/A	86	704	604	35	251	159	92	139
trichoderma icc 080 gamsii	N/A	N/A	86	704	604	35	251	159	92	139
trimethylamine	N/A	N/A	N/A	N/A	<1	N/A	<1	<1	<1	<1

Chemical	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
ulocladium oudemansii (u3 strain)	N/A	N/A	N/A	N/A	19	707	406	150	28	1,674
vanillin	471	74	412	271	88	68	73	N/A	4	198
vegetable oil	211,586	292,501	458,756	266,226	350,771	243,680	311,693	405,341	603,896	584,304
xanthine	N/A	N/A	N/A	N/A	N/A	6	N/A	N/A	N/A	N/A
yeast	3,957	1,307	5,261	3,729	325	142	220	25	6	14
yucca schidigera	598	2,316	4,907	16,093	19,524	11,285	7,347	9,376	6,289	10,926
z,e-9,12-tetradecadien-1-yl acetate	1,622	<1	49	<1	<1	<1	<1	<1	43	507
z-11-tetradecen-1-yl acetate	5,589	4,931	942	3,877	3,411	23	51	20	639	57
z-8-dodecenol	46,757	49,591	45,667	49,300	47,640	41,405	42,645	39,638	38,080	41,944
z-8-dodecenyl acetate	46,757	49,591	45,667	49,300	47,640	41,405	42,645	39,638	38,080	41,944
Total	3,986,178	4,910,149	5,503,387	5,585,447	6,547,837	6,925,141	7,487,719	8,018,198	8,558,267	8,604,231

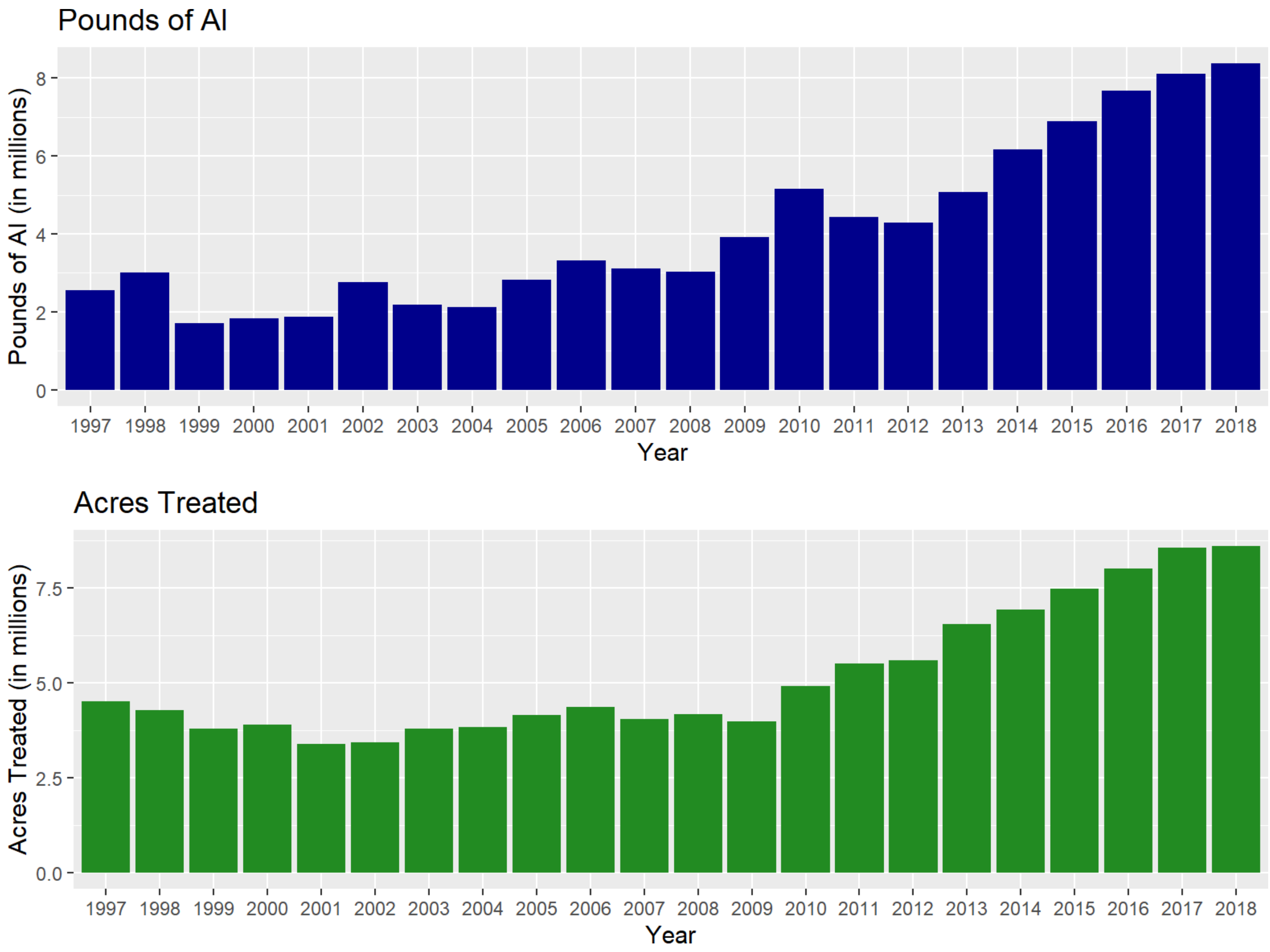

Figure 12: *Use trends of pesticides that are biopesticides. Biopesticides include microorganisms and naturally occurring compounds, or compounds similar to those found in nature that are not toxic to the target pest (such as pheromones). Reported pounds of active ingredient (AI) applied include both agricultural and nonagricultural applications. The reported cumulative acres treated include primarily agricultural applications. Data are available at <ftp://transfer.cdpr.ca.gov/pub/outgoing/pur/da*

5 Trends in Pesticide Use for Select Commodities

A grower's or applicator's decision to apply pesticides depends on many factors, such as the presence of biological control agents (e.g., predatory insects and other natural enemies), current pest levels, cost of pesticides and labor, value of the crop, pesticide resistance and effectiveness, other available management practices, and potential pesticide risk to the environment or farm workers. Pest population and the resulting pest pressure is determined by complex ecological interactions. Weather is a critically important factor and affects different pest species in different ways. However, sometimes the causes of pest outbreaks are unknown.

Crops treated with the greatest total pounds of pesticides in 2018 were almond, wine grape, table and raisin grape, processing tomato, and orange. Besides total pounds, the magnitudes of changes in use can be of interest in understanding pesticide use trends. Table 21 shows the change in pounds for ten crops (or sites): the first five rows are the crops with the greatest increases in pounds and the last five rows are the crops with the greatest decreases over the last year. In addition to the change in pounds of pesticide since last year, the table also includes the change in acres planted or harvested, as measured by external government agencies such as CDFA or USDA. Sometimes changes in use can be due to different pesticide practices, but other times the increase or decrease in use may simply be because the total crop acreage increased or decreased.

Crops or sites with the greatest *increase* in the pounds applied from 2017 to 2018 include almond, processing tomato, wine grape, tangerine and pistachio. All five crops increased in acreage as well as pesticide use (Table 21).

Crops or sites with the greatest *decrease* in the pounds applied included walnut, grape, orange, carrot, and strawberry. Orange and strawberry had decreasing pounds of pesticides accompanied by declining acreage, whereas pounds applied to walnuts, grapes and carrots decreased despite an increase in acreage (Table 21).

Table 21: *The change in pounds of AI applied and acres planted or harvested and the percent change from 2017 to 2018 for the crops or sites with the greatest increase and decrease in pounds applied.*

Crop Treated	Change in Pounds	Change in Acres	% Change in Pounds	% Change in Acres
Almond	4,742,352	30,000	14	2
Tomato, processing	2,059,886	11,000	21	5
Grape, wine	978,785	38,000	3	6
Tangerine	584,559	3,000	20	5
Pistachio	371,483	14,000	7	6
Walnut	-688,554	15,000	-9	4
Grape	-725,537	7,000	-5	2
Orange	-767,381	-5,000	-6	-3

Crop Treated	Change in Pounds	Change in Acres	% Change in Pounds	% Change in Acres
Carrot	-890,908	2,300	-14	4
Strawberry	-1,350,599	-3,100	-12	-8

Thirteen commodities were chosen for in-depth analyses of the possible reasons for changes in pesticide use from 2017 to 2018: alfalfa, almond, carrot, cotton, orange, peach and nectarine, pistachio, processing tomato, rice, strawberry, table and raisin grape, walnut, and wine grape. ('Peach and nectarine' and 'table and raisin grapes' each contain two crops grouped together for the purposes of the annual report due to similar pesticide use). They were selected because each commodity was treated with more than four million pounds of AIs or had more than three million acres treated, cumulatively. Collectively, the pesticides used on these commodities represent 72 percent of the total amount used (pounds) and 75 percent of the acres treated in 2018. Pest and disease pressure for a single commodity may differ by regions in some cases. The pooled figures in this report may not reflect differences in pesticide use patterns between production regions.

Acres treated by top 13 commodities: For these 13 commodities, the top five non-adjuvant AIs applied to the most area were sulfur, glyphosate, abamectin, oil, and methoxyfenozide. Sulfur was applied mostly to wine grape and table and raisin grape, although it was used on all 13 commodities except rice. Sulfur is a fungicide favored by both conventional and organic farmers and is used mostly to manage powdery mildew on grapes. It can also be used on some crops to suppress mites. Glyphosate is a broad-spectrum herbicide and crop desiccant. Glyphosate was used on all 13 commodities although 40 percent of the treated acreage was almond. Although not used on every one of the 13 commodities, the following AIs were used on over one million cumulative acres: the insecticides (and miticides) abamectin, lambda-cyhalothrin, bifenthrin, methoxyfenozide, chlorantraniliprole, and petroleum and mineral oils; the herbicides glyphosate, oxyfluorfen, and glufosinate-ammonium; and the fungicides (or fungicide/insecticides) copper, azoxystrobin, sulfur, and fluopyram.

Pounds applied to top 13 commodities: Sulfur was the most used AI by pounds as well as by acres treated for these 13 commodities. Petroleum and mineral oils were second to sulfur in amount of pounds of non-adjuvant pesticides. Almond, orange, peach and nectarine, and wine grape had the highest use of oils out of the 13 commodities. Oils are mostly used as insecticides, but can also be used as fungicides and adjuvants. The remaining top five AIs by pounds included the fumigants 1,3-dichloropropene and chloropicrin, and the herbicide glyphosate.

Information used to develop the trend analyses for each of the thirteen crops in this chapter was drawn from several publications and from the expertise of pest control advisors, growers, University of California Cooperative Extension farm advisors and specialists, researchers, and commodity association representatives. DPR scientists analyzed the information, using their knowledge of pesticides, California agriculture, pests, and pest management practices. As a result, the explanations for changes in pesticide use are largely based on the subjective opinions of experts as opposed to rigorous statistical analyses. Additional figures of pesticide distribution maps and graphs associated with each crop can be found in the Appendix of this document (Appendix figures are referenced by an "A" preceding the figure number). Note that graphs and tables of this section are based on statewide totals which may not accurately reflect regional differences in environmental conditions, pest pressure, and pesticide use patterns of crops grown in multiple, geographically-distinct areas of California.

Alfalfa

Alfalfa is grown primarily as a forage crop, providing protein and high energy for dairy cows and other livestock. Alfalfa flowers supply the nectar that bees use to make alfalfa honey, the main honey crop in the nation. Alfalfa is also an important rotational crop that has numerous ecosystem benefits, which include adding nitrogen to the soil, improving soil structure, and providing food and shelter for a large number of bird species and other wildlife.

California is the leading alfalfa hay-producing state in the United States. Second in acreage only to almonds, alfalfa is grown in 40 counties in California. There are six main alfalfa-growing regions in California, with a wide range of climatic conditions. (Figure A-3):

- Intermountain region (Northeastern region of California)
- Sacramento Valley (Central Valley north of the Sacramento - San Joaquin River Delta)
- San Joaquin Valley (Central Valley south of the Sacramento - San Joaquin River Delta)
- Coastal Region (Monterey, San Luis Obispo, and Santa Barbara area)
- High Desert (North and east of the Los Angeles Basin)
- Low Desert (Imperial and Palo Verde Valleys)

The price received per ton of alfalfa hay rose 14 percent in 2018 to $203 per ton, continuing an increasing trend since 2016 when it had dropped to $155 per ton (Table 22). The number of acres harvested decreased by six percent to 620,000 acres, and was at its lowest since the 1930s. This factor likely accounts for some of the observed trends in pesticide use in alfalfa in 2018. (Figures 14, A-4, and A-5).

Domestic dairies are the primary U.S. market for alfalfa. In recent years, dairy farmers have reduced the amount of alfalfa fed to dairy cows to keep production costs down. However, export demand from Asia and Middle Eastern countries has increased due to expanded or improved dairy and beef production coinciding with a lack of adequate space or water resources for growing alfalfa. Export demand from Saudi Arabia continued to increase, jumping 50 percent in one year, while exports to China dropped 30 percent. Although China is normally the largest importer of alfalfa, recent tariffs are affecting trade and exports are expected to continue to decrease in 2019.

Table 22: *Total reported pounds of all active ingredients (AI), acres treated, acres harvested, and prices for alfalfa each year from 2014 to 2018. Harvested acres are from USDA(a), 2015-2019; marketing year average prices are from USDA(c), 2016-2019. Acres treated means cumulative acres treated (see explanation p. 13).*

Pounds/Acres/Prices	2014	2015	2016	2017	2018
Pounds AI	3,737,221	3,506,607	3,151,391	3,137,237	2,698,394
Acres Treated	6,651,140	5,686,585	5,350,796	5,222,101	5,166,042
Acres Harvested	875,000	790,000	720,000	660,000	620,000
Price/ton	$ 244	$ 181	$ 155	$ 178	$ 203

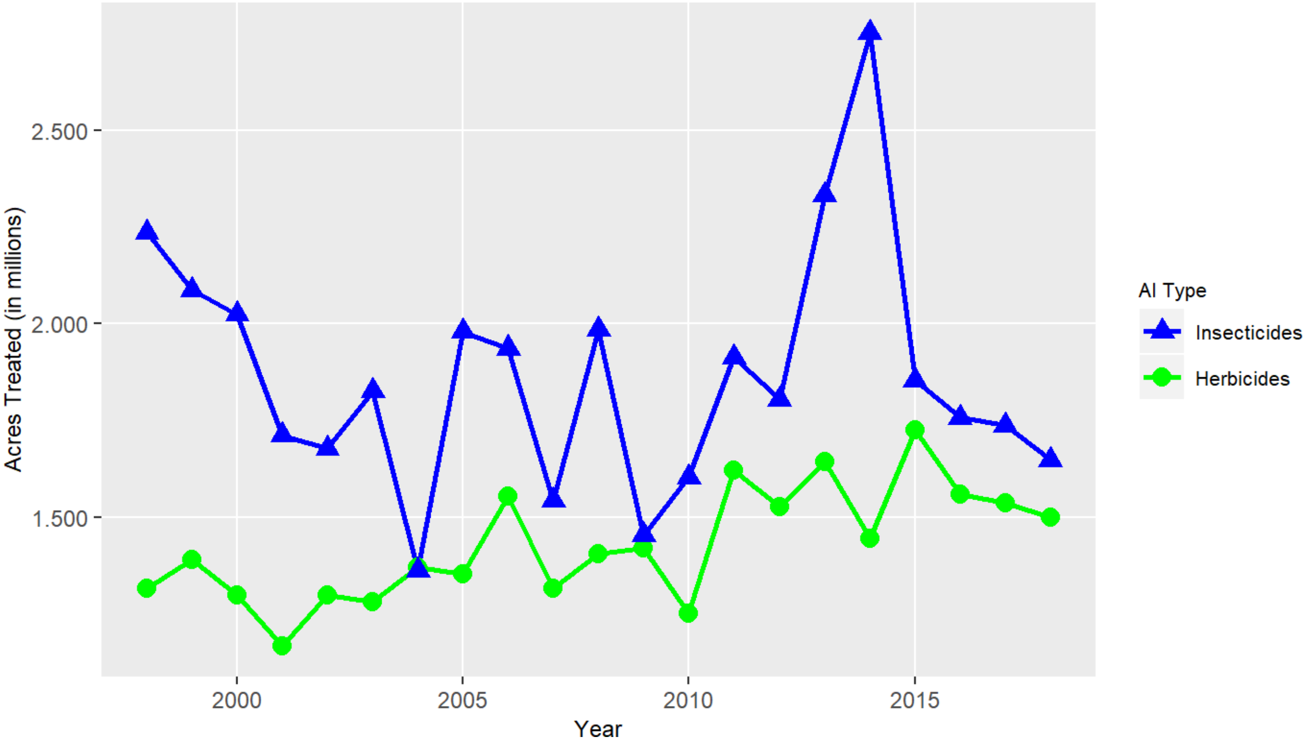

Figure 13: *Acres of alfalfa treated by all AIs in the major types of pesticides from 1998 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>*

Overall use of insecticides decreased in 2018 (Figure 13). The area treated with insecticides makes up 32 percent of total cumulative alfalfa acres treated with pesticides. The pounds of applied insecticides decreased by 46 percent and acres treated decreased by five percent. This decrease in insecticide use may be due in part to the reduced number of acres harvested. In 2018, insecticides made up 13 percent of the total pounds of AIs used to treat alfalfa. The top five insecticides by area treated were lambda-cyhalothrin, indoxacarb, flupyradifurone, dimethoate, and methoxyfenozide (Figure 14). The pyrethroid lambda-cyhalothrin and the organophosphate dimethoate were used on fewer acres in 2018. However, despite a three percent decrease in acres treated, lambda-cyhalothrin remained most used insecticide by acres treated at 351,221 acres. Acres treated with dimethoate decreased by seven percent. Flupyradifurone, indoxacarb, and methoxyfenozide use increased in the number of acres treated. Of the top five, flupyradifurone, a relatively new AI from 2015, had the largest increase in acres treated by 62 percent, with a total of 186,134 acres treated. This increase can likely be attributed to an increase in aphid outbreaks over the past few years, according to an expert source. Acres treated with indoxacarb increased by 28 percent. The increase in indoxacarb use is attributed to the need for a chlorpyrifos replacement, given the increasing regulations and restrictions on chlorpyrifos in recent years. The organophosphate malathion had a 38 percent increase in pounds and a 39 percent increase in acres treated. Indoxacarb, which is slower acting at cooler temperatures when weevils are less actively feeding, may be combined with malathion for faster control. Overall, use of the entire pyrethroid chemical class decreased by 10 percent in 2018, making it the fourth consecutive year where its use on alfalfa declined. The decline in pyrethroid use may be linked to increasing pest resistance to pyrethroids in the Low Desert and Intermountain regions, where alfalfa is primarily grown as a permanent crop with less crop rotation practices than other regions, due to fewer crop options. In these two regions, alfalfa stands stay in place from six to ten years. Growers in these regions do not rotate out the alfalfa crop to reduce alfalfa weevil pest pressure. They instead rely largely on pyrethroid insecticides for weevil control, which may contribute to pest resistance.

The organophosphate chlorpyrifos became a restricted material in July 2015 and was designated as a toxic air contaminant in 2018 by DPR. Its registration was cancelled and nearly all use will cease as of the end of December, 2020. Chlorpyrifos has been one of the most popular insecticides for managing key alfalfa pests, the alfalfa weevil and aphid complex. The acres treated with chlorpyrifos decreased by 63 percent, with a total of 57,367 acres treated. Chlorpyrifos use restrictions in 2018 made it impractical for smaller farms, according to a UC IPM farm advisor.

The number of acres treated with herbicides decreased by two percent in 2018 for the second consecutive year. (Figure 13). Herbicides make up 29 percent of alfalfa cumulative acres treated with pesticides. The top five herbicides by acres treated in 2018 included glyphosate, pendimethalin, clethodim, paraquat dichloride, and imazamox (ammonium salt) (Figure 14). Imazamox, which is used for some broadleaf weeds and annual grasses, and clethodim, used for annual and perennial grasses, had the largest percentage decreases in acres treated of the top five, with 11 and nine percent decreases, respectively. Paraquat dichloride was the only top five herbicide to increase in acres treated, with 104,207 acres treated, an eight percent increase.

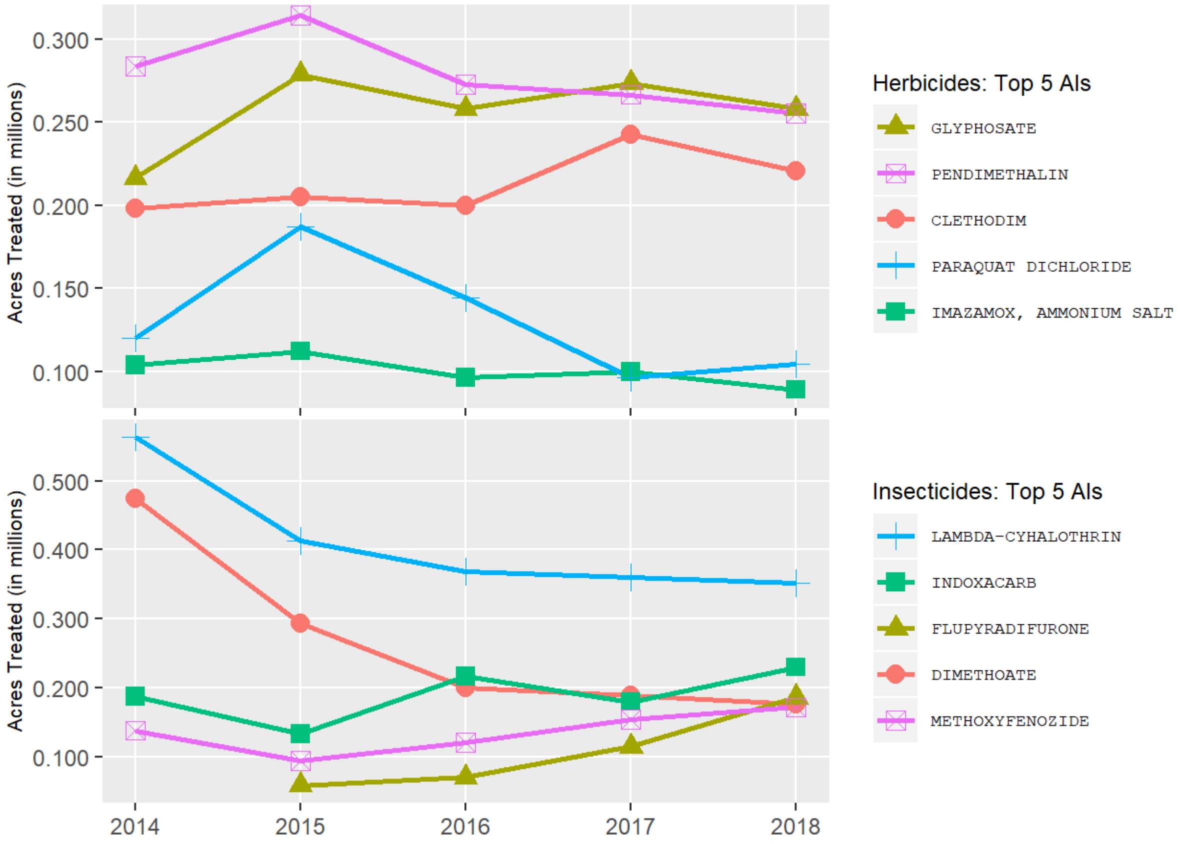

Figure 14: *Acres of alfalfa treated by the top five AIs of each AI type from 2014 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Glyphosate was the herbicide applied to the largest number of acres, treating 258,255 acres, a decrease of six percent. Glyphosate's popularity may be due in part to the use of genetically modified seeds resistant to glyphosate, which accounts for over 50 percent of alfalfa acres. The genetically modified alfalfa allows for use of glyphosate during establishment when young plants are more vulnerable to competition from weeds.

Use of fungicides in alfalfa continues to be minimal compared to the use of insecticides and herbicides, representing less than one percent of acres treated with all pesticides.

There were 39,660 acres treated with non-adjuvant biopesticides in 2018, an increase of 12 percent. The use of *Bacillus thuringiensis* increased 21 percent, with a total of 35,655 acres treated, the largest number of acres treated since 2006. *B. thuringiensis* was the most used biopesticide in acres treated and in pounds of AI applied. *B. thuringiensis* is used for the summer worm complex: armyworm and alfalfa caterpillar. An increase in use may be attributed to late infestations due to rain and the zero day pre-harvest interval for *B. thuringiensis*, which allows spraying to take place on the same day as cutting.

Almond

California produces over 80 percent of the world's almond supply. There are approximately 1.39 million almond acres, located over a 400-mile stretch from northern Tehama County to southern Kern County in the Central Valley (Figure A-6). Total acres planted increased by about two percent in 2018 (Table 23).

Table 23: *Total reported pounds of all active ingredients (AI), acres treated, acres planted, and prices for almond each year from 2014 to 2018. Planted acres are from CDFA(a), 2016-2019; marketing year average prices are from USDA(d), 2016-2019. Acres treated means cumulative acres treated (see explanation p. 13).*

Pounds/Acres/Prices	2014	2015	2016	2017	2018
Pounds AI	25,926,134	35,669,756	35,476,752	34,464,300	39,207,142
Acres Treated	18,042,842	20,593,410	21,825,015	23,439,717	25,309,756
Acres Planted	1,050,000	1,160,000	1,240,000	1,360,000	1,390,000
Price/lb	$ 4.00	$ 3.13	$ 2.39	$ 2.53	$ 2.44

Almond acreage treated with insecticides (including miticides) increased by 18 percent in 2018, which can be attributed to the increase in bearing acreage (Figure 15). Oil, abamectin, methoxyfenozide, chlorantraniliprole, and bifenthrin were the top five insecticides used in 2018 by acres treated (Figure 16). Major insect pests for almond include navel orangeworm, peach twig borer, web-spinning spider mites, leaffooted bug, San Jose scale, and ants. Oils (petroleum and mineral) were the most used insecticides, with a seven percent increase in acres treated for 2018. Abamectin use remained steady in 2018, with an increase of 0.5 percent in acres treated compared to 2017. Abamectin is used for web-spinning mite control and its use had been steadily increasing over the years, so this stabilization suggests that mite pressure was only moderate for the 2018 season. (Figures 15, 16, A-7, and A-8).

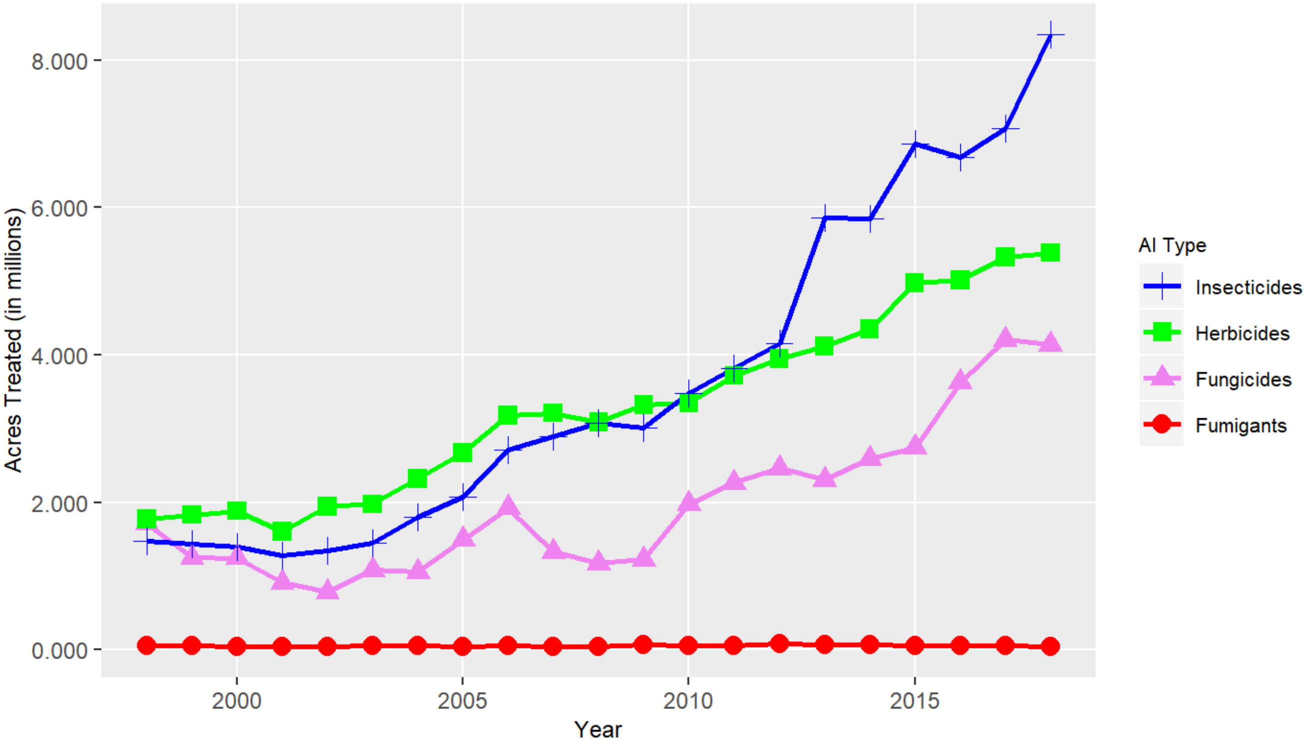

Figure 15: *Acres of almond treated by all AIs in the major types of pesticides from 1998 to 2018.* [*Data are available*](https://files.cdpr.ca.gov/pub/outgoing/pur/data/) *at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Navel orangeworm is the chief insect pest associated with almond production. Increased acreage can increase navel orangeworm pest pressure because they can fly a quarter-mile or more to find a new host. Not only does navel orangeworm cause direct yield losses to growers, but also market issues for the handlers since damage can lead to aflatoxin contamination, a major food safety concern. Methoxyfenozide, an insect growth regulator, has been increasing in pounds and acres treated over last few years and that trend continued in 2018, with an increase in acres treated of 50 percent. Chlorantraniliprole had a similar trend of increasing use, with 51 percent more acres treated in 2018. Bifenthrin, a pyrethroid used to control both navel orangeworm and leaffooted bug, was used on 36 percent more acreage in 2018.

In terms of biopesticides, the use of *Burkholderia* spp. strain A396, which can be used on almonds against peach twig borer and navel orangeworm, increased 192 percent in pounds used and 236 percent in terms of acres treated compared to 2017. *Bacillus thuringiensis*, a bioinsecticide, and *Bacillus amyloliquefaciens* strain D747, a biofungicide, also increased in use during 2018, almost doubling the amount of pounds used compared to 2017, and in the case of *B. amyloliquefaciens*, a 118 percent increase in acreage. Finally, *Chromobacterium subtsugae* strain PRAA4-1, another bioinsecticide introduced in 2013, increased in pounds and treated acreage by 79 and 52 percent, respectively.

Acres treated with herbicides increased by one percent during 2018 (Figure 15). The top five herbicides by acres treated remained the same as in 2017: glyphosate, oxyfluorfen, glufosinate-ammonium, paraquat dichloride, and saflufenacil (Figure 16). The acres treated with glyphosate decreased by one percent, but remained the most widely used herbicide in almond orchards in California. However, reports of weed resistance to glyphosate have been increasing in recent years, so new AIs have been increasing for the last few years. Glufosinate-ammonium, for example, has increased its use by 9 percent during 2018, most likely due to its ability to control glyphosate resistant weed species as well as increased availability of the AI for purchase on the west coast. Acres treated with oxyfluorfen rose by nine percent compared to 2017, while paraquat dichloride and glufosinate-ammonium use decreased by five and eleven percent, respectively. Paraquat dichloride and glufosinate-ammonium are non-selective, post-emergence herbicides that kill existing weeds on contact.

Acreage treated with fungicides during 2018 decreased by one percent, although the acres treated with the top five fungicides increased (Figure 15). The top five fungicides in 2018 were fluopyram, azoxystrobin, trifloxystrobin, propiconazole, and copper (Figure 16). As in 2017, fluopyram was the fungicide used on the most acreage in 2018 and its use increased by 22 percent. Azoxystrobin, trifloxystrobin, and copper acres treated also increased (by six, 24, and 64 percent respectively). Copper is used during the dormant season if scab (*Venturia carpophila*) has been present during the previous season and this was the case for 2017. Fluopyram, azoxystrobin, and propiconazole are fungicides used to control many diseases, such as powdery mildew, brown rot blossom blight, and scab. A newer fungicide, penthiopyrad, increased by 38 percent in treated acreage for 2018, continuing a rising trend in use over the last four years. The acres treated with potassium phosphite, a biopesticide used to control *Phytophthora* and *Pythium*, also continued to rise over the last four years, increasing by 30 percent in 2018.

Overall, fumigant use decreased by 19 percent in 2018, continuing a downwards trend that started in 2013 (Figure 15). Fumigants have multiple functions in almond production: post-harvest insect control during storage, pest control to meet phytosanitary and food safety standards, and pre-plant soil fumigation to control soil-borne diseases and nematodes. Only four fumigants were used in 2018: aluminum phosphide, 1,3-dichloropropene, chloropicrin, and metam-potassium (potassium N-methyldithiocarbamate) (Figure 16). A 30 percent decrease in the acres treated with aluminum phosphide explains most of the reduction in total fumigant use. Acres treated with 1,3-dichloropropene increased by 20 percent, while use of chloropicrin rose by 34 percent. There were less than 500 cumulative acres treated with metam potassium.

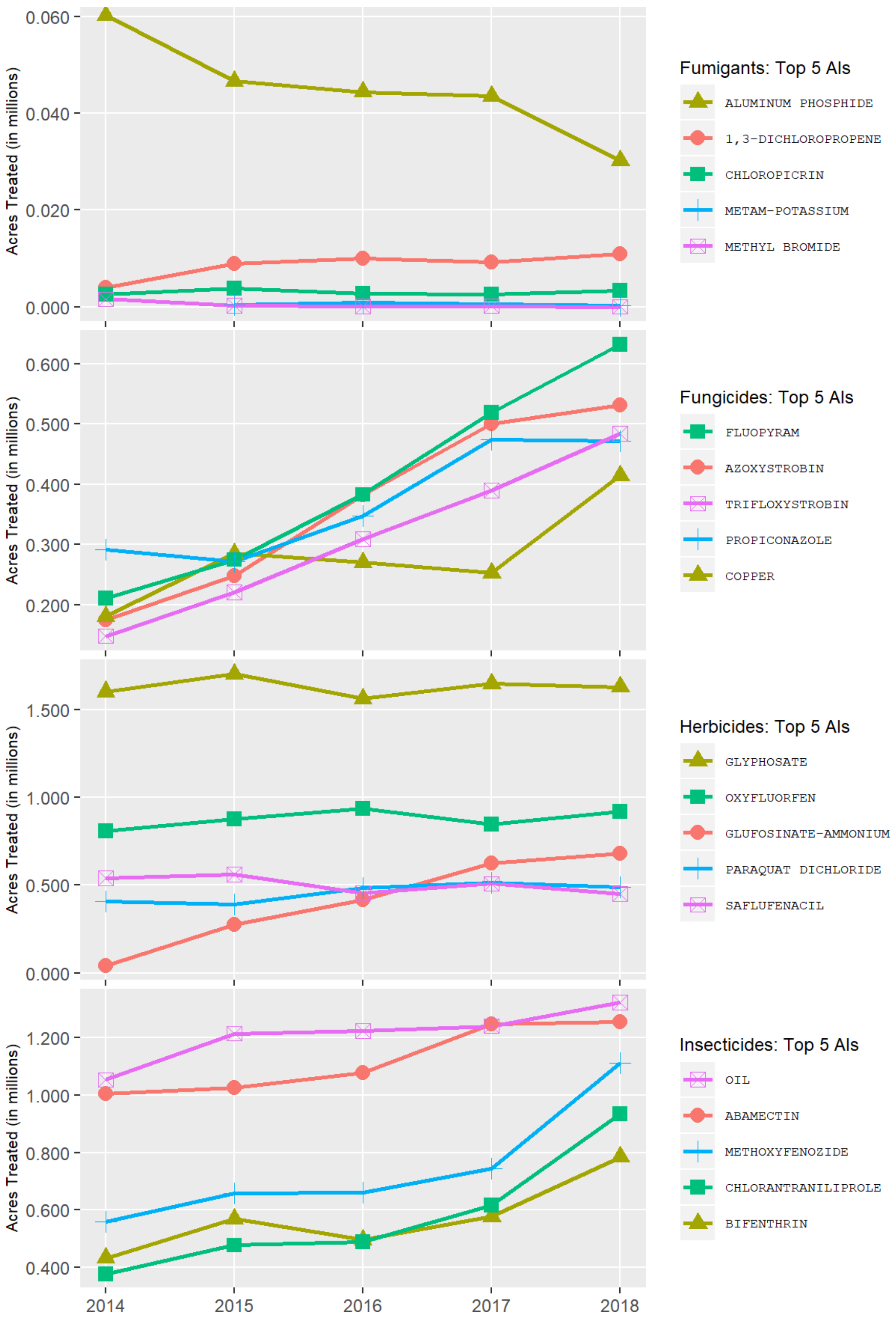

Figure 16: *Acres of almond treated by the top five AIs of each AI type from 2014 to 2018.* [*Data are available*](https://files.cdpr.ca.gov/pub/outgoing/pur/data/) *at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Carrot

California is the leading state for carrot production in the nation, producing 2.9 billion pounds of carrots (both fresh and processing) in 2018 (78 percent of total U.S. production, Table 24). California has four main carrot production regions: the San Joaquin Valley (Kern County), the Central Coast (San Luis Obispo, Santa Barbara, and Monterey counties), the Low Desert (Imperial and Riverside counties), and the High Desert (Los Angeles County) (Figure A-9). The San Joaquin Valley accounts for more than half the state's acreage.

Table 24: *Total reported pounds of all active ingredients (AI), acres treated, acres planted, and prices for carrot each year from 2014 to 2018. Planted acres and marketing year average prices are from USDA(e), 2016-2019. Acres treated means cumulative acres treated (see explanation p. 13).*

Pounds/Acres/Prices	2014	2015	2016	2017	2018
Pounds AI	5,497,708	5,597,575	6,046,414	6,485,294	5,594,387
Acres Treated	605,181	533,506	490,740	553,491	519,911
Acres Planted	66,000	67,000	61,000	62,500	64,800
Price/cwt	$ 28.2	$ 32.7	$ 31.3	$ 29.4	$ 26.8

In 2018, there were 64,800 (2017, 62,500) acres of carrots planted in California, an increase of four percent from 2017. The acres treated with all pesticides, including fumigants, herbicides, insecticides, and fungicides, decreased six percent in 2018 compared to 2017 (Figure 17). Nematodes, weeds, leaf blights, cavity spot, rots, and aphids remained the major pest concerns.

The most-applied fungicides by acres treated in 2018 were sulfur, mefenoxam, azoxystrobin, cyazofamid, and QST 713 strain of dried *Bacillus subtilis*. Fungicide-treated acreage decreased two percent while the amount used (pounds) increased seven percent since 2017. This increase was mostly due to higher use of azoxystrobin by acres treated (33 percent) and applied pounds (26 percent) since last year. Azoxystrobin is applied in conventional farms mainly to manage foliar blights (Figure 18).

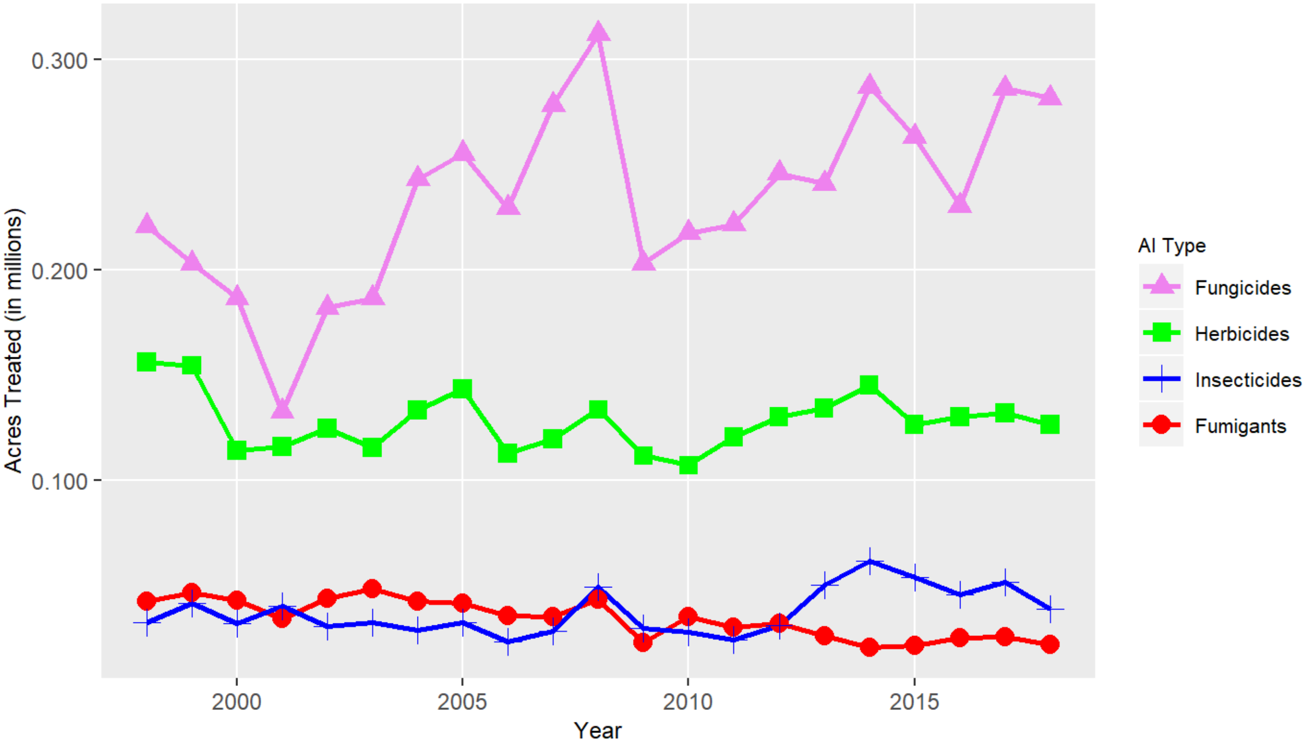

Figure 17: *Acres of carrot treated by all AIs in the major types of pesticides from 1998 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

In 2018, the most-applied herbicides in carrot production by treated area were linuron, pendimethalin, fluazifop-p-butyl, clethodim and trifluralin. Use of clethodim, a grass-selective herbicide, was slightly reduced (five percent) in comparison to 2017 (Figure 18).

In 2018, the most-used insecticides by treated area remained the same as the previous years (2016 and 2017): imidacloprid, esfenvalerate, methoxyfenozide, *Purpureocillium lilaciunum* Strain 251 (formerly *Paecilomyces lilacinus*), and s-cypermethrin (Figure 18). In 2018 both insecticide-treated acreage and the amount used decreased 24 percent. Use of *Purpureocillium lilacinum* strain 251, a nematicide, noticeably decreased by acres treated (53 percent) and applied pounds (48 percent) since last year.

Fumigants are used to control soil-borne diseases, nematodes, and weeds. Metam-potassium (potassium N-methyldithiocarbamate), 1,3-dichloropropene, and metam-sodium were the only fumigant AIs used on carrots. In 2018, fumigant-treated acreage and the amount used decreased by 13 percent and 16 percent, respectively. The use of metam-potassium decreased by acres treated (23 percent) and applied pounds (26 percent) since 2017 (Figure 18).

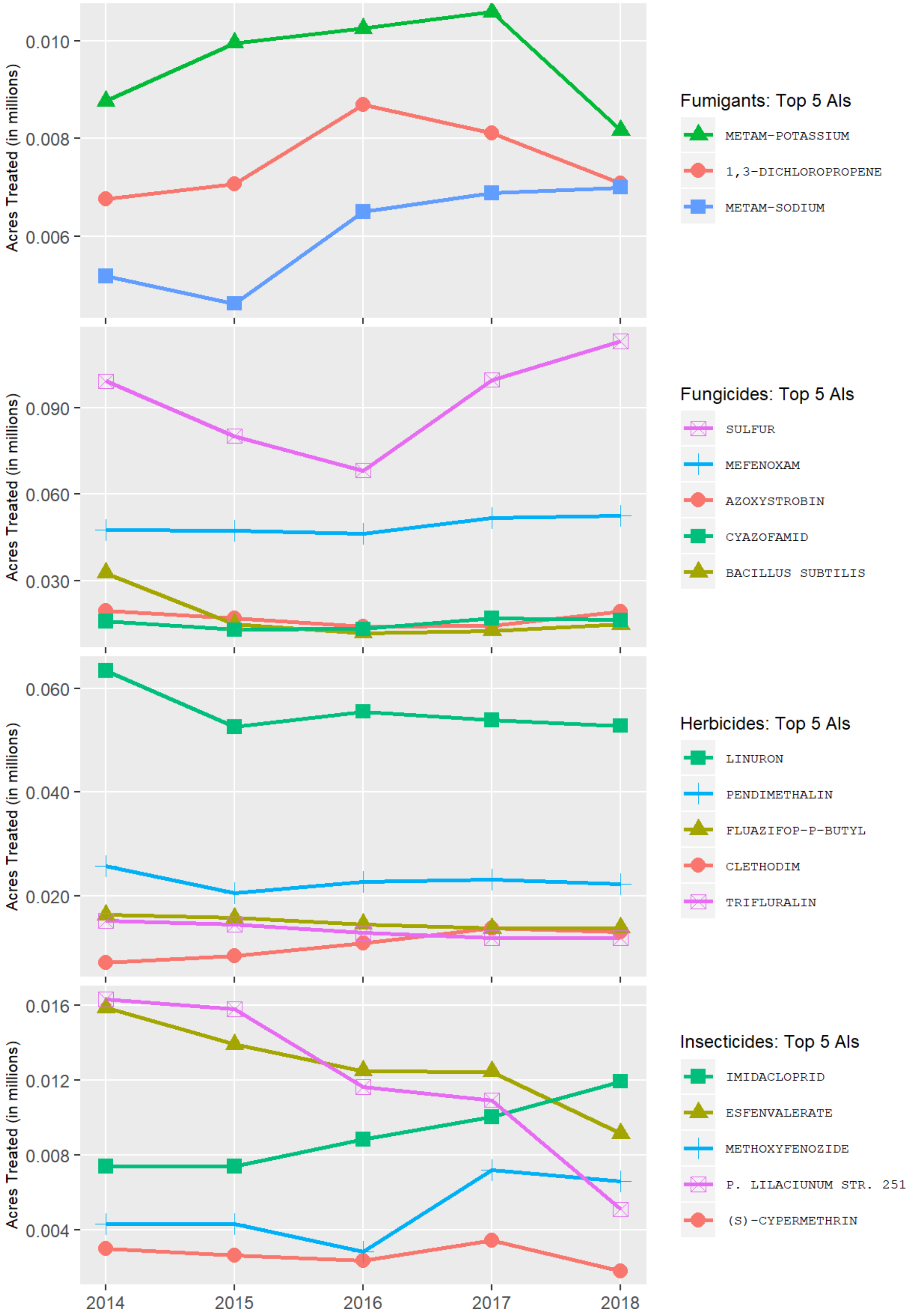

Figure 18: *Acres of carrot treated by the top five AIs of each AI type from 2014 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Cotton

Cotton is one of the top twenty commodities grown in California, with a value of over $600 million in 2018. Total planted cotton acreage decreased in 2018 by 15 percent (Table 25). However, market demand for cotton has been increasing. Three varieties of cotton–Pima, California Upland, and San Joaquin Valley (SJV) Acala (a very high quality Upland)–make up most of the cotton acreage in California. Nearly all SJV Acala and Pima produced in the U.S. are from California. Most cotton is grown in the southern San Joaquin Valley, with smaller acreages grown in Imperial and Riverside counties and a few counties in the Sacramento Valley (Figure A-12). Over 80 percent of the San Joaquin Valley cotton is Pima. Pounds of pesticides decreased by 14 percent and acres treated by 19 percent in 2018 (Table 25).

Table 25: *Total reported pounds of all active ingredients (AI), acres treated, acres planted, and prices for cotton each year from 2014 to 2018. Planted acres are from USDA(a), 2015-2019; marketing year average prices are from CDFA(c), 2016. Marketing year average prices after 2015 are no longer available (NA). Acres treated means* *cumulative acres treated* *(see explanation p. 13).*

Pounds/Acres/Prices	2014	2015	2016	2017	2018
Pounds AI	2,436,960	2,147,857	2,605,368	4,018,662	3,463,715
Acres Treated	4,594,373	4,405,363	5,659,519	9,005,353	7,258,611
Acres Planted	212,000	164,000	218,000	304,000	259,000
Price/lb	$ 1.36	$ 1.11	$ NA	$ NA	$ NA

Western lygus plant bug (referred to as "lygus") is the most widespread pest in cotton, with spider mites (especially strawberry spider mite), whiteflies, aphids, and thrips being important pests in some years but not others. Thrips and spider mites usually cause more problems for Upland varieties than Pima cotton. Late season aphids and whiteflies are a serious concern because they produce honeydew, a sugary excretion that drops onto the cotton lint creating a condition called sticky cotton. When ginned, sticky cotton produces a lower quality cotton lint, thus reducing the price growers receive. Leaf-eating worms (caterpillars) such as armyworms can cause early-spring damage to seedlings in the San Joaquin and Sacramento valleys, although they are not usually considered primary pests due to the limited injury they cause and sporadic pest pressure.

Cotton acres treated with insecticides (including miticides) decreased by 18 percent in 2018 (Figure 19). The top five insecticides by acres treated remained the same as in 2017, although the relative ranking order within the top five shuffled slightly: flonicamid, abamectin, novaluron, acetamiprid, and imidacloprid (Figure 20). Most of these insecticides treat lygus, aphids, whiteflies, and an assortment of various other pests, while abamectin is used to control mites.

Pounds of insecticide used on cotton decreased by 10 percent. The top five insecticides by pounds included chlorpyrifos, malathion, naled, oxamyl, and acephate. They were more or less the same as in 2017, except that oxamyl replaced dimethoate in the top five list and the relative ranking of the remaining four were in a slightly different order. With the exception of oxamyl, a carbamate, all other top five insecticides by pounds were organophosphates. Only malathion and oxamyl increased since 2017, by 33 and 84 percent respectively. Chlorpyrifos, naled, and acephate decreased by 24, 18, and 30 percent, respectively. On October 9, 2019, DPR announced that use of chlorpyrifos in California will end by December 31, 2020.

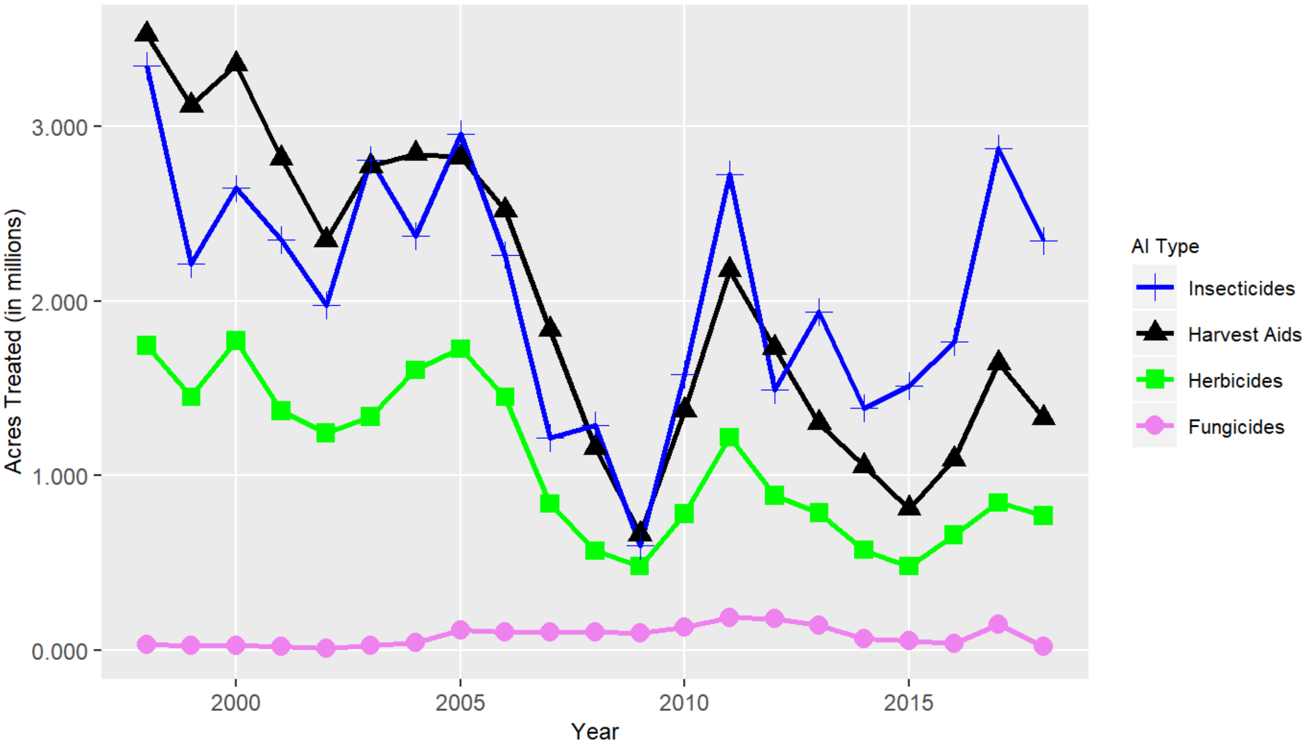

Figure 19: *Acres of cotton treated by all AIs in the major types of pesticides from 1998 to 2018.* *Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Cotton acres treated with herbicide decreased by nine percent, while pounds decreased by 13 percent (Figure 19). Glyphosate had the highest use in both pounds and treated acreage, likely due to plantings of glyphosate-resistant cotton. Pendimethalin took second place to glyphosate in both acres and pounds, and oxyfluorfen third in acres and fifth in pounds. Glyphosate and oxyfluorfen both decreased in acres treated (13 and 25 percent, respectively) and pounds (13 and 19 percent, respectively), while pendimethalin remained relatively the same as in 2017. Flumioxazin and clethodim made up the remainder of the top five herbicides by acres treated, with clethodim increasing by 72 percent to edge out paraquat dichloride for fifth place. Paraquat dichloride still made the top five list by pounds, however, although it decreased by 36 percent since 2017. Trifluralin replaced glufosinate-ammonium in the top five by pounds in 2018, increasing by 20 percent. (Figure 20).

Herbicides applied from August through November were assumed to be used as harvest aids. The use of harvest aids decreased by 19 percent in both pounds and acres treated. The top five harvest aids remained the same as in 2017. By acres treated, the top five included mepiquat chloride, thidiazuron, diuron, ethephon, and pyraflufen-ethyl. By pounds, the top five harvest aids were urea dihydrogen sulfate, ethephon, sodium chlorate, paraquat dichloride, and glyphosate (Figure 20). Use of all of the top five harvest aids by both pounds and treated acres dropped between 14 and 33 percent, except glyphosate, which increased in pounds by 11 percent and acres treated by six percent.

There is relatively low use of fungicides on cotton compared to insecticides, herbicides, and harvest aids. Fungicides represent less than one percent of all pesticides used on cotton. In 2018, fungicide use decreased by 86 percent by acres treated and 83 percent in pounds. Azoxystrobin had the highest use by acres treated and pounds, despite decreasing by 82 percent of acres treated and 85 percent of pounds. It is likely used mostly for control of seedling diseases. Iprodione, mefenoxam, fludioxonil, and a related mefenoxam chemical ("mefenoxam, other related") made up the remaining four fungicides in the top five list by acres treated, with minimal use (Figure 20).

Fumigant use in cotton was negligible. Although *Fusarium oxysporum* f. sp. *vasinfectum* race 4 (Race 4 FOV) continues to be an ongoing concern throughout the San Joaquin Valley, use of resistant varieties is the preferred way of handling this disease rather than fumigants.

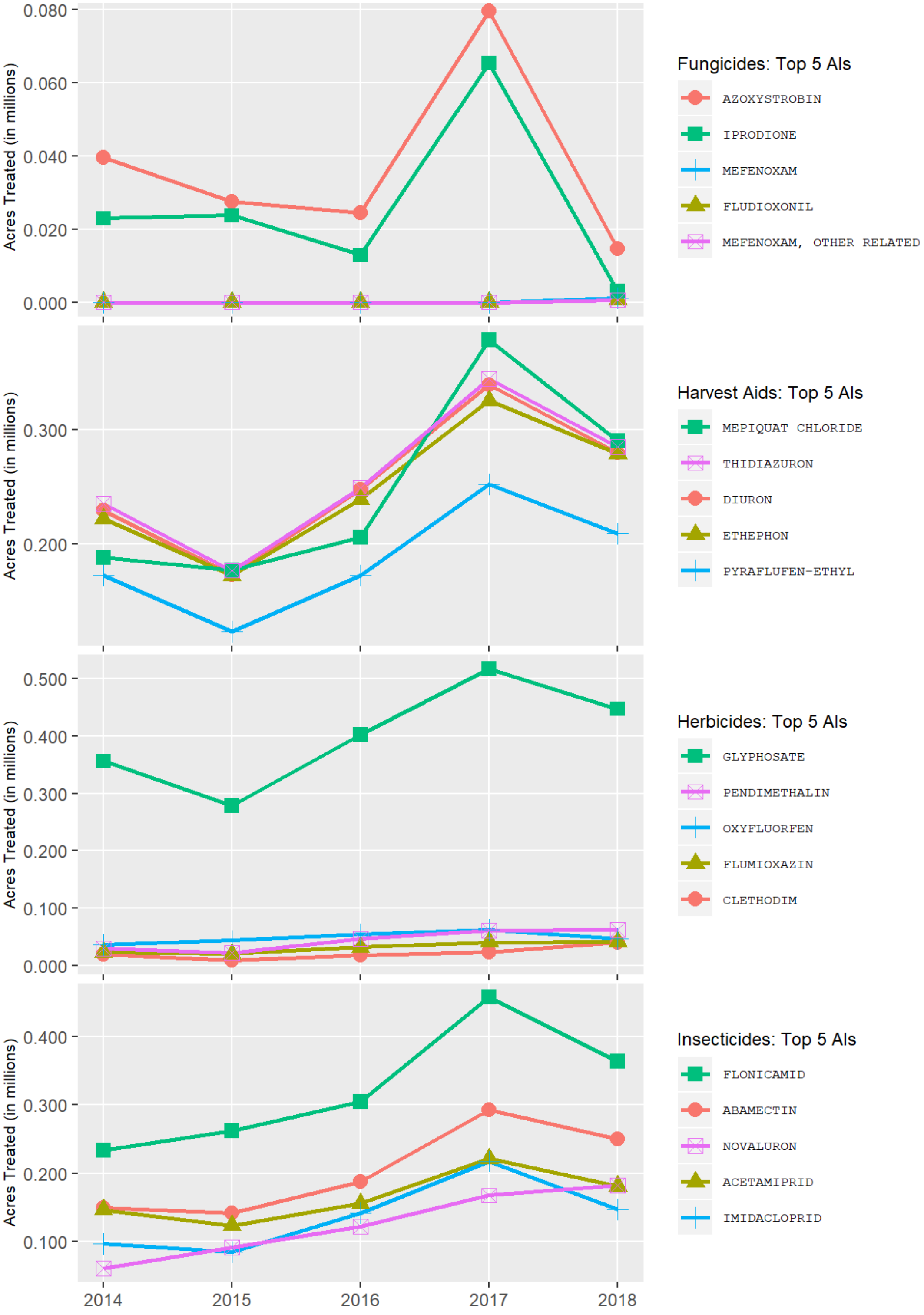

Figure 20: *Acres of cotton treated by the top five AIs of each AI type from 2014 to 2018. [Data are available](https://files.cdpr.ca.gov/pub/outgoing/pur/data/) at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Orange

California has the highest valued citrus industry in the United States. Citrus is grown in three distinct growing regions in California. The San Joaquin Valley region comprises 75 percent of the state's citrus acreage and is characterized by hot, dry summers and cold, wet winters. The Coastal region has a mild climate influenced by marine air. The Desert region includes the Coachella and Imperial valleys where temperatures fluctuate wildly.(Figure A-15).

Table 26: *Total reported pounds of all active ingredients (AI), acres treated, acres bearing, and prices for orange each year from 2014 to 2018. Bearing acres and marketing year average prices are from USDA(b), 2016-2019. Acres treated means [cumulative acres treated]() (see explanation p. 13).*

Pounds/Acres/Prices	2014	2015	2016	2017	2018
Pounds AI	8,490,235	9,959,413	11,123,907	11,908,185	11,140,803
Acres Treated	2,386,096	2,539,392	2,648,665	2,674,341	2,787,627
Acres Bearing	166,000	163,000	157,000	152,000	147,000
Price/box	$ 19.03	$ 16.04	$ 14.12	$ 18.39	$ 24.73

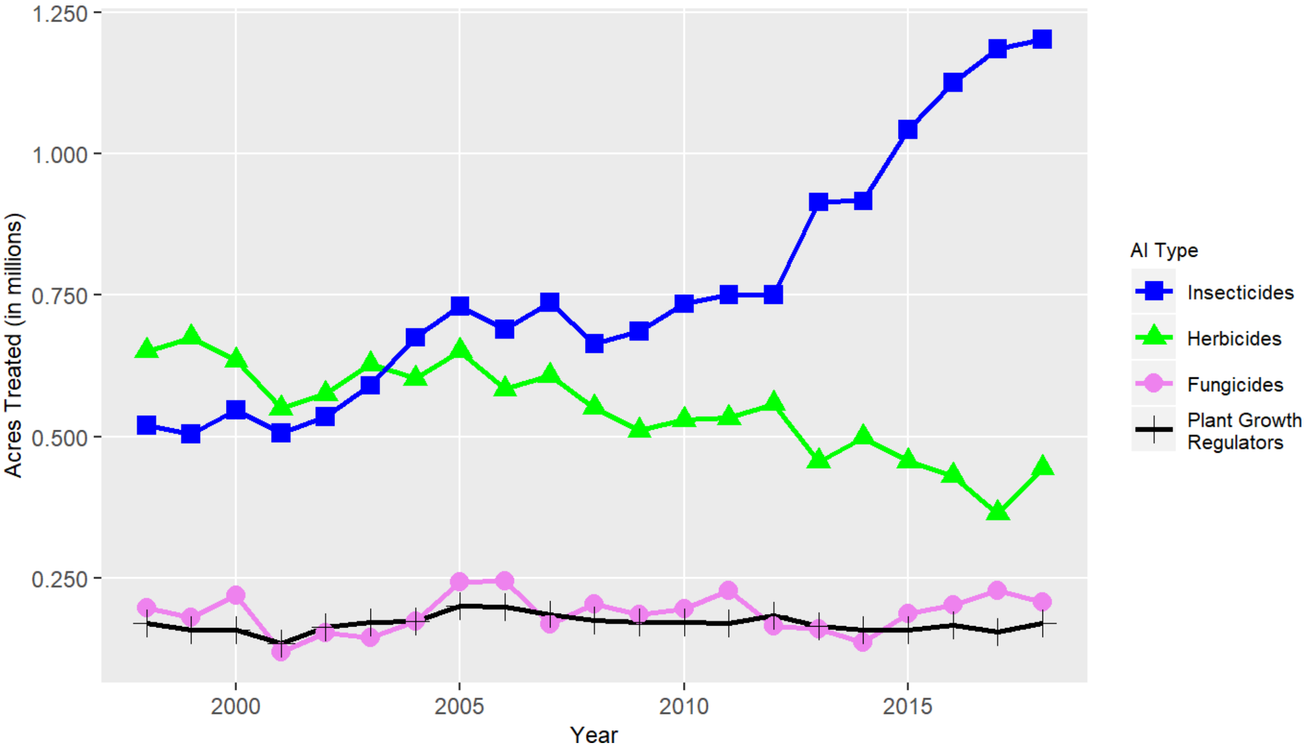

Figure 21: *Acres of orange treated by all AIs in the major types of pesticides from 1998 to 2018.* *[Data are available]() at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Bearing acres decreased by three percent (Table 26). Despite bearing acreage decreasing, production, measured in tons, was higher in 2018. The price per box increased 35 percent in 2018, following a 30 percent increase last year, and was the highest price in five years.

Insecticide pounds increased a fraction of a percent in 2018, but have increased 51 percent in the last five years, and 112 percent in the last 10 years (Figure 21). The top five insecticides (including miticides) by acres treated were oils, thiamethoxam, spirotetramat, abamectin, and spinetoram (Figure 22). Oils remained the most widely used insecticide on oranges by pounds and acres treated. Although oils increased by less than one percent in 2018, they continued to follow a rising trend since 2008 (Figure 22). Oil insecticides kill soft-bodied pests such as aphids, immature whiteflies, immature scales, psyllids, immature true bugs, thrips, mites, and some insect eggs, as well as powdery mildew and other fungi. Oils are also used as an adjuvant for most insecticide treatments in oranges, and, as insecticide use increases, so does oil use.

There are six key pests of oranges that require the majority of insecticide use; Asian citrus psyllid (ACP), Fuller rose beetle, citricola scale, California red scale, citrus thrips, and citrus bud mite. ACP, which vectors a bacterium that causes Huanglongbing (HLB) or citrus greening disease, was first detected in California in Los Angeles in 2008. Since that time, ACP has spread throughout Southern California, up the Central Coast, and appears periodically in the Central Valley and as far north as Placer County. Many insecticides are effective against Asian citrus psyllid but neonicotinoids and pyrethroids have the longest residual effect, and are thus heavily relied on. Whenever psyllids are found in central and northern California, eradication efforts are implemented, using a combination of a foliar pyrethroid and the systemic neonicotinoid imidacloprid.

ACP is now endemic to Southern California and growers apply area-wide treatments of a wide array of insecticides. The California Department of Food and Agriculture treats residential citrus around commercial groves when there is high participation from the growers. More than 1650 HLB-infected trees have been removed from the residential areas of Los Angeles, Orange, and Riverside counties, but thus far, no HLB-infected trees have been found in commercial groves. To prevent transportation of psyllids, orchards must be treated just prior to harvest, or fruit must be washed or cleaned before moving between major regions of the state. All of these actions to control ACP have increased insecticide use in citrus, especially in southern California. The neonicotinoid thiamethoxam increased seven percent by pounds applied to oranges, and the pyrethroids cyfluthrin and fenpropathrin increased 98 and 31 percent by pounds applied, respectively.

Fuller rose beetle is not considered a pest in California citrus, but it is a risk to South Korea which is a major navel orange exporter. California growers are required to do tree pruning and apply two insecticide treatments prior to export to South Korea. Bifenthrin and thiamethoxam are the main treatments used. Thiamethoxam was first used in 2010 and its use has rapidly increased since that time. It is the second most-used insecticide by acres treated, and increased 104 percent by acres in the past 5 years (Figure 22).

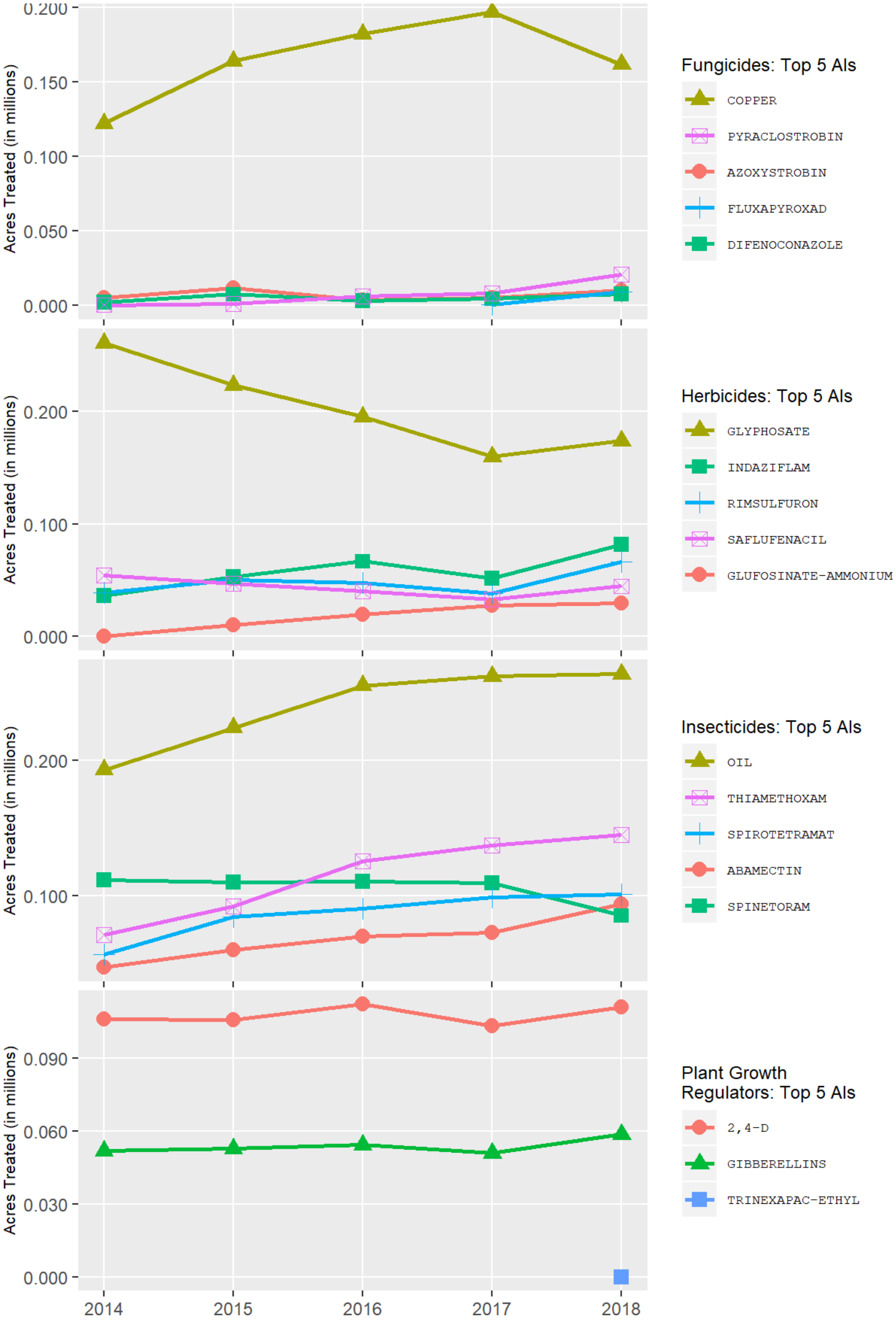

Figure 22: *Acres of orange treated by the top five AIs of each AI type from 2014 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Chlorpyrifos is a broad-spectrum insecticide used primarily for scale insects such as citricola scale and California red scale, as well as for ants and earwigs that attack nonbearing trees. It became a restricted material in 2015 and the significant restrictions and anticipated cancellation caused many growers to switch to other insecticides such as neonicotinoids for citricola scale, insect growth regulators and spirotetramat for California red scale, and bifenthrin for ants and earwigs. Registration of chlorpyrifos was recently cancelled and nearly all use will cease as of the end of December, 2020.

Chlorpyrifos resistance in citricola scale has been documented and imidacloprid, thiamethoxam and acetamiprid are increasingly being used to suppress the resistant populations. During the past eight years, drought situations have caused California red scale to increase and citricola scale to decline, thus treatments for citricola have diminished somewhat.

California red scale has traditionally been controlled primarily by pyriproxyfen and, in 2018, the pounds applied declined 11 percent. Spirotetramat use has steadily increased for this insect pest in the past decade and is the third most commonly used insecticide by acres treated. Drought conditions over the past eight years have exacerbated California red scale populations by increasing the number of generations of scale per year and reducing the efficacy of natural enemies. Growers have responded since 2015 with increased treatments of the most available red scale insecticides (oil, buprofezin, spirotetramat, carbaryl, pyriproxyfen, and chlorpyrifos).

For many years, citrus thrips were controlled with dimethoate and formetanate hydrochloride. Abamectin, spinosad, and spinetoram have more recently replaced these older products. Spinetoram was the primary product used to manage citrus thrips, however, because of spinetoram resistance in thrips and the introduction of cyantraniliprole in 2015, its use declined 22 percent in acres treated, while cyantraniliprole use increased 216 percent. Though formetanate hydrochloride is an older chemical, its use increased more than 50 percent in both pounds applied and acres treated. The increased use is likely due to drought conditions that exacerbate thrips and the need for other chemistries because of spinetoram resistance Figure A-17).

Bud mites were usually controlled using chlorpyrifos, however restrictions on chlorpyrifos use have caused the increased use of spirotetramat and abamectin for their control in the past few years. Drought conditions have increased pest pressure from mites around the state, which has increased the use of most miticides including abamectin, cyflumetofen, hexythiazox, pyridaben, and fenbutatin-oxide, as well as the insect growth regulator diflubenzuron.

Flupyradifurone, a new pesticide that was registered in 2015, increased in acres treated and pounds applied in 2018, more than doubling the acres used in 2017 for a total of 7,978 acres. It is used for a variety of pests including citrus thrips suppression, ACP, and citricola scale.

In 2018 citrus growers experienced extensive damage from rodents girdling limbs, nesting in trees, and eating fruit. Growers took extra control measures to protect their crops and orchards.

Chlorophacinone and strychnine were used on 113 and 75 percent more orange acres, respectively, while diphacinone was used on 38 percent fewer acres. Timing of rodent control is critical because diphacinone and chlorophacinone grain baits are highly restricted and not allowed during the growing season.

Fungicides are used to prevent Phytophthora gummosis, Phytophthora root rot, and fruit diseases such as brown rot and Septoria spot. These diseases are exacerbated by wet, cool weather during harvest, but the harvest period was relatively dry in 2018. Fungicide use decreased in both pounds and acres treated by 18 percent and nine percent, largely due to reductions in use of copper, potassium phosphite, and imazalil (Figures 21, 22, and A-16).

Weed management is important in citrus groves to prevent competition for nutrients and water, which affects tree growth and reduces yield. Excessive weed growth also impedes production and harvesting operations. Both pre-emergence and post-emergence herbicides, as well as mechanical removal, are used to control weeds. Herbicide use increased in acres and pounds in 2018 by 22 and seven percent, respectively, following a substantial decrease in 2017. Herbicide use has been declining since 2005 (Figure 21). Glyphosate, a post-emergence herbicide, was the most-used herbicide by acres treated, followed by indaziflam, rimsulfuron, saflufenacil, and glufosinate-ammonium (Figure 22). Simazine is widely used for pre- and post-emergence weed management and was second to glyphosate for the most pounds applied. Saflufenacil, a post-emergence, burn-down herbicide first used in 2010, is replacing glyphosate for use on horseweed and fleabane due to resistance. Indaziflam, a pre-emergence herbicide was used on 57 percent more acres in 2018, and with the exception of 2017, its use has been increasing each year since its registration in 2011. Acres treated with Rimsulfuron increased by 72 percent in 2018 (Figures 21, 22, and A-16).

The use of the biopesticide kaolin clay increased in 2018. Kaolin, a white nonabrasive fine-grained mineral that is sprayed on plants to form a particle film, is used as a fungicide and insecticide and as a sunburn protection. A recent study in Brazil investigated the influence of two kaolin formulations on the landing and feeding behavior of ACP. Both kaolin formulations had a repellent effect and interfered with the feeding behavior of ACP on citrus. Kaolin reduced the number of psyllids and protected the citrus plants from insect feeding. Kaolin use increased 20 percent by pounds and 31 percent by acres in 2018. Potassium phosphite is a biopesticide that is used as a fungicide, effective for Alternaria brown spot. Its use decreased 65 percent by pounds applied and 60 percent by treated acres in 2018, similar to its use prior to 2017.

Peach and nectarine

California produced about 73 percent of all U.S. peaches, including 48 percent of fresh market peaches and 95 percent of processed peaches, and almost 100 percent of nectarines in 2018. Most freestone peaches and nectarines are grown in Fresno, Tulare, and Kings Counties in the central San Joaquin Valley and sold on the fresh market. Clingstone peach, largely grown in the Sacramento Valley, is exclusively canned and processed into products such as baby food, fruit salad, and juice (Figure A-18). Peach and nectarine are discussed together because pest management issues for the two crops are similar.

The price per pound in Table 27 is an average of the prices of peach and nectarine, weighted by their respective acreages. Due to the wide variation in individual prices, it is best to consult USDA and CDFA for specific prices.

Table 27: *Total reported pounds of all active ingredients (AI), acres treated, acres bearing, and prices for peach and nectarine each year from 2014 to 2018. Bearing acres and marketing year average prices are from USDA(d), 2016-2019. Acres treated means cumulative acres treated (see explanation p. 13).*

Pounds/Acres/Prices	2014	2015	2016	2017	2018
Pounds AI	3,619,099	4,378,984	4,648,063	4,500,795	4,477,028
Acres Treated	1,397,734	1,466,825	1,566,658	1,620,771	1,658,889
Acres Bearing	65,000	63,000	57,200	55,300	50,000
Price/ton	$ 670.95	$ 674.06	$ 690.60	$ 759.44	$ 704.80

Cumulative peach and nectarine acreage treated with pesticides increased just over two percent in 2018, but the total pounds of AI used showed a slight decrease (0.5 percent decrease). Bearing acres continued decreasing, with a reduction of about ten percent in 2018 (Table 27). The use of insecticides and herbicides increased in 2018, with herbicides showing the highest percentage change in acres treated of about 16 percent compared to 2017. Fungicide use, on the other hand, decreased by about three percent (Figure 23).

The top five insecticides by acres treated included oil, esfenvalerate, chlorantraniliprole, spinetoram, and lambda-cyhalothrin (Figure 24). Oil was used on the most cumulative acreage in 2018 and its use increased by five percent. Oils are applied prophylactically during the dormant season or during the growing season to prevent outbreaks of scales, mites, and moth species (Figure A-20). Esfenvalerate, an insecticide, ranked second to oil for the most treated acreage, increasing by 13 percent. This insecticide is mostly used in peaches as control for peach twig borer during the dormant season. The acres treated with chlorantraniliprole, an insecticide that controls many moth species, decreased by eight percent. Acres treated with spinetoram remained relatively constant (0.20 percent increase). Spinetoram is applied to control moths, katydids, and thrips. Acres treated with lambda-cyhalothrin, a pyrethroid, increased by nine percent.

Acres treated with herbicides increased by 16 percent (Figure 23). The top five herbicides by acreage were glyphosate, glufosinate-ammonium, oxyfluorfen, rimsulfuron, and pendimethalin. All increased in 2018 (Figures 24 and A-19). Pre-emergence herbicides such as oxyfluorfen, pendimethalin, and rimsulfuron are applied to soil before the growing season to prevent weed germination. Post-emergence herbicides, such as glyphosate, kill existing weeds on contact. Glufosinate-ammonium use has been continually increasing over the last few years, with a 24 percent increase in acres treated in 2018. Glufosinate-ammonium is a broad-spectrum herbicide that has gained popularity in recent years because of its ability to control glyphosate-resistant weed species.

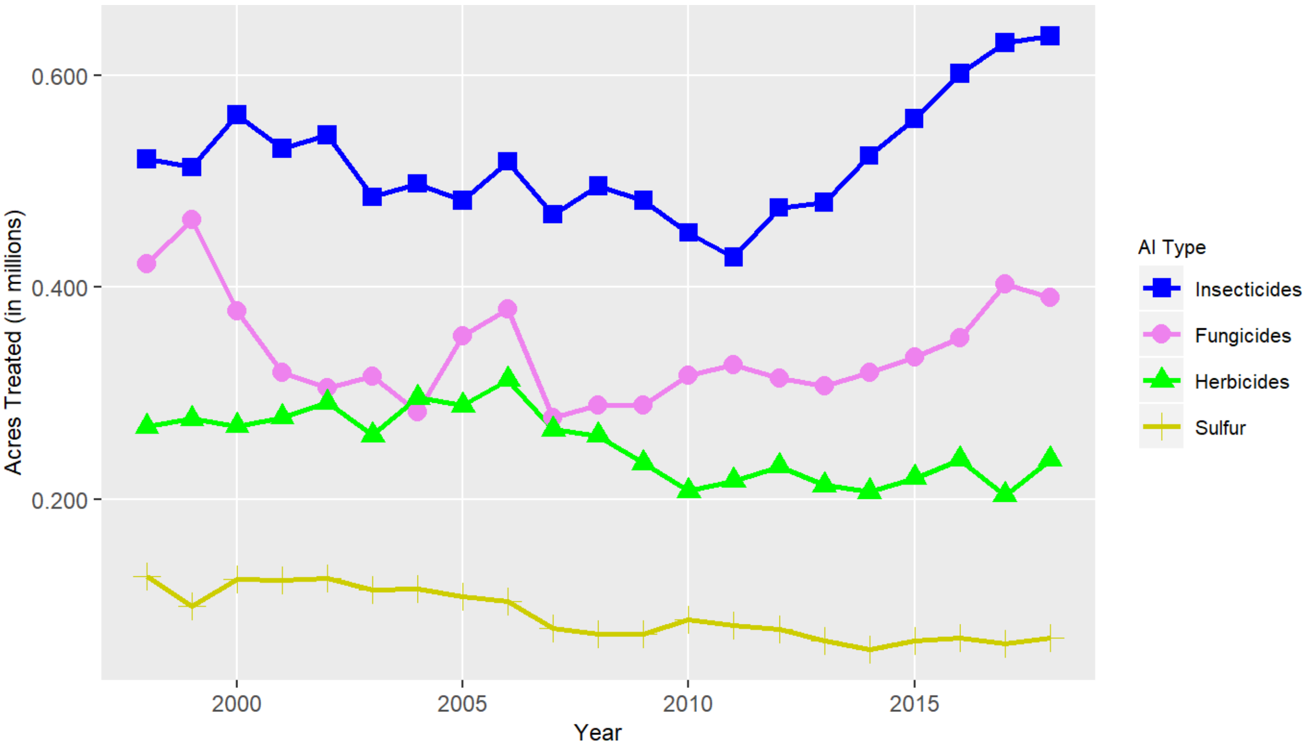

Figure 23: *Acres of peach and nectarine treated by all AIs in the major types of pesticides from 1998 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Cumulative acreage of peach and nectarine orchards treated with fungicides during 2018 decreased by three percent. (Figure 23). Brown rot, powdery mildew, scab, and rust are the top diseases for peach and nectarine. The top five fungicides by acres treated included propiconazole, ziram, copper, pyraclostrobin, and cyprodinil. Acres treated with each of the first four decreased in 2018, while cyprodinil increased by 34 percent (Figure 24). Brown rot is the chief cause of postharvest fruit decay and propiconazole, cyprodinil and pyraclostrobin are all used as treatment against this pathogen. Copper and ziram are usually used during the dormant period to treat prophylactically against shot hole disease.

The use of sulfur, which acts both as insecticide and fungicide, decreased by two percent in 2018 (Figure 24). As a fungicide, sulfur is used mainly against rust, with applications during the spring. As an insecticide, the main use of sulfur in peach orchards is against the peach silver mite, especially in organic orchards.

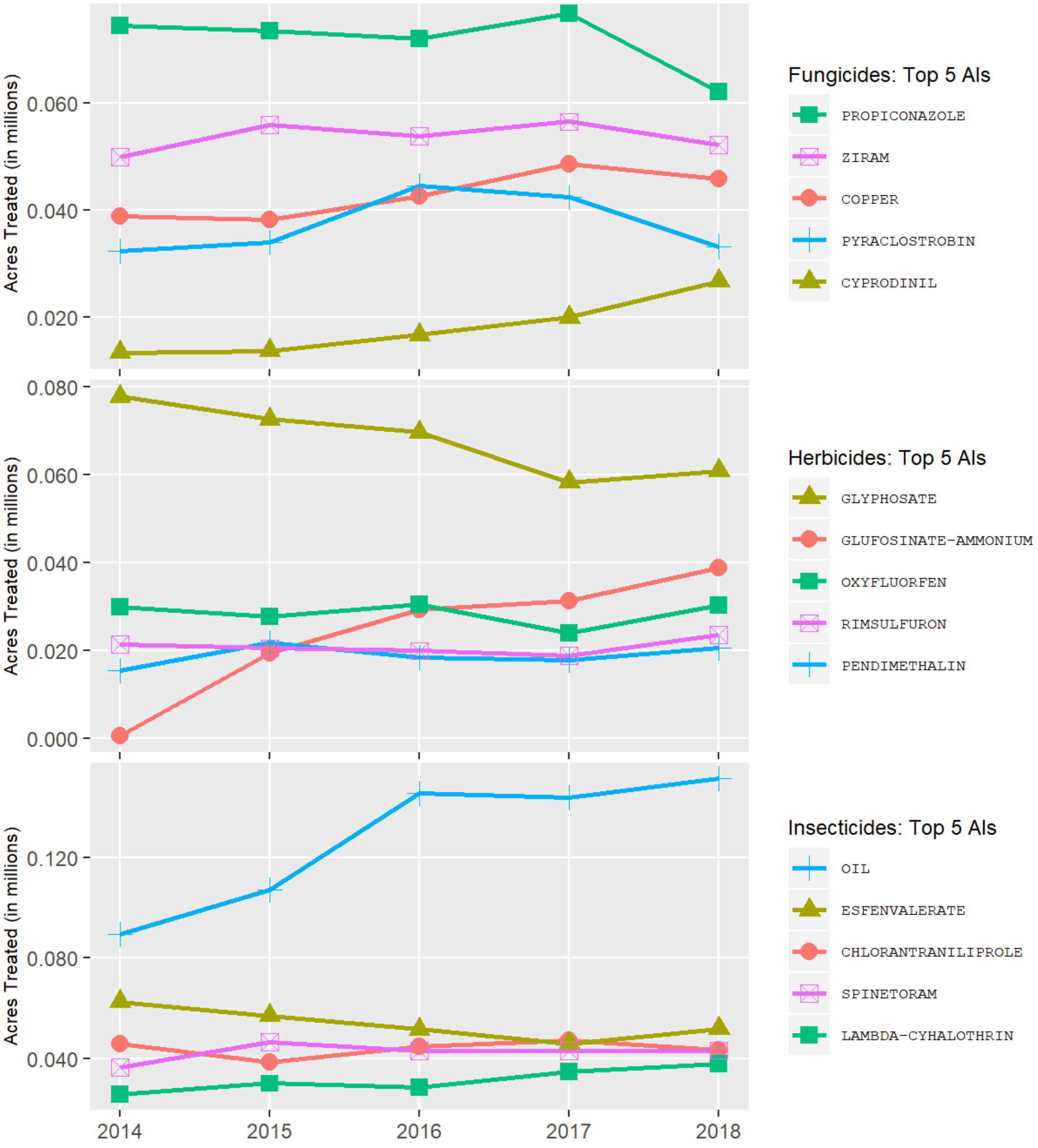

Figure 24: *Acres of peach and nectarine treated by the top five AIs of each AI type from 2014 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Pistachio

Pistachio is grown in 22 counties, from San Bernardino County in the south, to Tehama County in the north. Ninety-eight percent of the bearing acreage is in the central and southern San Joaquin Valley counties of Kern, Madera, Merced, Kings, Fresno, and Tulare, while most of the remainder is distributed in the Sacramento Valley and centered around Colusa County (Figure A-21). Climate changes significantly from south to north within the Central Valley, which contains the San Joaquin and Sacramento valleys. The south to north climate gradient significantly affects pest pressure and pesticide use. For example, navel orangeworm pressure is high in the south but nonexistent in the north where fungal pathogens replace it as a significant concern.

In 2018, California accounted for 264,000 bearing acres of pistachio, or 99 percent of the U.S. crop (Table 28). Production in California was a record 987 million pounds, up 65 percent from 2017 which was both an off-year for this alternate bearing nut tree, and a year in which very high naval orangeworm pressure reduced the duration of the harvest (number of shakes). Additionally, because of the insecticide applications described below, growers were able to harvest a second and, occasionally, a third shake which increased production. The price received per pound increased by 57 percent due to reduced competition with Iran, which suffered significant weather-induced crop losses. Reported bearing acreage increased six percent from 2017 to 2018. However, data for reported acreage and the annual rate of growth of bearing acreage are no longer as accurate as they have been. That change is the result of an estimated 30,000 non-bearing acres, planted between 2011 and 2016, that have potentially been affected by a rootstock problem that results in pistachio bushy top syndrome. There are no accurate data for how much of that acreage has been removed and replanted.

Table 28: *Total reported pounds of all active ingredients (AI), acres treated, acres bearing, and prices for pistachio each year from 2014 to 2018. Bearing acres and marketing year average prices are from USDA(d), 2016-2019. Acres treated means cumulative acres treated (see explanation p. 13).*

Pounds/Acres/Prices	2014	2015	2016	2017	2018
Pounds AI	4,856,138	7,818,009	5,185,532	5,449,465	5,820,948
Acres Treated	3,767,178	4,311,511	4,912,009	5,236,407	6,061,791
Acres Bearing	221,000	233,000	239,000	250,000	264,000
Price/lb	$ 3.57	$ 3.29	$ 1.68	$ 1.69	$ 2.65

Acres treated with pesticides increased 16 percent from 2017 to 2018 due to the prophylactic response to the large number of nuts remaining on tree after the 2017 harvest (known as mummy nuts) that were infested with naval orangeworm, the expanding range of Gill's mealybug, the European Union's extension of the maximum residual level standard for phosphite-containing products, and the intensification and diversification of herbicide use to reduce the selective pressure for glyphosate resistance in weeds.

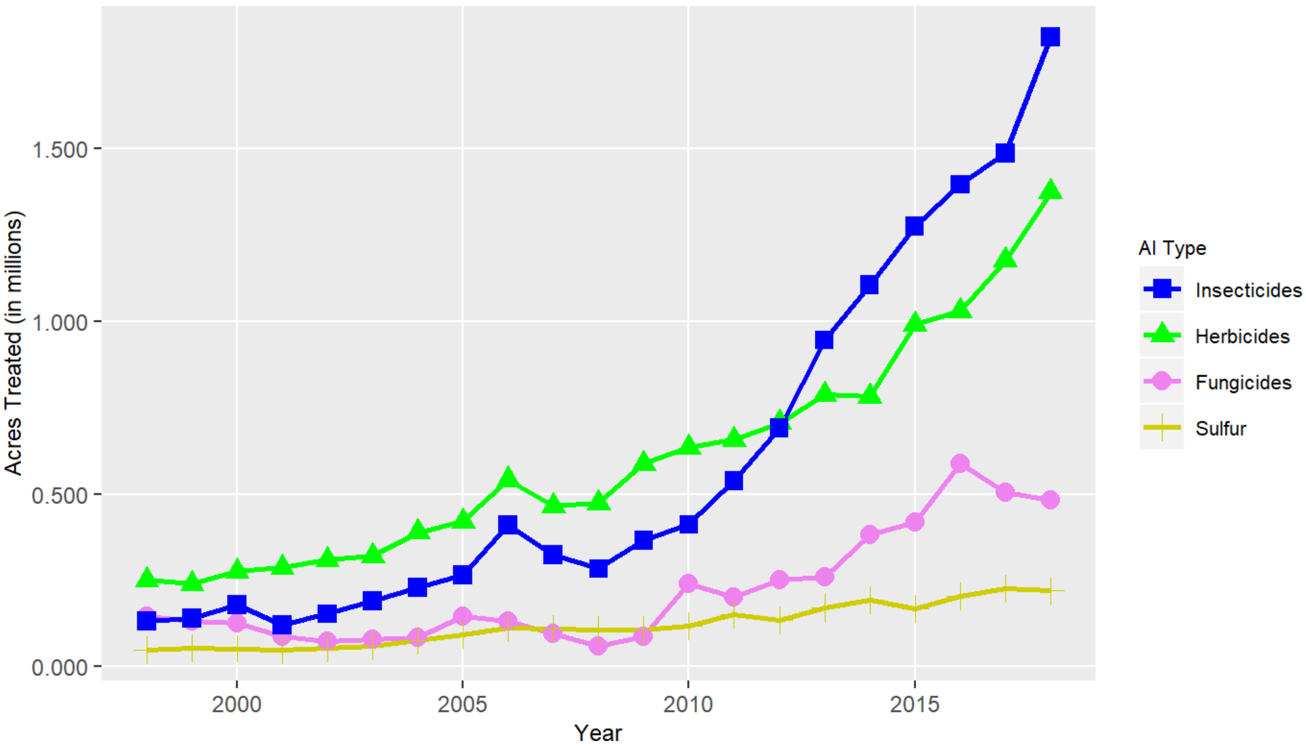

Figure 25: *Acres of pistachio treated by all AIs in the major types of pesticides from 1998 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

In 2018, important arthropod pests of pistachio included mites, leaffooted plant bugs, false chinch bug, stink bugs, San Jose scale, Gill's mealybug, and navel orangeworm. Acres treated with insecticides (including miticides) increased by 23 percent compared to the previous year (Figure 25). The top five insecticides by acres treated also increased: lambda-cyhalothrin (11 percent), bifenthrin (14 percent), chlorantraniliprole (44 percent), methoxyfenozide (77 percent), and spinetoram (38 percent), with most of the treated acreage targeting navel orangeworm in the San Joaquin Valley (Figure 26).

Feeding by leaffooted plant bugs (a complex of three *Leptoglossus* species) shortly after the April bloom can cause lesions on the expanding nuts, which leads to kernel necrosis after the shell hardens in June. Growers often preemptively apply insecticides such as lambda-cyhalothrin and bifenthrin before the bugs cause damage. Spring use of both of these insecticides began in April (Figures 25, A-22, and A-23). Buprofezin, used to control San Jose scale and Gill's mealybug, was applied in April. Acetamiprid and imidacloprid are also used to control Gill's mealybug and were applied from May through August. Acres treated with acetamiprid increased by 200 percent but acres treated with imidacloprid decreased by 50 percent. Early season insect control in pistachio contributes to disease management by reducing the impacts of pathogenic fungi on trees and nuts by killing the insect vectors of those diseases and by reducing insect-caused tissue damage which makes it harder for fungi to infect trees and nuts.

Navel orangeworm damages nuts in August (third generation) and September (fourth generation). Insecticide applications generally target the larvae of these two generations as they hatch beginning in late July through mid-September (Figure A-23). However, in 2018, because navel orangeworm pressure was anticipated to be high because of the carryover of infested mummy nuts from 2017, some growers responded by applying insecticides in May. The usual July through September amount of acres treated with lambda-cyhalothrin, bifenthrin, chlorantraniliprole, methoxyfenozide, and spinetoram increased dramatically. In addition, acres treated with the pyrethroid (s)-cypermethrin increased by 319 percent and the mating disruption pheromone, (Z,Z)-11,13-hexadecadienal, applied in April, increased by 79 percent. As more earlier-ripening cultivars transition to bearing acreage, significantly less exposure of the nuts to navel orangeworm in the San Joaquin Valley is expected. That reduced exposure should lead to observable changes in insecticide and fungicide use in the coming years.

Sulfur, used as a low-risk miticide, is applied at several pounds per acre once per season, and is used to manage citrus flat mite. The acres treated with sulfur decreased by 3 percent (Figure 25). The mites feed on the stems of nut clusters as well as the nut hulls and nuts themselves, which can lead to shell stain. As the weather warms up in May, mite populations thrive and peak in late July and August. Sulfur is applied May through August to control those populations (Figure A-23).

In 2018, the acres treated with herbicides increased by 17 percent (Figure 25). The top five herbicides by acres treated all increased except for saflufenacil: glyphosate (13 percent), glufosinate-ammonium (45 percent), oxyfluorfen (23 percent), saflufenacil (- 5 percent), and paraquat dichloride (14 percent) (Figure 26). A significant portion of the increased use of glufosinate-ammonium, oxyfluorfen, and paraquat dichloride was to manage glyphosate resistance in weeds. The peak use of glyphosate, glufosinate-ammonium, saflufenacil, and paraquat dichloride occurs April through November. Oxyfluorfen's peak use is from November through February when it is used as a pre-emergence herbicide, but it is also used as a post-emergence herbicide the rest of the year.

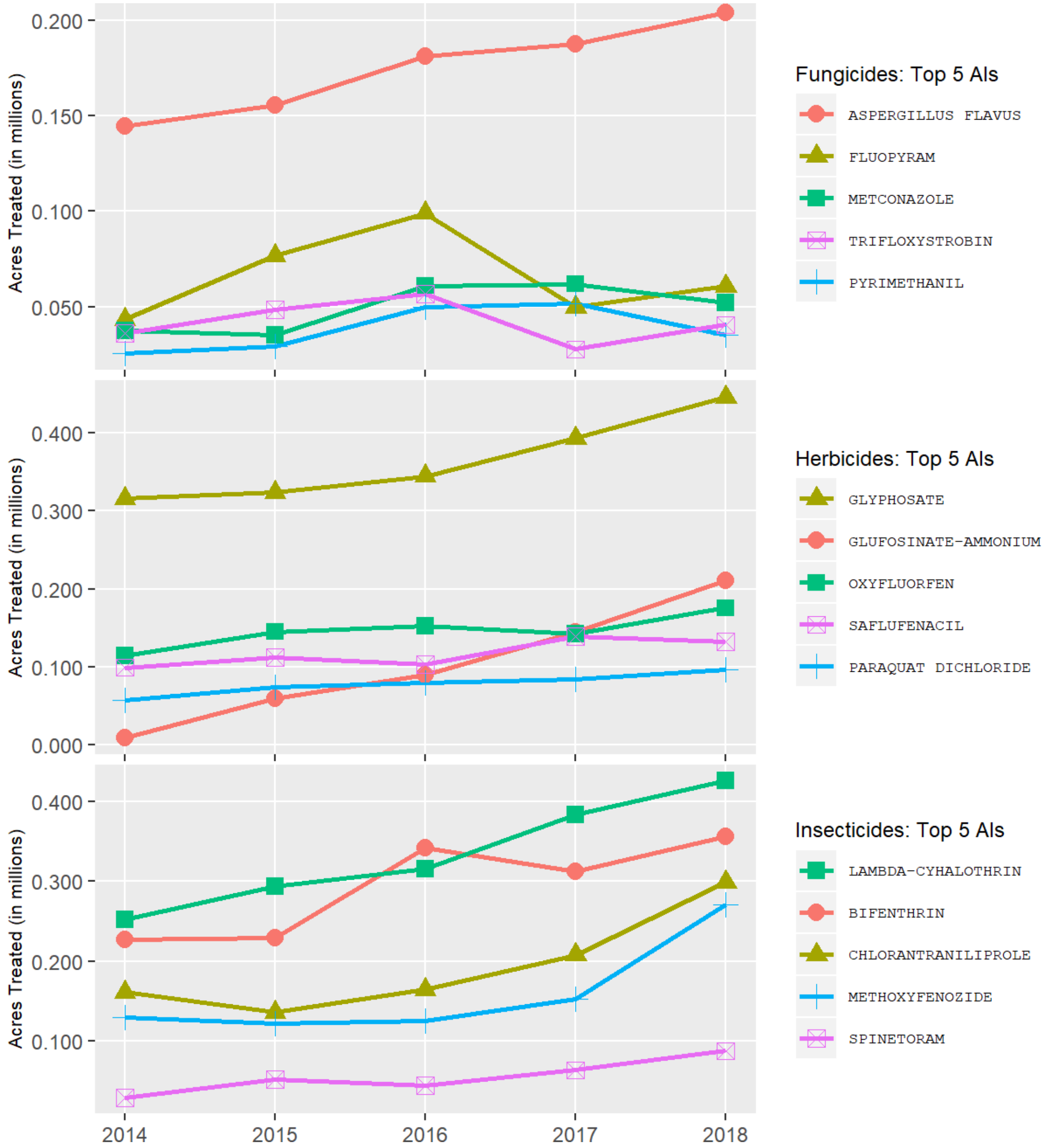

Figure 26: *Acres of pistachio treated by the top five AIs of each AI type from 2014 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

The acres treated with fungicides dropped by four percent (Figure 25). The top five fungicides by acres treated included *Aspergillus flavus*, strain AF36, fluopyram, metconazole, trifloxystrobin, and pyrimethanil (Figure 26). Fungicide use tends to vary annually with efforts to minimize the evolutionary rate of resistance (Figure 26), particularly for *Alternaria alternata* (late-blight) and Botryosphaeria sp. (panicle and shoot blight). Use of *Aspergillus flavus*, strain AF36, continued to rise, with a nine percent increase in acres treated. It is a fungal inoculant that acts as a biological control agent and prevents contamination of nuts by aflatoxins. The aflatoxin-producing fungi, a complex of *Aspergillus flavus* and *A. parasiticus*, grow on pest-damaged nuts. Aflatoxins are both toxic and carcinogenic. About half of the strains of *A. flavus* found in the orchard are atoxigenic – that is, they do not produce aflatoxin. However, almost all *A. parasiticus* strains produce aflatoxins. When applied to orchards, the atoxigenic strain of *A. flavus*, AF36, prevents aflatoxin-producing strains from establishing and significantly reduces aflatoxin levels in harvested nuts. The ratio of fungicide acres treated to bearing acreage is highest in the Sacramento Valley, lower in the central San Joaquin Valley, and lowest in the southern San Joaquin Valley.

Processing tomato

In 2018, processing tomato growers planted 241,000 acres, yielding 12.3 million tons, a 17 percent yield increase from 2017. About 95 percent of U.S. processing tomatoes are grown in California. The U.S. is the world's top producer of processing tomatoes, contributing 34 percent of total production, followed by the European Union and China. California processing tomatoes, valued at $970 million in 2018, are primarily grown in the Sacramento and San Joaquin Valleys (Figure A-24). Fresno County leads the state in acreage with 32 percent (78,000 acres) of the statewide total, followed by Yolo County (34,000 acres), Kings County (26,000 acres), and San Joaquin County (19,000 acres). Significant production also occurs in Merced, Colusa, Kern, Stanislaus, and Solano counties.

Table 29: *Total reported pounds of all active ingredients (AI), acres treated, acres planted, and prices for processing tomato each year from 2014 to 2018. Planted acres are from USDA(f), 2019; marketing year average prices are from USDA(e), 2016-2019. Acres treated means* *cumulative acres treated* *(see explanation p. 13).*

Pounds/Acres/Prices	2014	2015	2016	2017	2018
Pounds AI	15,007,230	15,165,941	13,997,992	9,969,311	12,029,198
Acres Treated	3,701,499	4,047,856	3,522,972	2,803,077	2,909,818
Acres Planted	292,000	299,000	262,000	230,000	241,000
Price/ton	$ 98.6	$ 93.0	$ 86.3	$ 81.0	$ 79.0

Total cumulative treated acres of processing tomatoes increased four percent in 2018 (Table 29). Sulfur, chlorothalonil, metam-sodium, kaolin clay, and potassium N-methyldithiocarbamate (metam-potassium) accounted for 92 percent of the total pounds of non-adjuvant pesticide AIs applied, while sulfur, imidacloprid, chlorothalonil, trifluralin, and azoxystrobin were applied to the most acreage. The most-used pesticide type as measured by acres treated was insecticides, which decreased two percent (Figure 27). The most-used type as measured by the pounds of AI applied was fungicide/insecticide (mostly sulfur and kaolin clay), which increased 20 percent.

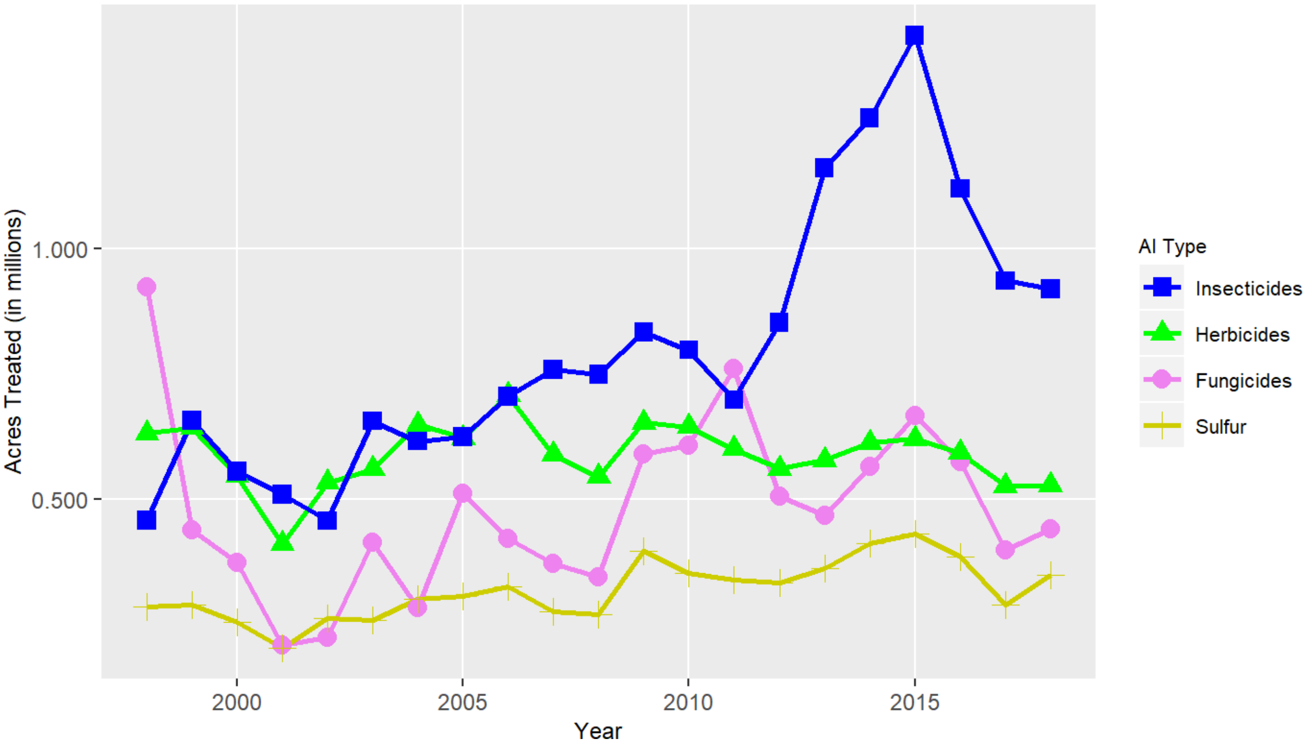

Figure 27: *Acres of processing tomato treated by all AIs in the major types of pesticides from 1998 to 2018. [Data are available](https://files.cdpr.ca.gov/pub/outgoing/pur/data/) at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Overall fungicide use, expressed as cumulative acres treated, increased 11 percent, while pounds of fungicide AI increased 16 percent (Figure 27). The top five fungicides by acres treated included chlorothalonil, azoxystrobin, difenoconazole, pyraclostrobin, and fluxapyroxad (Figure 28). Disease pressure was heavy in processing tomato in 2018: area treated with pyraclostrobin and chlorothalonil increased by 27 percent, and area treated with fluxapyroxad increased by 29 percent. Lower-risk fungicide use increased in 2018, as area treated with kaolin clay and potassium phosphite increased by 66 percent and 24 percent, respectively: however, the biopesticide, *Bacillus amyloliquefaciens* strain D747, decreased over 34 percent.

The area treated with herbicides was nearly unchanged from 2017 (Figure 27); the pounds used increased one percent. The top five herbicides by acres treated included trifluralin, s-metolachlor, glyphosate, rimsulfuron, and oxyfluorfen (Figure 28). Primary weeds of concern for processing tomatoes are nightshades and bindweed. Trifluralin and pendimethalin are used to control bindweed and are often used in combination with s-metolachlor. The area treated with pendimethalin increased one percent, while trifluralin use increased by less than one percent (Figures 28 and A-25). S-metolachlor use decreased by two percent. Glyphosate is commonly used for preplant treatments in late winter and early spring; its use decreased five percent. (Figures 28 and A-26).

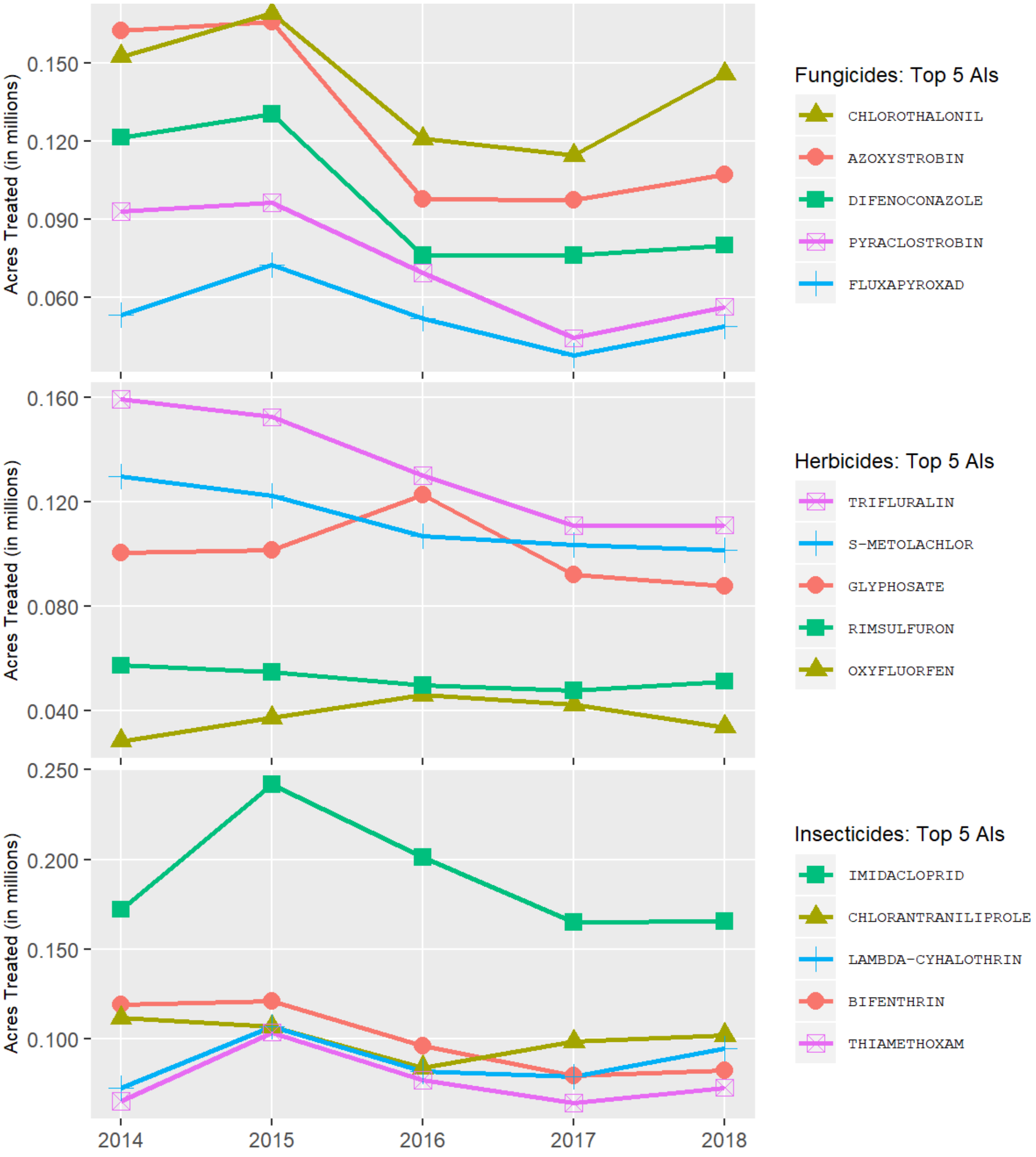

Figure 28: *Acres of processing tomato treated by the top five AIs of each AI type from 2014 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Rice

California is the largest producer of short- and medium-grain rice in the United States and the second largest rice-growing state in the nation, second to Arkansas which produces mostly long-grain rice. Ninety-five percent of the rice in California is grown in six counties in the

Sacramento Valley (Colusa, Sutter, Glenn, Butte, Yuba, and Yolo, Figure A-27). While the acres planted with rice increased by 14 percent, the price decreased by 14 percent (Table 30). The yield of 8,620 pounds per acre was up 2.5 percent from a year earlier when it was the smallest yield since 2012 and 2013.

Table 30: *Total reported pounds of all active ingredients (AI), acres treated, acres planted, and prices for rice each year from 2014 to 2018. Planted acres are from USDA(a), 2015-2019; marketing year average prices are from USDA(c), 2016-2019. Acres treated means cumulative acres treated (see explanation p. 13).*

Pounds/Acres/Price	2014	2015	2016	2017	2018
Pounds AI	4,923,648	4,375,427	5,397,598	4,481,027	4,596,564
Acres Treated	2,657,101	2,607,488	3,149,009	2,580,438	2,910,030
Acres Planted	434,000	423,000	541,000	445,000	506,000
Price/cwt	$ 21.8	$ 18.4	$ 14.3	$ 20.3	$ 17.5

Growers experienced late spring rains that delayed planting by 10 to 14 days. However, high temperatures in July sped growth of the crop and allowed delayed plantings to catch up. Growers harvested 506,000 acres of rice in 2018, which was up from 445,000 acres in 2017, when torrential spring rains and flooded fields caused some growers to plant fewer acres.

Because much of California's rice is grown repeatedly in the same fields and there is a limited number of new herbicide modes of action, herbicide resistance is one of the major production challenges that growers currently face. Yield loss can range from 10 to 82 percent depending on the type of weeds present and the severity of competition. Grasses, sedges, and broadleaf weeds make up the spectrum that challenges California rice production. The most challenging weeds are watergrass, sprangletop, bulrush, and smallflower umbrella sedge. Watergrass, smallflower umbrella sedge, bulrush, and sprangletop are showing some resistance to certain herbicides. Many weed species are difficult to manage and if allowed to grow unimpeded, will severely compete with the rice crop for resources. An integrated pest management approach that incorporates various practices such as planting clean certified seed and leveling the ground is important for rice production. Land leveling allows water for weed suppression to be put on quickly, removed for pinpoint herbicide treatments, and returned efficiently back to the fields. Fields are also monitored and scouted regularly for weeds.

Herbicides were the most-used type of pesticides on rice in terms of acres treated and pounds applied. Pounds of herbicide increased in 2018 by eight percent, and acres treated increased by eleven percent. These increases may be largely due to the increased number of acres planted (Figure 29). Collaborative water monitoring efforts between the California Rice Commission and the thiobencarb registrant has been ongoing since 1995. The top five herbicides by acres treated included propanil, triclopyr (triethylamine salt), thiobencarb, bispyribac-sodium, and halosulfuron-methyl (Figure 30). With the exception of thiobencarb, the top five herbicides by pounds and treated acres all increased in use: Propanil, a post-emergence herbicide, was the most-used rice herbicide in California. Both the pounds applied and the acres treated with propanil increased 11 percent in 2018 (Figures 30 and A-28). Use of thiobencarb decreased in pounds used and acres applied in 2018, but was higher than any year prior to 2016. This high use was probably due to the progressive resistance of sprangletop to clomazone and cyhalofop-butyl. Although bensulfuron methyl increased between 20 to 30 percent in pounds and acres treated, the overall use in 2018 remained relatively low compared with use in the earlier part of the decade. This more recent lower use may have resulted from a 2013 introduction of a product that combined thiobencarb and imazosulfuron and has exhibited excellent control of bensulfuron methyl-resistant sedges. The pounds applied of imazosulfuron increased 28 percent and use has steadily increased since it was first used in 2013. The number of acres treated with halosulfuron-methyl increased 102 percent in 2018 and 144 percent in 2017 due to the registration of a granular herbicide that combines benzobicyclon and halosulfuron-methyl. The number of acres treated with benzobicyclon increased 96 percent in 2018.

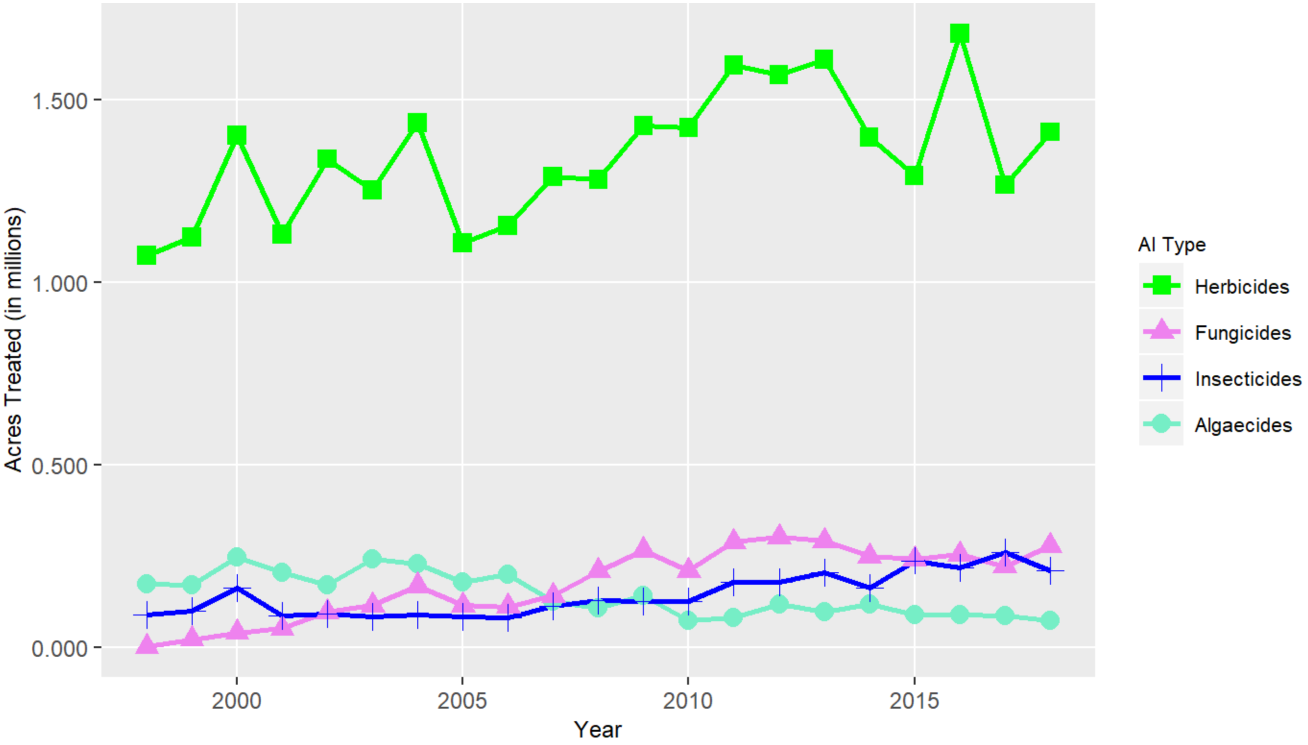

Figure 29: *Acres of rice treated by all AIs in the major types of pesticides from 1998 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Weedy rice (red rice), a close relative of cultivated rice that competes for resources, was reported on more than 10,000 acres in a 2016 survey. This acreage is thought to have remained relatively stable in 2018. The origin and spread of weedy rice is not well understood. Five bio-types were known in 2016 and a sixth type was confirmed in 2018. Currently no herbicides are available to control weedy rice during the season. For larger infestations, glyphosate may be used as a burndown herbicide before seeding or during fallowing. A new granular into-the-water herbicide product that combines two AIs with different modes of action (an HPPD-inhibitor (benzobicyclon), and an ALS-inhibitor (halosulfuron-methyl)) was registered for California use in 2017, and was used on a limited number of acres. It is the first HPPD-inhibitor available to California rice growers. This herbicide will be a new option for resistance management, particularly with herbicide resistant sedges.

Disease problems in California rice tend to be minor, however, some areas can have problems with stem rot and aggregate sheath spot. Blast is sporadic, and during 2018, blast incidence was low. However, kernel smut, usually a minor disease, was severe in the northern part of the Valley. The acres treated with fungicides increased 27 percent (Figure 29) and the pounds applied increased 96 percent in 2018. The acres treated were the highest since 2013. The top five fungicides by acres treated included azoxystrobin, *Reynoutria sachalinensis*, propiconazole, trifloxystrobin, and *Bacillus subtilis*. Azoxystrobin was used on the greatest number of acres, accounting for 89 percent of the acres where fungicide was applied and 18 percent of the pounds. Azoxystrobin, propiconazole, and trifloxystrobin are fungicides often used as preventive treatments.

Copper sulfate (pentahydrate) is the key algaecide AI registered for rice in California. However, algaecides are only used on two percent of the total treated rice acres, and the acres treated in 2018 decreased 22 percent. Copper sulfate (pentahydrate) is used primarily for algal management in rice fields as well as to manage tadpole shrimp in both conventional and organic production. It can bind to organic matter such as straw residue and potentially reduce the algaecide efficacy. Sodium carbonate peroxyhydrate was registered as an alternative to copper sulfate (pentahydrate) to manage algae. However, it has yet to displace copper sulfate (pentahydrate) as the most used algaecide (Figure A-28). Sodium carbonate peroxyhydrate was registered in 2006 and allowed for use in organic rice production. Its use increased 120 percent, the highest since 2014.

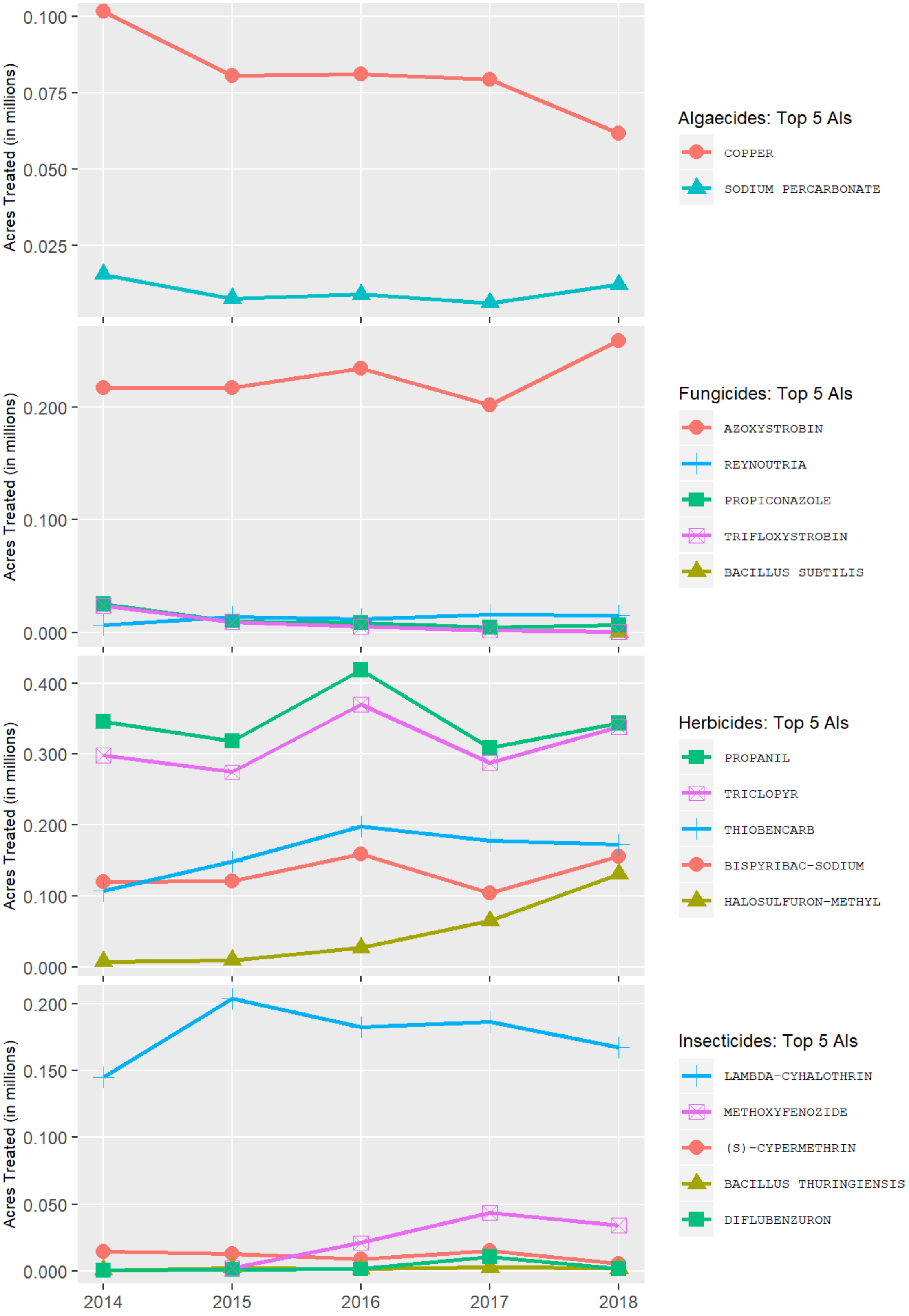

Figure 30: *Acres of rice treated by the top five AIs of each AI type from 2014 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Usually, arthropod pressure on California rice is low, and insecticides are used on relatively few acres (Figure 29). The use of insecticides decreased in 2018 by 19 and 31 percent in acres treated and pounds, respectively. The top five insecticides by acres treated included lambda-cyhalothrin, methoxyfenozide, s-cypermethrin, *Bacillus thuringiensis*, and diflubenzuron (Figure 29).

A severe armyworm outbreak in 2015 caused yield losses ranging from four to twelve percent. In 2015, no registered insecticide was effective in managing the significant outbreak. Multiple applications of different pesticides, predominantly pyrethroids and carbaryl or *Bacillus thuringiensis*, had little effect on the pest. An emergency exemption for a methoxyfenozide-containing product was first issued in 2015, and again in 2016, 2017, and 2018. While armyworms have not reached 2015 levels again, pressure has remained higher than previous decades. Growers rely on area-wide monitoring using pheromone traps to help them time treatments with methoxyfenozide and diflubenzuron.

Several pyrethroids have been used intensively over the last 20 years for rice water weevil (Figures 30 and A-29). Tadpole shrimp are also a major pest, and in some areas, they are the main pest of rice during the seedling stage. Tadpole shrimp are omnivorous crustaceans that cause damage either by chewing on parts of the seedlings or by digging in the soil to lay eggs which creates cloudy water that prevents adequate light penetration. Growers often rely on lambda-cyhalothrin, copper sulfate (pentahydrate), or carbaryl, applied soon after flooding to manage tadpole shrimp.

Strawberry

In 2018, California produced 2.58 billion pounds of strawberries valued at more than $2.3 billion. Market prices determine how much of the crop goes to fresh market and how much is processed, however the bulk of each year's crop goes to fresh market. About 35,900 acres of strawberry were planted in 2018, primarily along the central and southern coast, with smaller but significant production occurring in the Central Valley (Figure A-30 and Table 31).

Table 31: *Total reported pounds of all active ingredients (AI), acres treated, acres planted, and prices for strawberry each year from 2014 to 2018. Planted acres and marketing year average prices are from USDA(d), 2016-2019. Acres treated means cumulative acres treated (see explanation p. 13).*

Pounds/Acres/Prices	2014	2015	2016	2017	2018
Pounds AI	12,282,750	11,810,151	11,346,534	10,983,202	9,632,790
Acres Treated	2,820,800	2,686,649	2,512,769	2,423,631	2,340,970
Acres Planted	41,500	40,500	38,500	39,000	35,900
Price/cwt	$ 88.4	$ 67.7	$ 105.0	$ 103.0	$ 90.9

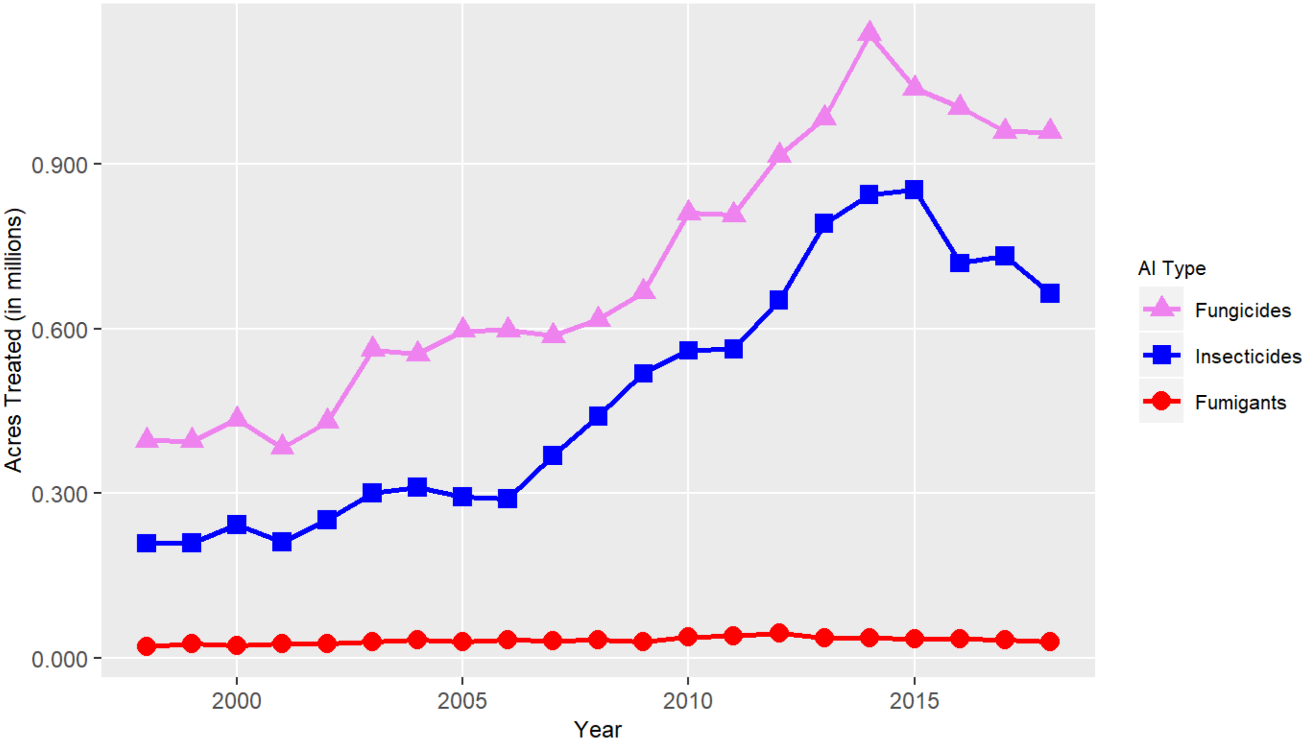

Figure 31: *Acres of strawberry treated by all AIs in the major types of pesticides from 1998 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

The acres treated with insecticides (including miticides) decreased by nine percent in 2018 (Figure 31). The top five insecticides included *Bacillus thuringiensis*, novaluron, flonicamid, bifenthrin, and spinetoram (Figure 32). The major insect pests of strawberry are lygus bugs and worms (various moth and beetle larvae), especially in the Central and South Coast growing areas. Until recently, lygus bugs were not considered a problem in the South Coast, but lygus has become a serious threat probably due to warmer, drier winters and increased diversity in the regional crop complex that includes more crops which support this pest. Flonicamid is an insecticide used to control lygus. Flonicamid was applied to almost nine percent fewer acres in 2018. Overall insecticide pounds decreased by two percent from 2017; pyrethroid pounds decreased by nearly seven percent, while neonicotinoid pounds increased by two percent (Figures 32, A-31, and A-32).

Herbicide use in 2018 increased 27 percent by pounds and 23 percent by acres treated (Figure 31). The primary contributors to the increased acres treated were a 25 percent increase in oxyfluorfen use, a 17 percent increase in pendimethalin, and a 45 percent increase in flumioxazin. Glyphosate joined pendimethalin, oxyfluorfen, carfentrazone-ethyl, and flumioxazin in the top five herbicide AIs by acres treated, increasing in acres treated by 72 percent (Figure 32).

Fungicides continued to be the most-used pesticides in 2018, as measured by acres treated. Overall, acres treated with fungicides did not change from 2017, with most fungicides showing a slight decrease in use. There are a number of different diseases that affect strawberries, including powdery mildew, verticillium wilt, anthracnose, and various rots and leaf spots (Figure 31). Acres treated with sulfur increased, a change of 13 percent from 2017. The top five fungicides by acres treated included captan, sulfur, captan (other related), cyprodinil, and fludioxonil (Figure 32).

Most strawberry fields are treated with fumigants. In 2018, there were 30,161 fumigant-treated strawberry acres, a decrease of 12 percent from 2017 (Figure 31). The top five fumigant AIs by acres treated included chloropicrin, 1,3-dichloropropene, metam potassium (potassium n-methyldithiocarbamate), metam-sodium, and methyl bromide (Figure 32). Acres treated with chloropicrin and 1,3-dichloropropene decreased by 15 percent and 23 percent, respectively, while metam-sodium increased by 66 percent. Metam-sodium is generally more effective in controlling weeds than the other fumigants, but is less effective than 1,3-dichloropropene or 1,3-dichloropropene plus chloropicrin against soil-borne diseases and nematodes.

Fumigants represented less than two percent of the total cumulative acres treated with all pesticide types on strawberry, although they accounted for about 78 percent of all pesticide pounds. Fumigants usually are applied at higher rates than other pesticide types, such as fungicides and insecticides, in part because they treat a volume of space rather than a surface such as leaves and stems of plants. Thus, the amounts applied are large relative to other pesticide types even though the number of applications or number of acres treated may be relatively small.

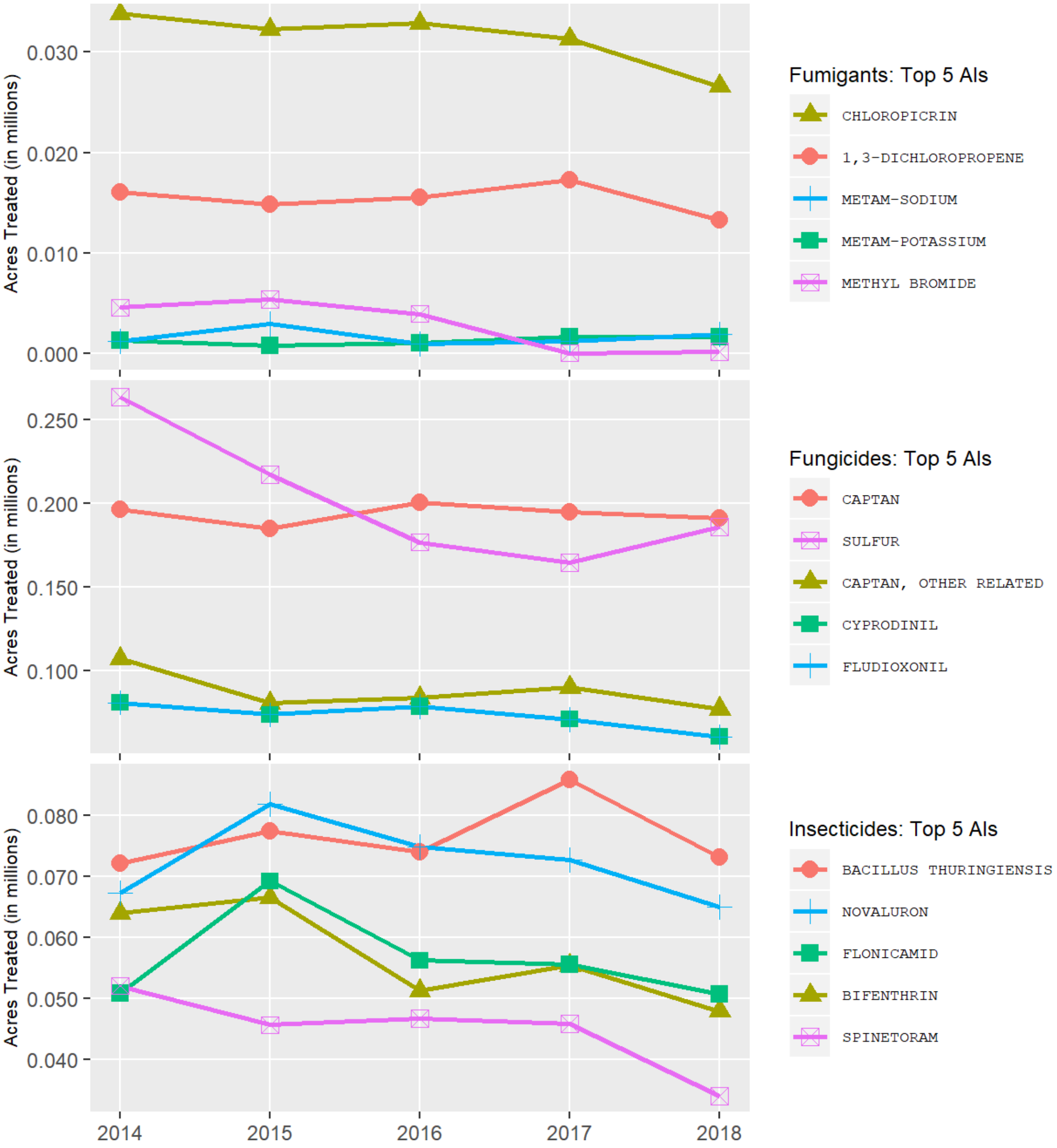

Figure 32: *Acres of strawberry treated by the top five AIs of each AI type from 2014 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Table and raisin grape

The southern San Joaquin Valley region accounts for more than 90 percent of California's raisin and table grape production (Figure A-33). Total acreage planted in table and raisin grapes increased by an estimated 7,000 acres in 2018 due to a 9.1 percent increase in table grape acreage even as raisin grape acreage fell by 2.5 percent. Weighted average prices for table and raisin grapes fell strongly in 2018, dropping over 16 percent to under $700 per ton (Table 32). The California Grape Acreage survey for 2018 found that Thompson Seedless was again the leading raisin grape variety, while Flame Seedless was the leader in table grape variety. Acreage planted for both varieties has been decreasing since at least 2008.

Table 32: *Total reported pounds of all active ingredients (AI), acres treated, acres planted, and prices for table and raisin grape each year from 2014 to 2018. Planted acres are from CDFA(b), 2016-2019; marketing year average prices are from USDA(d), 2016-2019. Acres treated means cumulative acres treated (see explanation p. 13).*

Pounds/Acres/Prices	2014	2015	2016	2017	2018
Pounds AI	15,107,518	14,779,234	15,792,426	15,423,123	14,798,813
Acres Treated	7,115,207	6,868,827	6,971,218	6,702,325	6,481,607
Acres Planted	313,000	310,000	295,000	281,000	288,000
Price/ton	$ 755.60	$ 795.86	$ 720.22	$ 808.43	$ 677.92

The price per ton in Table 32 is an average of the prices of table and raisin grapes, weighted by their respective acreages. Due to the wide variation in prices depending on type and use of the grape, it is best to consult USDA and CDFA for specific prices.

Patterns in pesticide use on table and raisin grapes are influenced by a number of factors, including phenology, weather, topography, pest pressure, evolution of resistance, competition from newer pesticide products, commodity prices, application restrictions, and efforts by growers to reduce costs. It is often difficult to isolate which factors explain particular patterns of use.

Generally, in 2018, pesticide usage fell by both pounds of AI applied and acres treated (four percent and three percent, respectively). Acres treated with sulfur, other fungicides, and herbicides decreased in 2018. There has been a seven-year trend of acres treated with herbicides declining, despite herbicide pounds increasing by six percent in 2018. (Figure 33).

The major arthropod pests in table and raisin grapes continue to be the vine mealybug, leafhoppers, western grape leaf skeletonizer and other Lepidoptera, and spider mites. Vine mealybug has now been found throughout most of the grape growing regions of California.

The two insecticides with the highest use by acreage, imidacloprid (-0.51 percent) and spirotetramat (-one percent), held nearly steady in 2018 (Figure 34), although 29 percent fewer pounds of imidacloprid was applied to these acres. Abamectin (six percent) and methoxyfenozide (five percent) acreage rose slightly following four years of decline. Fifty-eight percent more pounds of oil were applied in 2018, reflecting increasing use as a reduced-risk option. Diatomaceous earth, another reduced-risk pesticide, recorded use for the first time since 2009, with 48,241 pounds applied. Chlorpyrifos use has declined since 2014 but large vine mealybug populations have kept this AI as an important tool for growers.

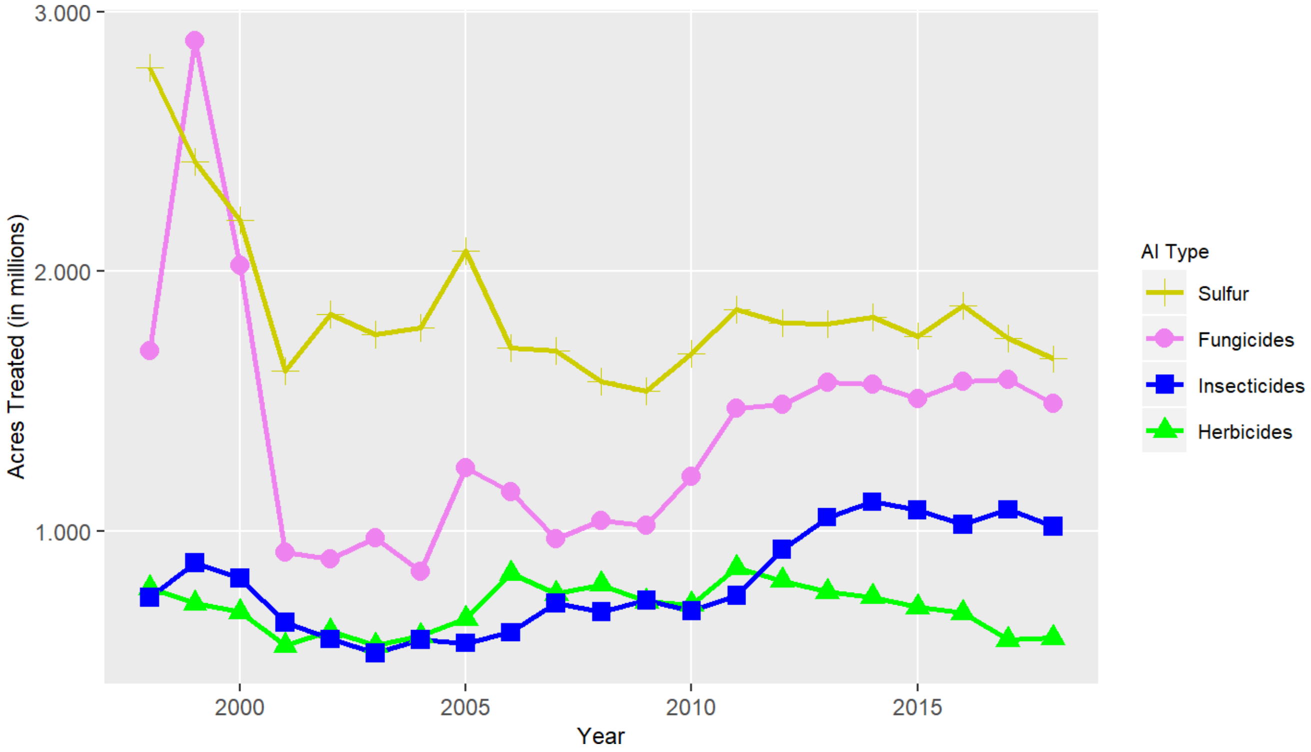

Figure 33: *Acres of table and raisin grape treated by all AIs in the major types of pesticides from 1998 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Following a very heavy rain year in 2016-2017, rainfall totals fell short of average in much of California in 2017-2018. Both acres treated with fungicides and pounds applied decreased six percent in 2018, in part due to the drier than average year (Figure 33). Use of the top five fungicides with the greatest acres treated (copper, tebuconazole, quinoxyfen, myclobutanil, and trifloxystrobin) were similar to use in in 2017, with the addition of trifloxystrobin in place of pyraclostrobin (Figure 34and A-34). Use of all five AIs decreased in total acres in 2018, between three percent and 18 percent. Fluopyram (2012) and cyflufenamid (2013) are recently registered compounds with strong sustained increases year-over-year, with 50 percent and 12 percent more pounds applied, respectively. Much of the pattern of fungicide use across years can be explained by the rotation of AIs as part of a resistance management program. Most applications were in spring to early summer, likely for powdery mildew.

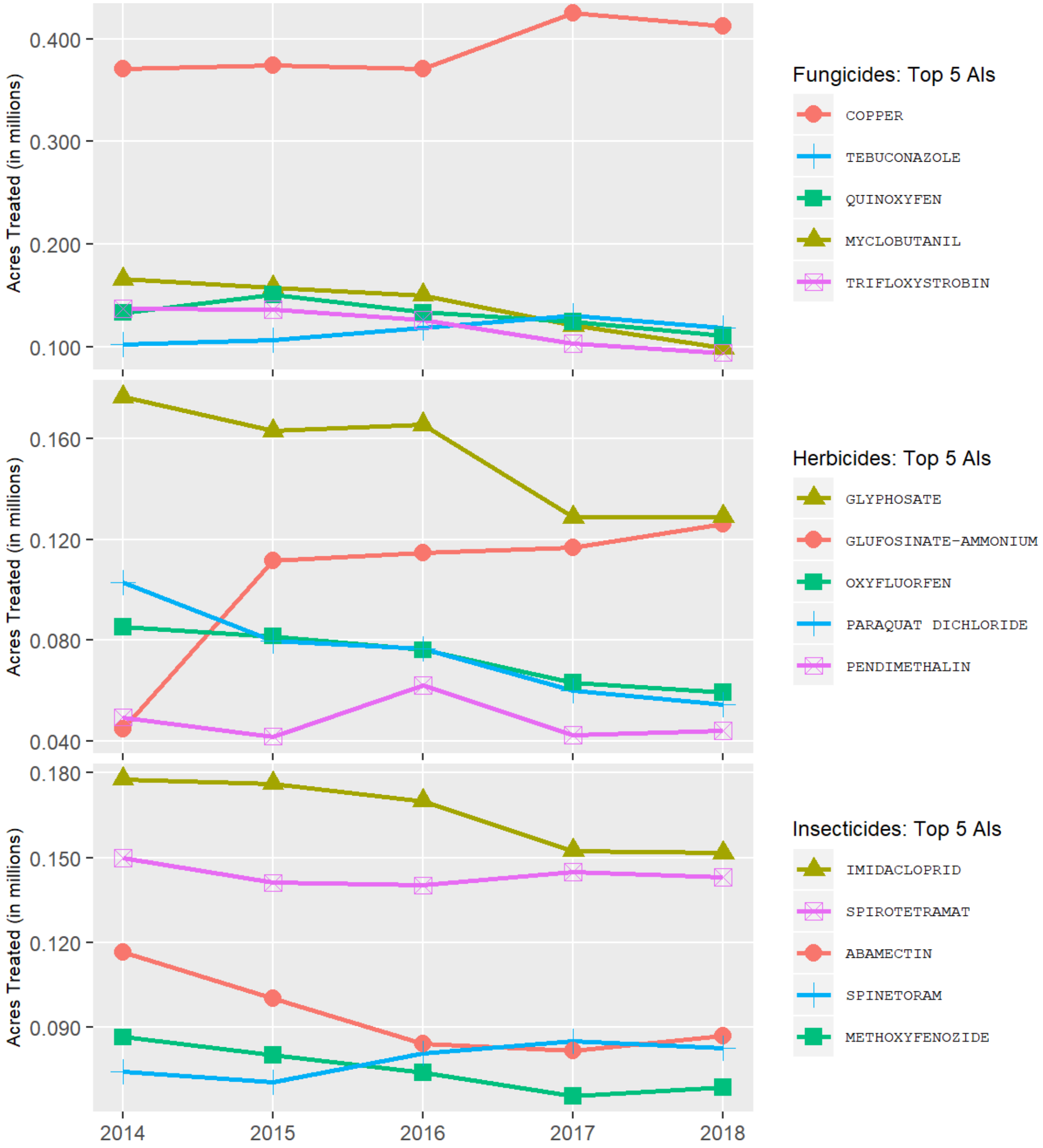

Figure 34: *Acres of table and raisin grape treated by the top five AIs of each AI type from 2014 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

After falling for seven years, applied acreage of herbicide had little change in 2018, likely due to the mild rain year (Figure 33). The top five herbicides by acres treated included glyphosate, glufosinate-ammonium, oxyfluorfen, paraquat dichloride, and pendimethalin, the same as in 2017. Among them, oxyfluorfen (-six percent) and paraquat dichloride (-nine percent) fell (Figure 34). Glufosinate-ammonium reached a five-year high at 126,086 acres, nearly reaching levels not seen since 2011 (169,979). While acres treated with glyphosate changed by only 0.13 percent, pounds applied rose by 13 percent, the first rise since 2013.

Fumigants represented only 0.06 percent of the acres treated with all pesticides in 2018, although they made up five percent of all pesticide pounds applied to table and raisin grapes. Fumigant use decreased strongly by acreage (24 percent) and pounds applied (23 percent) Figure 33). The top five fumigants used by acres treated included 1,3-dichloropropene, metam-potassium (potassium n-methyldithiocarbamate), aluminum phosphide, metam sodium, and chloropicrin (Figure 34). 1,3-dichloropropene made up 96 percent of the 670,244 pounds of total fumigant applied. It declined by 23 percent in pounds applied in 2018, explaining most of the drop in fumigant usage.

The acres treated with plant growth regulators decreased by five percent in 2018 to 421,930 cumulative acres treated, although pounds of plant growth regulators rose by 12 percent to 492,691 pounds. Gibberellins were applied to the most acreage, at 319,086 acres. However, hydrogen cyanamide dominated the pounds of plant growth regulator applied, with 461,707 (up 13 percent from 2017) pounds applied. Gibberellins are applied in early spring to lengthen and loosen grape clusters and increase berry size. Ethephon releases ethylene and is used to enhance fruit ripening in raisin grapes and fruit color in table grapes. Hydrogen cyanamide is applied after pruning to promote bud break. Forchlorfenuron, a synthetic cytokinin, is applied after fruit set to increase the size and firmness of table grapes. Acres treated with forchlorfenuron decreased by 34 percent and pounds applied decreased by 56 percent as growers turned to alternate chemistries.

Walnut

California produces 99 percent of the walnuts grown in the United States. Around 65 percent of the crop is exported to countries such as Germany, Turkey, China, and India. The California walnut industry is comprised of over 4,000 growers who farmed 350,000 bearing acres in 2018 (Table 33 and Figure A-36). According to the 2018 Walnut Objective Measurement Report, cool weather and rains in late spring helped to increase kernel size and quality of nuts, and there was lower insect pest pressure compared to 2017. Walnut production was estimated at 690,000 tons in 2018, a 10 percent increase from the previous year. The price fell by 48 percent, thought by various experts to be due to trade wars with other countries, increased production in China and Chile, and the large harvest in California. The amount of applied pesticides and the acres treated both decreased by almost nine percent, despite a four percent increase in bearing acreage. (Table 33).

Table 33: *Total reported pounds of all active ingredients (AI), acres treated, acres bearing, and prices for walnut each year from 2014 to 2018. Bearing acres and marketing year average prices are from USDA(d), 2016-2019. Acres treated means cumulative acres treated (see explanation p. 13).*

Pounds/Acres/Prices	2014	2015	2016	2017	2018
Pounds AI	5,709,108	6,978,971	7,361,671	8,087,061	7,398,507
Acres Treated	4,031,790	4,843,350	4,980,790	5,607,035	5,126,851
Acres Bearing	290,000	300,000	315,000	335,000	350,000
Price/ton	$ 3,340	$ 1,670	$ 1,850	$ 2,490	$ 1,300

The acres treated with insecticides, which includes miticides, decreased by nine percent (Figure 35), and total insecticide pounds decreased by 23 percent. Important pests for walnuts include codling moth, walnut husk fly, navel orangeworm, aphids and webspinning spider mites. The top five insecticides by acres treated in 2018 were chlorantraniliprole, abamectin, bifenthrin, lambda-cyhalothrin, and acetamiprid (Figure 36). The acres treated with chlorantraniliprole, an anthranilic diamide insecticide for treatment of codling moth, navel orangeworm, and other caterpillars, increased by seven percent since 2017. The pyrethroid lambda-cyhalothrin also increased by seven percent, in part due to its inclusion in some products that contain chlorantraniliprole. Abamectin, a miticide, retained second place in the top five insecticides due to its low cost and continued efficacy, although acres treated with the miticide decreased by five percent. Bifenthrin, a pyrethroid, decreased by eleven percent, and acetamiprid, a neonicotinoid, increased by nine percent (Figures 36 and A-37).

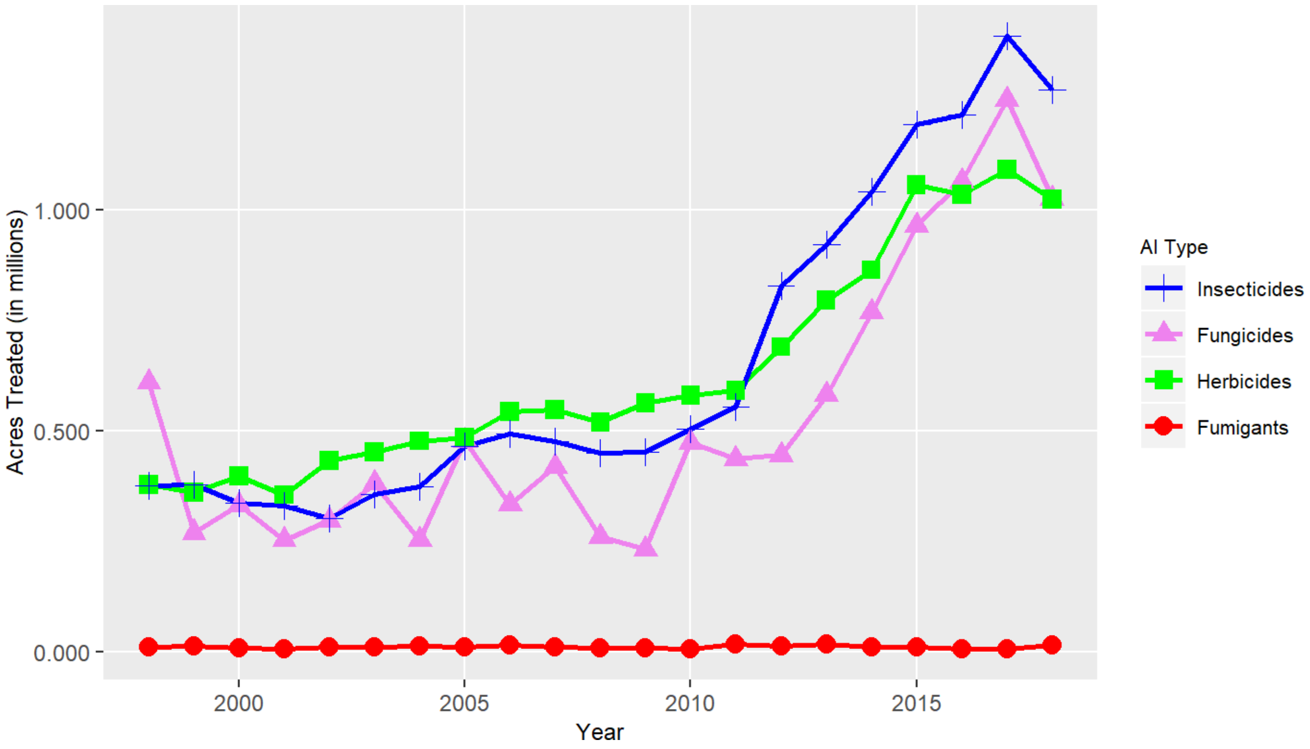

Figure 35: *Acres of walnut treated by all AIs in the major types of pesticides from 1998 to 2018. [Data are available](https://files.cdpr.ca.gov/pub/outgoing/pur/data/) at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

The cumulative acres treated with herbicides remained relatively unchanged from 2017, increasing by two percent (Figure 35), a bit less than the four percent increase in walnut bearing acres. Similar to previous years, glyphosate, oxyfluorfen, glufosinate-ammonium, saflufenacil, and paraquat dichloride were the top five herbicides by acres treated (Figure 36). Glyphosate remained the herbicide with the most use due to its effectiveness at controlling a wide variety of weeds and its relatively low cost. However, reports of glyphosate-resistant weeds continue to surface, causing growers to take measures to delay or prevent resistance. The Sacramento Valley is dominated by glyphosate-resistant ryegrass whereas in the San Joaquin Valley, glyphosate-resistant fleabane and horseweed are more prevalent. In both areas, glyphosate-resistant summer grasses such as junglerice are becoming increasingly important problems. Glufosinate-ammonium and paraquat dichloride are non-selective herbicides that are often used in conjunction with a protoporphyrinogen oxidase (PPO) inhibitor such as saflufenacil or oxyfluorfen as an alternative to glyphosate that can slow or prevent glyphosate resistance. Saflufenacil is less expensive than glufosinate-ammonium and controls broadleaf weeds like fleabane and horseweed, but is not effective on grass weeds. Glyphosate had less than one percent decrease from 2017, remaining largely unchanged. Oxyfluorfen and saflufenacil both decreased by nine percent, and paraquat dichloride decreased by 25 percent of acres treated. Glufosinate-ammonium was the only herbicide in the top five that increased, with eight percent more acres treated than in 2017 (Figures 36, A-37 and A-38).

The acres treated with fungicides decreased by 18 percent (Figure 35). Copper and mancozeb, used for blight control, had the highest use, although both decreased in acres treated by 24 percent. Propiconazole retained its place as third highest acres treated in the top five fungicides, despite a 21 percent decrease. Pyraclostrobin and potassium phosphite (a biopesticide) joined the top five list in 2018, with 25 and 77 percent increases in acres treated, respectively. The increase in potassium phosphite is likely due in part to the extension of the European Union's (EU) maximum residue limit (MRL) for phosphite-containing materials. Potassium phosphite treats a wide range of diseases, including Phytophthora. The EU's earlier stricter controls on phosphites were meant to target phosphites such as fosetyl-al, not potassium phosphite, which is thought to have very low toxicity. The extension of the MRL allowed potassium phosphite to be used on walnuts exported to the EU.

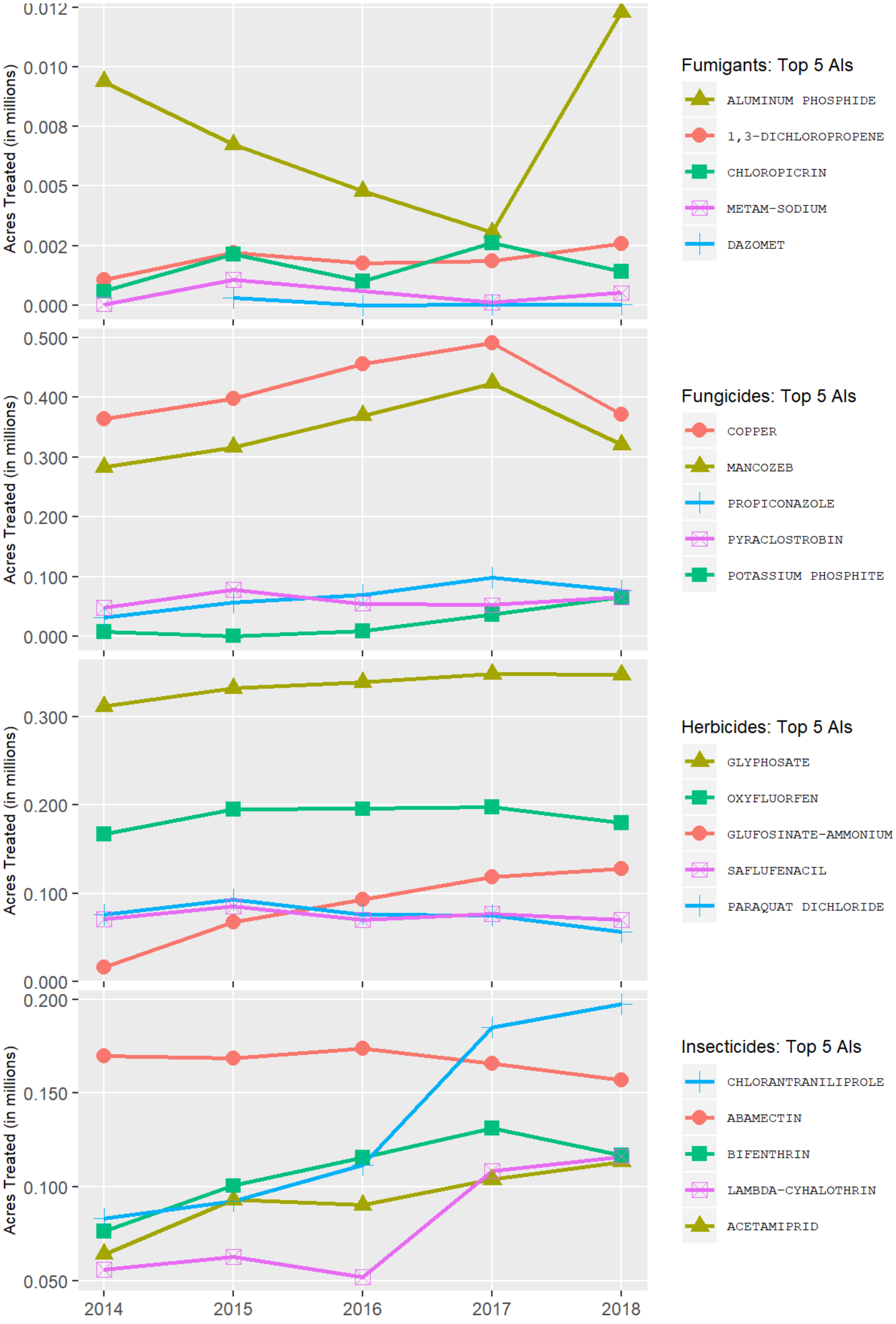

Figure 36: *Acres of walnut treated by the top five AIs of each AI type from 2014 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Wine grape

There are four major wine grape production regions: North Coast (Lake, Mendocino, Napa, Sonoma, and Solano counties); Central Coast (Alameda, Monterey, San Luis Obispo, Santa Barbara, San Benito, Santa Cruz, and Santa Clara counties); northern San Joaquin Valley (San Joaquin, Calaveras, Amador, Sacramento, Merced, Stanislaus, and Yolo counties); and southern San Joaquin Valley (Fresno, Kings, Tulare, Kern, and Madera counties) (Figure A-39).

Table 34: *Total reported pounds of all active ingredients (AI), acres treated, acres planted, and prices for wine grape each year from 2014 to 2018. Planted acres are from CDFA(b), 2016-2019; marketing year average prices are from USDA(d), 2016-2019. Acres treated means cumulative acres treated (see explanation p. 13).*

Pounds/Acres/Prices	2014	2015	2016	2017	2018
Pounds AI	26,802,960	29,550,464	27,795,160	29,467,964	30,345,692
Acres Treated	10,103,488	10,769,194	10,584,748	10,733,065	11,101,106
Acres Planted	615,000	608,000	602,000	599,000	637,000
Price/ton	$ 759	$ 781	$ 905	$ 927	$ 1,010

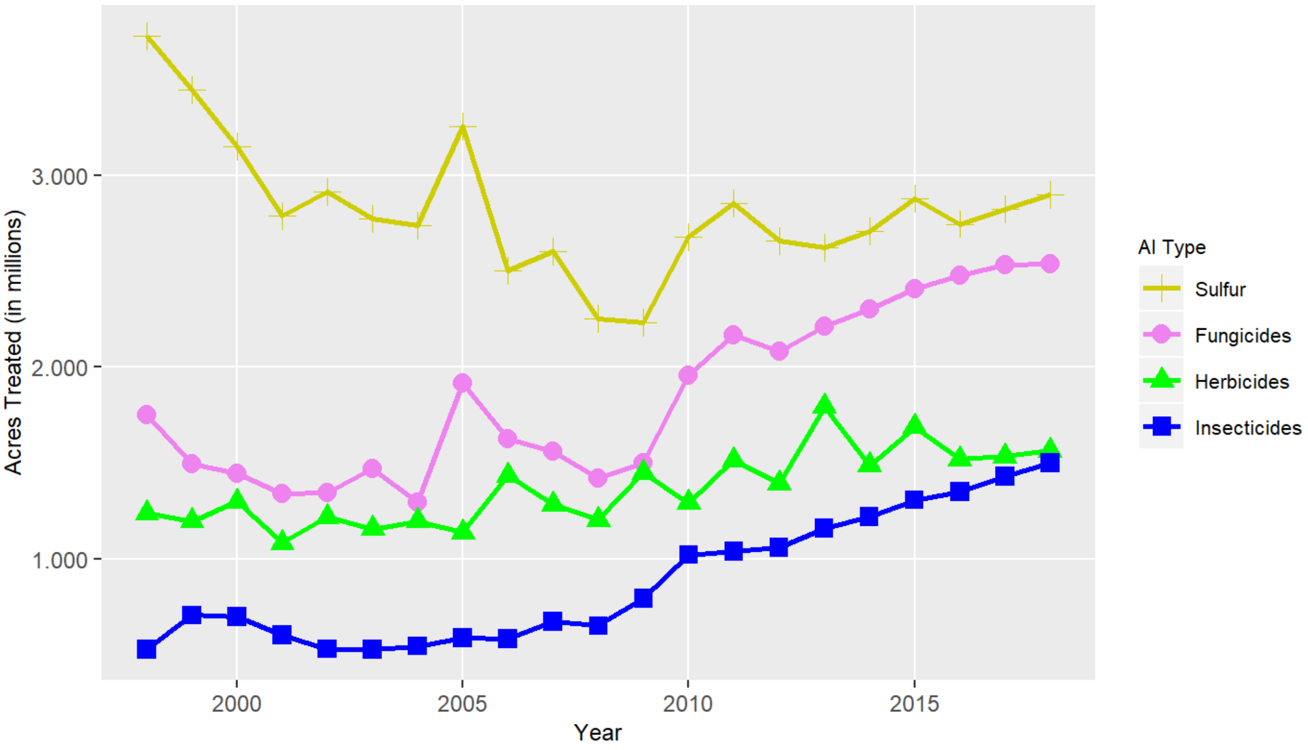

Figure 37: *Acres of wine grape treated by all AIs in the major types of pesticides from 1998 to 2018.* *Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

Changes in pesticide use on wine grape are influenced by a number of factors, including weather, topography, pest pressure, evolution of resistance, competition from newer pesticide products, commodity prices, application restrictions, efforts by growers to reduce costs, and increased emphasis on sustainable farming. It is often difficult to isolate which factors explain particular patterns of use. However, some broad conclusions can be drawn. The California wine grape industry expanded to 637,000 acres in 2018, up from roughly 600,000 from 2015-2017. Correspondingly, total pesticide use rose to over 30 million pounds of AI, and over 11 million acres treated. Price per ton rose above $1,000 for the first time ($1,010).

The total pounds of pesticides applied and the cumulative acres treated in 2018 both increased by three percent (Table 34). The acres treated with sulfur increased by seven percent, while overall use of fungicides had less than one percent change. Herbicides use was also nearly unchanged (-one percent by acreage). Use of fumigants went up 55 percent by weight but down 39 percent by acreage. Insecticide use increased slightly by acreage (5 percent). (Figure 37).

The top five insecticides by both acreage and pounds applied (including miticides) in 2018 included imidacloprid, abamectin, spirotetramat, methoxyfenozide, and oils (Figure 38). Of these five, none changed by more than plus or minus six percent. Vine mealybug continued to be a concern for growers. Since its first detection in California around 1994, it has spread and it is now found throughout most of the grape growing regions of California. Years of warm winters have allowed vine mealybug populations to build up early in the season. Use of mating disruption has been on the rise over the last few years; lavanduyl senecioate, a mealybug pheromone, was used on 115 percent more acreage in 2018 than 2017 after rising the previous year by 268 percent. The increase was largely due to registration in mid-2016 of a new spray formulation, which is less expensive than the dispenser-based products. In the North Coast region, the Virginia creeper leafhopper, a recently introduced pest, continued to cause substantial damage in some locations, as did the western grape leafhopper. While there is effective biological control for western grape leafhopper, Virginia creeper leafhopper infestations require insecticide applications. In this region, these leafhoppers have generally been treated with organic materials (botanical pyrethrins and oils) as well as imidacloprid. Use of chlorpyrifos dropped off sharply in 2011 and remained relatively low ever since, despite some annual increases over the last ten years. Chlorpyrifos was made a restricted material in 2015. However, there is a special local need registration in place for control of grape and vine mealybugs infesting grapes in California. Large vine mealybug populations have kept this AI as an important tool for growers. Chlorantraniliprole, used for Lepidoptera control, increased to an all-time high of 6,924 pounds applied (up 184 percent).

Overall, the cumulative acres treated with fungicides have been increasing since 2012 (Figure 37). The top five fungicides by acres treated included copper, quinoxyfen, tebuconazole, fluopyram, and pyraclostrobin (Figure 38). The 2017 top five list included boscalid but not fluopyram. The 2017-2018 rain year was below average, leading to lower powdery mildew pressure in some areas, and total pounds of fungicide decreased 16 percent from 2017. This decrease is largely due to a 45 percent decrease in potassium bicarbonate usage for powdery mildew as growers had less need and used alternative chemistries to rotate around resistance. Fungicides that were registered in the last two to seven years (fluopyram, cyflufenamid, flutriafol) have been applied on increasing acreage, as might be expected as growers explore new options. A product containing both fluopyram (up 37 percent by acreage) and tebuconazole (up nine percent by acreage) was registered in 2012 and accounts for increases in applications of these AIs. Pyriofenone, a fungicide that targets powdery mildew, was newly registered in 2018 and was used on over 44,000 acres.

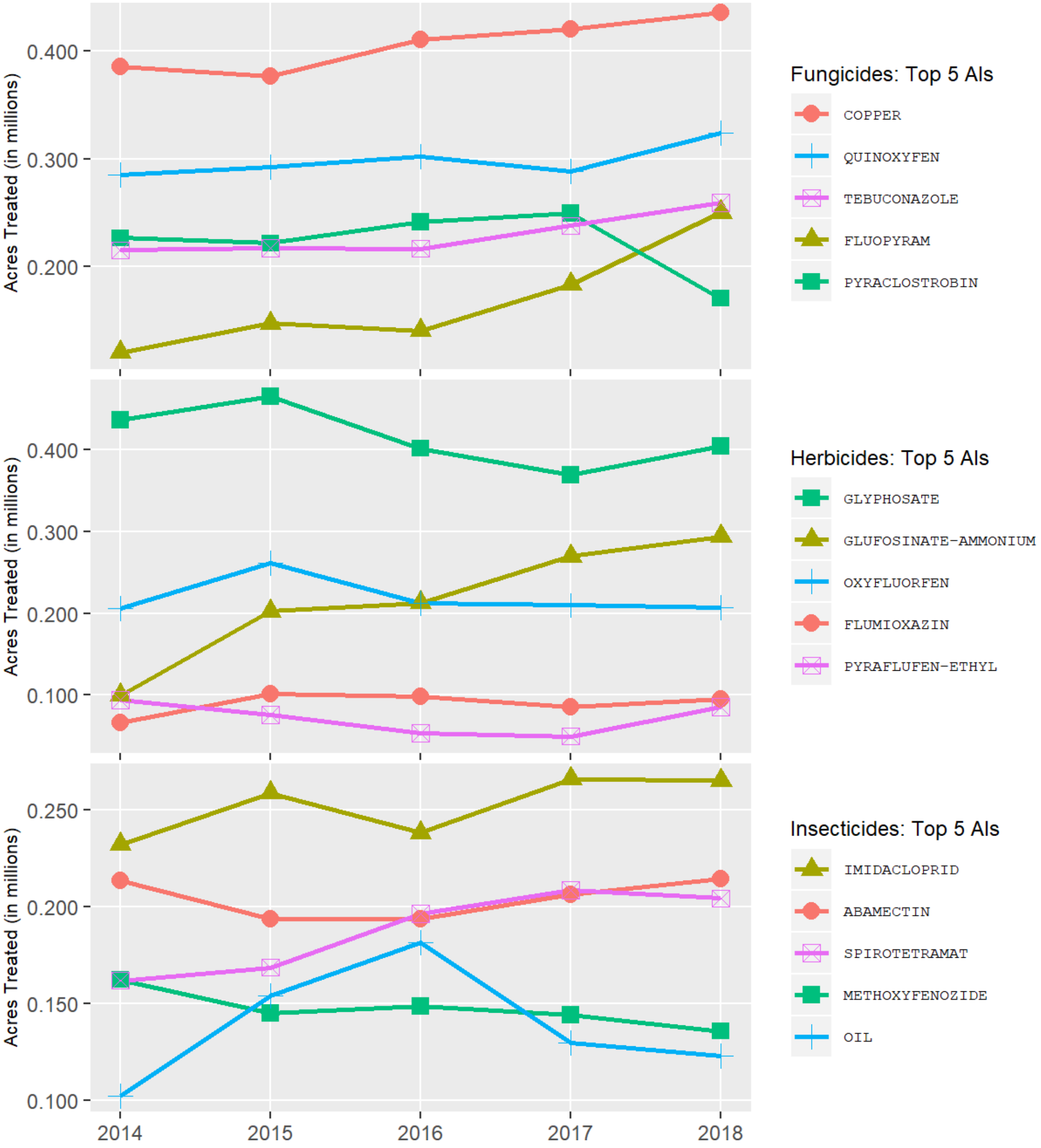

Figure 38: *Acres of wine grape treated by the top five AIs of each AI type from 2014 to 2018. Data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.*

The top five herbicides in acres treated included glyphosate, glufosinate-ammonium, oxyfluorfen, flumioxazin, and indaziflam (Figure 38). Use of paraquat dichloride decreased 13 percent by acreage and 25 percent by pounds. Indaziflam decreased in pounds by 19 percent. Glufosinate-ammonium is a post-emergence contact herbicide used later in the year since, unlike glyphosate, it does not move to actively growing grapevine root tissue. It increased by nine percent by treated acreage and 17 percent by pounds applied.

Fumigant acreage made up only 0.04 percent of acreage treated with all pesticides for wine grapes, but two percent of pounds applied. 1,3-dichloropropene made up 606,881 pounds of the 624,804 total fumigant pounds applied in 2018, an increase of 59 percent from 2017. The top five fumigants by acres treated included aluminum phosphide, 1,3-dichloropropene, chloropicrin, methyl bromide, and metam-potassium (potassium n-methyldithiocarbamate), though the last three fumigants in the list were all under 100 acres (Figure 38). There were 7,442 pounds of methyl bromide used in 2018, the highest amount since 2012. Use of methyl bromide after 2016 is only allowed under the Quarantine and Preshipment exemption (U.S. EPA, 2015).

Gibberellins were by far the most commonly applied plant growth regulator. Acres treated with all plant growth regulators increased by two percent in 2018.

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7 Appendix

Text files of data for all appendix figures <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Figure A-1, PDF: Acres treated by the major AIs from 1999 to 2018.

Figure A-2, PDF: Acres treated by the major AIs and crops in 2018.

Figure A-3, JPG: Number of pesticide applications in alfalfa by township in 2018.

Figure A-4, PDF: Acres of alfalfa treated by the major AIs from 1999 to 2018.

Figure A-5, PDF: Acres of alfalfa treated by the major AIs by month and AI type from 2015 to 2018.

Figure A-6, JPG: Number of pesticide applications in almond by township in 2018.

Figure A-7, PDF: Acres of almond treated by the major AIs from 1999 to 2018.

Figure A-8, PDF: Acres of almond treated by the major AIs by month and AI type from 2015 to 2018.

Figure A-9, JPG: Number of pesticide applications in carrot by township in 2018.

Figure A-10, JPG: Acres of carrot treated by the major AIs from 1999 to 2018.

Figure A-11, PDF: Acres of carrot treated by the major AIs by month and AI type from 2015 to 2018.

Figure A-12, JPG: Number of pesticide applications in cotton by township in 2018.

Figure A-13, PDF: Acres of cotton treated by the major AIs from 1999 to 2018.

Figure A-14, PDF: Acres of cotton treated by the major AIs by month and AI type from 2015 to 2018.

Figure A-15, JPG: Number of pesticide applications in orange by township in 2018.

Figure A-16, PDF: Acres of orange treated by the major AIs from 1999 to 2018.

Figure A-17, PDF: Acres of orange treated by the major AIs by month and AI type from 2015 to 2018.

Figure A-18, JPG: Number of pesticide applications in peach and nectarine by township in 2018.

Figure A-19, PDF: Acres of peach and nectarine treated by the major AIs from 1999 to 2018.

Figure A-20, PDF: Acres of peach and nectarine treated by the major AIs by month and AI type from 2015 to 2018.

Figure A-21, JPG: Number of pesticide applications in pistachio by township in 2018.

Figure A-22, PDF: Acres of pistachio treated by the major AIs from 1999 to 2018.

Figure A-23, PDF: Acres of pistachio treated by the major AIs by month and AI type from 2015 to 2018.

Figure A-24, JPG: Number of pesticide applications in processing tomato by township in 2018.

Figure A-25, PDF: Acres of processing tomato treated by the major AIs from 1999 to 2018.

Figure A-26, PDF: Acres of processing tomato treated by the major AIs by month and AI type from 2015 to 2018.

Figure A-27, JPG: Number of pesticide applications in rice by township in 2018.

Figure A-28, PDF: Acres of rice treated by the major AIs from 1999 to 2018.

Figure A-29, PDF: Acres of rice treated by the major AIs by month and AI type from 2015 to 2018.

Figure A-30, JPG: Number of pesticide applications in strawberry by township in 2018.

Figure A-31, PDF: Acres of strawberry treated by the major AIs from 1999 to 2018.

Figure A-32, PDF: Acres of strawberry treated by the major AIs by month and AI type from 2015 to 2018.

Figure A-33, JPG: Number of pesticide applications in table and raisin grape by township in 2018.

Figure A-34, PDF: Acres of table and raisin grape treated by the major AIs from 1999 to 2018.

Figure A-35, PDF: Acres of table and raisin grape treated by the major AIs by month and AI type from 2015 to 2018.

Figure A-36, JPG: Number of pesticide applications in walnut by township in 2018.

Figure A-37, PDF: Acres of walnut treated by the major AIs from 1999 to 2018.

Figure A-38, PDF: Acres of walnut treated by the major AIs by month and AI type from 2015 to 2018.

Figure A-39, JPG: Number of pesticide applications in wine grape by township in 2018.

Figure A-40, PDF: Acres of wine grape treated by the major AIs from 1999 to 2018.

Figure A-41, PDF: Acres of wine grape treated by the major AIs by month and AI type from 2015 to 2018.