PESTICIDE USE ANNUAL REPORT

2022 Data Summary

dpr

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STATE OF CALIFORNIA
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Year in Summary

Overview:

Reported pesticide use for California in 2022 totaled 181 million pounds of applied active ingredients (AIs) and 92 million acres treated. Eleven percent of the pounds applied and 27 percent of the acres treated were adjuvants[1]. Since 2021, pounds applied of AIs decreased by ten million pounds (5 percent decrease), while the acres treated decreased by three million acres (3 percent decrease). This decrease in pesticide use may have partly occurred due to increases in fallowed agricultural land resulting from drought conditions 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 to be 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. Higher-risk categories include carcinogens, cholinesterase inhibitors, fumigants, groundwater contaminants, reproductive toxins, and toxic air contaminants.

2021 to 2022 Changes: The pounds applied and the acres treated with biopesticides increased while oils decreased from 2021 to 2022. Higher-risk pesticides characterized as carcinogens, fumigants, and reproductive toxins decreased in pounds applied and acres treated. Cholinesterase inhibitors increased in pounds applied but decreased in acres treated, while groundwater contaminants and toxic air contaminants decreased in pounds applied while increasing in acres treated.

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 2021 to 2022.

Category	Change in Pounds Applied	Percent Change Pounds	Change in Acres Treated	Percent Change Acres
Biopesticides	↑ 240,095	3	↑ 22,519	0.3
Oils	↓ -2,889,721	-8	↓ -326,016	-7
Carcinogens	↓ -2,763,026	-7	↓ -398,734	-6
Cholinesterase Inhibitors	↑ 78,066	3	↓ -33,788	-2
Fumigants	↓ -1,254,294	-3	↓ -218	0
Groundwater Contaminants	↓ -16,361	-8	↑ 21,154	9
Reproductive Toxins	↓ -27,367	0	↓ -315,189	-9
Toxic Air Contaminants	↓ -1,004,608	-3	↑ 67,915	4

[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 2013, acres treated with lower-risk biopesticides and oils increased by 30 and 1 percent, respectively, while use of higher-risk categories decreased by at least 29 percent, and up to 64 percent. The pounds applied of biopesticides during this ten-year period increased by 56 percent, while use of oils decreased by 4 percent and higher-risk pesticide categories decreased by at least 17 percent, and up to 77 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 2013 to 2022.

Category	Change in Pounds Applied	Percent Change Pounds	Change in Acres Treated	Percent Change Acres
Biopesticides	2,826,391	56	1,934,054	30
Oils	-1,326,525	-4	46,796	1
Carcinogens	-8,622,348	-20	-2,668,634	-29
Cholinesterase Inhibitors	-2,034,276	-45	-2,113,024	-52
Fumigants	-7,152,905	-17	-138,676	-41
Groundwater Contaminants	-651,688	-77	-447,165	-64
Reproductive Toxins	-5,174,511	-45	-2,272,605	-41
Toxic Air Contaminants	-9,978,562	-21	-1,778,140	-48

The AIs with the highest total reported pounds applied in 2022 were sulfur (fungicide/insecticide), petroleum and mineral oils (fungicide/insecticide), glyphosate (herbicide), 1,3-dichloropropene (fumigant), and chloropicrin (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 2022 were sulfur, petroleum and mineral oils, glyphosate, lambda-cyhalothrin (insecticide), and abamectin (miticide/insecticide).

2022 TOP FIVE

Top 5 AIs by Pounds Applied

- Sulfur
- Oils
- Glyphosate
- 1,3-Dichloropropene
- Chloropicrin

Top 5 AIs by Acres Treated

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

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. By considering the use factors and data trends for both measures together, it is possible to get 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, kaolin clay, 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)

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 influenced by high application rates but 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 Agricultural (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 2022 data submitted to DPR as of August 17, 2023. 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), that contain record corrections made after August 17, 2023.

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.

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.

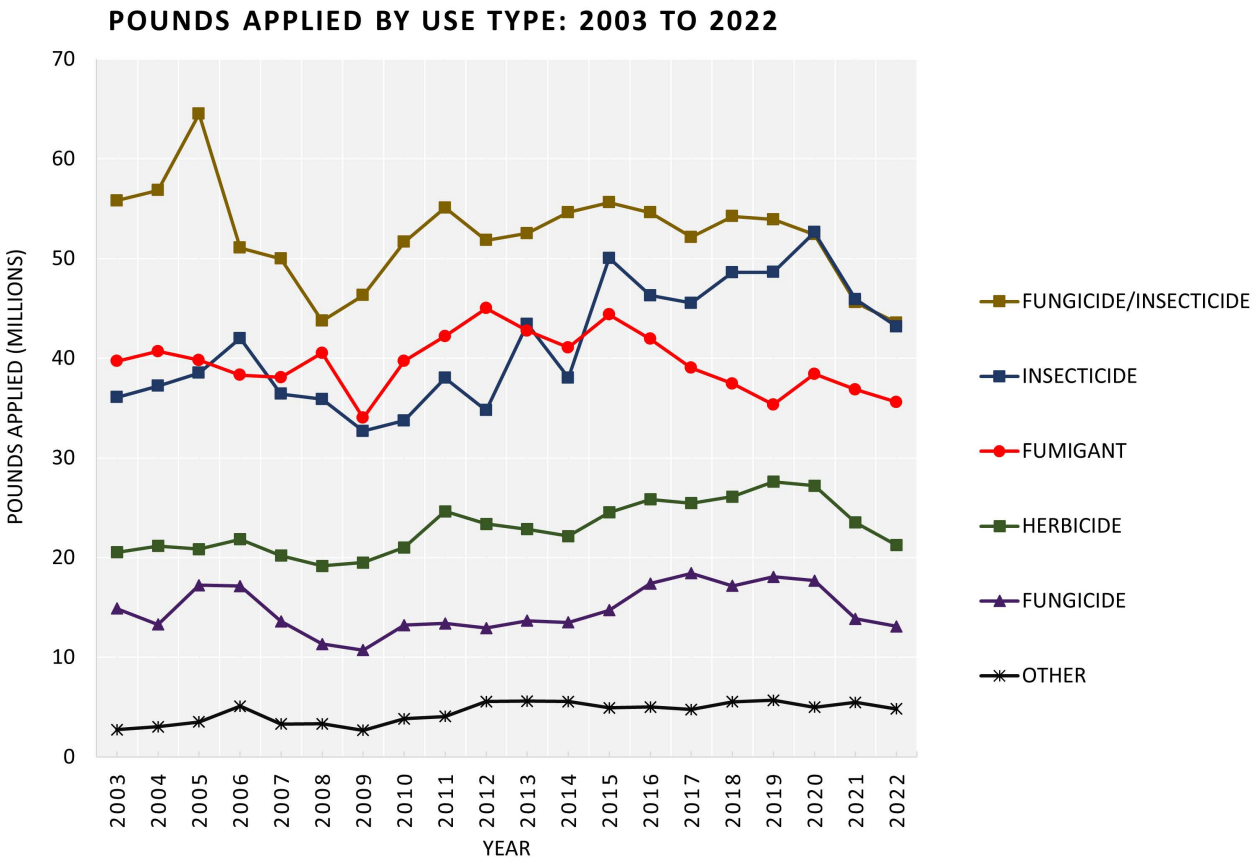


Figure 1. Pounds applied of all AIs in the major types of pesticides from 2003 to 2022, where "Other" includes pesticides such as plant growth regulators, bactericides, harvest aids, rodenticides, molluscicides, algaecides, repellents, antimicrobials, antifoulants, disinfectants, and biocides.

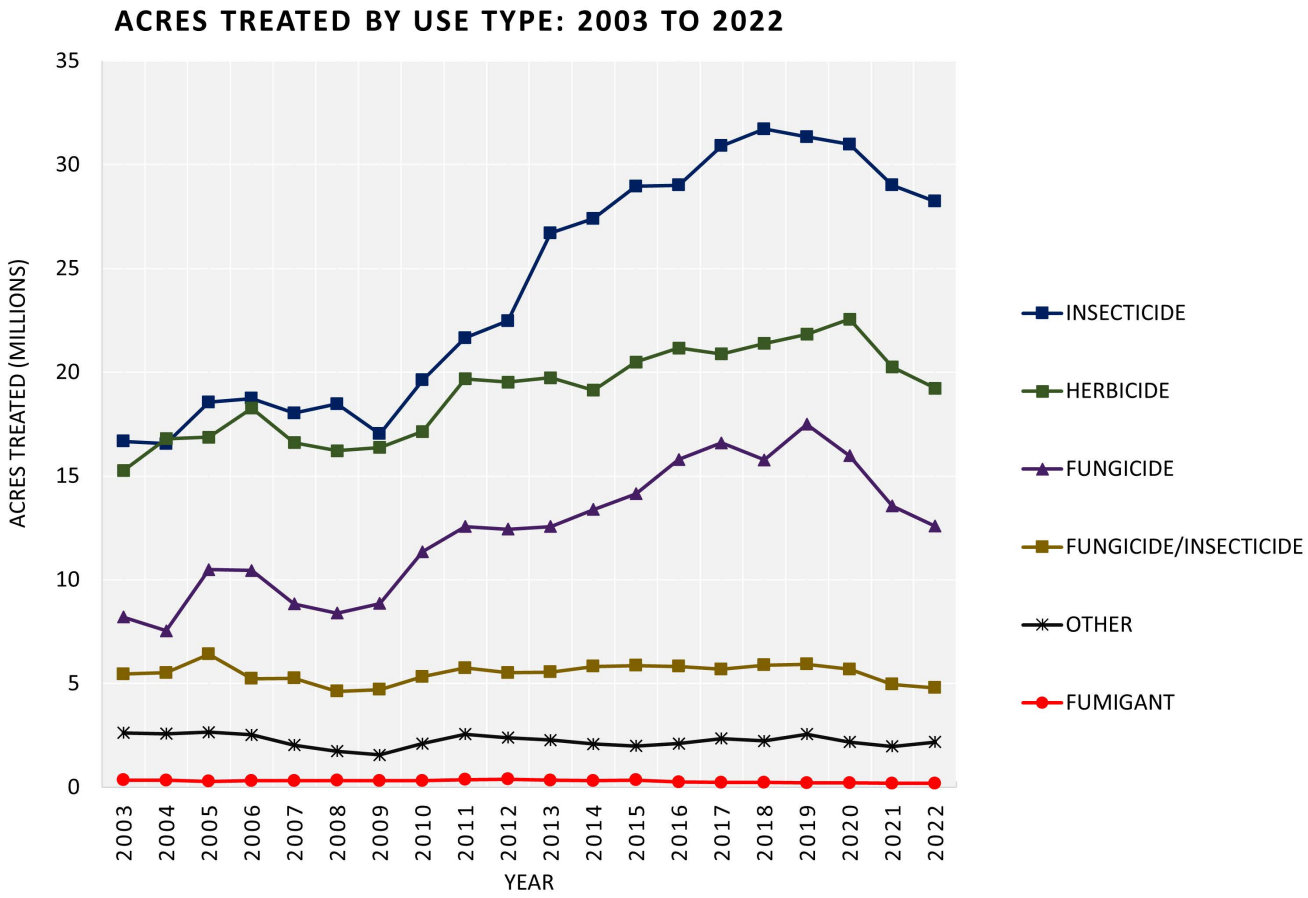


Figure 2. Acres treated by all AIs in the major types of pesticides from 2003 to 2022, where "Other" includes pesticides such as plant growth regulators, bactericides, harvest aids, rodenticides, molluscicides, algaecides, repellents, antimicrobials, antifoulants, disinfectants, and biocides.

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 pyrethroid lambda-cyhalothrin, the botanical miticide/insecticide abamectin, the anthranilic diamide chlorantraniliprole, and the diacylhydrazine insect growth regulator methoxyfenozide were the remaining three of the top five insecticide AIs by acres treated. The microbials *Bacillus thuringiensis* and *Burkholderia Rinojensis* Strain A396, the inorganic boric acid, and the inorganic diatomaceous earth made up the remainder of the top five insecticides measured by pounds applied (Figure 3a and b, Table 3, and Table 4).

Table 3. Top five insecticides in California by acres treated for 2022.

Top Five	Acres Treated
Oil	4,543,066
Lambda-Cyhalothrin	2,394,279
Abamectin	2,176,168
Chlorantraniliprole	2,140,108
Methoxyfenozide	1,842,633

Table 4. Top five insecticides in California by pounds applied for 2022.

Top Five	Pounds Applied
Oil	34,508,857
Boric Acid	884,285
Diatomaceous Earth	778,768
***Burkholderia Rinojensis* Strain A396**	587,377
Bacillus Thuringiensis	573,123

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 3a and b, Table 5, and Table 6).

Table 5. Top five fungicides in California by acres treated for 2022.

Top Five	Acres Treated
Copper	1,800,542
Azoxystrobin	1,118,743
Pyraclostrobin	863,344
Fluopyram	723,000
Tebuconazole	625,590

Table 6. Top five fungicides in California by pounds applied for 2022.

Top 5	Pounds Applied
Copper	6,010,805
Potassium Phosphite	1,177,730
Mancozeb	996,511
Chlorothalonil	800,485
Ziram	385,720

Fungicide/Insecticide

The category fungicide/insecticide includes a number of AIs which are used 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. Four inorganic AIs—sulfur, lime-sulfur, the biopesticide kaolin clay, and borax—ranked in the top five when measured by either acres treated or by pounds applied. The botanical margosa oil was the remaining AI in the top five when measured by acres treated and the inorganic AI disodium octaborate tetrahydrate was the remaining AI in the top five by pounds applied (Figure 3a and b, Table 7, and Table 8).

Table 7. Top five fungicide/insecticides in California by acres treated for 2022.

Top Five	Acres Treated
Sulfur	4,587,375
Lime-Sulfur	104,083
Kaolin	77,820
Margosa Oil	43,245
Borax	39,727

Table 8. Top five fungicide/insecticides in California by pounds applied for 2022.

Top Five	Pounds Applied
Sulfur	38,982,187
Kaolin	2,862,924
Lime-Sulfur	1,168,482
Disodium Octaborate Tetrahydrate	286,960
Borax	145,077

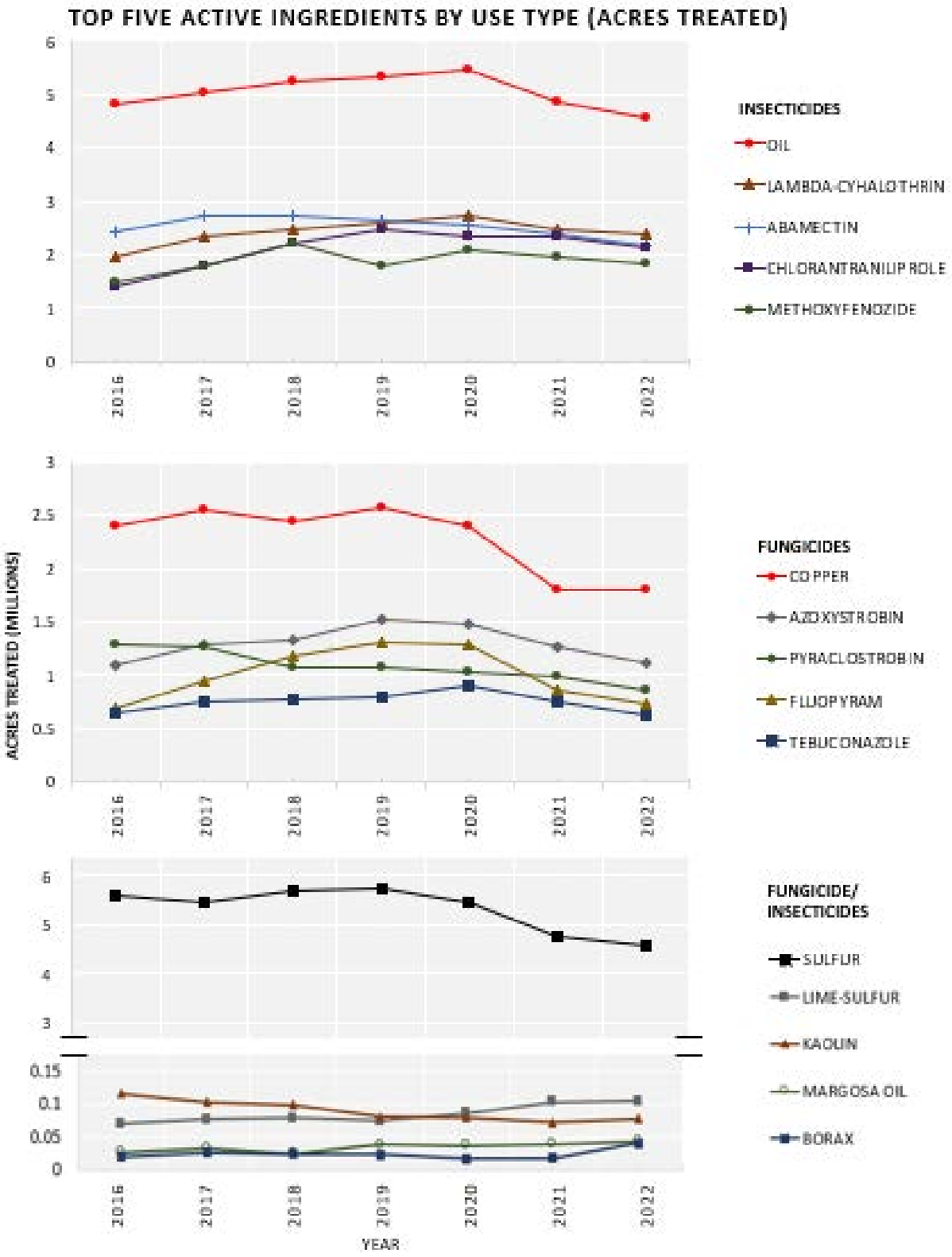


Figure 3a. Acres treated by the top five AIs in each of the major types of pesticides from 2016 to 2022. Vertical axis may be split to visually display AIs with substantially different ranges in use.

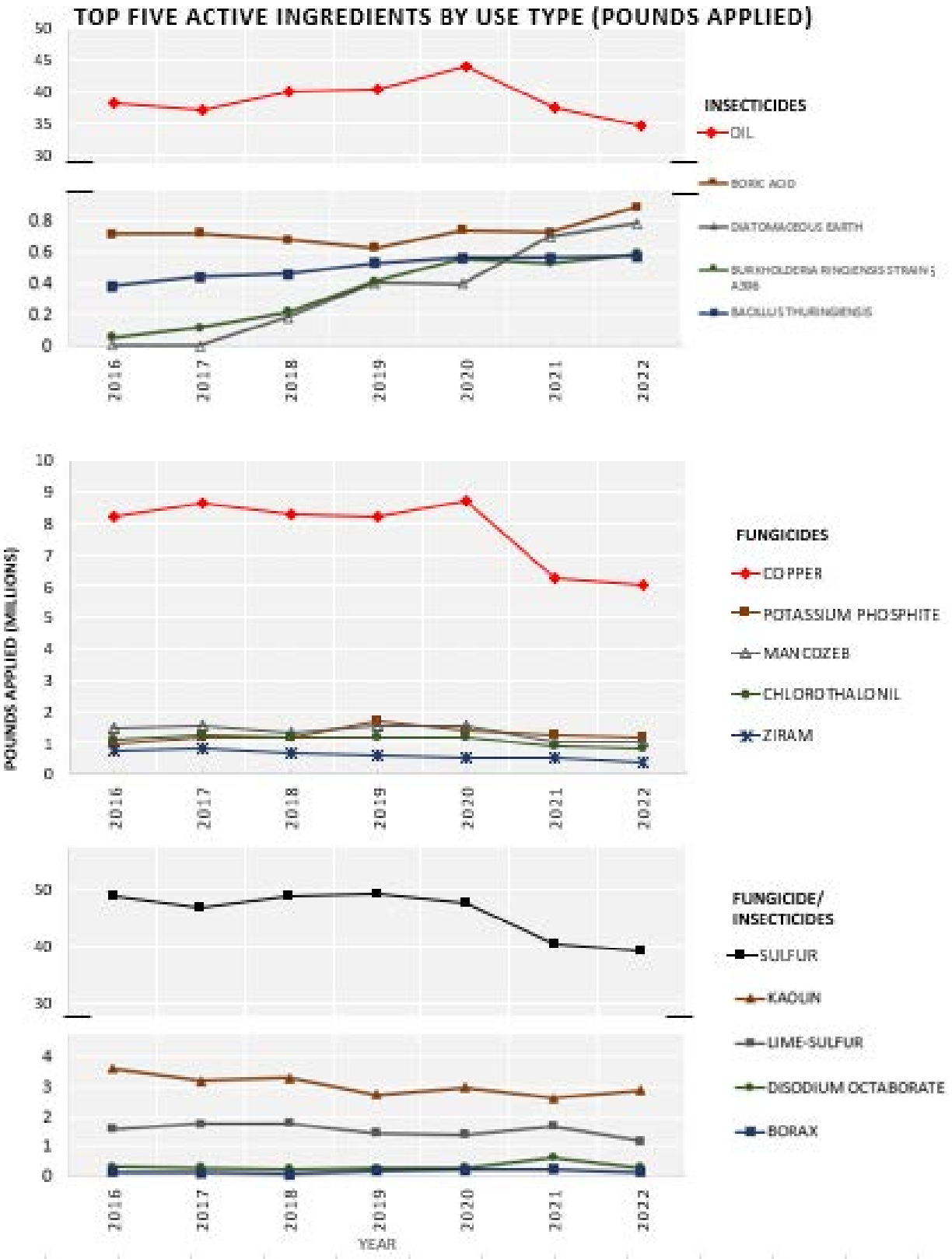


Figure 3b. Pounds applied of the top five AIs in each of the major types of pesticides from 2016 to 2022. Vertical axis may be split to visually display AIs with substantially different ranges in use.

Herbicides

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

Table 9. Top five herbicides in California by acres treated for 2022.

Top Five	Acres Treated
Glyphosate	4,514,553
Oxyfluorfen	1,863,502
Glufosinate-Ammonium	1,799,657
Clethodim	1,142,468
Saflufenacil	1,044,936

Table 10. Top five herbicides in California by pounds applied for 2022.

Top Five	Pounds Applied
Glyphosate	9,764,010
Pendimethalin	2,184,221
Glufosinate-Ammonium	1,781,692
Propanil	1,333,940
Oxyfluorfen	806,714

Fumigants

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

Table 11. Top five fumigants in California by acres treated for 2022.

Top Five	Acres Treated
1,3-Dichloropropene	57,076
Chloropicrin	49,077
Aluminum Phosphide	48,414
Metam-potassium	40,018
Metam-Sodium	18,209

Table 12. Top five fumigants in California by pounds applied for 2022.

Top Five	Pounds Applied
1,3-Dichloropropene	9,748,837
Chloropicrin	8,769,970
Metam-potassium	8,005,692
Metam-Sodium	3,630,276
Sulfuryl Fluoride	3,472,322

Other

The remaining "Other" 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 lower-risk bactericides/fungicides/algaecides in some crops, and thidiazuron used primarily as a defoliant in cotton, 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 cyanamide mostly used as a growth regulator, chlorine used as a post-harvest treatment and sanitizer, hydrogen peroxide used as sanitizer and disinfectant, and the growth regulator ethephon (Figure 4a and b, Table 13, and Table 14).

Table 13. Top five "Other" in California by acres treated for 2022.

Top Five	Acres Treated
Gibberellins	466,836
Ethephon	381,928
Hydrogen Peroxide	199,930
Peroxyacetic Acid	197,890
Thidiazuron	162,333

Table 14. Top five "Other" in California by pounds applied for 2022.

Top Five	Pounds Applied
Sodium Hypochlorite	930,880
Hydrogen Cyanamide	532,002
Chlorine	510,828
Hydrogen Peroxide	430,997
Ethephon	333,362

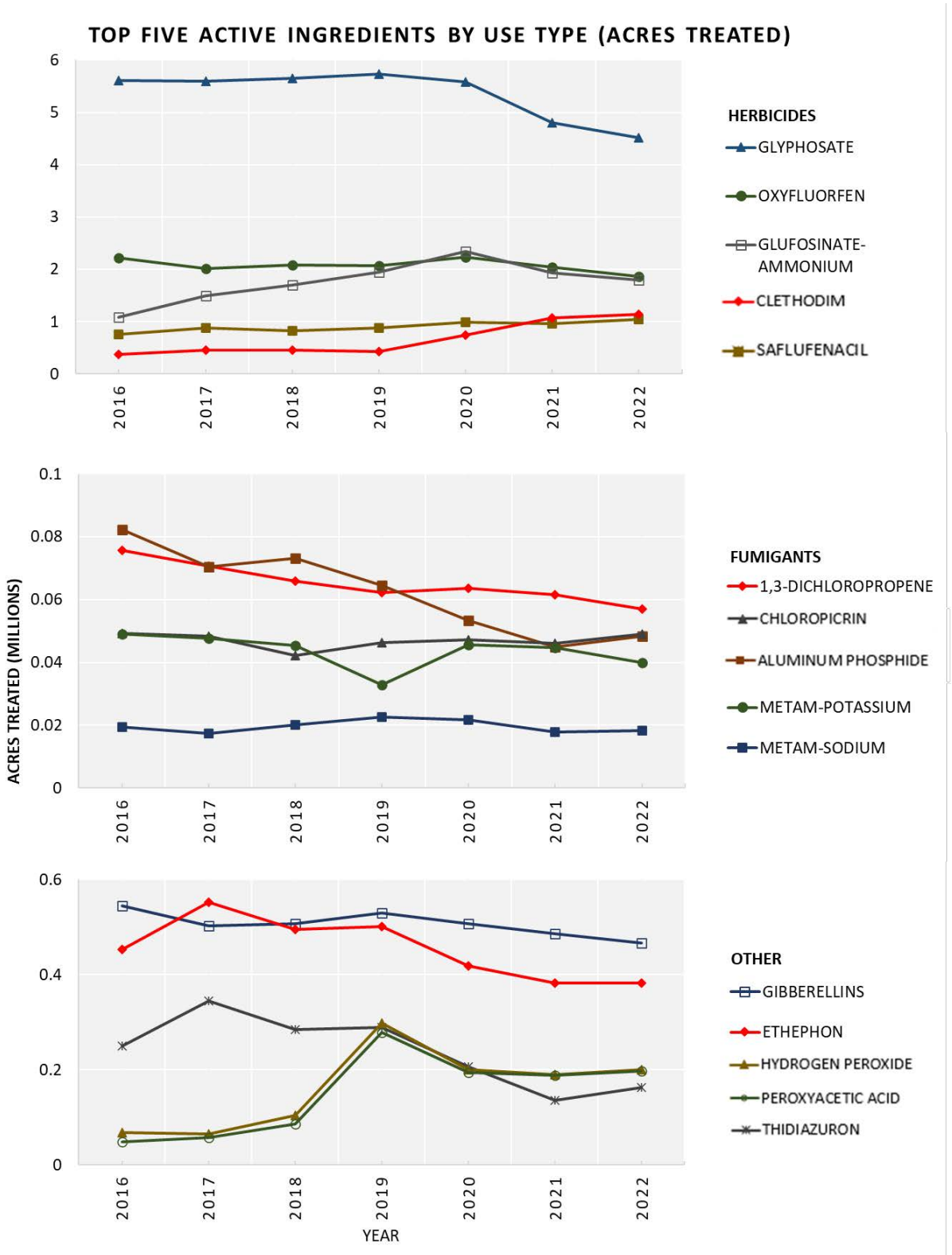


Figure 4a. Acres treated by the top five AIs in each of the major types of pesticides from 2016 to 2022: herbicides, fumigants, and other.

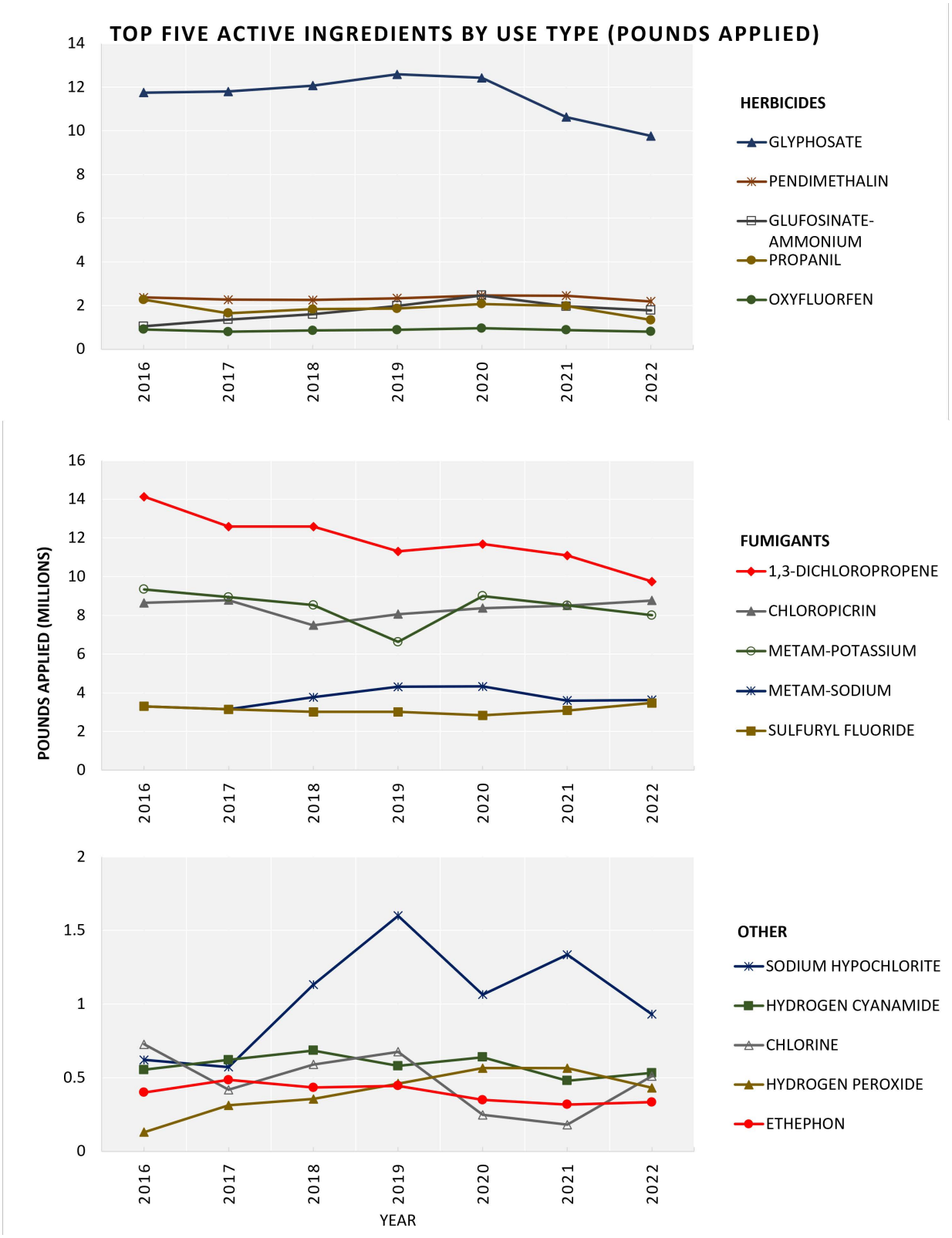


Figure 4b. Pounds applied of the top five AIs in each of the major types of pesticides from 2016 to 2022: herbicides, fumigants, and other.

Pesticide Use by County

In 2022, 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 Monterey 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 AIs by county, rank, and the percent change from 2021 and 2022, ordered by 2022 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.

County	2021 Lbs Applied	2021 Rank	2022 Lbs Applied	2022 Rank	Percent Change
Fresno	29,513,246	1	26,468,541	1	-10
Kern	25,152,175	2	25,835,076	2	3
Tulare	18,173,572	3	17,537,932	3	-3
San Joaquin	12,885,969	4	11,969,511	4	-7
Monterey	9,145,180	6	9,187,117	5	0.5
Madera	9,269,168	5	8,313,969	6	-10
Merced	8,727,250	7	8,005,882	7	-8
Kings	6,866,520	9	6,665,233	8	-3
Stanislaus	7,819,011	8	6,386,408	9	-18
Ventura	6,016,438	10	6,238,569	10	4
Santa Barbara	6,001,982	11	6,025,426	11	0.4
Sacramento	4,194,185	13	4,499,558	12	7
Imperial	5,020,799	12	4,433,052	13	-12
Yolo	3,569,545	14	3,735,238	14	5
Butte	2,734,760	17	2,892,919	15	6
Riverside	2,996,390	15	2,818,998	16	-6
San Luis Obispo	2,996,298	16	2,687,678	17	-10
Sutter	2,557,671	19	2,460,627	18	-4
Los Angeles	2,322,073	20	2,362,207	19	2
Sonoma	2,698,075	18	2,313,992	20	-14
Mendocino	2,189,468	22	1,995,053	21	-9
San Diego	1,514,061	25	1,557,503	22	3
Glenn	2,058,552	23	1,510,915	23	-27
Siskiyou	1,293,719	27	1,475,294	24	14
Colusa	2,297,020	21	1,344,045	25	-41
Santa Cruz	1,371,264	26	1,342,869	26	-2
Solano	1,672,629	24	1,192,385	27	-29
Napa	1,095,362	30	1,144,942	28	5
Yuba	1,211,308	28	1,079,614	29	-11
Tehama	1,101,821	29	1,065,913	30	-3
Orange	906,922	31	800,590	31	-12
San Benito	722,108	33	775,704	32	7

County	2021 Lbs Applied	2021 Rank	2022 Lbs Applied	2022 Rank	Percent Change
Santa Clara	870,533	32	676,151	33	-22
Lake	570,372	34	579,575	34	2
Placer	364,703	37	478,049	35	31
Contra Costa	456,378	36	472,548	36	4
San Bernardino	538,535	35	433,381	37	-20
Shasta	343,894	38	258,887	38	-25
Alameda	246,456	39	257,269	39	4
El Dorado	238,028	40	253,400	40	6
San Mateo	215,741	42	193,135	41	-10
Lassen	174,925	43	170,231	42	-3
Modoc	119,597	46	136,420	43	14
Del Norte	226,845	41	134,850	44	-41
Amador	120,205	45	119,239	45	-1
Plumas	90,640	47	97,004	46	7
Marin	76,309	48	86,016	47	13
Calaveras	58,271	51	82,487	48	42
Nevada	61,859	50	72,113	49	17
Tuolumne	63,284	49	44,333	50	-30
Humboldt	131,026	44	36,690	51	-72
Trinity	31,971	53	33,053	52	3
San Francisco	32,416	52	28,729	53	-11
Inyo	16,370	54	15,324	54	-6
Mariposa	7,449	55	5,278	55	-29
Mono	6,163	56	3,431	56	-44
Sierra	1,977	57	2,965	57	50
Alpine	644	58	305	58	-53
Total	**191,159,132**	**N/A**	**180,793,623**	**N/A**	**-5.4**

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.[1] In 2022, 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 2022, 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

[1] 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

furniture. Together, the "All Other" category represented 5 percent of total pounds applied. In 2022, production agriculture, post-harvest treatments, structural pesticide use, landscape maintenance, and all other uses ("All Others") decreased in pounds applied by 5 percent, 4 percent, 9 percent, 13 percent, and 11 percent, respectively (Table 16).

Table 16. Pounds applied of pesticide AIs, from 2003 to 2022, by general use categories.

Year	Production Agriculture	Post-Harvest Treatment	Structural Pest Control	Landscape Maintenance	All Others	Total Pounds Applied
2003	161,056,091	1,785,861	5,177,132	1,975,921	7,527,645	177,522,651
2004	165,918,291	1,874,540	5,120,304	1,612,029	6,998,029	181,523,193
2005	178,372,743	2,267,314	5,625,436	1,775,130	8,517,928	196,558,551
2006	168,671,713	2,216,144	5,273,699	2,286,768	10,269,756	188,718,079
2007	157,486,231	2,279,837	3,967,384	1,672,331	7,346,125	172,751,908
2008	151,551,228	2,540,305	3,202,933	1,589,070	7,237,790	166,121,325
2009	147,138,775	1,479,857	2,911,101	1,345,168	6,017,982	158,892,882
2010	160,576,073	2,164,741	3,699,144	1,734,574	8,026,211	176,200,743
2011	177,987,535	1,548,110	3,149,112	1,723,367	8,743,819	193,151,943
2012	172,181,053	1,234,560	3,464,623	1,551,824	9,300,579	187,732,639
2013	179,365,255	1,495,051	3,804,611	1,465,321	9,958,053	196,088,291
2014	174,864,811	1,333,933	3,714,898	1,618,947	8,902,190	190,434,779
2015	195,215,459	1,475,660	4,216,827	1,688,329	9,316,223	211,912,499
2016	192,089,666	1,790,475	3,933,428	1,735,854	10,384,463	209,933,886
2017	188,886,689	1,666,169	3,644,323	1,580,057	10,324,546	206,101,784
2018	191,830,352	1,504,593	3,458,572	1,519,598	11,911,196	210,224,312
2019	190,789,318	1,600,846	3,369,095	2,291,623	12,547,754	210,598,636
2020	197,117,591	1,976,570	3,303,081	2,097,027	11,027,989	215,522,258
2021	173,426,568	1,674,774	4,298,097	1,577,684	10,182,007	191,159,130
2022	164,782,290	1,609,482	3,915,457	1,374,864	9,111,530	180,793,623

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):

- 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 actual pesticide impacts 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 AIs 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.

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. Note that some AIs belong to more than one higher-risk category. For example, many fumigants are also toxic air contaminants, so the total use of those AIs is included under both the fumigant and toxic air contaminant category totals. Tables of the amount of the individual chemicals used in each category over the last ten years can be downloaded using the Pesticide Category Lists drop-down menus on the 2022 Summary Data website.

Table 17. The total pounds applied for eight different pesticide categories with the change and percent change from 2021 to 2022.

Category	2021 Lbs Applied	2022 Lbs Applied	Change	% Change
Biopesticides	7,677,168	7,917,262	240,095	3
Oils	37,517,684	34,627,963	-2,889,721	-8
Carcinogens	37,259,484	34,496,458	-2,763,026	-7
Cholinesterase inhibitors	2,411,858	2,489,924	78,066	3
Fumigants	36,853,885	35,599,591	-1,254,294	-3
Ground water contaminants	211,452	195,091	-16,361	-8
Reproductive toxins	6,400,460	6,373,093	-27,367	-0.4
Toxic air contaminants	39,331,053	38,326,444	-1,004,608	-3

Table 18. The total acres treated for eight different pesticide categories with the change and percent change from 2021 to 2022.

Category	2021 Acres Treated	2022 Acres Treated	Change	% Change
Biopesticides	8,463,393	8,485,912	22,519	0.3
Oils	5,014,453	4,688,437	-326,016	-7
Carcinogens	6,943,436	6,544,702	-398,734	-6
Cholinesterase inhibitors	1,981,093	1,947,306	-33,788	-2
Fumigants	197,522	197,304	-218	-0.1
Ground water contaminants	227,106	248,260	21,154	9
Reproductive toxins	3,581,643	3,266,454	-315,189	-9
Toxic air contaminants	1,832,695	1,900,610	67,915	4

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 increased by 240 thousand pounds applied (3 percent increase) and by 23 thousand acres treated (0.3 percent increase) between 2021 and 2022. Most of the increase in pounds applied since the last year was due to greater use of the fungicide/insecticide kaolin clay, the insecticide *Burkholderia rinojensis* strain A396, and the adjuvants vegetable oil and citric acid, which increased by 246 thousand pounds applied (9 percent increase), 60 thousand pounds applied (11 percent increase), 66 thousand pounds applied (15 percent increase), and 20 thousand pounds applied (11 percent increase), respectively. The increase in acres treated was largely due to 91 thousand more acres treated (4 percent increase) with citric acid and 27 thousand more acres treated (31 percent increase) with the insecticide *Burkholderia rinojensis* strain A396. Over the last ten years, biopesticide pounds applied have increased by 56 percent and acres treated have increased by 30 percent (Figure 5).

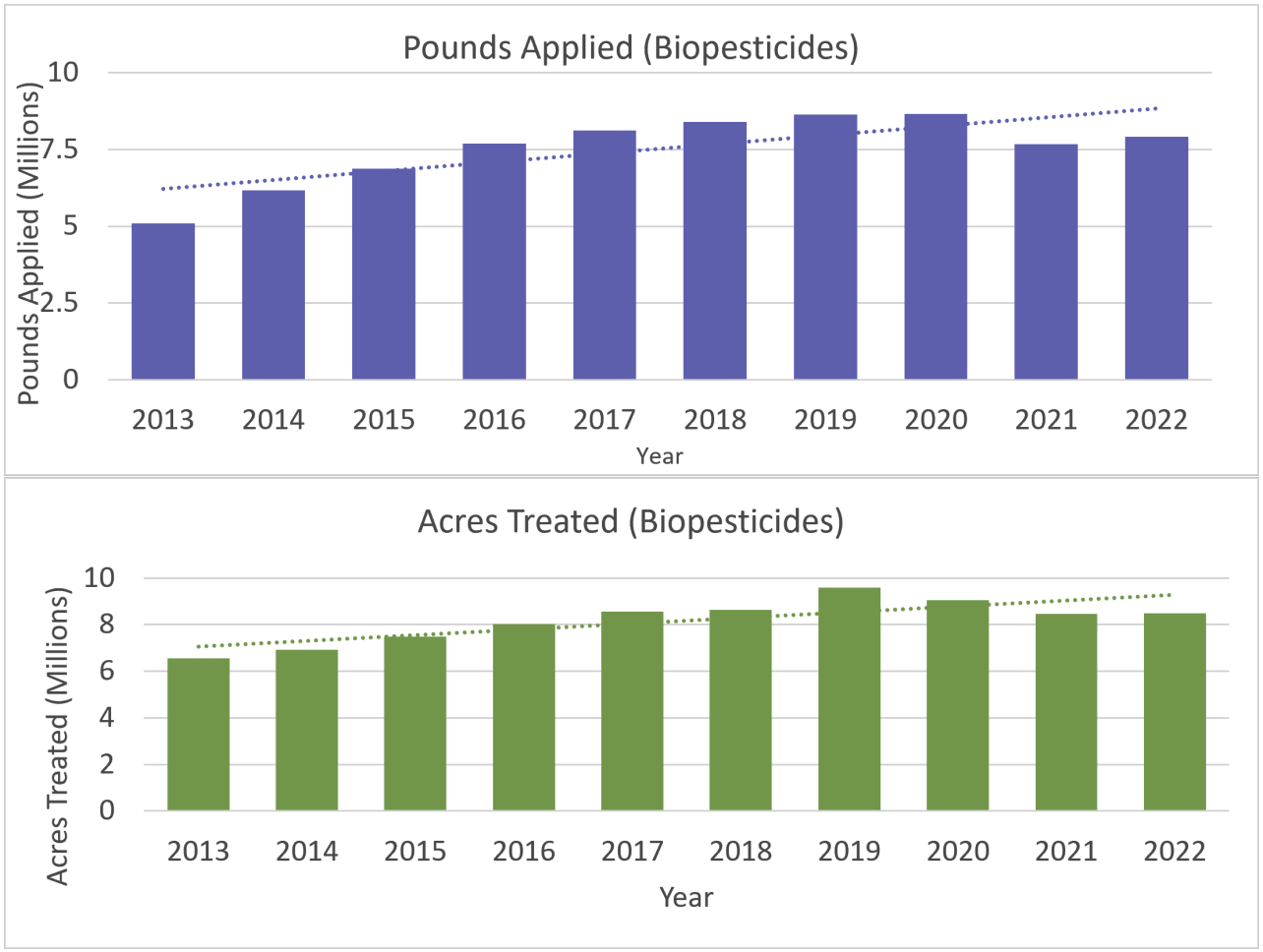


Figure 5. Use trends of pesticides that are biopesticides from 2013 to 2022.

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 2.9 million pounds applied (8 percent decrease) and decreased in acres treated by 326 thousand acres treated (7 percent decrease) between 2021 and 2022. Only oil AIs derived from petroleum distillation are included in these totals. Over the last ten years, pounds applied of oils have decreased by 4 percent and acres treated have increased by 1 percent (Figure 6).

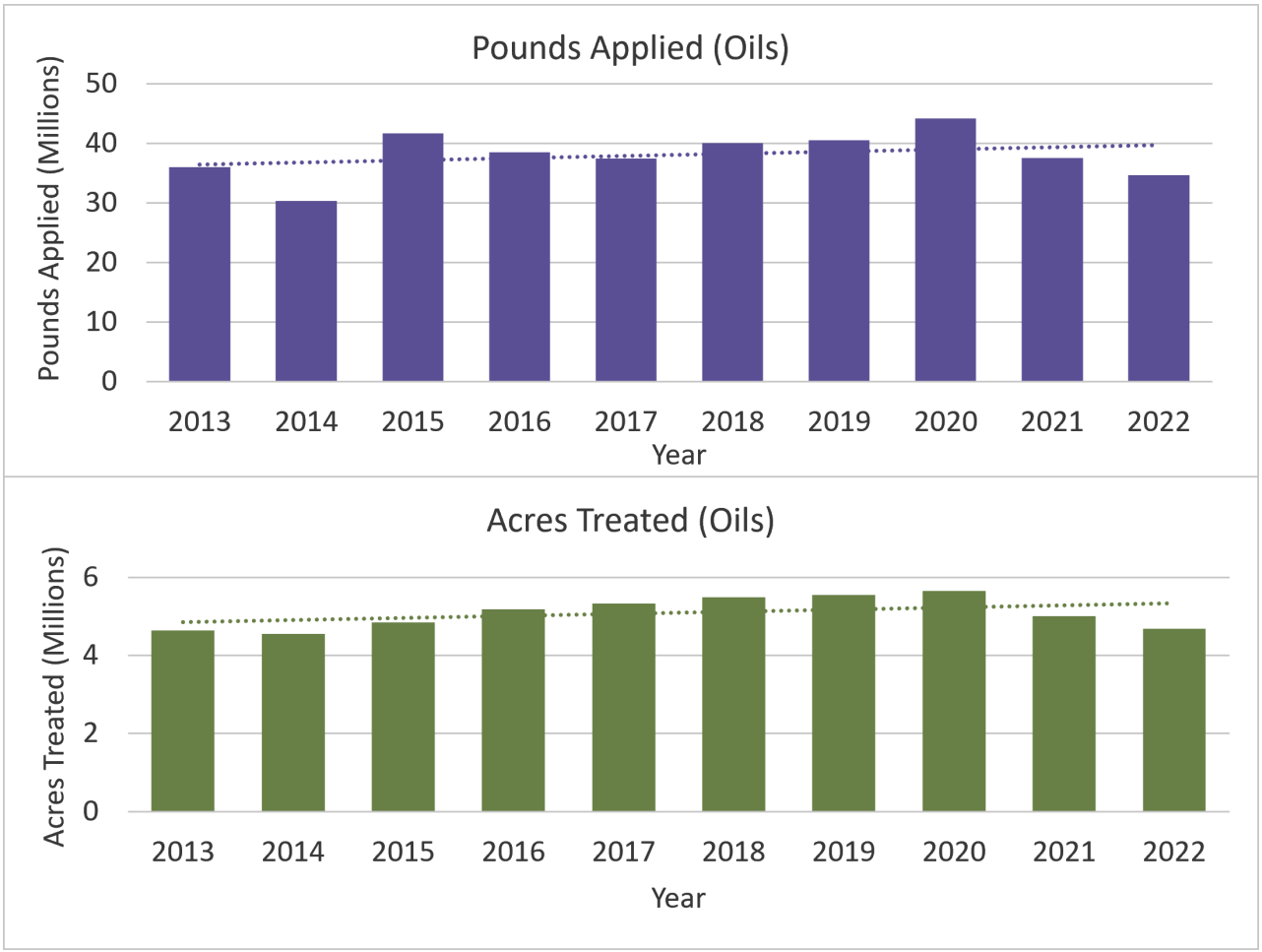


Figure 6. Use trends of pesticides that are oils from 2013 to 2022.

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 2.8 million pounds applied from 2021 to 2022 (7 percent decrease). The acres treated with carcinogens decreased by 399 thousand acres treated (6 percent decrease). The decrease in pounds applied was largely due to less use of the fumigant 1,3-dichloropropene, which decreased by 1.3 million pounds applied (12 percent decrease), the herbicide glyphosate, potassium salt, which decreased by 1.3 million acres treated (22 percent decrease), the fumigant potassium N-methyldithiocarbamate (metam-potassium), which decreased by 507 thousand pounds (6 percent decrease), and the fungicide chlorothalonil, which decreased by 115 thousand pounds (13 percent decrease). The decrease in acres treated was mostly due to fewer acres treated with the herbicide glyphosate, potassium salt, which decreased by 561 thousand acres treated (20 percent decrease) and the fungicide chlorothalonil which decreased by 49 thousand acres treated (12 percent decrease). Over the last ten years, pounds applied of pesticides that are carcinogens have decreased by 20 percent and acres treated have decreased by 29 percent (Figure 7).

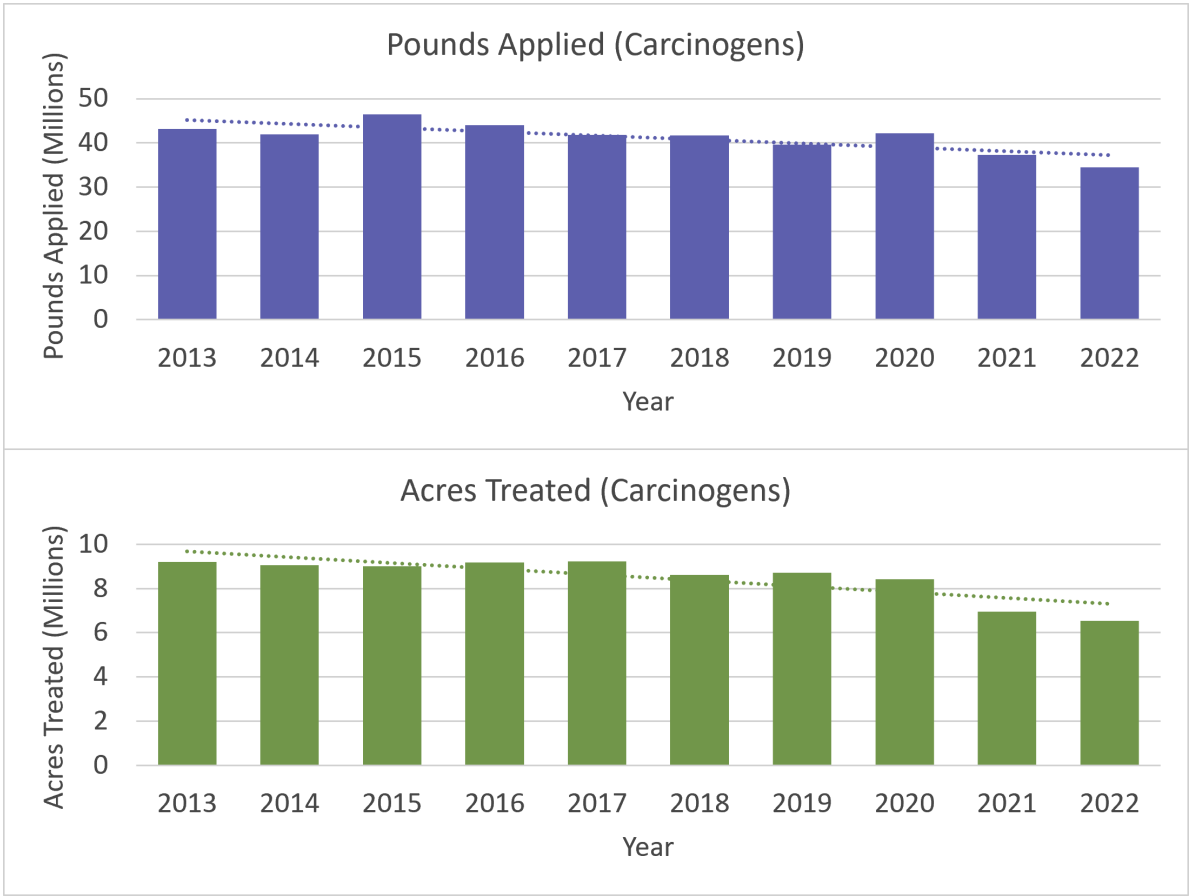


Figure 7. Use trends of pesticides identified as potentially carcinogenic by the U.S. EPA or the State's Proposition 65 list from 2013 to 2022.

Cholinesterase inhibitors

Use of organophosphorus and carbamate cholinesterase-inhibiting pesticides in 2022 increased from the previous year by 78 thousand pounds applied (3 percent increase) but decreased by 34 thousand acres treated (2 percent decrease). The increase in pounds applied since the last year was largely due to greater use of the insecticide malathion, which increased by 198 thousand pounds applied (79 percent increase), largely due to mosquito vector control needs. The drop in acres treated was predominantly due to 46 thousand fewer acres treated with the herbicide thiobencarb (40 percent decrease) and 21 thousand fewer acres treated with the insecticide dimethoate (7 percent decrease). Over the last ten years, pounds applied of pesticides that are cholinesterase inhibitors have decreased by 45 percent and acres treated have decreased by 52 percent (Figure 8).

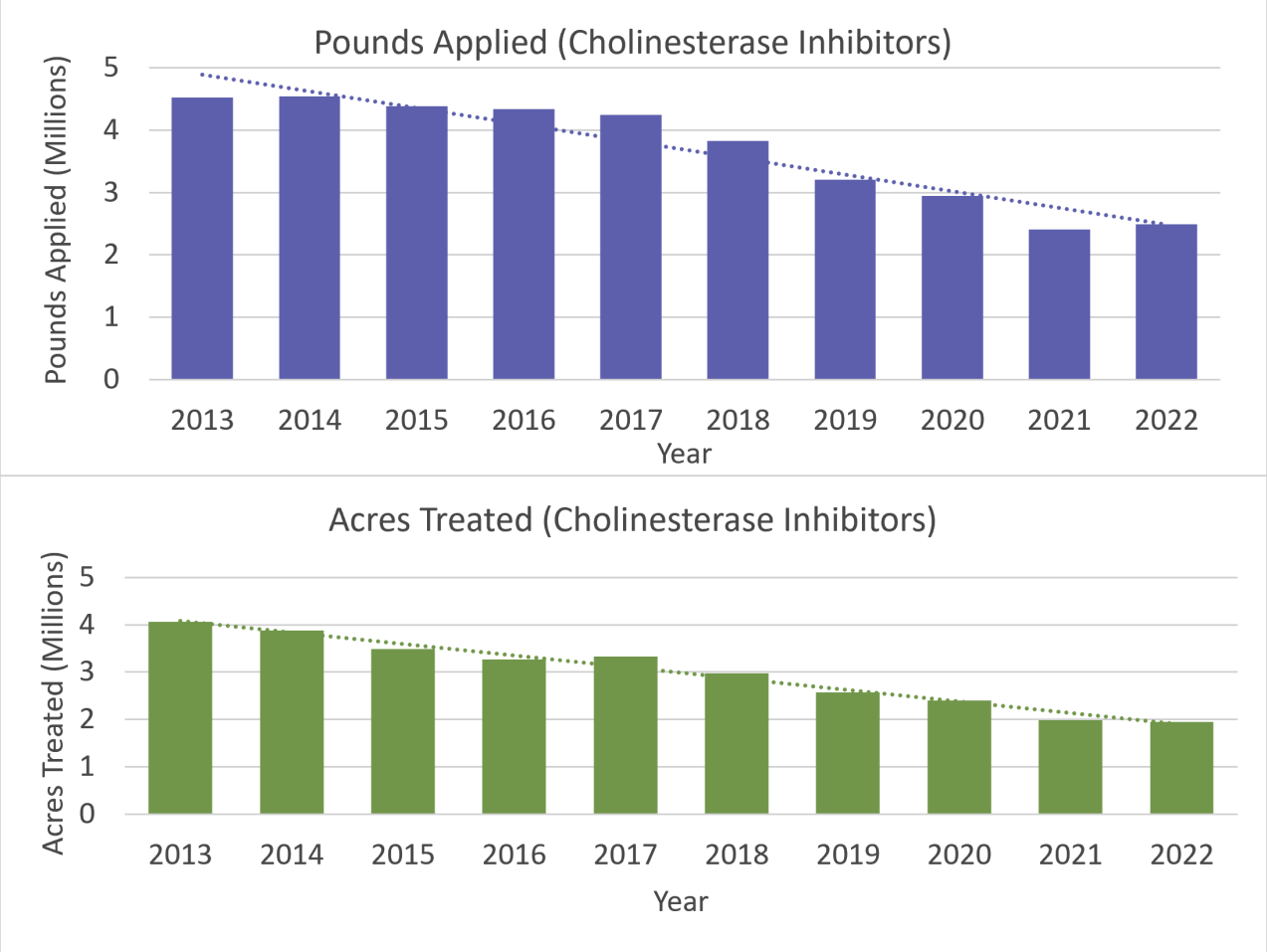


Figure 8. Use trends of pesticides that are organophosphorus or carbamate cholinesterase-inhibiting pesticides from 2013 to 2022.

Fumigants

The use of fumigant AIs declined by 1.3 million pounds applied (3 percent decrease) and by 218 acres treated (0.1 percent decrease) between 2021 and 2022. The decrease in pounds applied since the last year was largely due to less use of the fumigants 1,3-dichloropropene and potassium N-methyldithiocarbamate (metam-potassium), which decreased by 1.3 million pounds applied (12 percent decrease) and 507 thousand pounds applied (6 percent decrease), respectively. The small decrease in acres treated was predominantly due to 4.7 thousand less acres treated with potassium N-methyldithiocarbamate (metam-potassium) (11 percent decrease) and 4.4 thousand less acres treated with 1,3-dichloropropene (7 percent decrease). Over the last ten years, pounds applied of pesticides that are fumigants have decreased by 17 percent and acres treated have decreased by 41 percent (Figure 9).

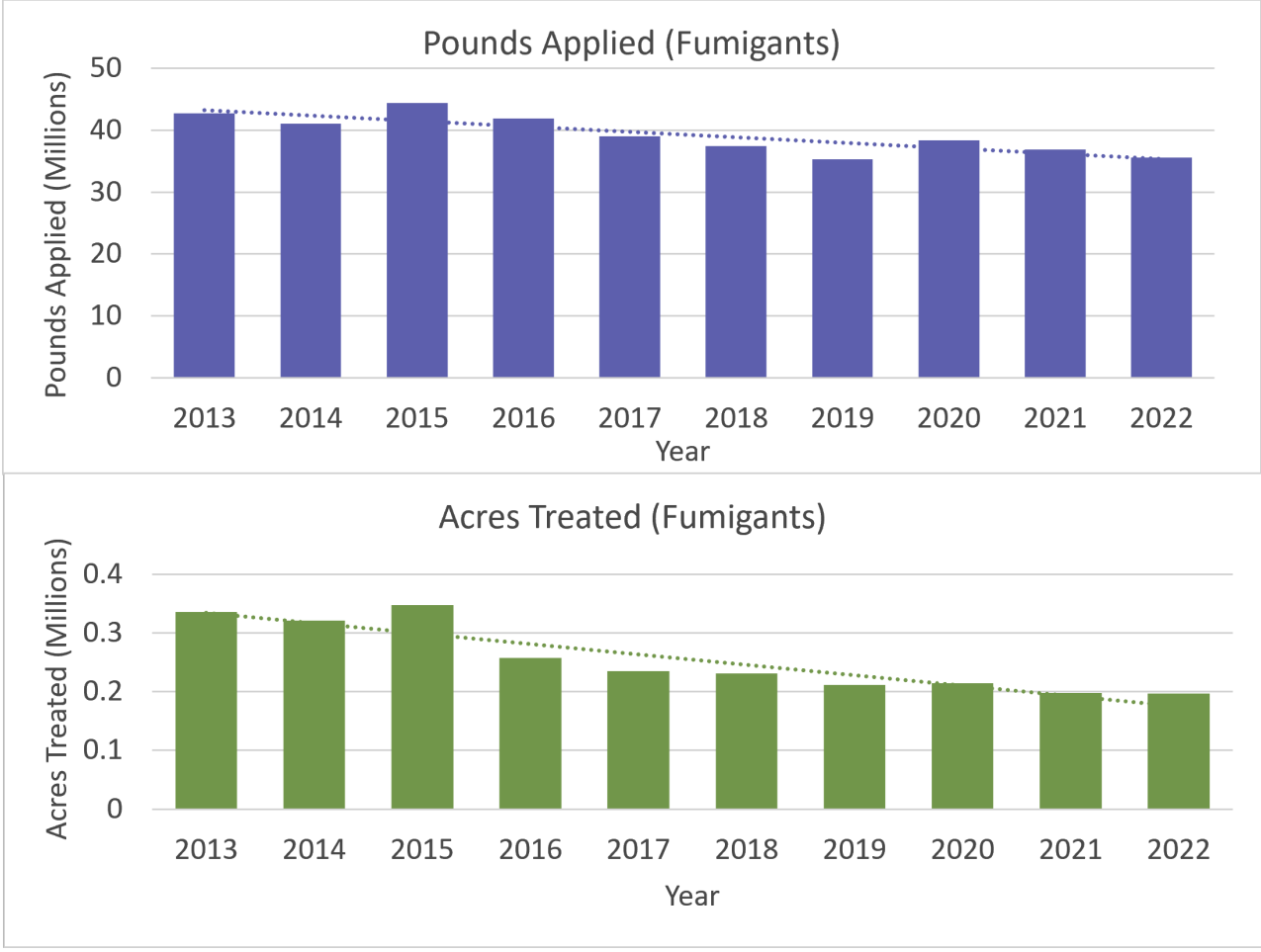


Figure 9. Use trends of pesticides that are fumigants from 2013 to 2022.

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 16 thousand pounds applied (8 percent decrease) but increased by 21 thousand acres treated (9 percent increase) between 2021 and 2022. The reduction in pounds applied since the last year was mostly due to less use of the herbicide diuron, which decreased by 19 thousand pounds applied (17 percent decrease). Diuron was also largely responsible for the annual increase in acres treated, with 28 thousand more acres treated since 2021 (17 percent increase). The increase in pounds applied and simultaneous decrease in acres treated from 2021 to 2022 is due in part to non-agricultural uses which do not report acres treated and to increased acres treated with products containing smaller percentages of diruon. Over the last ten years, pounds applied of pesticides that are groundwater contaminants have decreased by 77 percent and acres treated have decreased by 64 percent (Figure 10).

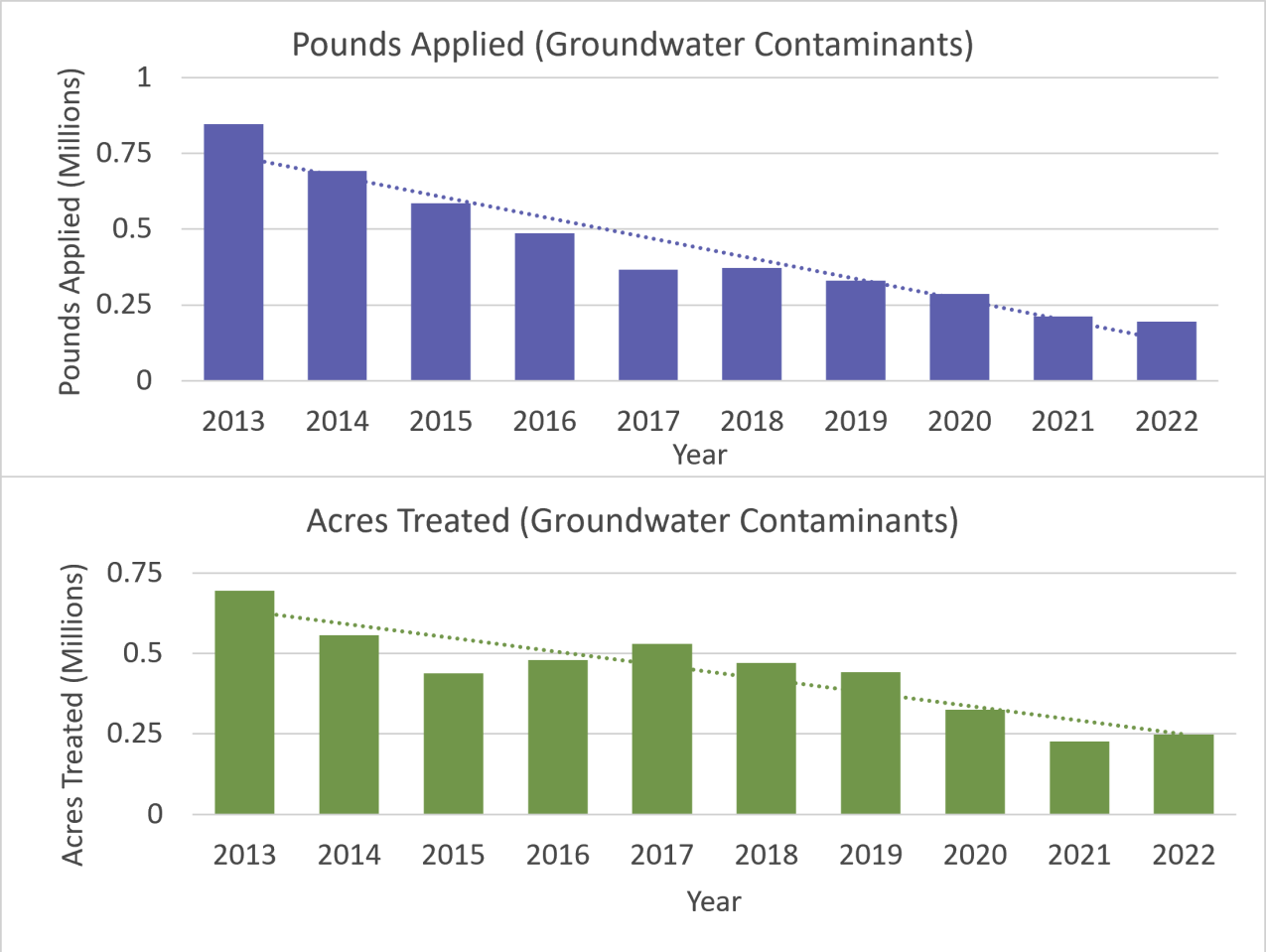


Figure 10. Use trends of pesticides that are groundwater contaminants from 2013 to 2022.

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 27 thousand pounds applied (0.4 percent decrease) and 315 thousand acres treated (9 percent decrease) between 2021 and 2022. The small change in pounds applied since the last year was mostly due to decreased use of the fungicide myclobutanil and the insecticide abamectin by 4.7 thousand pounds applied (12 percent decrease) and 3.9 thousand pounds applied (8 percent decrease), respectively. The decrease in acres treated was largely due to 211 thousand fewer acres treated with the insecticide abamectin (9 percent decrease) and 32 thousand fewer acres treated with the fungicide myclobutanil (10 percent decrease). Over the last ten years, pounds applied of pesticides that are reproductive toxins have decreased by 45 percent and acres treated have decreased by 41 percent (Figure 11).

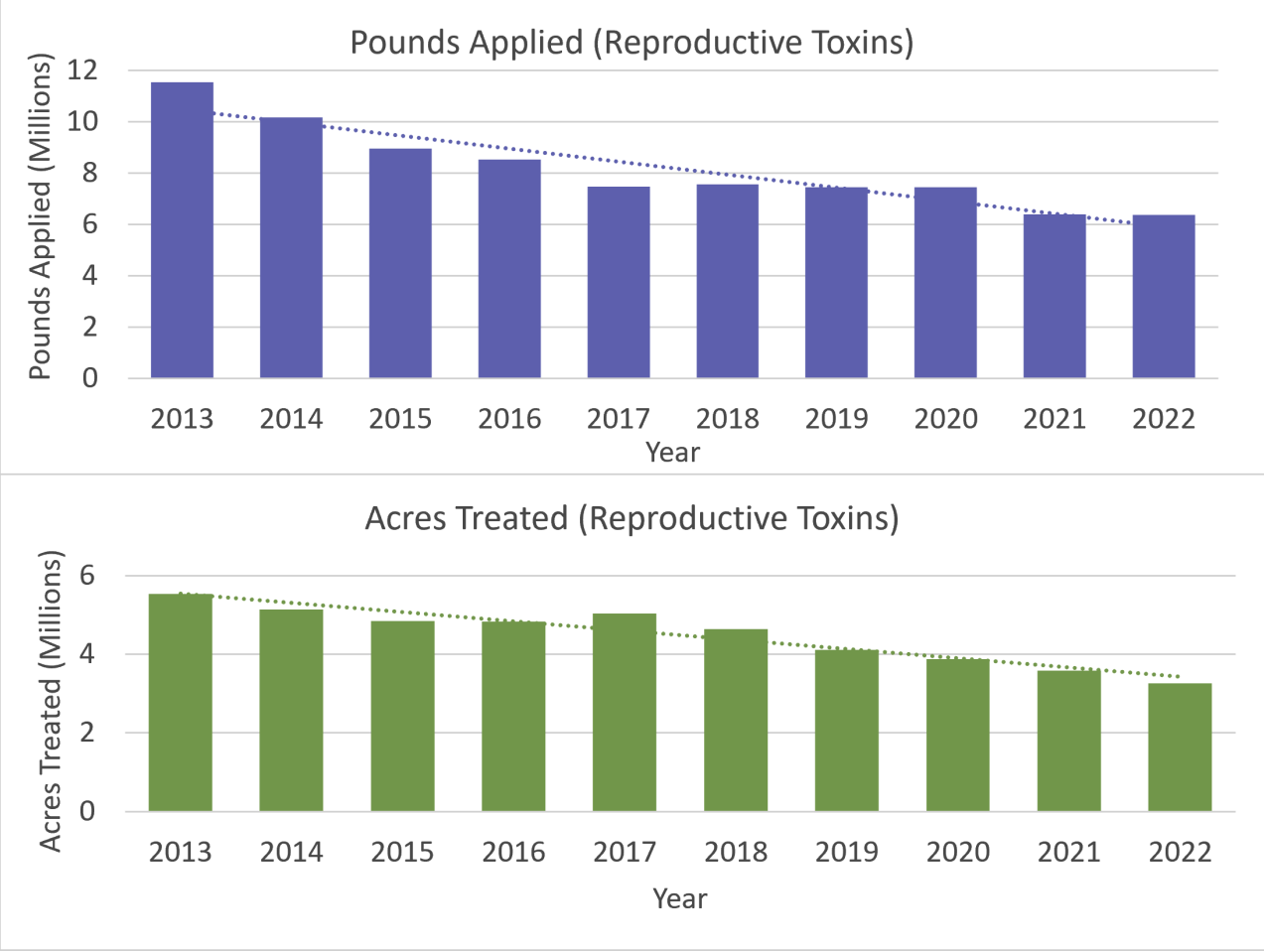


Figure 11. Use trends of pesticides that are on the State's Proposition 65 list of chemicals that are "known to cause reproductive toxicity" from 2013 to 2022.

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 one million pounds applied (3 percent decrease) but increased by 68 thousand acres treated (4 percent increase) between 2021 and 2022. Most of the change in pounds applied since the last year was due to decreased use of the fumigants 1,3-dichloropropene and potassium N-methyldithiocarbamate (metam-potassium), which declined by 1.3 million pounds applied (12 percent decrease) and 507 thousand pounds applied (6 percent decrease), respectively. The increase in acres treated was largely due to more acreage treated with the herbicides trifluralin and 2,4-D, dimethylamine salt, which increased by 19 thousand acres treated (7 percent increase) and 13 thousand acres treated (5 percent increase), respectively. Over the last ten years, pounds applied of pesticides that are toxic air contaminants have decreased by 21 percent and acres treated have decreased by 48 percent (Figure 12).

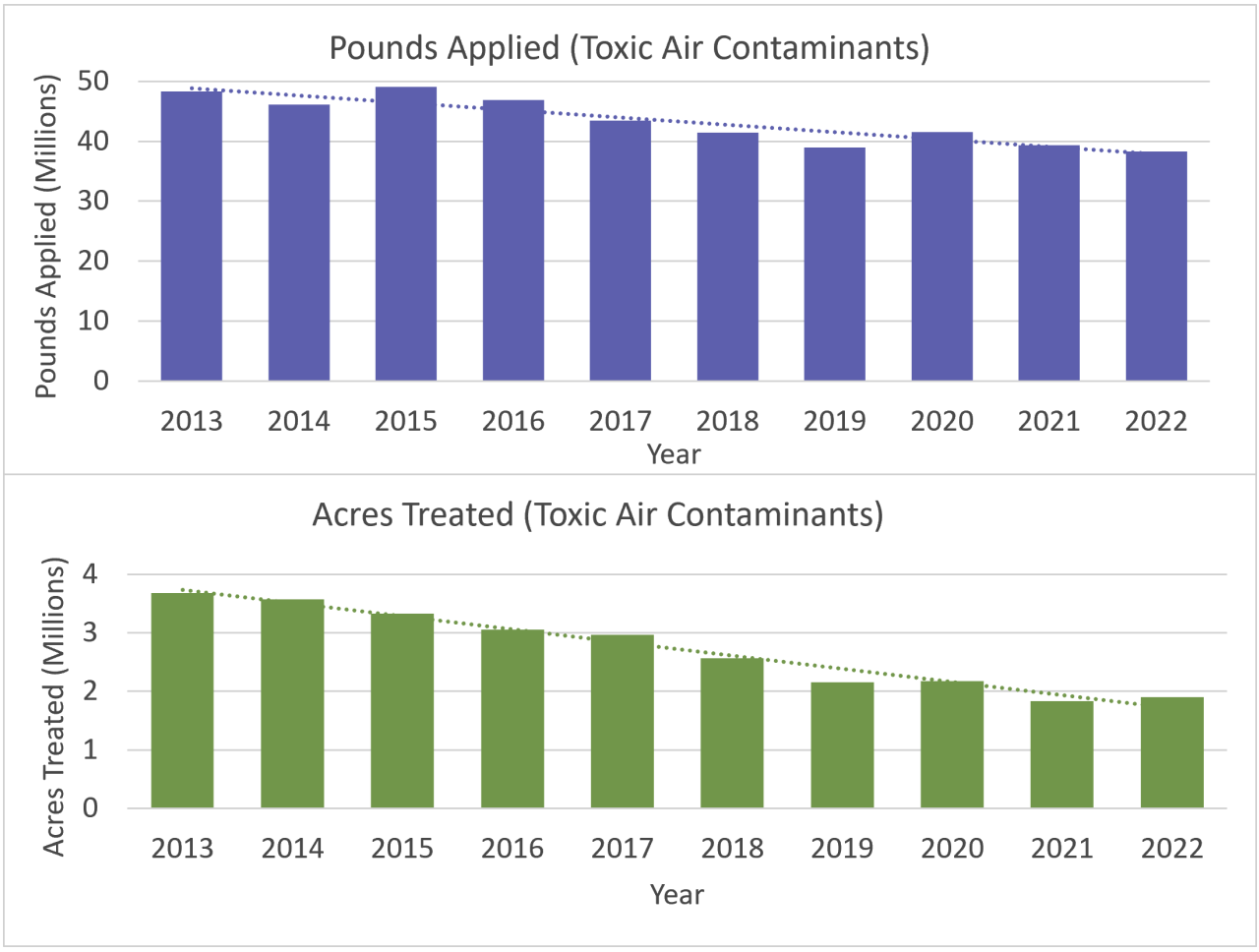


Figure 12. Use trends of pesticides that are toxic air contaminants from 2013 to 2022.

Trends in Pesticide Use for Select Commodities

A grower's or applicator's decision to apply pesticides may depend on several 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 2022 were:

1. Almond,
2. Wine grape,
3. Strawberry,
4. Table and raisin grape, and
5. Processing tomato

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 occur 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. The change in pounds of AI applied and acres planted, bearing, or harvested, and the percent change from 2021 to 2022 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.

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
Strawberry	830712	3200	7	8
Tangerine	447650	2000	10	3
Cotton	244159	20000	16	18
Regulatory pest control	138945	NA	99	NA
Blackberry	130344	NA	53	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	-3,712,474	30,000	-11	2
Orange	-1,119,944	-1,000	-11	-1
Rice	-1,106,200	-151,000	-25	-37
Alfalfa	-395,012	-50,000	-16	-10
Structural pest control	-382,641	NA	-9	NA

Crops or sites with the greatest *increase* in the amount applied from 2021 to 2022 include strawberry, tangerine, cotton, regulatory pest control, and blackberry. The increase in pounds applied to strawberry, tangerine, and cotton may be due in part to the increase in planted (strawberry and cotton) or bearing (tangerine) acreage. Acreage for blackberries is not annually calculated by NASS and is therefore not available (Table l9a).

Crops or sites with the greatest *decrease* in the amount applied from 2021 to 2022 included almond, orange, rice, alfalfa, and structural pest control. The decrease in pounds applied to almond, orange, rice, and alfalfa may be due in part to less planted (almond, rice), harvested (alfalfa), or bearing (orange) 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 2022. Twelve commodities were chosen based on these criteria, listed here in descending order by pounds applied:

1. Almond
2. Wine grape

3. Strawberry
4. Table and raisin grape[1]
5. Processing tomato
6. Orange
7. Pistachio
8. Walnut
9. Carrot
10. Tangerine
11. Alfalfa
12. Cotton

Collectively, the pesticides used on these commodities represent 69 percent of the total amount used (pounds applied) and 72 percent of the acres treated in 2022 (Table 20).

Table 20. Pounds applied and acres treated of the top 12 crops, sorted by descending pounds applied, for 2022.

Crop	Million Pounds Applied	Million Acres Treated
Almond	30.72	22.3
Wine grape	25.53	9.5
Strawberry	13.16	2.93
Table and raisin grape	11.57	4.95
Processing tomato	9.69	2.92
Orange	9.53	2.5
Pistachio	6.37	7.41
Walnut	5.07	4.52
Carrot	4.83	0.46
Tangerine	4.77	1.27
Alfalfa	2.12	4.21
Cotton	1.73	3.65

Pesticide use may increase or decrease due to new acreage put into production or acreage taken out of production. Using total acreage[2] 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 alfalfa, orange, and carrot is likely due, at least in part, to decreases in total acreage from 2021 to 2022. Similarly, the increase in pounds applied for strawberry, pistachio, tangerine, and cotton may be due in part to increased acreage in production in 2022 compared to 2021. The pounds applied to wine grape, table and raisin grape, and processing tomato declined despite little to no change in acreage, while the pounds applied to walnut and almond declined despite an increase in acreage (Figure 13).

[1] Table and raisin grapes are grouped together due to similar pesticide use.
[2] Total acreage may be acres planted, harvested, or bearing depending on the unit reported for the commodity in NASS

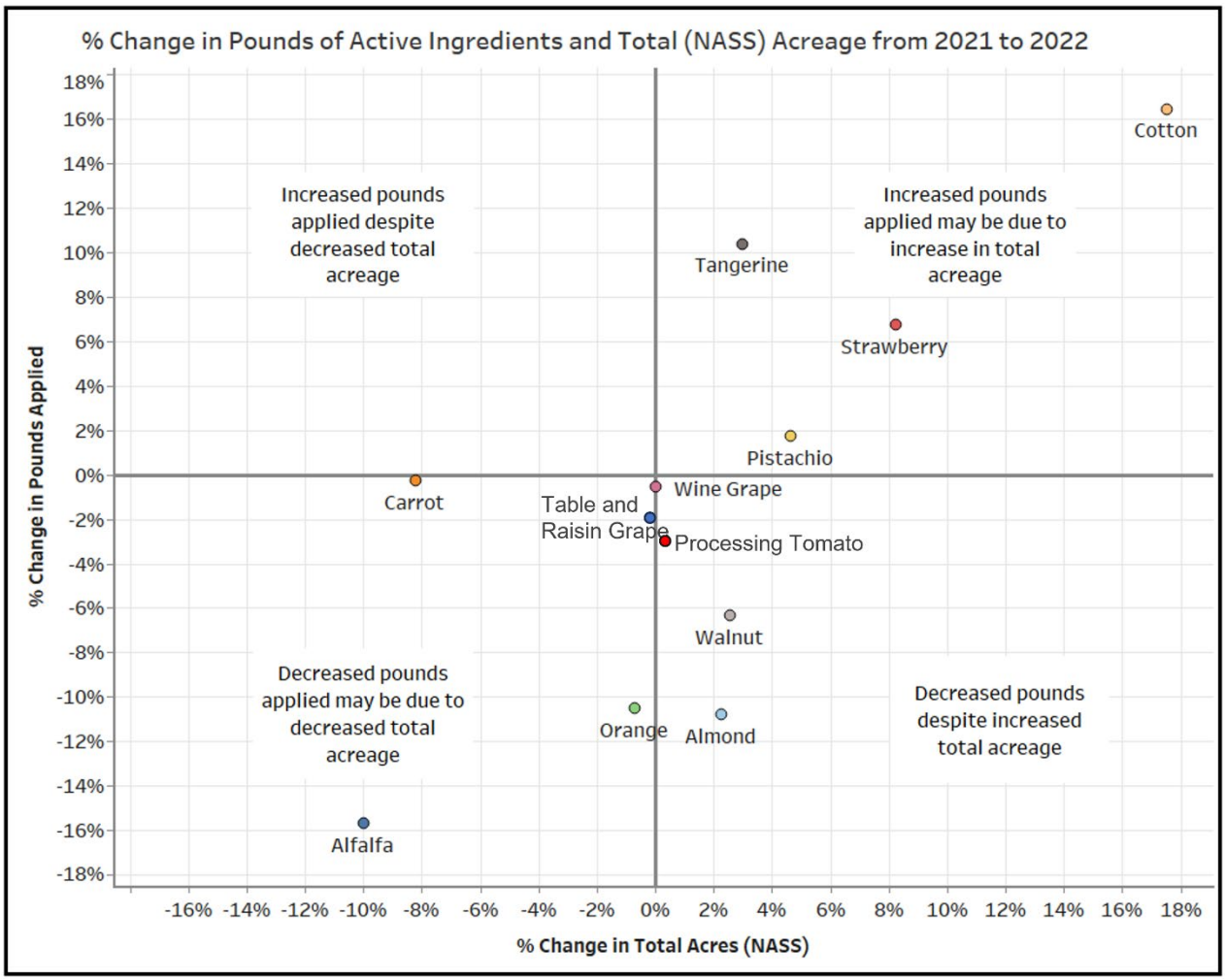


Figure 13. Graph showing percentage change in pounds of AIs applied from 2021 to 2022 against the change in the total acreage of the commodity. Pounds applied is determined from the PUR data while the total acreage comes from the Quick Stats database, USDA National Agricultural Statistics Service (NASS). 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 twelve 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

Harvested alfalfa acreage[1] decreased from 500 thousand acres in 2021 to 450 thousand acres in 2022 (10 percent decrease) (Figure 14). In 2022, there were 2.1 million pounds of AI applied to alfalfa compared to 2.5 million pounds applied in 2021 (16 percent decrease). Similarly, the acres treated also decreased, going from 4.6 million acres treated in 2021 to 4.2 million in 2022 (8 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 (S-Ethyl dipropylthiocarbamate), and the fungicide/insecticide sulfur comprised the remaining top five when measure by pounds applied (Table 21,22).

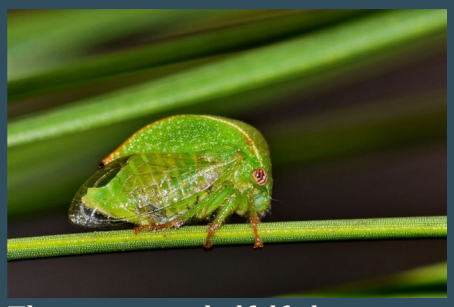
Table 21. The 2022 top five AIs by acres treated on alfalfa.

Top 5	Type	Acres Treated
Lambda-cyhalothrin	Insecticide	316,427
Pendimethalin	Herbicide	238,856
Clethodim	Herbicide	234,885
Glyphosate	Herbicide	232,958
Chlorantraniliprole	Insecticide	158,315

Table 22. The 2022 top five AIs by pounds applied to alfalfa. Fung/Insect = Fungicide/Insecticide

Top 5	Type	Pounds Applied
Pendimethalin	Herbicide	494,506
Glyphosate	Herbicide	351,246
Trifluralin	Herbicide	102,752
EPTC	Herbicide	82,713
Sulfur	Fung/Insect	67,200

ALFALFA



Threecornered alfalfa hopper (*Spissistilus festinus*), a pest on alfalfa. Adobe stock photo.

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

Beet armyworm (*Spodoptera exigua*). Caterpillars are a pest on alfalfa. Adobe stock photo.

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

Almond

Statewide bearing almond acreage[1] increased from 132 thousand acres in 2021 to 135 thousand acres in 2022 (2 percent increase) (Figure 14). Despite the increased acreage, the pounds of AI applied to almonds decreased from 34 million pounds in 2021 to 31 million pounds in 2022 (11 percent decrease). Almond acres treated with AIs decreased from 24 million acres treated to 22 million acres treated (8 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 2022 top five AIs by acres treated on almond.

Top 5	Type	Acres Treated
Glyphosate	Herbicide	1,491,608
Abamectin	Insecticide	1,089,580
Oil	Many	1,079,361
Chlorantraniliprole	Insecticide	950,460
Methoxyfenozide	Insecticide	933,986

Table 24. The 2022 top five AIs by pounds applied to almond. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Oil	Many	15,146,386
Glyphosate	Herbicide	2,823,467
1,3-Dichloropropene	Fumigant	1,655,926
Glufosinate-ammonium	Herbicide	660,066
Pendimethalin	Herbicide	610,953

ALMOND

Almond branch heavy with nuts. DPR staff photo.

European Fruit Lecanium (*Parthenolecanium sp.*), an almond pest. Adobe stock 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[1] statewide decreased from 58.5 thousand acres in 2021 to 53.7 thousand acres in 2022 (8 percent decrease) (Figure 14). The pounds of AI applied to carrots decreased from 4.84 million pounds in 2021 to 4.83 million pounds in 2022 (0.28 percent decrease). The amount of carrot acres treated with AIs increased from 435 thousand acres treated in 2021 to 462 thousand acres treated in 2022 (6 percent increase).

The fungicide/insecticide sulfur and the herbicide linuron made the top five lists by both acres treated and pounds applied. The herbicides pendimethalin and fluazifop-p-butyl and the fungicide mefenoxam 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 2022 top five AIs by acres treated on carrot. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Acres Treated
Sulfur	Fung/Insect	106,733
Linuron	Herbicide	47,502
Mefenoxam	Fungicide	42,720
Pendimethalin	Herbicide	22,189
Fluazifop-P-Butyl	Herbicide	15,504

Table 26. The 2022 top five AIs by pounds applied to carrot. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Metam-Potassium	Fumigant	1,954,620
Metam-Sodium	Fumigant	1,283,281
1,3-Dichloropropene	Fumigant	697,069
Sulfur	Fung/Insect	689,373
Linuron	Herbicide	33,706

CARROT

Crown and root aphid damage on carrots (*Dysaphis sp.*). Adobe stock photo.

Field of carrots. Adobe stock photo.

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 total acres planted[1] of cotton increased from 114 thousand acres in 2021 to 134 thousand acres in 2022 (18 percent increase) (Figure 14). Similarly, the pounds of AI applied and acres treated also increased from 2021 to 2022. The pounds applied increased from 1.5 million pounds applied in 2021 to 1.7 million pounds applied in 2022 (16 percent increase). Acres treated increased from 3.2 million acres treated in 2021 to 3.7 million acres treated in 2022 (13 percent increase).

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/defoliant urea dihydrogen sulfate and the insecticides malathion and naled were the remaining three top five AIs by pounds applied (Table 27, 28).

Table 27. The 2022 top five AIs by acres treated on cotton. PGR = Plant Growth Regulator. Herb/Def = Herbicide/Defoliant

Top 5	Type	Acres Treated
Glyphosate	Herbicide	224,444
Flonicamid	Insecticide	164,258
Thidiazuron	Defoliant	162,333
Ethephon	PGR	160,059
Diuron	Herbicide	157,323

Table 28. The 2022 top five AIs by pounds applied to cotton.

Top 5	Type	Pounds Applied
Glyphosate	Herbicide	345,443
Urea Dihydrogen Sulfate	Herb/Def	193,562
Ethephon	PGR	161,620
Malathion	Insecticide	61,406
Naled	Insecticide	51,782

COTTON

Field of cotton. Adobe stock photo.

Cotton aphid (*Aphis gossypi*), a pest on cotton. Adobe stock photo.

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

Total statewide bearing acreage[1] for orange decreased from 141 thousand acres in 2021 to 140 thousand acres in 2022 (1 percent decrease) (Figure 14). Pounds of AI applied decreased from 11 million pounds applied in 2021 to 10 million pounds applied in 2022 (11 percent decrease). The acres treated decreased from 2.56 million acres in 2021 to 2.50 million acres treated in 2022 (2 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 insecticide thiamethoxam rounded out the top five AIs by acres treated, while the biopesticide kaolin clay and the insecticide cryolite completed the top five list by pounds applied (Table 29, 30).

Table 29. The 2022 top five AIs by acres treated on orange.

Top 5	Type	Acres Treated
Oil	Many	295,712
Abamectin	Insecticide	133,646
Copper	Fungicide	126,889
Glyphosate	Herbicide	107,782
Thiamethoxam	Insecticide	101,772

Table 30. The 2022 top five AIs by pounds applied to orange. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Oil	Many	4,873,940
Copper	Fungicide	523,551
Kaolin	Fung/Insect	216,297
Glyphosate	Herbicide	138,700
Cryolite	Insecticide	99,968

ORANGE

Citrus leafminer (*Phyllocnistis citrella*). DPR staff photo.

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

Pistachio

The total bearing acreage[1] of pistachio increased from 409 thousand acres in 2021 to 428 thousand acres in 2022 (5 percent increase) (Figure 14). Similarly, pesticide use also increased: Pounds of AI applied to pistachio increased from 6.3 million pounds applied in 2021 to 6.4 million pounds applied in 2022 (2 percent increase). Acres treated increased from 7.0 million acres treated in 2021 to 7.4 million acres treated in 2022 (6 percent increase).

The herbicide glyphosate made the top five AIs when ranked by both pounds applied and by acres treated. Three insecticides – lambda cyhalothrin, chlorantraniliprole, and bifenthrin, – 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 33, 34).

Table 31. The 2022 top five AIs by acres treated on pistachio. Fung/Insect = Fungicide/Insecticide

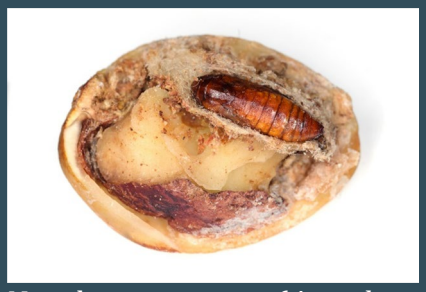
Top 5	Type	Acres Treated
Lambda-cyhalothrin	Insecticide	519,983
Glyphosate	Herbicide	446,462
Chlorantraniliprole	Insecticide	342,701
Bifenthrin	Insecticide	323,714
***Aspergillus flavus* str. AF36**	Fungicide	255,833

Table 32. The 2022 top five AIs by pounds applied to pistachio.

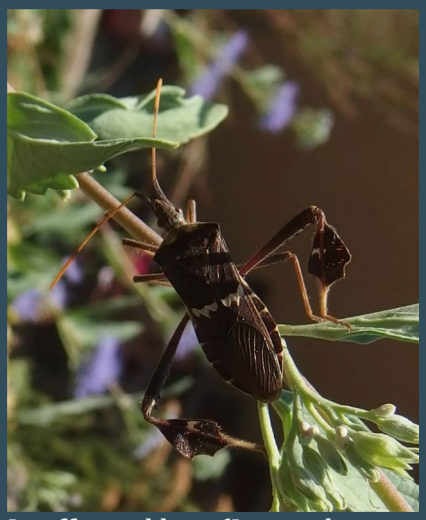
Top 5	Type	Pounds Applied
Sulfur	Fung/Insect	1,096,374
Glyphosate	Herbicide	866,635
Oil	Many	741,897
Pendimethalin	Herbicide	257,748
Glufosinate-Ammonium	Herbicide	241,495

PISTACHIO

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



Navel orangeworm (*Amyelois transitella*), a pest on pistachio. Adobe stock photo.



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[1] of processing tomatoes slightly increased from 230 thousand acres in 2021 to 231 thousand acres in 2022 (0.4 percent increase) (Figure 14). Pounds of AI applied dropped from 10.0 million pounds applied in 2021 to 9.7 million pounds applied in 2022 (3 percent decrease). The acres treated increased from 2.7 million acres treated in 2021 to 2.9 million acres treated in 2022 (7 percent increase).

The fungicide/insecticide sulfur and the fungicide chlorothalonil made the top five list by both pounds applied and acres treated. The insecticides imidacloprid, lambda-cyhalothrin, and chlorantraniliprole made up the remaining three of the top five AIs by acres treated. The biopesticide kaolin and the two fumigants potassium N-methyldithiocarbamate (metam-potassium) and metam-sodium ranked in the top five by pounds applied (Table 35, 36).

Table 33. The 2022 top five AIs by acres treated on processing tomato. Fung/Insect = Fungicide/Insecticide

Top 5	Type	Acres Treated
Sulfur	Fung/Insect	253,140
Imidacloprid	Insecticide	148,585
Lambda-cyhalothrin	Insecticide	126,073
Chlorantraniliprole	Insecticide	122,265
Chlorothalonil	Fungicide	121,002

Table 34. The 2022 top five AIs by pounds applied to processing tomato. Fung/Insect = Fungicide/Insecticide

Top 5	Type	Pounds Applied
Sulfur	Fung/Insect	5,994,093
Metam-potassium	Fumigant	1,759,398
Kaolin	Fung/insect	290,676
Metam-sodium	Fumigant	281,882
Chlorothalonil	Fungicide	227,776

PROCESSING TOMATO

Tobacco hornworm (*Manduca sexta*), a pest on tomato. DPR staff photo.

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

Strawberry

The total planted acreage[1] of strawberry in California increased from 38.9 thousand acres in 2021 to 42.1 thousand acres in 2022 (8 percent increase) (Figure 14). The pounds applied increased from 12 million pounds applied in 2021 to 13 million pounds applied in 2022 (7 percent increase). The acres treated increased from 2.7 million acres treated in 2021 to 2.9 million acres treated in 2022 (10 percent increase).

Sulfur, a fungicide/insecticide, ranked in the top five by both pounds applied and acres treated. The fungicides captan and "captan, other related" and the insecticides *Bacillus thuringiensis* and novaluron 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, potassium N-methyldithiocarbamate (metam-potassium), and metam sodium made up the remaining four of the top five AIs by pounds applied (Table 39, 40).

Table 35. The 2022 top five AIs by acres treated on strawberry. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Acres Treated
Captan	Fungicide	177,858
Sulfur	Fung/Insect	136,249
Novaluron	Insecticide	80,026
Captan, Other Related	Fungicide	79,581
Bacillus Thuringiensis	Insecticide	75,007

Table 36. The 2022 top five AIs by pounds applied to strawberry. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Chloropicrin	Fumigant	7,028,228
1,3-Dichloropropene	Fumigant	1,756,985
Metam-Potassium	Fumigant	1,495,192
Sulfur	Fung/Insect	631,826
Metam-Sodium	Fumigant	362,422

STRAWBERRY

European earwig (*Forficula Auricularia*). Adobe stock photo.

Botrytis fruit rot on strawberry (*Botrytis cinerea*). 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

Total bearing acreage[1] of table and raisin grape slightly decreased from 254 thousand acres in 2021 to 253 thousand acres in 2022 (0.4 percent decrease) (Figure 14). The pounds of AI applied decreased from 11.8 million pounds applied in 2021 to 11.6 million pounds applied in 2022 (2 percent decrease). The acres treated declined from 4.99 million acres treated in 2021 to 4.95 million acres treated in 2022 (1 percent decrease).

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

Table 37. The 2022 top five AIs by acres treated on table and raisin grape. Fung/Insect = Fungicide/Insecticide. PGR = Plant Growth Regulator.

Top 5	Type	Acres Treated
Sulfur	Fung/Insect	1,336,782
Copper	Fungicide	308,539
Gibberellins	PGR	293,451
Glufosinate-Ammonium	Herbicide	102,120
Imidacloprid	Insecticide	101,307

Table 38. The 2022 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	8,162,858
1,3-Dichloropropene	Fumigant	465,507
Lime-Sulfur	Fung/Insect	421,332
Copper	Fungicide	390,444
Hydrogen Cyanamide	PGR	303,150

TABLE AND RAISIN GRAPE

Bunch of green grapes. DPR staff photo.

Drosophila flies (*Drosophila melanogaster*), a pest on grapes. Adobe stock 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

Tangerine

Total statewide bearing acreage[1] for tangerine increased from 67 thousand acres in 2021 to 69 thousand acres in 2022 (3 percent increase) (Figure 14). Pounds of AI applied increased from 4.3 million pounds applied in 2021 to 4.7 million in 2022 (10 percent increase). In contrast, the acres treated decreased from 1.34 million acres treated in 2021 to 1.27 million acres treated in 2022 (5 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 plant growth regulator gibberellins 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 43, 44).

Table 43. The 2022 top five AIs by acres treated on tangerine.

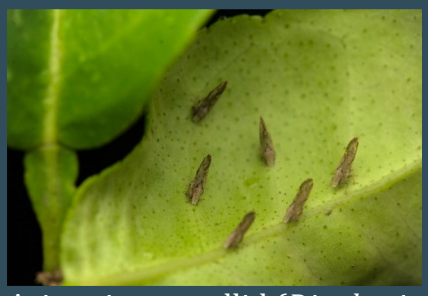
Top 5	Type	Acres Treated
Oil	Many	144,650
Glyphosate	Herbicide	67,903
Abamectin	Insecticide	58,574
Copper	Fungicide	49,905
Gibberellins	PGR	45,124

Table 44. The 2022 top five AIs by pounds applied to tangerine. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Oil	Many	2,131,123
Kaolin	Fung/Insect	943,990
Copper	Fungicide	180,496
1,3-Dichloropropene	Fumigant	180,387
Glyphosate	Herbicide	125,181

TANGERINE

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



Asian citrus psyllid (*Diaphorina citri*), a pest on citrus. Adobe stock photo.

Citrus leafminer (*Phyllocnistis citrella*), a pest on citrus. DPR staff photo.

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

Walnut

Total bearing acreage[1] of walnuts increased from 390 thousand acres in 2021 to 400 thousand acres in 2022 (3 percent increase) (Figure 14). Despite the increase in acreage, the pounds of AI applied decreased from 5.4 million pounds applied in 2021 to 5.1 million pounds applied in 2022 (6 percent decrease). Acres treated decreased from 4.9 million in 2021 to 4.5 million acres treated in 2022 (8 percent decrease).

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 fumigant 1,3-dichloropropene and the biopesticide kaolin clay made up the remaining two top five AIs when measured by pounds applied (Table 45, 46).

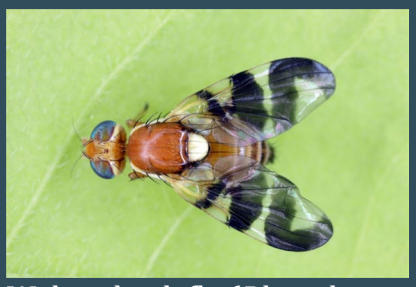
Table 45. The 2022 top five AIs by acres treated on walnut.

Top 5	Type	Acres Treated
Glyphosate	Herbicide	311,501
Copper	Fungicide	298,394
Mancozeb	Fungicide	270,312
Oxyfluorfen	Herbicide	163,138
Chlorantraniliprole	Insecticide	145,369

Table 46. The 2022 top five AIs by pounds applied to walnut. Fung/Insect = Fungicide/Insecticide

Top 5	Type	Pounds Applied
Copper	Fungicide	1,065,545
Glyphosate	Herbicide	594,948
Mancozeb	Fungicide	480,535
1,3-Dichloropropene	Fumigant	371,818
Kaolin	Fung/Insect	312,837

WALNUT



Walnut husk fly (*Rhagoletis completa*), a pest on walnuts. Adobe stock photo.

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[1] of wine grapes in California remained unchanged from 2021 to 2022 at 575 thousand acres (Figure 14). Pounds of AI applied decreased slightly from 25.7 million pounds applied in 2021 to 25.5 million pounds applied in 2022 (0.5 percent decrease). The acres treated decreased from 9.6 million acres treated in 2021 to 9.5 million acres treated in 2022 (1 percent decrease).

The fungicide/insecticide sulfur, oil, and the herbicides glufosinate-ammonium and glyphosate made up the top five AIs when ranked by either acres treated or pounds applied. The fungicide copper rounded out the top five AIs by acres treated, while the fumigant 1,3-dichloropropene was the remaining AI of the top five by pounds applied (Table 47, 48).

Table 39. The 2022 top five AIs by acres treated on wine grape. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Acres Treated
Sulfur	Fung/Insect	2,265,727
Copper	Fungicide	353,547
Glufosinate-Ammonium	Herbicide	330,250
Oil	Many	295,186
Glyphosate	Herbicide	271,045

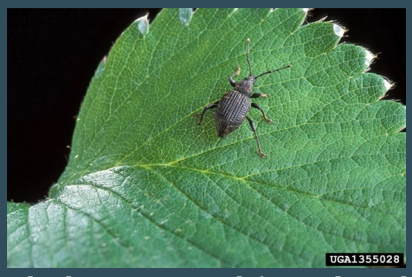
Table 40. The 2022 top five AIs by pounds applied to wine grape. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Sulfur	Fung/Insect	19,335,447
Oil	Many	1,742,423
1,3-Dichloropropene	Fumigant	813,275
Glyphosate	Herbicide	474,962
Glufosinate-Ammonium	Herbicide	319,302

WINE GRAPE

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

Light brown apple moth (*Epiphyas postvittana*), a pest on grapes. Adobe stock 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

Pesticide Use Annual Report
2022 Data Summary

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