PESTICIDE USE ANNUAL REPORT

2021 Data Summary

PUR

Pesticide Use Report Program

California Department of Pesticide Regulation
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STATE OF CALIFORNIA
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DEPARTMENT OF PESTICIDE REGULATION
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For information on obtaining electronic data files, see the Pesticide Use Annual Report Data Access, References, and Definitions Guide, How to Access Pesticide Use Report Data section <https://www.cdpr.ca.gov/docs/pur/pur_references_definitions.pdf>

This report is available on DPR's Web site <www.cdpr.ca.gov/docs/pur/purmain.htm>. If you have questions concerning this report, email DPR's PUR program <PUR.Inquiry@cdpr.ca.gov>

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Year in Summary

Overview:

Reported pesticide use for California in 2021 totaled 191 million pounds of applied active ingredients (AIs) and 95 million acres treated. Ten percent of the pounds applied and 27 percent of the acres treated were adjuvants[1]. Since 2020, pounds applied of AIs decreased by 24.8 million pounds (11.5 percent decrease), while the acres treated decreased by 10.9 million acres (10.3 percent decrease). This decrease in pesticide use may be in part a result of increases in fallowed agricultural land due to the drought in California.

Pesticide trends are reported by category based on the type of pesticide (e.g., biopesticide) or potential to cause health or environmental impacts (e.g., carcinogen). Biopesticides and petroleum/mineral oils are considered lower risk to human health and the environment. Most oil pesticides used in California serve as alternatives to more toxic pesticides. Some highly refined petroleum-based oils are used by organic growers. Both the pounds applied and the acres treated with biopesticides and oils decreased from 2020 to 2021. Pesticides characterized as carcinogens, cholinesterase inhibitors, groundwater contaminants, fumigants, reproductive toxins, and toxic air contaminants also decreased in pounds applied and acres treated from 2020 to 2021.

Table 1. Annual change in pounds applied and acres treated of pesticides characterized as biopesticides, oils, carcinogens, cholinesterase inhibitors, groundwater contaminants, fumigants, reproductive toxins, and toxic air contaminants from 2020 to 2021.

Category	Change in Pounds Applied	Percent Change Pounds	Change in Acres Treated	Percent Change Acres
Biopesticides	↓ -1,001,356	-12	↓ -607,435	-7
Oils	↓ -6,720,312	-15	↓ -646,897	-11
Carcinogens	↓ -4,933,941	-12	↓ -1,499,627	-18
Cholinesterase Inhibitors	↓ -530,238	-18	↓ -411,996	-17
Fumigants	↓ -1,590,908	-4	↓ -30,537	-12
Groundwater Contaminants	↓ -74,764	-26	↓ -98,413	-30
Reproductive Toxins	↓ -1,049,689	-14	↓ -306,435	-8
Toxic Air Contaminants	↓ -2,271,512	-5	↓ -346,315	-16

[1] An adjuvant is broadly defined as any non-pesticide material used with a pesticide product or pesticide spray mixture to improve the pesticide's performance or the physical properties of the spray mixture (Examples: spreader stickers, surfactants, oils, buffering agents, etc.). California law requires registration of adjuvants, which are not considered pesticides under federal law.

Long Term Trends: Evaluating pesticide use trends spanning multiple years provides a broader overview of changes and trends in pesticide use compared to annual changes that can vary from one year to the next based on short-term conditions such as weather, water availability, changes in pricing and supply, and other factors. Since 2012, acres treated with lower risk biopesticides and oils increased by 51 and 22 percent, respectively, while use of higher-risk categories has decreased by 27 to 74 percent. Similarly, the pounds applied of biopesticides and oils during this ten-year period increased by 77 and 31 percent, respectively, while use of higher risk pesticide categories decreased by 17 to 81 percent.

Table 2. Long-term change in pounds applied and acres treated of pesticides characterized as biopesticides, oils, carcinogens, cholinesterase inhibitors, groundwater contaminants, fumigants, reproductive toxins, and toxic air contaminants from 2012 to 2021.

Category	Change in Pounds Applied	Percent Change Pounds	Change in Acres Treated	Percent Change Acres
Biopesticides	3,331,017	77	2,849,208	51
Oils	8,924,618	31	894,606	22
Carcinogens	-7,711,013	-17	-2,510,038	-27
Cholinesterase Inhibitors	-1,601,732	-40	-1,657,085	-46
Fumigants	-8,190,384	-18	-192,949	-47
Groundwater Contaminants	-878,001	-81	-632,653	-74
Reproductive Toxins	-8,810,333	-58	-1,649,250	-32
Toxic Air Contaminants	-11,110,820	-22	-1,765,249	-49

The AIs with the highest total reported pounds applied in 2021 were sulfur (fungicide/insecticide), petroleum and mineral oils (fungicide/insecticide), 1,3-dichloropropene (fumigant), glyphosate (herbicide), and potassium N-methyldithiocarbamate (metam-potassium, fumigant). 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 acres treated in 2021 were sulfur, glyphosate, petroleum and mineral oils, abamectin (miticide/insecticide) and lambda-cyhalothrin (insecticide).

2021 TOP FIVE

Top 5 AIs by Pounds Applied

- Sulfur
- Oils
- 1,3-Dichloropropene
- Glyphosate
- Metam potassium

Top 5 AIs by Acres Treated

- Sulfur
- Glyphosate
- Oils
- Abamectin
- Lambda-cyhalothrin

Pesticide Use Measures

This report focuses on two different measures of pesticide use: pounds of AI applied and acres treated. Pesticide use trends measured in pounds applied tend to be driven by pesticides with large application rates, such as sulfur, oil, or fumigants. Trends reported in 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.

Pounds of AI applied: 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 applied will emphasize pesticides used at high rates, such as sulfur, horticultural oils, and fumigants.

Acres treated: The acres treated is the cumulative sum of the acres treated with an AI (applications reported in square feet are converted to acres). The acres treated measure is often greater than the total planted acreage due to multiple applications being made to the same area during a given year. For example, if a one-acre field is treated with an AI three times in a year, then the cumulative acres treated for the year is three acres, although the field itself is only one acre.

As a pesticide use measure, acres treated reflects application frequency and geographic coverage and is not influenced by high application rates that drive rankings by pounds applied. It is limited as a use measure, however, in that it 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 or weight units cannot be converted to acres so they are excluded. In addition, acres treated is not a measure for some non-agricultural ("NonAg") pesticide use reports (PURs) such as structural and other types of urban uses, so these pesticide applications are not included in acres treated totals (For more information about agricultural and non-agricultural pesticide uses, see the Agricultural (Ag) versus Nonagricultural (NonAg) Pesticide Uses section of the Pesticide Use Annual Report Data Access, References, and Definitions Guide < https://www.cdpr.ca.gov/docs/pur/pur_references_definitions.pdf >.

DID YOU KNOW?

Pesticide use trends may differ depending on what "pesticide use metric" is used to measure pesticide use. Pesticide use metrics include *pounds applied, acres treated, and application counts.*

Pounds applied is a use metric that tends to be driven by pesticides with high application rates, such as oil, sulfur, kaolin clay, and fumigants. These pesticides will top most lists when pesticide use is measured by pounds applied.

Acres Treated and **Application Counts** are not available for all types of pesticide use. The legal requirements for certain types of NonAg PURs do not require acres treated or application counts to be reported.

Analyzing trends using multiple pesticide use metrics can offer a more nuanced, complete understanding of pesticide use.

The number of applications can also be a useful measure of pesticide use; however, its utility is limited because of inconsistencies in reporting methodologies for NonAg use and because it is not required for structural use reporting. For Ag use, each PUR represents a single application. Whereas for NonAg use, each PUR is a monthly summary of all the applications of a single product on a specific type of application site. Inconsistency in NonAg use reporting arises because there is not a standardized definition for what is to be considered as a single application, as opposed to the standard, quantified definitions that exist for a single acre or a single pound. The user-interpreted definition of a single application in NonAg use can therefore vary greatly among different pesticide applicators or businesses. For example, one business may treat an apartment building for termites and consider the building application as a whole to be a single application, while another business may treat a similar apartment building but consider each room in the building to be a single application. The differences in the user-interpreted definition of a single application result in large variation in the total number of applications for very similar pesticide applications of NonAg pesticide uses. As a result, application counts for agricultural uses are included in some of the larger tables available on the Annual Report website but are rarely used in Annual Report graphs or discussion.

The trends in use for a single AI will usually follow similar patterns of increases or decreases for both pounds applied and acres treated. However, when pounds applied and acres treated move in different directions for one AI, it is often due to fluctuations in NonAg uses of the AI which do not legally have to report acreage, or it could be from a change in use of products with higher or lower percentage concentration of the AI.

Data Summary

This report is a snapshot summary based on 2021 data submitted to DPR as of September 19, 2022. The PUR data is continually updated, so this snapshot summary may not fully correlate to later PUR data queries, including those from the California Pesticide Information Portal (CalPIP, an online query tool, https://calpip.cdpr.ca.gov/main.cfm), that contain record corrections made after September 19, 2022.

Since 1990, the reported pounds applied of pesticides and acres treated have fluctuated from year to year. These fluctuations can be attributed to a variety of factors, including:

- New regulations,
- Changes in planted acreage,
- Types of crops planted,
- Changes in pricing and supply,
- Changes in pest management practices,
- 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 use trend, but rather may represent variations related to changes in weather, pricing, supply of raw ingredients, or regulations. Regression analysis on use since 1990 does not indicate a significant trend of either increase or decrease in total

pesticide use. However, there can be significant changes in the types of pesticides that makeup the statewide total, such as changes in the use of AIs with higher or lower risk to human health or the environment. See the Evaluating Risk chapter of the Pesticide Use Annual Report History and Background document for more information on the relationship between use amounts and risk
< https://www.cdpr.ca.gov/docs/pur/pur_history_background.pdf>.

Trends by Use Type

Pesticide use can be classified into broad use types based on the overall generalized pest categories targeted by the pesticide. Examples of use types include herbicides (for treating various weeds); insecticides, including miticides (for treating many arthropod pests); fungicides (for treating assorted fungal diseases); and many more. The PUR data does not include information on the pest targeted by any individual pesticide application, which can make it difficult to determine the intended use type. Trends were analyzed for the most common use types: insecticides, fungicides, fungicide/insecticides, herbicides, and fumigants. Given the high reported use of sulfur, oils, and other similar AIs which have both fungicidal and insecticidal activity, the fungicide/insecticide category was created. “Fumigant” is technically an application method rather than a use type, often spanning multiple target pest categories, such as a soil fumigant that treats insect, fungal disease, nematodes, and weeds.

Figures 1 and 2 measure six pesticide use types:

- Fungicides,
- Insecticides (including miticides),
- Fungicide/Insecticides (pesticides with both fungicide and insecticide/miticide properties, such as sulfur and some oils),
- Fumigants,
- Herbicides, and
- Other (all remaining pesticide types that did not have significant enough amounts used to warrant their own graph trend line).

Fumigants and fungicide/insecticides typically have high application rates, and therefore ranked high in use at the top of the graph when measured by pounds applied (Figure 1), but ranked near the bottom of the graph when measured by acres treated (Figure 2) due to less widespread use compared to other types of pesticides.

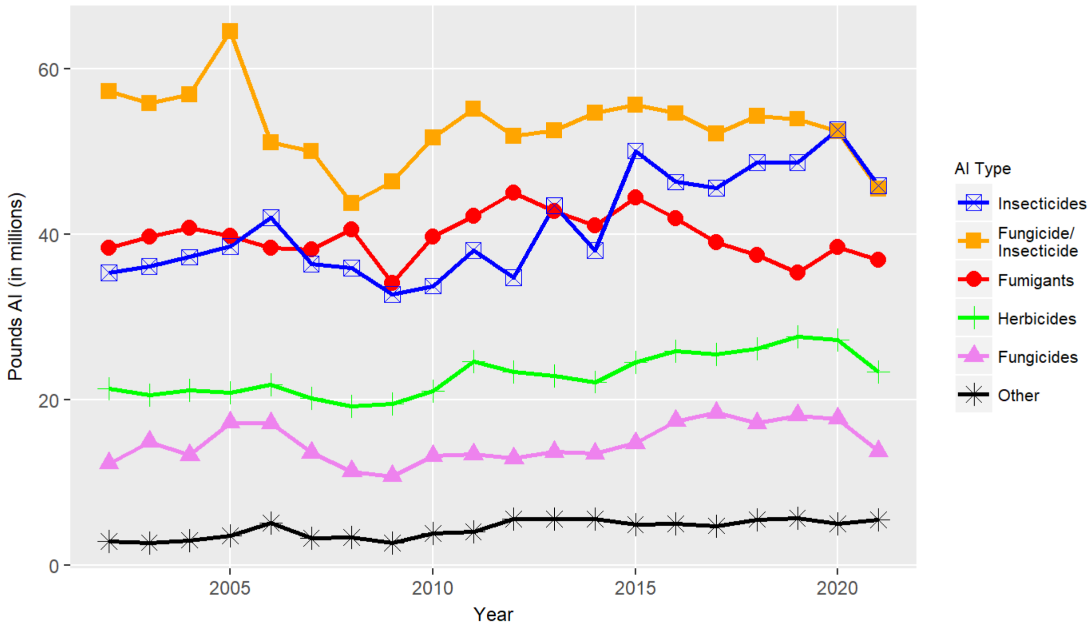

Figure 1. Pounds applied of all AIs in the major types of pesticides from 2002 to 2021, where "Other" includes pesticides such as rodenticides, molluscicides, algaecides, repellents, antimicrobials, antifoulants, disinfectants, and biocides. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

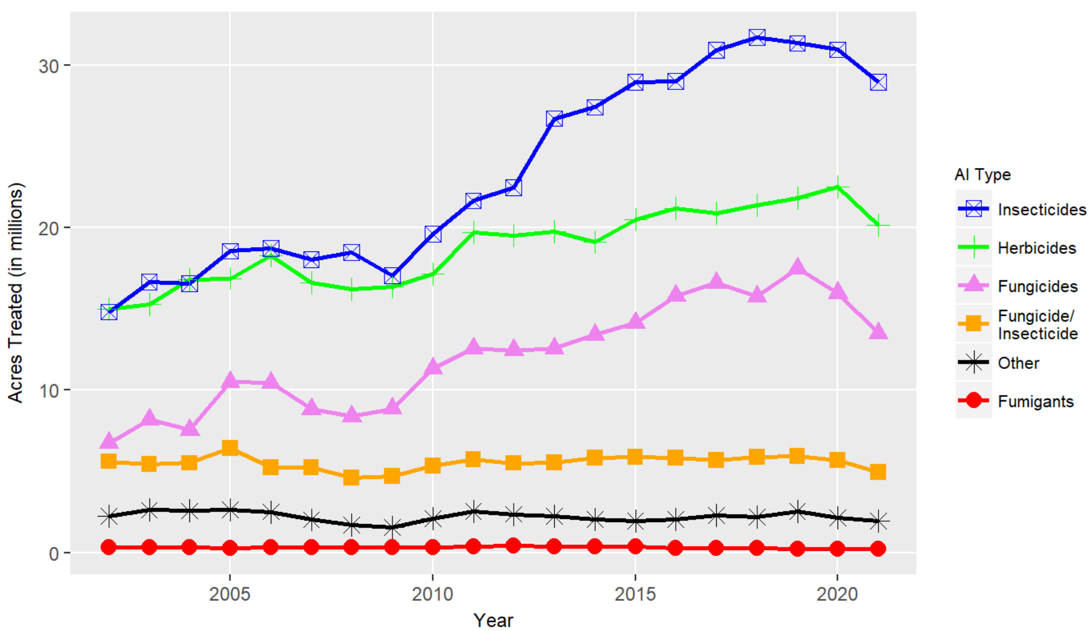

Figure 2. Acres treated by all AIs in the major types of pesticides from 2002 to 2021, where "Other" includes pesticides such as rodenticides, molluscicides, algaecides, repellents, antimicrobials, antifoulants, disinfectants, and biocides. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

The top five AIs for each use type by acres treated and pounds applied are detailed below.

Insecticide (including miticide)

Petroleum and mineral oils ("Oil") used in insecticides ranked highest when measured by either acres treated or by pounds applied. The diacylhydrazine insect growth regulator methoxyfenozide also ranked in the top five under both measures. The pyrethroid lambda-cyhalothrin, the botanical miticide/insecticide abamectin, and the anthranilic diamide chlorantraniliprole were the remaining three of the top five insecticide AIs by acres treated. The microbial *Bacillus thuringiensis*, the inorganic boric acid, and the inorganic diatomaceous earth made up the remainder of the top five insecticides measured by pounds applied (Figure 3, Table 3, and Table 4).

Table 3. Top five insecticides in California by acres treated for 2021.

Top Five	Acres Treated
Oil	4,846,893
Lambda-Cyhalothrin	2,473,490
Abamectin	2,377,782
Chlorantraniliprole	2,323,295
Methoxyfenozide	1,951,177

Table 4. Top five insecticides in California by pounds applied for 2021.

Top Five	Pounds Applied
Oil	37,345,194
Boric Acid	725,765
Diatomaceous Earth	695,186
Methoxyfenozide	571,255
Bacillus Thuringiensis	555,518

Fungicide

The inorganic fungicide copper was the most used fungicide when ranked by either acres treated or pounds applied. Two strobilurin fungicides (azoxystrobin and pyraclostrobin), the pyradine fluopyram, and the azole tebuconazole comprised the remaining four of the top five fungicides by acres treated. The inorganic potassium phosphite, the carbamates mancozeb and ziram, and the substituted benzene chlorothalonil made up the remainder of the top five fungicides by pounds applied (Figure 3, Table 5, and Table 6).

Table 5. Top five fungicides in California by acres treated for 2021.

Top Five	Acres Treated
Copper	1,793,951
Azoxystrobin	1,266,941
Pyraclostrobin	975,417
Fluopyram	852,335
Tebuconazole	742,493

Table 6. Top five fungicides in California by pounds applied for 2021.

Top 5	Pounds Applied
Copper	6,233,781
Potassium Phosphite	1,259,728
Mancozeb	1,043,342
Chlorothalonil	913,164
Ziram	487,948

Fungicide/Insecticide

The category fungicide/insecticide includes a number of AIs which are able to control insects, mites, and fungal diseases. Sulfur represents most of the use in this category, with relatively minimal use of the remaining four of the top five AIs. Three inorganic AIs—sulfur, lime-sulfur, and the biopesticide kaolin clay—ranked in the top five when measured by either acres treated or by pounds applied. Two botanical oils from the neem tree — margosa oil and botanical clarified hydrophobic extract of neem oil ("Neem oil")—were the last two AIs in the top five when measured by acres treated. The inorganic AIs disodium octaborate tetrahydrate and borax ranked fourth and fifth by pounds applied (Figure 3, Table 7, and Table 8).

Table 7. Top five fungicide/insecticides in California by acres treated for 2021.

Top Five	Acres Treated
Sulfur	4,732,431
Lime-Sulfur	103,118
Kaolin	71,882
Margosa Oil	38,862
Neem Oil	27,797

Table 8. Top five fungicide/insecticides in California by pounds applied for 2021.

Top Five	Pounds Applied
Sulfur	40,158,469
Kaolin	2,616,436
Lime-Sulfur	1,679,134
Disodium Octaborate Tetrahydrate	615,180
Borax	241,002

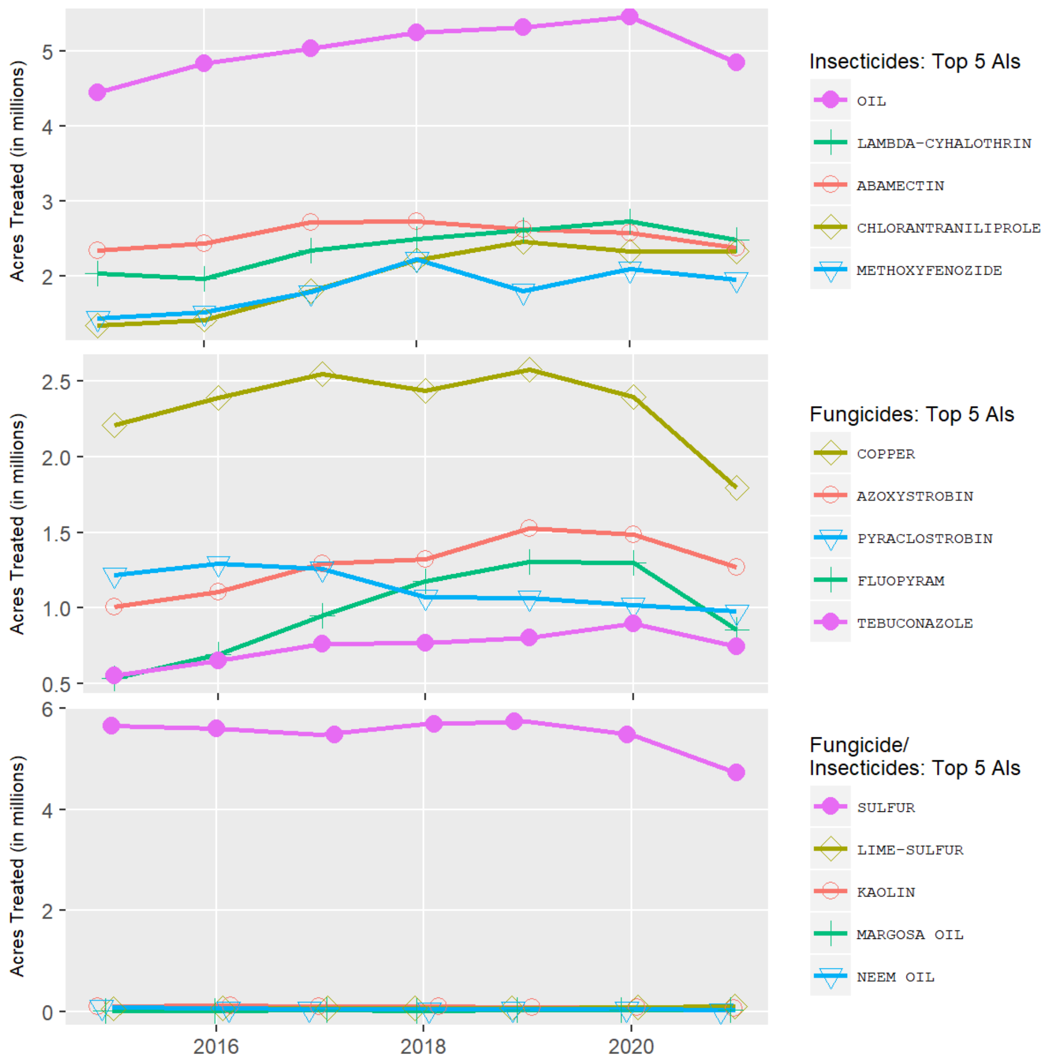

Figure 3. Acres treated by the top five AIs in each of the major types of pesticides from 2015 to 2021. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Herbicides

Glyphosate, oxyfluorfen, pendimethalin, and glufosinate-ammonium ranked in the top five herbicide AIs when measured by both acres treated and by pounds applied. Clethodim ranked fifth in the top five herbicides by acres treated, while propanil made up the remaining top five when ranked by pounds applied. (Figure 4, Table 9, and Table 10).

Table 9. Top five herbicides in California by acres treated for 2021.

Top Five	Acres Treated
Glyphosate	4,778,325
Oxyfluorfen	2,028,785
Glufosinate-Ammonium	1,920,076
Pendimethalin	1,114,304
Clethodim	1,062,714

Table 10. Top five herbicides in California by pounds applied for 2021.

Top Five	Pounds Applied
Glyphosate	10,560,615
Pendimethalin	2,437,026
Propanil	1,968,013
Glufosinate-Ammonium	1,952,176
Oxyfluorfen	869,732

Fumigants

1,3-Dichloropropene , chloropicrin, and potassium N-methyldithiocarbamate (metam-potassium) were in the top five fumigant AIs when ranked by either acres treated or pounds applied. Aluminum phosphide and zinc phosphide made up the remainder of the top five by acres treated, while metam sodium and sulfuryl fluoride comprised the final two top five fumigant AIs by pounds applied (Figure 4, Table 11, and Table 12).

Table 11. Top five fumigants in California by acres treated for 2021.

Top Five	Acres Treated
1,3-Dichloropropene	61,509
Chloropicrin	45,991
Metam-potassium	44,736
Aluminum Phosphide	44,340
Zinc Phosphide	21,230

Table 12. Top five fumigants in California by pounds applied for 2021.

Top Five	Pounds Applied
1,3-Dichloropropene	11,086,414
Metam-potassium	8,513,080
Chloropicrin	8,506,588
Metam-Sodium	3,593,891
Sulfuryl Fluoride	3,065,098

The remaining "Others" category was largely comprised of plant growth regulators, bactericides, and harvest aids. The growth regulators gibberellins and ethephon ranked highest by acres treated. Hydrogen peroxide and peroxyacetic acid, used as low risk bactericides/fungicides/algaecides in some crops, and 2,4-D used as a growth regulator in citrus crops, made up the remainder of the top five by acres treated. By pounds applied, post-harvest germicidal crop treatments of sodium hypochlorite ranked highest, followed by hydrogen peroxide used as sanitizer and disinfectant, hydrogen cyanamide mostly used as a growth regulator, sodium bromide used as a bactericide in industrial water systems, and the growth regulator ethephon (Figure 4, Table 13, and Table 14).

Table 13. Top five "Others" in California by acres treated for 2021.

Top Five	Acres Treated
Gibberellins	485,924
Ethephon	381,836
Hydrogen Peroxide	189,893
Peroxyacetic Acid	189,103
2,4-D	148,247

Table 14. Top five "Others" in California by pounds applied for 2021.

Top Five	Pounds Applied
Sodium Hypochlorite	1,335,028
Hydrogen Peroxide	564,514
Hydrogen Cyanamide	478,503
Sodium Bromide	417,695
Ethephon	317,821

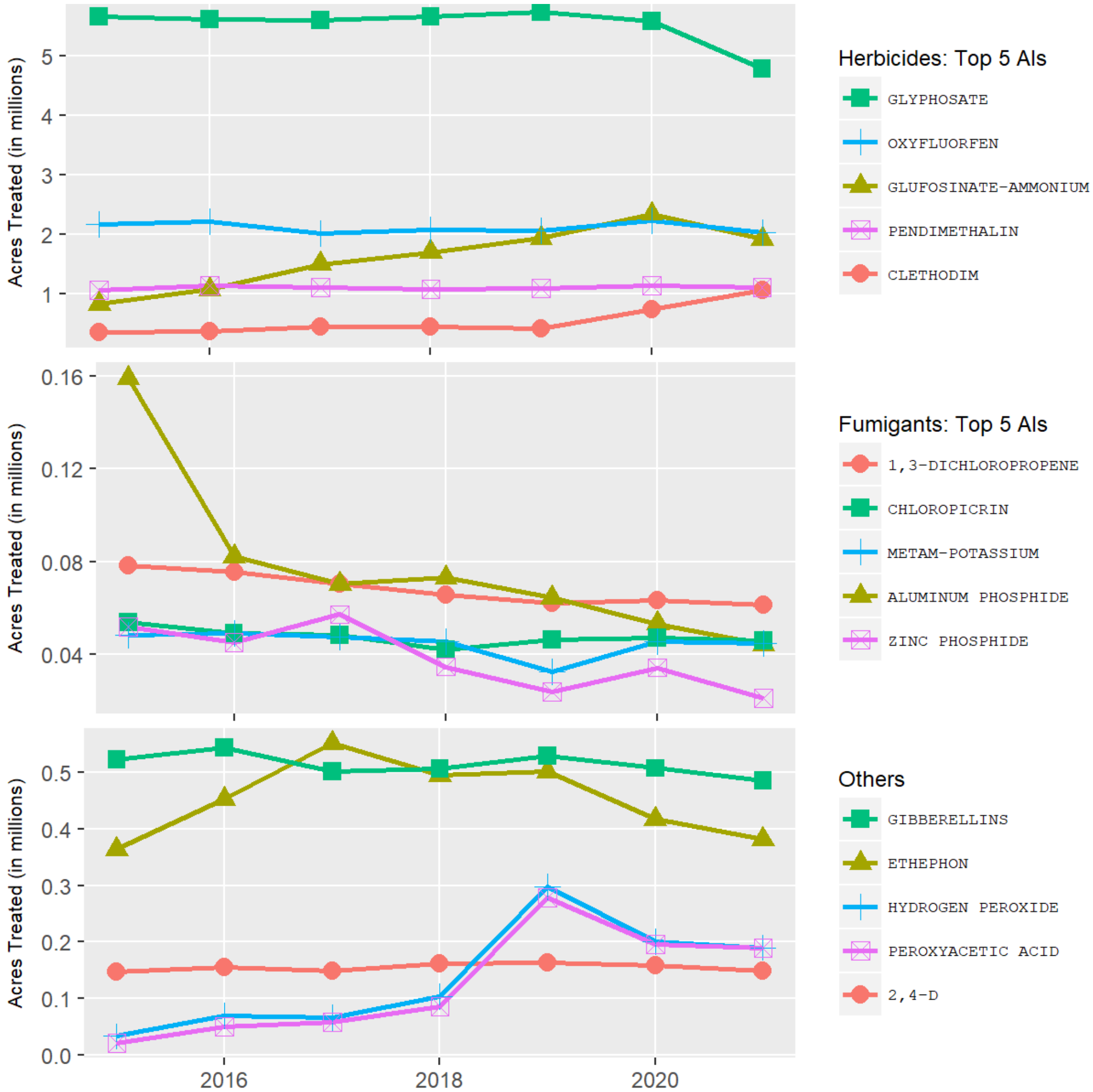

Figure 4. Acres treated by the top five AIs in each of the major types of pesticides from 2015 to 2021. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Pesticide Use by County

In 2021, as in previous years, the region of highest pesticide use was California's San Joaquin Valley (Table 15). The top five counties with the highest use were Fresno, Kern, Tulare, San Joaquin, and Madera, accounting for 50 percent of the total pounds applied in California. These counties were also among the leading producers of agricultural commodities.

Table 15. Total pounds applied of active ingredients by county, rank, and the percent change from 2020 and 2021, ordered by 2021 rank, descending. Shaded rows show the counties where pounds applied decreased. N/A stands for Not Applicable. Statewide totals may not exactly equal the sum of the columns due to rounding Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

County	2020 Lbs Applied	2020 Rank	2021 Lbs Applied	2021 Rank	Percent Change
Fresno	36,342,181	1	29,462,927	1	-19
Kern	29,113,507	2	25,133,091	2	-14
Tulare	19,931,193	3	18,159,350	3	-9
San Joaquin	14,380,151	4	12,749,687	4	-11
Madera	10,913,163	5	9,254,734	5	-15
Monterey	9,795,620	7	9,048,176	6	-8
Merced	10,099,018	6	8,694,336	7	-14
Stanislaus	8,531,703	8	7,801,862	8	-9
Kings	7,840,786	9	6,853,561	9	-13
Ventura	5,900,867	10	6,009,875	10	2
Santa Barbara	5,650,490	12	6,002,983	11	6
Imperial	5,773,917	11	4,993,910	12	-14
Sacramento	4,287,609	13	4,189,296	13	-2
Yolo	3,965,651	14	3,570,579	14	-10
Riverside	3,395,499	16	2,994,621	15	-12
San Luis Obispo	2,952,222	18	2,989,913	16	1
Butte	3,429,225	15	2,742,486	17	-20
Sonoma	2,676,713	20	2,699,494	18	1
Sutter	3,307,839	17	2,557,389	19	-23
Los Angeles	2,456,437	22	2,316,863	20	-6
Colusa	2,845,244	19	2,286,474	21	-20
Mendocino	2,281,995	23	2,188,733	22	-4
Glenn	2,551,539	21	2,058,552	23	-19
Solano	1,699,194	24	1,673,222	24	-2
San Diego	1,394,015	27	1,444,344	25	4
Santa Cruz	1,315,679	29	1,370,862	26	4
Siskiyou	1,326,092	28	1,320,979	27	0
Yuba	1,268,414	30	1,166,746	28	-8
Tehama	1,652,390	25	1,101,720	29	-33
Napa	1,421,598	26	1,095,193	30	-23
Orange	929,062	31	905,701	31	-3

County	2020 Lbs Applied	2020 Rank	2021 Lbs Applied	2021 Rank	Percent Change
Santa Clara	750,789	33	870,382	32	16
San Benito	744,203	34	721,475	33	-3
Lake	787,960	32	570,353	34	-28
San Bernardino	559,784	35	536,881	35	-4
Contra Costa	482,806	36	454,324	36	-6
Placer	385,892	37	364,693	37	-5
Shasta	334,006	38	343,894	38	3
Alameda	251,952	40	245,591	39	-3
El Dorado	246,453	41	238,061	40	-3
Del Norte	290,634	39	226,845	41	-22
San Mateo	188,731	43	215,745	42	14
Lassen	204,877	42	174,538	43	-15
Humboldt	47,035	51	131,022	44	179
Modoc	150,164	44	120,386	45	-20
Amador	110,617	45	109,573	46	-1
Plumas	22,250	55	90,640	47	307
Marin	88,266	46	76,310	48	-14
Tuolumne	68,119	48	63,284	49	-7
Nevada	54,558	49	61,859	50	13
Calaveras	73,399	47	58,182	51	-21
San Francisco	25,646	54	32,377	52	26
Trinity	51,107	50	31,971	53	-37
Inyo	35,328	52	16,343	54	-54
Mariposa	25,820	53	7,449	55	-71
Mono	11,245	56	6,163	56	-45
Sierra	5,433	57	1,977	57	-64
Alpine	1,889	58	644	58	-66
Total	**215,427,971**	**N/A**	**190,608,623**	**N/A**	**-11.5**

Production Ag and Largest NonAg Uses

Production agricultural pesticide use (Ag PURs) has always made up the majority of total reported pounds applied in California (For more information about what pesticide uses are reported, see the Types of Pesticide Use Reported section in the Pesticide Use Annual Report Data Access, References, and Definitions Guide <https://www.cdpr.ca.gov/docs/pur/pur_references_definitions.pdf >). In 2021, Ag PURs made up 91 percent of the total pounds applied. Post-harvest treatments, structural pest control, and landscape maintenance are typically the largest non-production-agricultural pesticide uses (NonAg PURs), contributing 1, 2, and 1 percent of the total pounds applied in 2021, respectively. Post-harvest treatments are predominantly commodity fumigations but can also include pesticide treatments to irrigation ditches and other parts of fields not planted in crops. “All Other” uses include the remaining assortment of NonAg types of pesticide applications that are not high enough in volume on their own to warrant their own individual group heading, such as 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. Together, the "All Other" category represented 5 percent of total pounds applied. In 2021, production agriculture, post-harvest treatments, structural pesticide use, landscape maintenance, and all other uses ("All Others") decreased in pounds applied by 12 percent, 16 percent, 31 percent, 27 percent, and 8 percent, respectively.

Table 16. Pounds applied (in millions) of pesticide active ingredients, from 2002 to 2021, 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 Applied
2002	159.22	1.86	5.47	1.45	6.84	174.84
2003	161.06	1.79	5.18	1.98	7.53	177.52
2004	165.92	1.87	5.12	1.61	7.00	181.52
2005	178.37	2.27	5.63	1.78	8.52	196.56
2006	168.67	2.22	5.27	2.29	10.27	188.72
2007	157.49	2.28	3.97	1.67	7.35	172.75
2008	151.55	2.54	3.20	1.59	7.24	166.12
2009	147.14	1.48	2.91	1.35	6.02	158.89
2010	160.58	2.16	3.70	1.73	8.03	176.20
2011	177.99	1.55	3.15	1.72	8.74	193.15
2012	172.18	1.23	3.46	1.55	9.30	187.73
2013	179.37	1.50	3.80	1.47	9.96	196.09
2014	174.86	1.33	3.71	1.62	8.90	190.43
2015	195.22	1.48	4.22	1.69	9.32	211.91
2016	192.09	1.79	3.93	1.74	10.38	209.93
2017	188.89	1.67	3.64	1.58	10.32	206.10
2018	191.84	1.50	3.46	1.52	11.91	210.24
2019	190.79	1.60	3.37	2.29	12.55	210.60
2020	197.04	1.97	3.30	2.10	11.02	215.43
2021	172.96	1.65	4.30	1.54	10.15	190.61

Trends in Use for Select Pesticide Categories

Pesticide use is summarized for the following eight categories that are based on either the type of pesticide (e.g., biopesticides) or a pesticide's potential to cause health or environmental impacts (e.g., carcinogens). The same pesticide may appear in multiple categories:

- Biopesticides,
- Oils,
- Carcinogens,

- Cholinesterase inhibitors,
- Fumigants,
- Groundwater contaminants,
- Reproductive toxins, and
- Toxic air contaminants.

The summaries and the data are not intended to serve as indicators of pesticide risks to the public or the environment as they do not account for label restrictions, mitigation methods, and other practices that may significantly reduce offsite movement of pesticides and potential for exposure. Rather, the data supports DPR regulatory functions to enhance public safety and environmental protection by increasing the understanding of the change in use of lower and higher risk active ingredients over time. Note that the pounds of AI applied include both Ag and NonAg PURs, while the reported acres treated include primarily Ag PURs since most NonAg uses do not require reporting of acres treated.

Since 2012, acres treated with biopesticides and oils increased by 51 and 22 percent, respectively, while use of all other categories has decreased by 27 to 74 percent. Similarly, the pounds applied of biopesticides and oils increased by 77 and 31 percent, respectively, while use of all other categories has decreased by 17 to 81 percent. Tables of the amount used of the individual chemicals in each category over the last ten years can be downloaded using the Pesticide Category Lists drop-down menus on the 2021 Summary Data website < https://www.cdpr.ca.gov/docs/pur/pur21rep/21_pur.htm>.

The following section discusses changes in use from the previous year as well as graphs showing long-term use for each of the eight categories.

Table 17. The total pounds applied for eight different pesticide categories with the change and percent change from 2020 to 2021.

Category	2020 Lbs Applied	2021 Lbs Applied	Change	% Change
Biopesticides	8,652,867	7,651,511	-1,001,356	-12
Oils	44,186,349	37,466,036	-6,720,312	-15
Carcinogens	42,123,800	37,189,859	-4,933,941	-12
Cholinesterase inhibitors	2,930,408	2,400,170	-530,238	-18
Fumigants	38,423,378	36,832,470	-1,590,908	-4
Ground water contaminants	285,918	211,154	-74,764	-26
Reproductive toxins	7,447,399	6,397,711	-1,049,689	-14
Toxic air contaminants	41,576,631	39,305,119	-2,271,512	-5

Table 18. The total acres treated for eight different pesticide categories with the change and percent change from 2020 to 2021.

Category	2020 Acres Treated	2021 Acres Treated	Change	% Change
Biopesticides	9,047,137	8,439,702	-607,435	-7
Oils	5,646,860	4,999,962	-646,897	-11
Carcinogens	8,433,168	6,933,541	-1,499,627	-18
Cholinesterase inhibitors	2,391,727	1,979,731	-411,996	-17
Fumigants	248,640	218,102	-30,537	-12
Ground water contaminants	325,157	226,745	-98,413	-30
Reproductive toxins	3,878,127	3,571,692	-306,435	-8
Toxic air contaminants	2,176,071	1,829,756	-346,315	-16

Biopesticides

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. Use of biopesticides and AIs considered to be lower risk to human health or the environment decreased by 1 million pounds applied (11.6 percent decrease) and by 607 thousand acres treated (6.7 percent decrease) between 2020 and 2021. Most of the decrease in pounds applied was due to less use of the fungicide/insecticide kaolin clay, the fungicide potassium phosphite, and the adjuvant vegetable oil, which decreased by 341 thousand pounds applied (11.5 percent decrease), 149 thousand pounds applied (10.6 percent decrease), and 133 thousand pounds applied (22.8 percent decrease), respectively. The decline in acres treated was largely due to 150 thousand fewer acres treated (13.1 percent decrease) with the adjuvant propylene glycol and 140 thousand fewer acres treated (6 percent decrease) with the adjuvant citric acid (Figure 5).

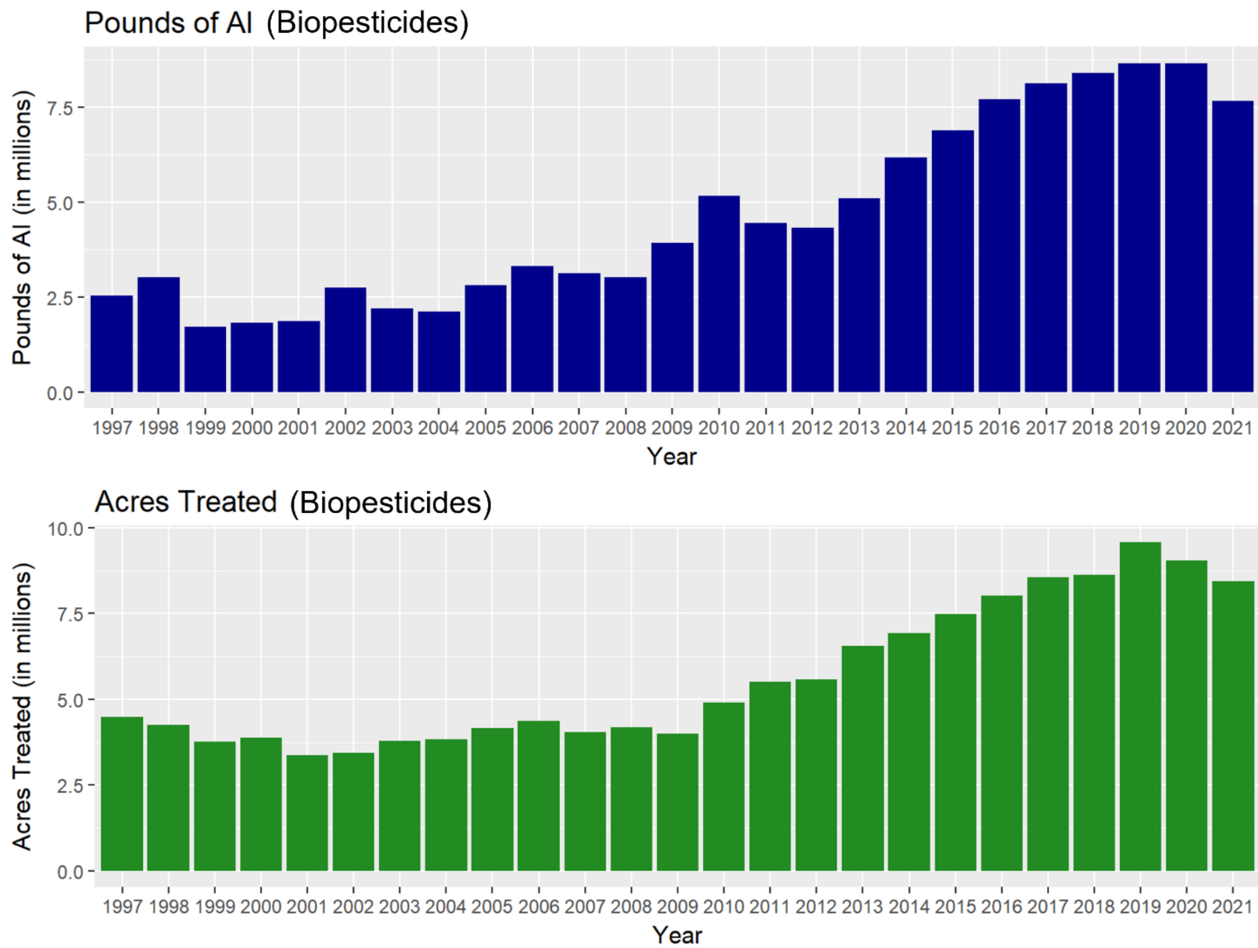

Figure 5. Use trends of pesticides that are biopesticides. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Oils

Most oil pesticides used in California serve as alternatives to more toxic pesticides. Although some oils are listed on the State's Proposition 65 list of chemicals known to cause cancer, none of these carcinogenic oils are registered for use as pesticides in California. Some highly refined petroleum-based oils are used by organic growers. Use of oil pesticides decreased in amount by 6.7 million pounds applied (15.2 percent decrease)and decreased in acres treated by 647 thousand acres treated (11.5 percent decrease) between 2020 and 2021. Only oil AIs derived from petroleum distillation are included in these totals (Figure 6).

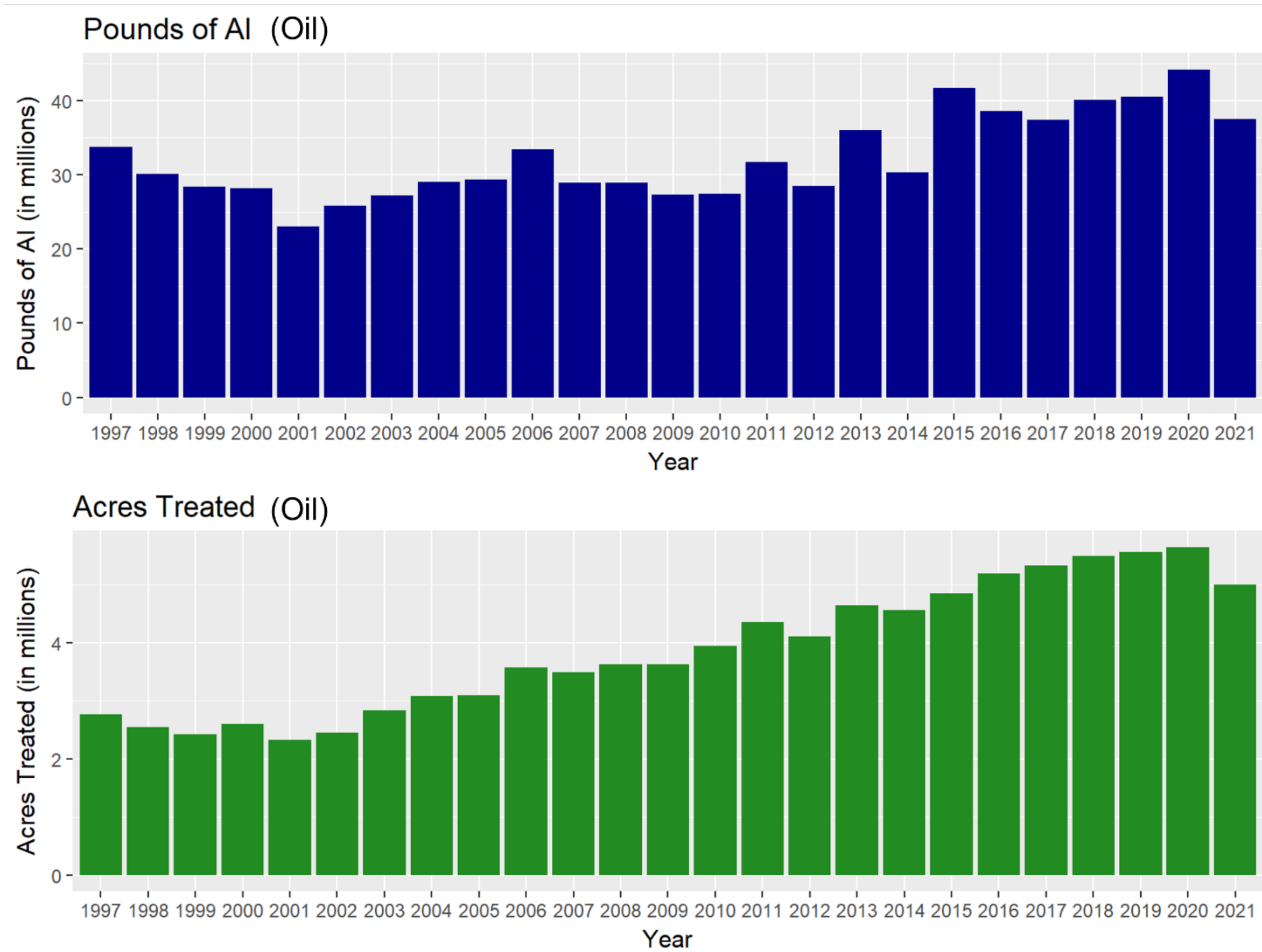

Figure 6. Use trends of pesticides that are oils. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Carcinogens

The carcinogens category included all AIs listed on the State's Proposition 65 list of chemicals known to cause cancer as well as the AIs receiving a "carcinogen," "probable carcinogen," or "possible carcinogen" rating from the U.S. EPA's Chronic Dose-Response Assessment Table (Dose-Response Assessment for Assessing Health Risks Associated with Exposure to Hazardous Air Pollutants). The amount used of pesticides classified as carcinogens decreased by 4.9 million pounds applied from 2020 to 2021 (11.7 percent decrease). The acres treated with carcinogens decreased by 1.5 million acres treated (17.8 percent decrease). The decrease in pounds applied was largely due to less use of the herbicide glyphosate: glyphosate, isopropylamine salt decreased by 1 million pounds (17.7 percent decrease) and glyphosate, potassium salt decreased by 857 thousand pounds (13.3 percent decrease). In addition, the fumigants metam-sodium, 1,3-dichloropropene , and potassium N-methyldithiocarbamate (metam-potassium) decreased by 732 thousand pounds (16.9 percent decrease), 592 thousand pounds (5.1 percent decrease), and 487 thousand pounds (5.4 percent decrease), respectively. Two fungicides, mancozeb and chlorothalonil, decreased by 515 thousand pounds (33 percent decrease) and 236 thousand pounds (20.6 percent decrease). The decrease in acres treated was mostly due less acreage treated with the herbicide glyphosate: glyphosate, potassium salt decreased by 479 thousand acres treated (14.7 percent decrease) and glyphosate, isopropylamine salt decreased by 333 thousand acres treated (14.8 percent decrease). The fungicides mancozeb and chlorothalonil also contributed to the decrease in acres treated, with 255 thousand (31.5 percent decrease) and 118 thousand (22.4 percent decrease) less acres treated, respectively (Figure 7).

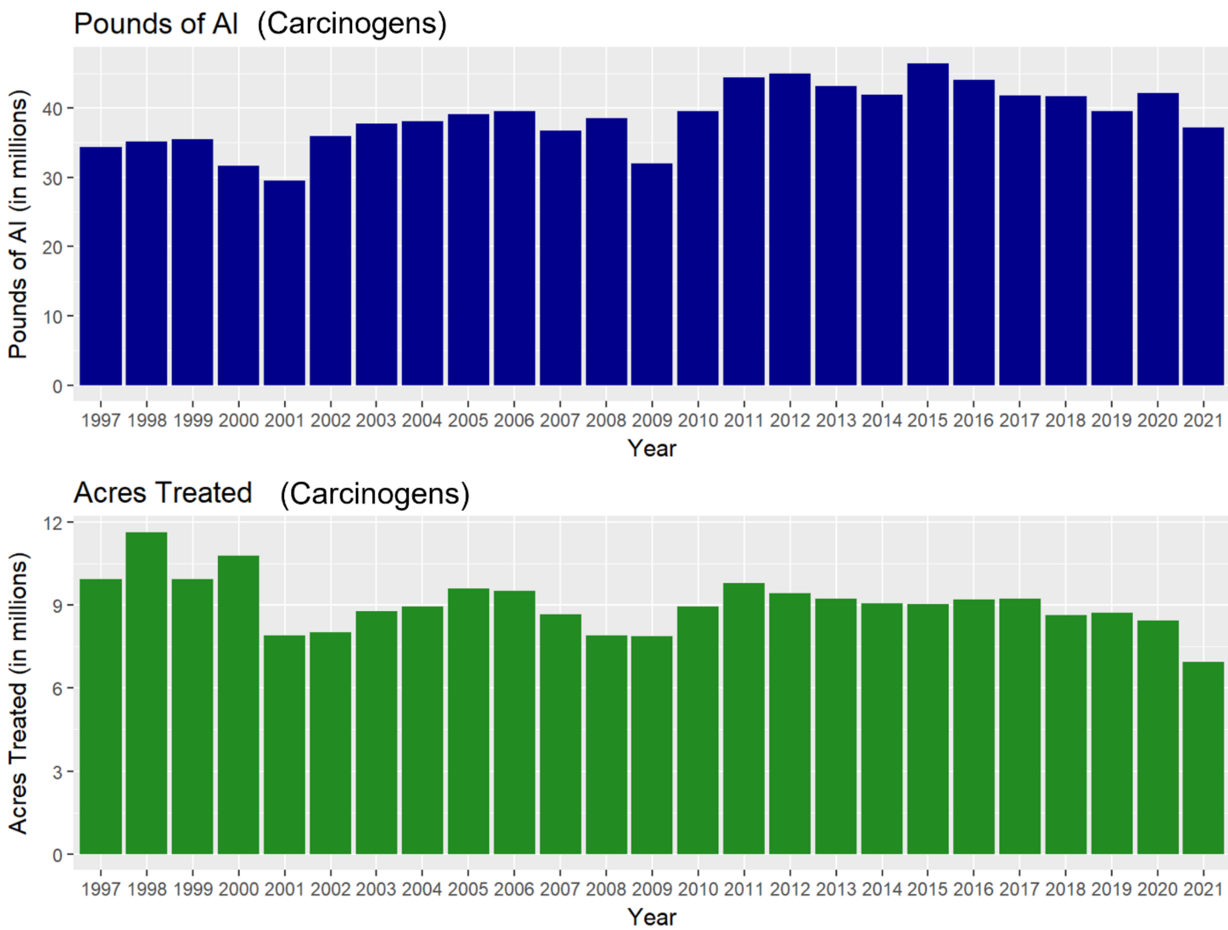

Figure 7. Use trends of pesticides that are listed on the State's Proposition 65 list of chemicals that are "known to cause cancer" or identified by U.S. EPA as "carcinogens," "probable carcinogens," or "possible carcinogens." Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Cholinesterase inhibitors

Use of organophosphorus and carbamate cholinesterase-inhibiting pesticides in 2021 decreased from the previous year by 530 thousand pounds applied (18.1 percent decrease) and by 412 thousand acres treated (17.2 percent decrease). The decrease in pounds applied was largely due to less use of the herbicide thiobencarb and the insecticide malathion, which decreased by 201 thousand pounds applied (33.8 percent decrease) and 109 thousand pounds applied (30.6 percent decrease), respectively. The drop in acres treated was predominantly due to 147 thousand fewer acres treated with the insecticide dimethoate (33.5 percent decrease), 61 thousand fewer acres treated with the insecticide malathion (28 percent decrease), and 61 thousand fewer acres treated with the herbicide thiobencarb (34.3 percent decrease) (Figure 8).

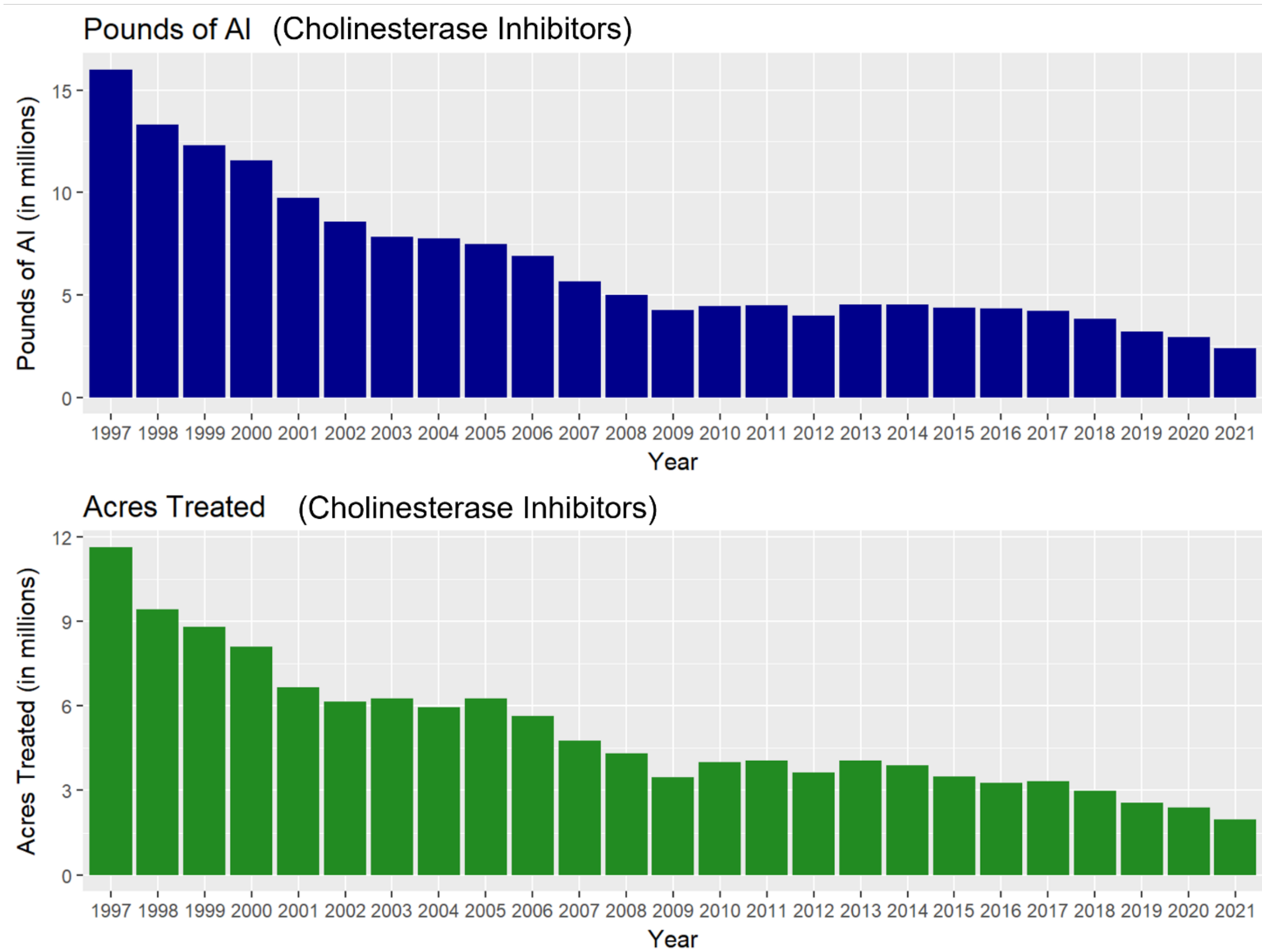

Figure 8. Use trends of pesticides that are organophosphorus or carbamate cholinesterase-inhibiting pesticides. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Fumigants

The use of fumigant AIs declined by 1.6 million pounds applied (4.1 percent decrease) and by 31 thousand acres treated (12.3 percent decrease) between 2020 and 2021. The decrease in pounds applied can be largely attributed to less use of three fumigants: metam-sodium, 1,3-dichloropropene , and metam-potassium (potassium N-methyldithiocarbamate) which decreased by 732 thousand pounds applied (16.9 percent decrease), 592 thousand pounds applied (5.1 percent decrease), and 487 pounds applied (5.4 percent decrease), respectively. Much of the decrease in acres treated was due to 13 thousand less acres treated with zinc phosphide (38.2 percent decrease) and 9 thousand less acres treated with aluminum phosphide (16.7 percent decrease) (Figure 9).

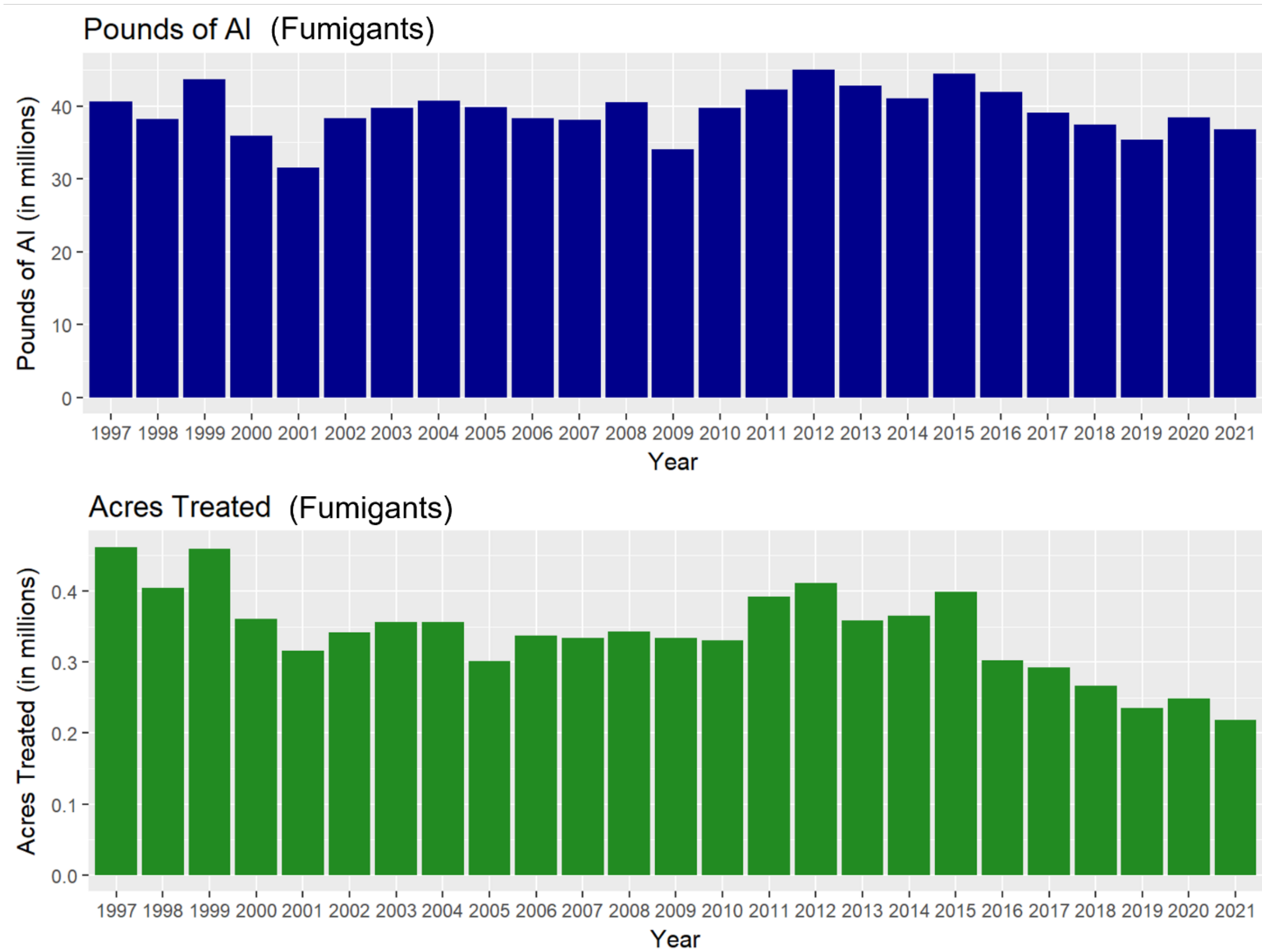

Figure 9. Use trends of pesticides that are fumigants. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Groundwater contaminants

Groundwater contaminants are defined as pesticides that have the potential to pollute groundwater based on their chemical properties and labeled use. The groundwater contaminant category included all AIs listed in the California Code of Regulations, Title 3, Division 6, Chapter 4, Subchapter 1, Article 1, Section 6800(a). Groundwater contaminants decreased by 75 thousand pounds applied (26.2 percent decrease) and by 98 thousand acres treated (30.3 percent decrease) between 2020 and 2021. The reduction in pounds applied was mostly due to less use of the herbicides simazine and diuron. Diuron decreased by 51 thousand pounds applied (31.6 percent decrease) and simazine decreased by 14 thousand pounds applied (19 percent decrease). Diuron was also largely responsible for the decline in acres treated, with 93 thousand fewer acres treated (36.8 percent decrease) (Figure 10).

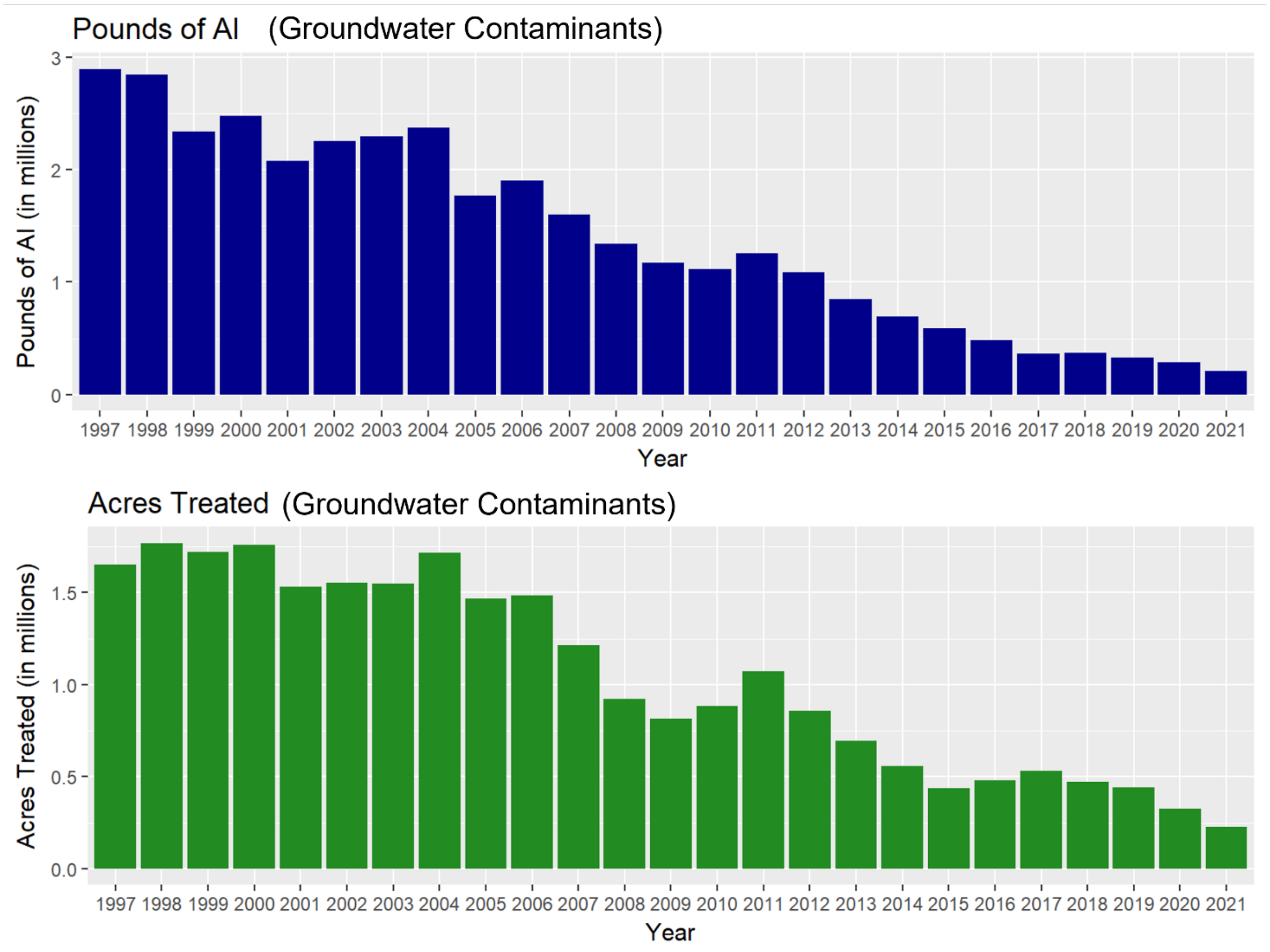

Figure 10. Use trends of pesticides from DPR's groundwater protection list. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Reproductive Toxins

The reproductive toxins category included all AIs listed on the State's Proposition 65 list of chemicals known to cause reproductive toxicity in the form of birth defects or reproductive harm. Use of reproductive toxins decreased by 1 million pounds applied (14.1 percent decrease) and 306 thousand acres treated (7.9 percent decrease) between 2020 and 2021. The change in pounds applied was mostly due to decreased use of the fumigants metam-sodium and methyl bromide by 732 thousand pounds applied (16.9 percent decrease) and 84 thousand pounds applied (5 percent decrease), respectively. The decrease in acres treated was largely due to 194 thousand fewer acres treated with the insecticide abamectin (7.6 percent decrease) and 32 thousand fewer acres treated with the fungicide myclobutanil (9 percent decrease) (Figure 11).

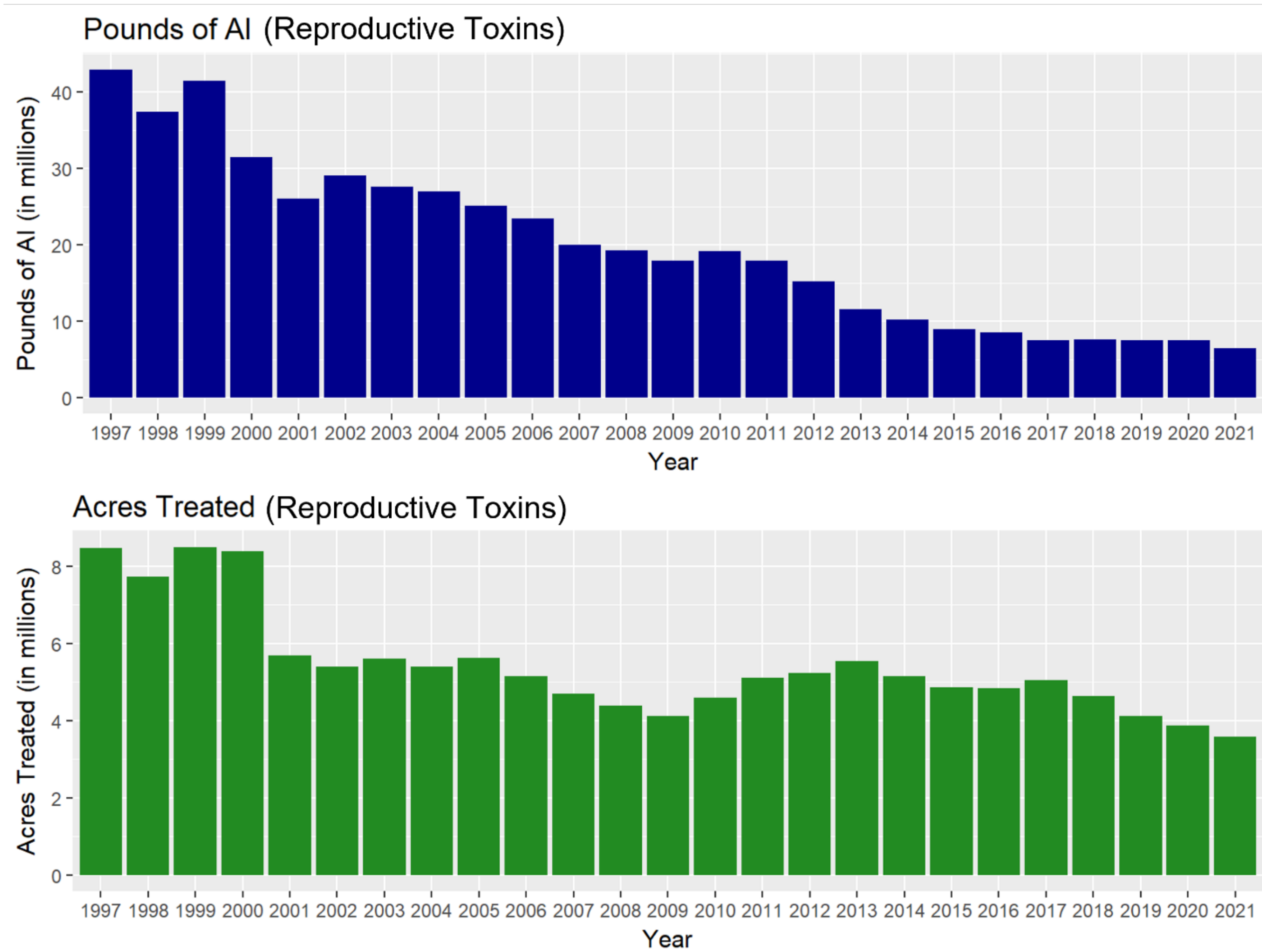

Figure 11. Use trends of pesticides that are on the State's Proposition 65 list of chemicals that are "known to cause reproductive toxicity." Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Toxic air contaminants

Toxic air contaminants are defined as air pollutants that may cause or contribute to increases in serious illness or death, or that may pose a present or potential hazard to human health. The toxic air contaminants category included all AIs listed in the California Code of Regulations, Title 3, Division 6, Chapter 4, Subchapter 1, Article 1, Section 6860. Toxic air contaminants decreased by 2.3 million pounds applied (5.5 percent decrease) and 346 thousand acres treated (15.9 percent decrease) between 2020 and 2021. Most of the change in pounds applied was due to decreased use of the fumigants metam-sodium, 1,3-dichloropropene , and potassium N-methyldithiocarbamate (metam-potassium), which declined by 732 thousand pounds applied (16.9 percent decrease), 592 thousand pounds applied (5.1 percent decrease), and 487 thousand pounds applied (5.4 percent decrease), respectively. In addition, the fungicide mancozeb decreased by 515 thousand pounds applied (33 percent decrease). The decrease in acres treated was largely due to less acreage treated with the fungicide mancozeb, which was used on 255 thousand fewer acres treated (31.5 percent decrease) (Figure 12).

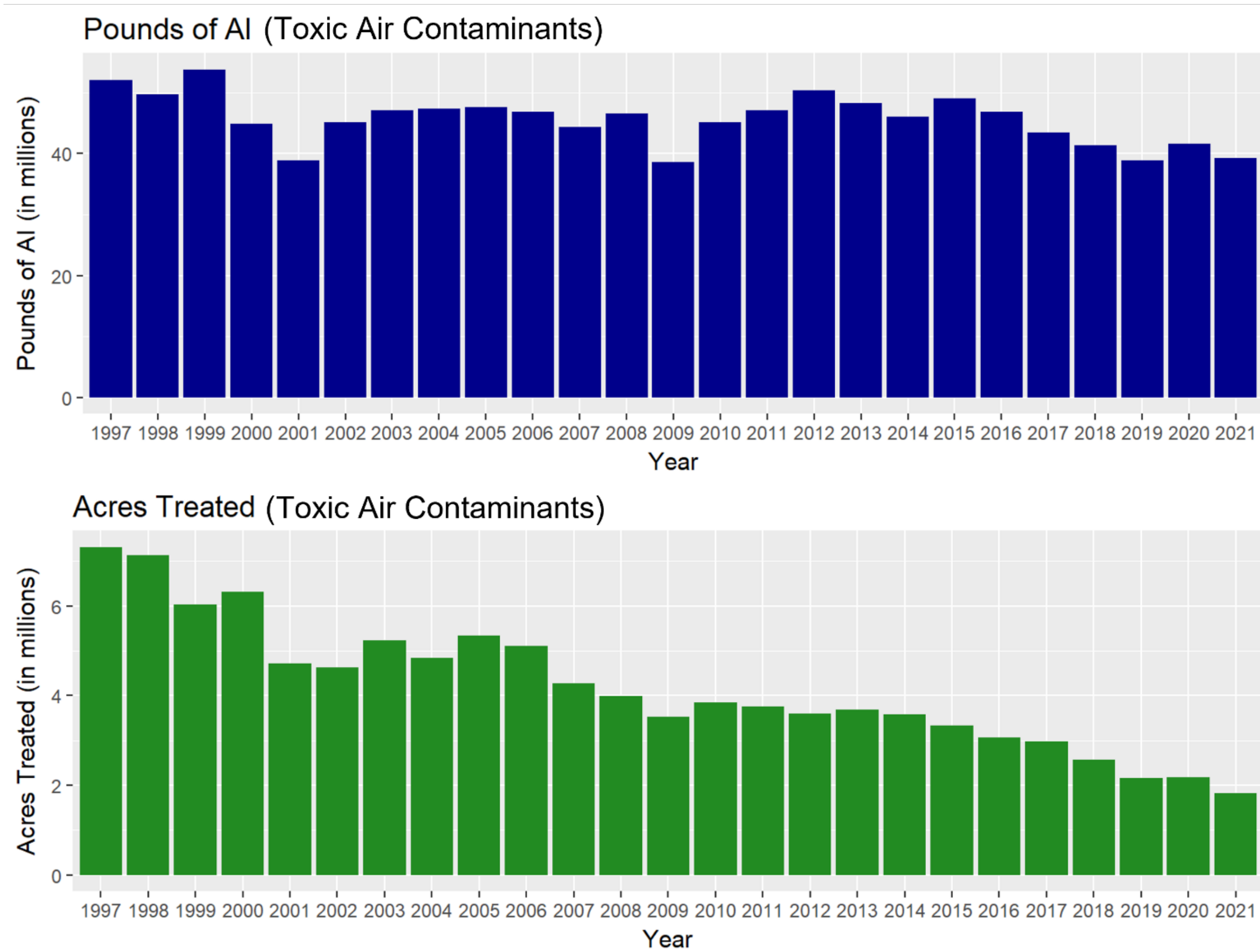

Figure 12. Use trends of pesticides that are on DPR's toxic air contaminants list. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Trends in Pesticide Use for Select Commodities

A grower's or applicator's decision to apply pesticides depends on many factors, such as:

- Potential pesticide risk to the environment, farm workers, or general public,
- The presence of biological control agents (e.g., predatory insects and other natural enemies),
- Other available management practices,
- Pest pressure,
- Cost of pesticides and labor,
- Value of the crop, and
- Pesticide resistance and effectiveness.

Pest population and the resulting pest pressure are 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 highest total pounds applied of pesticides in 2021 were:

1. Almond,
2. Wine grape,
3. Orange and tangerine,
4. Strawberry, and
5. Table and raisin grape.

Besides total pounds applied, the magnitudes of changes in use can be of interest in understanding pesticide use trends. Table 19 shows the change in pounds applied for ten crops (or sites): Table 19a shows the crops with the greatest *increases* in pounds applied, and 19b shows the crops with the greatest *decreases* in pounds applied, over the last year. 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. Therefore, in addition to the change in pounds applied of pesticide since last year, the table also includes the change in acres planted, bearing, or harvested, as measured by the Quick Stats Database of US Department of Agriculture, National Agricultural Statistics Service (USDA NASS).

Table 19 a,b: The change in pounds of active ingredient applied and acres planted, bearing, or harvested, and the percent change from 2020 to 2021 for the crops or sites with the greatest increase (a) and decrease (b) in pounds applied. NA means not available. Acre values sourced from the USDA NASS Quickstats database. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

a. Crops or Sites with Greatest Increase	Change in pounds applied	Change in acres planted, bearing, or harvested	Percent Change in pounds applied	Percent Change in acres treated
Structural pest control	1,006,810	NA	31	NA
Water (industrial)	723,786	NA	56	NA
Strawberry	688,861	2,100	6	6
Tangerine	382,118	1,000	10	2
Bermudagrass	123,312	NA	22	NA

b. Crops or Sites with Greatest Decrease	Change in pounds applied	Change in acres planted, bearing, or harvested	Percent Change in pounds applied	Percent Change in acres treated
Almond	-9,635,395	70,000	-22	6
Wine grape	-3,009,122	-10,000	-11	-2
Table and raisin grape	-2,870,029	-10,000	-19	-4
Walnut	-1,843,055	10,000	-26	3
Rights of way	-1,406,900	NA	-27	NA

Crops or sites with the greatest *increase* in the amount applied from 2020 to 2021 include structural pest control, water (industrial), strawberry, tangerine, and bermudagrass. The increase in pounds applied to strawberry and tangerine may be due in part to the increase in acreage (planted acres for strawberry, bearing acres for tangerine) (Table 19a).

Crops or sites with the greatest *decreas*e in the amount applied from 2020 to 2021 included almond, wine grape, table and raisin grape, walnut, and rights of way. The decrease in pounds applied to wine grape and table and raisin grape may be due in part to less bearing acreage. The pounds applied to almond and walnut declined despite an increase in the bearing acreage (Table 19b).

Top Agricultural Commodities by Pesticide Use:

Top commodities by pesticide use were defined as the commodities that were treated with more than 4 million pounds of AIs applied or had more than 3 million acres treated in 2021. Thirteen commodities[1] were chosen based on these criteria, listed here in descending order by pounds applied:

[1] "Orange and tangerine", "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

1. Almond
2. Wine grape
3. Orange and tangerine
4. Strawberry
5. Table and raisin grape
6. Processing tomato
7. Pistachio
8. Walnut
9. Carrot
10. Rice
11. Peach and nectarine
12. Alfalfa
13. Cotton

Collectively, the pesticides used on these commodities represent 72 percent of the total amount used (pounds applied) and 76 percent of the acres treated in 2021 (Table 18).

Table 20. Pounds applied and acres treated of the top 13 crops, sorted by descending pounds applied, for 2021.

Crop	Million Pounds Applied	Million Acres Treated
Almond	34.32	24.15
Wine grape	25.56	9.53
Orange and tangerine	14.96	3.9
Strawberry	12.24	2.6
Table and raisin grape	11.82	4.99
Processing tomato	10.02	2.74
Pistachio	6.25	6.96
Walnut	5.38	4.92
Carrot	4.84	0.43
Rice	4.41	2.77
Peach and nectarine	3.83	1.51
Alfalfa	2.5	4.53
Cotton	1.48	3.23

Pesticide use may increase or decrease due to new acreage put into production or acreage taken out of production. Using total acreage[1] values from the Quick Stats Database of US Department of Agriculture, National Agricultural Statistics Service (USDA NASS), Figure 13 shows that the decrease in pounds of AIs applied for orange and tangerine, processing tomato, peach and nectarine, wine grape, table and raisin grape, rice, and cotton is likely due, at least in part, to decreases in total acreage from 2020 to 2021. Similarly, the increase in pounds applied for strawberry may be due in part to increased acreage in production in 2021 compared to 2020. The pounds applied to walnut, almond, carrot, alfalfa, and pistachio declined despite increasing acreage (Figure 13).

[1] Total acreage may be acres planted, harvested, or bearing depending on the unit reported for the commodity in NASS

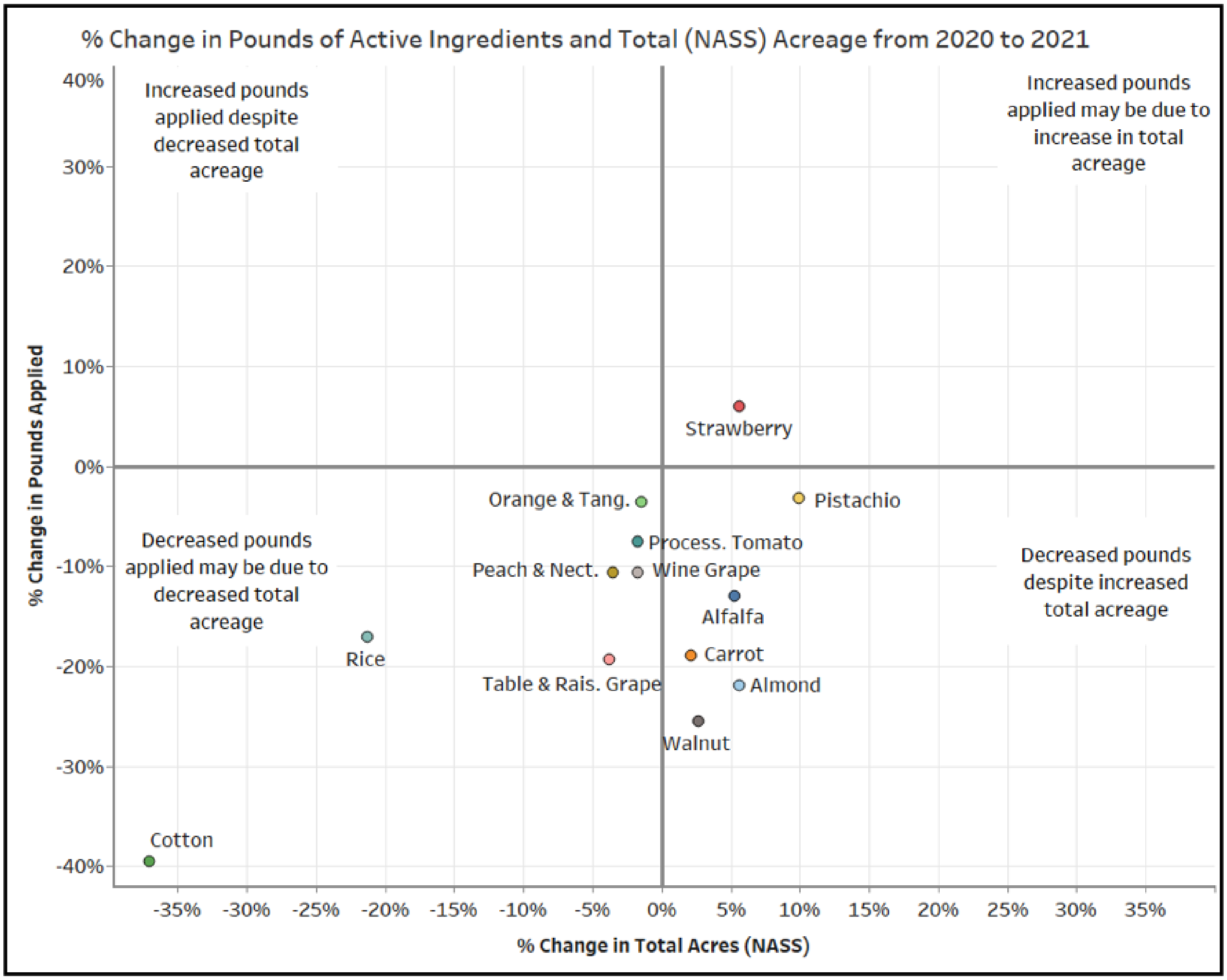

Figure 13. Graph showing percentage change in pounds of active ingredients applied from 2020 to 2021 against the change in the total acreage of the commodity. Pounds applied is determined from the PUR data while the total acreage comes from the Quick Stats database, USDA National Agricultural Statistics Service (NASS). Total acreage may be acres planted, harvested, or bearing depending on the unit reported for the commodity in NASS.

The following section summarizes the changes in pesticide use and top five pesticides by pounds applied and acres treated for the 13 top commodities. A general use type (insecticide, fungicide, herbicide, etc.) is included for each AI. Note that use types may vary depending on the product that contains the AI, and there may be more than one use type for each AI. The tables contain the use type most often associated with the AI. Oil is listed as “many types” due to the many different types of pesticides that contain oil as an AI. The majority are insecticides, fungicides, and adjuvants. Most oil pesticides used in California serve as alternatives to more toxic pesticides. For the top five tables for each of the thirteen crops, the following AIs are summations of all related salts, esters, subspecies/strains, or other closely related chemical derivatives: glyphosate, 2,4-D, *bacillus thuringiensis,* copper, and oil.

Alfalfa

Despite a 5 percent increase in harvested acreage in 2021,[1] pesticide use on alfalfa decreased (Figure 13). In 2021, there were 2.5 million pounds of AI applied to alfalfa compared to 2.9 million pounds applied in 2020 (13 percent decrease). Similarly, the acres treated also decreased, going from 5.1 million acres treated in 2020 to 4.5 million in 2021 (11.7 percent decrease).

The top five AIs used in alfalfa were mostly herbicides. Glyphosate and pendimethalin were in the top five when ranked by pounds applied and by acres treated. The insecticides lambda-cyhalothrin and chlorantraniliprole, and the herbicide clethodim, made up the remainder of the top five by acres treated, while the herbicides trifluralin and EPTC, and the fungicide/insecticide sulfur comprised the remaining top five when measure by pounds applied (Table 21,22).

Table 21. The 2021 top five AIs by acres treated in alfalfa.

Top 5	Type	Acres Treated
Lambda-cyhalothrin	Insecticide	306,243
Clethodim	Herbicide	248,321
Pendimethalin	Herbicide	247,486
Glyphosate	Herbicide	245,911
Chlorantraniliprole	Insecticide	188,894

Table 22. The 2021 top five AIs by pounds applied to alfalfa. Fung/Insect = Fungicide/Insecticide

Top 5	Type	Pounds Applied
Pendimethalin	Herbicide	516,834
Glyphosate	Herbicide	412,874
Sulfur	Fung/Insect	211,355
Trifluralin	Herbicide	124,460
EPTC	Herbicide	65,218

ALFALFA

Alfalfa in bloom. DPR staff photo.

Blue alfalfa aphid (Acyrthosiphon kondoi), a pest on alfalfa. DPR staff photo.

Alfalfa sulfur (Colias eurytheme). Caterpillars are a pest on alfalfa. DPR staff photo.

[1] Quick Stats Database of US Department of Agriculture, National Agricultural Statistics Service

Almond

Statewide bearing almond acreage[1] increased by 6 percent from 2020 to 2021 (Figure 13). The pounds of AI applied to almonds decreased from 44 million in 2020 to 34.3 million in 2021 (21.9 percent decrease). The acres treated with AIs decreased from 27.5 million acres treated to 24.1 million acres treated (12.2 percent decrease).

Glyphosate and oil AIs made the top five AIs when ranked by both pounds applied and acres treated. The remaining three top five AIs by acres treated included the insecticides abamectin, chlorantraniliprole, and methoxyfenozide. The remaining top five AIs by pounds applied included the fumigant 1,3-dichloropropene, and the herbicides glufosinate-ammonium and pendimethalin. (Table 23, 24).

Table 23. The 2021 top five AIs by acres treated in almond.

Top 5	Type	Acres Treated
Glyphosate	Herbicide	1,580,579
Abamectin	Insecticide	1,253,919
Oil	Many types	1,227,582
Chlorantraniliprole	Insecticide	1,030,882
Methoxyfenozide	Insecticide	982,830

Table 24. The 2021 top five AIs by pounds applied to almond. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Oil	Many types	16,407,891
Glyphosate	Herbicide	3,032,265
1,3-Dichloropropene	Fumigant	2,812,381
Glufosinate-ammonium	Herbicide	803,295
Pendimethalin	Herbicide	769,769

ALMOND

Almond branch heavy with nuts. DPR staff photo

Almond nut. DPR staff photo.

Navel orangeworm (Amyelois transitella), an almond pest. Photo by Mark Dreiling, Bugwood.org

[1] Quick Stats Database of US Department of Agriculture, National Agricultural Statistics Service

Carrot

The acres of carrots planted statewide decreased by 2 percent in 2021[1] (Figure 13). Similarly, the pounds of AI applied and the acres treated also both decreased. In 2021, 4.8 million pounds were applied compared to the 6 million pounds applied in 2020 (18.9 percent decrease). The amount of carrot acres treated with AIs decreased from 536 thousand acres treated in 2020 to 434 thousand acres treated in 2021 (19 percent decrease).

The fungicide/insecticide sulfur and the herbicide linuron made the top five lists by both acres treated and pounds applied. The herbicide pendimethalin and the fungicides mefenoxam and azoxystrobin made up the remainder of the top five by acres treated, while the fumigants potassium N-methyldithiocarbamate (metam-potassium), metam sodium, and 1,3-dichloropropene rounded out the top five by pounds applied (Table 25, 26).

Table 25. The 2021 top five AIs by acres treated in carrot. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Acres Treated
Sulfur	Fung/Insect	87,109
Linuron	Herbicide	48,029
Mefenoxam	Fungicide	43,525
Pendimethalin	Herbicide	18,879
Azoxystrobin	Fungicide	17,768

Table 26. The 2021 top five AIs by pounds applied to carrot. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Metam-Potassium	Fumigant	2,419,352
Metam-Sodium	Fumigant	1,157,964
Sulfur	Fung/Insect	544,649
1,3-Dichloropropene	Fumigant	536,837
Linuron	Herbicide	33,658

CARROT

Carrots. Creative Commons CC0 1.0 Universal Public Domain Dedication.

Harvested carrots. Gerald Holmes, Strawberry Center, Cal Poly San Luis Obispo, Bugwood.org

Palestriped flea beetle (*Systena blanda*), a pest on carrots. Photo by Whitney Cranshaw, Colorado State University, Bugwood.org

[1] Quick Stats Database of US Department of Agriculture, National Agricultural Statistics Service

Cotton

The acres treated and pounds of AI applied to cotton decreased in 2021, likely due in part to a decrease in the total acres planted[1] by 37 percent (Figure 13). Pounds of AI applied decreased from 2.5 million pounds applied in 2020 to 1.5 million in 2021 (39.5 percent decrease). Acres treated decreased from 5.5 million acres treated in 2020 to 3.2 million acres treated in 2021 (40.8 percent decrease).

The herbicide glyphosate and the plant growth regulator ethephon made the top five lists by both acres treated and pounds applied. The insecticide flonicamid, the defoliant thidiazuron, and the herbicide diuron made up the remaining top five AIs by acres treated, while the herbicide/defoliants urea dihydrogen sulfate and sodium chlorate and the insecticide naled were the remaining three top five AIs by pounds applied (Table 27, 28).

Table 27. The 2021 top five AIs by acres treated in cotton. PGR = Plant Growth Regulator. Herb/Def = Herbicide/Defoliant

Top 5	Type	Acres Treated
Glyphosate	Herbicide	216,269
Flonicamid	Insecticide	141,990
Thidiazuron	Defoliant	135,065
Ethephon	PGR	134,802
Diuron	Herbicide	128,912

Table 28. The 2021 top five AIs by pounds applied to cotton.

Top 5	Type	Pounds Applied
Glyphosate	Herbicide	333,970
Urea Dihydrogen Sulfate	Herb/Def	168,402
Ethephon	PGR	128,092
Sodium Chlorate	Herb/Def	55,472
Naled	Insecticide	55,313

COTTON

Harvested cotton. USDA NRCS.

Cotton boll. Johnny Crawford, University of Georgia, Bugwood.org

Western tarnished plant bug (*Lygus Hesperus*), a cotton pest. Photo by Whitney Cranshaw, Colorado State University, Bugwood.org

[1] Quick Stats Database of US Department of Agriculture, National Agricultural Statistics Service

Orange and Tangerine

Orange and tangerine are grouped together due to similar pest management methods. Total statewide bearing acreage for orange and tangerine combined decreased by 1 percent from 2020 to 2021 (Figure 13).[1] Pounds of AI applied decreased from 15.5 million pounds applied in 2020 to 15 million in 2021 (3.6 percent decrease). The acres treated decreased from 4 million in 2020 to 3.9 million acres treated in 2021 (2.9 percent decrease).

Oil was the most used AI by both pounds applied and acres treated. The fungicide copper and the herbicide glyphosate were also ranked in the top five AIs when measured by either pounds applied or acres treated. The insecticide/miticide abamectin and the herbicide 2,4-D rounded out the top five AIs by acres treated, while the biopesticide kaolin clay and the fumigant 1,3-dichloropropene completed the top five list by pounds applied (Table 29, 30).

Table 29. The 2021 top five AIs by acres treated in orange and tangerine.

Top 5	Type	Acres Treated
Oil	Many types	450,097
Abamectin	Insecticide	181,180
Copper	Fungicide	180,923
Glyphosate	Herbicide	172,546
2,4-D	Herbicide	126,386

Table 30. The 2021 top five AIs by pounds applied to orange and tangerine. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Oil	Many types	7,717,684
Copper	Fungicide	731,451
Kaolin	Fung/Insect	548,073
1,3-Dichloropropene	Fumigant	306,248
Glyphosate	Herbicide	272,771

ORANGE AND TANGERINE

Tangerines. Photo by Forest and Kim Starr, Starr Environmental, Bugwood.org


Orange. DPR staff photo

Asian citrus psyllid (*Diaphorina citri*), a pest on citrus. Photo by David Hall, USDA Agricultural Research Service, Bugwood.org

[1] Quick Stats Database of US Department of Agriculture, National Agricultural Statistics Service

Peach and Nectarine

Peach and nectarine are grouped together due to similar pest management methods. A 3 percent decrease[1] in statewide bearing acreage of peaches and nectarines may explain part of why pounds applied declined from 4.3 million in 2020 to 3.8 million in 2021 (10.6 percent decrease) (Figure 13). Similarly, the acres treated decreased in 2021, going from 1.6 million acres treated in 2020 to 1.5 million in 2021 (3.1 percent decrease).

Oil and the fungicide ziram were included in the top five when measured by both pounds of AI applied and by acres treated. The fungicide propiconazole, the herbicide glyphosate, and the insecticide chlorantraniliprole were the remaining three AIs in the top five list when ranked by acres treated, while the fungicide/insecticide sulfur, the fungicide copper, and the fumigant 1,3-dichloropropene made up the remaining three of the top five when measured by pounds applied (Table 31, 32).

Table 31. The 2021 top five AIs by acres treated in peach and nectarine.

Top 5	Type	Acres Treated
Oil	Many types	120,589
Propiconazole	Fungicide	71,083
Glyphosate	Herbicide	56,625
Ziram	Fungicide	52,151
Chlorantraniliprole	Insecticide	46,990

Table 32. The 2021 top five AIs by pounds applied to peach and nectarine. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Oil	Many types	2,163,247
1,3-Dichloropropene	Fumigant	307,806
Ziram	Fungicide	294,626
Sulfur	Fung/Insect	227,063
Copper	Fungicide	144,474

PEACH AND NECTARINE

Peaches. DPR staff photo.

Nectarines on tree. DPR staff photo.

Forktailed bush katydid nymph (Scudderia furcata), a pest on peaches and nectarines. DPR staff photo.

[1] Quick Stats Database of US Department of Agriculture, National Agricultural Statistics Service

Pistachio

The total bearing acreage of pistachio increased by 10 percent in 2021[1] (Figure 13). Despite the increase in acreage, pesticide use decreased: Pounds of AI applied to pistachio decreased from 6.5 million pounds applied in 2020 to 6.3 million pounds applied in 2021 (3.3 percent decrease). Acres treated decreased from 7.2million acres treated in 2020 to 7.0 million acres treated in 2021 (2.8 percent decrease).

The herbicide glyphosate made the top five AIs when ranked by both pounds applied and by acres treated. Three insecticides – lambda cyhalothrin, bifenthrin, and chlorantraniliprole – and the biopesticide fungicide *Aspergillus flavus* strain AF36 completed the top five when measured by acres treated, while the fungicide/insecticide sulfur, oil, and the herbicides pendimethalin and glufosinate-ammonium made up the top five when measured by pounds applied (Table 333, 34).

Table 33. The 2021 top five AIs by acres treated in pistachio. Fung/Insect = Fungicide/Insecticide

Top 5	Type	Acres Treated
Lambda-cyhalothrin	Insecticide	508,771
Glyphosate	Herbicide	434,299
Chlorantraniliprole	Insecticide	360,777
Bifenthrin	Insecticide	327,159
***Aspergillus flavus* str. AF36**	Fungicide	296,588

Table 34. The 2021 top five AIs by pounds applied to pistachio.

Top 5	Type	Pounds Applied
Sulfur	Fung/Insect	1,355,034
Glyphosate	Herbicide	876,504
Oil	Many types	674,697
Pendimethalin	Herbicide	272,130
Glufosinate-Ammonium	Herbicide	249,279

PISTACHIO

Pistachio branch. Gerald Holmes, Strawberry Center, Cal Poly San Luis Obispo, Bugwood.org

Pistachios. USDA ARS Photo Unit, USDA Agricultural Research Service, Bugwood.org

Leaffooted bug (Leptoglossus zonatus), a pistachio pest. DPR staff photo.

[1] Quick Stats Database of US Department of Agriculture, National Agricultural Statistics Service

Processing Tomato

The statewide planted acreage of processing tomatoes decreased by 2 percent in 2021[1] (Figure 13). Pounds of AI applied dropped from 10.9 million pounds applied in 2020 to 10.0 million pounds applied in 2021 (7.6 percent decrease). The acres treated decreased from 2.8 million acres treated in 2020 to 2.7 million acres treated in 2021 (1.8 percent decrease).

Sulfur was ranked as the most-used AI in terms of both pounds applied and acres treated. The insecticides imidacloprid, lambda-cyhalothrin, and chlorantraniliprole, and the fungicide azoxystrobin made up the remaining four of the top five AIs by acres treated. The biopesticide kaolin, the two fumigants, potassium N-methyldithiocarbamate (metam-potassium) and metam-sodium, and the fungicide chlorothalonil ranked in the top five by pounds applied (Table 35, 36).

Table 35. The 2021 top five AIs by acres treated in processing tomato. Fung/Insect = Fungicide/Insecticide

Top 5	Type	Acres Treated
Sulfur	Fung/Insect	280,057
Imidacloprid	Insecticide	133,231
Lambda-cyhalothrin	Insecticide	111,118
Azoxystrobin	Fungicide	106,352
Chlorantraniliprole	Insecticide	104,843

Table 36. The 2021 top five AIs by pounds applied to processing tomato. Fung/Insect = Fungicide/Insecticide

Top 5	Type	Pounds Applied
Sulfur	Fung/Insect	6,648,512
Metam-potassium	Fumigant	1,515,261
Kaolin	Fung/insect	289,650
Metam-sodium	Fumigant	271,668
Chlorothalonil	Fungicide	197,176

PROCESSING TOMATO


Tomatoes. Creative Commons CC0 1.0 Universal Public Domain Dedication.


Tomatoes on the vine. DPR staff photo.


Redshouldered stink bug (*Thyanta custator*), one of multiple species of stink bug pests on tomato. DPR staff photo.

[1] Quick Stats Database of US Department of Agriculture, National Agricultural Statistics Service

Rice

The statewide acres planted of rice decreased by 21 percent in 2021[1] (Figure 13). This decrease may explain the decline in the pounds of AI applied to rice in 2021, going from 5.3 million pounds applied in 2020 to 4.4 million pounds applied in 2021 (17.1 percent decrease). The acres treated with AIs decreased from 3.3 million acres treated in 2020 to 2.8 million acres treated in 2021 (16.9 percent decrease).

The herbicides propanil and triclopyr (triethylamine salt) ranked in the top five AIs by both acres treated and pounds applied. The fungicide azoxystrobin and the herbicides halosulfuron-methyl and benzobicyclon were in the top five by acres treated, while the fungicide copper, the herbicide thiobencarb, and the algaecide sodium carbonate peroxyhydrate ranked in the top five by pounds applied (Table 37, 38).

Table 37. The 2021 top five AIs by acres treated in rice.

Top 5	Type	Acres Treated
Propanil	Herbicide	413,305
Triclopyr, triethylamine salt	Herbicide	281,925
Azoxystrobin	Fungicide	251,897
Halosulfuron-methyl	Herbicide	192,488
Benzobicyclon	Herbicide	178,266

Table 38. The 2021 top five AIs by pounds applied to rice.

Top 5	Type	Pounds Applied
Propanil	Herbicide	1,968,008
Copper	Algaecide	666,308
Thiobencarb	Herbicide	394,055
Sodium carbonate peroxyhydrate	Algaecide	175,162
Triclopyr, triethylamine salt	Herbicide	54,058

RICE

Rice grains. Photo courtesy of USDA NRCS

Rice field. Natalie Hummel, Louisiana State University Ag Center, Bugwood.org

Tadpole shrimp (*Triops longicaudatus*), a rice pest. Photo by Steve Jurvetson, Creative Commons Attribution 2.0 Generic License.

[1] Quick Stats Database of US Department of Agriculture, National Agricultural Statistics Service

Strawberry

The total planted acreage of strawberry in California increased by 6 percent in 2021[1] (Figure 13). The pounds applied increased from 11.6 million pounds applied in 2020 to 12.2 million pounds applied in 2021 (6 percent increase). The acres treated decreased from 2.64 million acres treated in 2020 to 2.60 million acres treated in 2021 (1.5 percent decrease).

Captan, a fungicide, and sulfur, a fungicide/insecticide, ranked in the top five by both pounds applied and acres treated. The insecticide *Bacillus thuringiensis* and the fungicides fludioxonil and "captan, other related" rounded off the top five by acres treated (AIs with "other related" following their name are the naturally occurring impurities or impurities formed during the synthesis of the chemical compound). The fumigants chloropicrin, 1,3-dichloropropene, and potassium N-methyldithiocarbamate (metam-potassium) made up the remaining three of the top five AIs by pounds applied (Table 39, 40).

Table 39. The 2021 top five AIs by acres treated in strawberry. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Acres Treated
Captan	Fungicide	178,407
Sulfur	Fung/Insect	162,581
Captan, other related	Fungicide	84,551
Bacillus thuringiensis	Insecticide	69,537
Fludioxonil	Fungicide	64,299

Table 40. The 2021 top five AIs by pounds applied to strawberry. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Chloropicrin	Fumigant	6,840,200
1,3-Dichloropropene	Fumigant	1,704,230
Metam-Potassium	Fumigant	1,105,404
Sulfur	Fung/Insect	776,962
Captan	Fungicide	308,613

STRAWBERRY

Row of strawberries. DPR staff photo.

Strawberry on vine. DPR staff photo.

Gray garden slug (Deroceras reticulatum), a pest on strawberries. Photo by Joseph Berger, Bugwood.org

[1] Quick Stats Database of US Department of Agriculture, National Agricultural Statistics Service

Table and Raisin Grape

Pesticide use on table and raisin grapes decreased in 2021, possibly in part due to a decline in total bearing acreage by 4 percent[1] (Figure 13). The pounds of AI applied decreased from 14.7 million pounds applied in 2020 to 11.8 million pounds applied in 2021 (19.3 percent decrease). The acres treated also decreased, declining from 5.9 million acres treated in 2020 to 5.0 million acres treated in 2021 (14.8 percent decrease).

Sulfur and copper made the top five AIs by acres treated and pounds applied. The plant growth regulator gibberellin, the herbicide glufosinate-ammonium, and the insecticide imidacloprid comprised the remaining three top five AIs by acres treated, while the fungicide/insecticide lime-sulfur, the fumigant 1,3-dichloropropene, and the plant growth regulator hydrogen cyanamide were in the top five AIs by pounds applied (Table 41, 42).

Table 41. The 2021 top five AIs by acres treated in table and raisin grape. Fung/Insect = Fungicide/Insecticide. PGR = Plant Growth Regulator.

Top 5	Type	Acres Treated
Sulfur	Fung/Insect	1,369,629
Gibberellins	PGR	298,031
Copper	Fungicide	260,851
Glufosinate-Ammonium	Herbicide	117,100
Imidacloprid	Insecticide	114,972

Table 42. The 2021 top five AIs by pounds applied to table and raisin grape. Fung/Insect = Fungicide/Insecticide. PGR = Plant Growth Regulator.

Top 5	Type	Pounds Applied
Sulfur	Fung/Insect	8,114,795
Lime-Sulfur	Fung/Insect	911,408
1,3-Dichloropropene	Fumigant	453,842
Copper	Fungicide	297,410
Hydrogen Cyanamide	PGR	285,014

TABLE AND RAISIN GRAPE

Bunch of green grapes. DPR staff photo.

Raisin grapes drying on the vine. DPR staff photo.

Glassy-winged sharpshooter (Homalodisca vitripennis), a pest on grapes. Photo by Charles Ray, Auburn University, Bugwood.org

[1] Quick Stats Database of US Department of Agriculture, National Agricultural Statistics Service

Walnut

Total bearing acreage of walnuts increased by 3 percent in 2021[1] (Figure 13). Despite the increase in acreage, the pounds of AI applied decreased from 7.2 million pounds applied in 2020 to 5.4 million pounds applied in 2021 (25.5 percent decrease). Acres treated decreased from 5.7 million in 2020 to 4.9 million acres treated in 2021 (13.8 percent increase).

The top five AIs used in walnut included the fungicides copper and mancozeb and the herbicide glyphosate for both pounds applied and acres treated. The remaining two AIs by acres treated were the herbicide oxyfluorfen and the insecticide chlorantraniliprole, while the biopesticide kaolin clay and the fumigant 1,3-dichloropropene made up the remaining two top five AIs when measured by pounds applied (Table 43, 44).

Table 43. The 2021 top five AIs by acres treated in walnut.

Top 5	Type	Acres Treated
Glyphosate	Herbicide	341,738
Copper	Fungicide	278,911
Mancozeb	Fungicide	244,841
Chlorantraniliprole	Insecticide	189,071
Oxyfluorfen	Herbicide	183,733

Table 44. The 2021 top five AIs by pounds applied to walnut. Fung/Insect = Fungicide/Insecticide

Top 5	Type	Pounds Applied
Copper	Fungicide	1,053,889
Glyphosate	Herbicide	657,668
Kaolin	Fung/Insect	525,797
Mancozeb	Fungicide	433,276
1,3-Dichloropropene	Fumigant	283,561

WALNUT

Walnuts. Creative Commons CC0 1.0 Universal Public Domain Dedication.

Walnut on branch. DPR staff photo.

Codling moth (Cydia pomonella), a walnut pest. Photo by Gyorgy Csoka, Hungary Forest Research Institute, Bugwood.org

[1] Quick Stats Database of US Department of Agriculture, National Agricultural Statistics Service

Wine Grape

The bearing acreage of wine grapes in California decreased by 2 percent from 2020 to 2021 (Figure 13).[1] Pounds of AI applied decreased from 28.6 million pounds applied in 2020 to 25.6 million pounds applied in 2021 (10.6 percent decrease). The acres treated decreased from 10.2 million acres treated in 2020 to 9.5 million acres treated in 2021 (6.4 percent decrease).

Sulfur, oil, and glyphosate made up the top five AIs when ranked by either acres treated or pounds applied. The fungicide copper and the herbicide glufosinate-ammonium rounded out the top five AIs by acres treated, while the fumigant 1,3-dichloropropene and the fungicide/insecticide lime-sulfur comprised the remaining two AIs of the top five by pounds applied (Table 45, 46).

Table 45. The 2021 top five AIs by acres treated in wine grape. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Acres Treated
Sulfur	Fung/Insect	2,233,582
Copper	Fungicide	357,522
Glufosinate-Ammonium	Herbicide	337,545
Oil	Many	301,343
Glyphosate	Herbicide	270,973

Table 46. The 2021 top five AIs by pounds applied to wine grape. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Sulfur	Fung/Insect	18,904,177
Oil	Many	1,900,776
1,3-Dichloropropene	Fumigant	563,472
Glyphosate	Herbicide	518,525
Lime-Sulfur	Fung/Insect	369,253

WINE GRAPE

Wine grape bunches. William M. Brown Jr., Bugwood.org

Wine grape vineyard. DPR staff photo.

Black vine weevil (Otiorhynchus sulcatus), a pest in grapes. Photo by Peggy Greb, USDA Agricultural Research Service, Bugwood.org

[1] Quick Stats Database of US Department of Agriculture, National Agricultural Statistics Service

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