PESTICIDE USE ANNUAL REPORT

2020 Data Summary

PUR
Pesticide Use Report Program

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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>

Contents

Table of Contents

Year in Summary

Overview:

Reported pesticide use for California in 2020 totaled 216 million pounds of applied active ingredients (AIs) and 106 million cumulative acres treated. Ten percent of the pounds applied and 27 percent of the acres treated were adjuvants[1]. Compared to 2019, pounds applied of AIs increased by 5.1 million pounds (2.4 percent increase), while the acres treated decreased by 2.8 million acres (2.6 percent decrease).

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. Both the pounds applied and the acres treated with biopesticides decreased in 2020. Oils increased in both pounds applied and acres treated in 2020. Most oil pesticides used in California serve as alternatives to more toxic pesticides. Some highly refined petroleum-based oils are used by organic growers.

Pesticides characterized as carcinogens, fumigants, reproductive toxins, and toxic air contaminants increased in pounds applied during 2020, while cholinesterase inhibitors and groundwater contaminants decreased. The acres treated with fumigants and toxic air contaminants increased, while acres treated with carcinogens, cholinesterase inhibitors, groundwater contaminants, and reproductive toxins decreased from 2019 to 2020.

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 2019 to 2020.

Category	Change in Pounds Applied	Percent Change Pounds	Change in Acres Treated	Percent Change Acres
Biopesticides	-34,488	-0.4	-560,344	-6
Oils	3,633,083	9	87,317	2
Carcinogens	2,525,266	6	-236,798	-3
Cholinesterase Inhibitors	-280,308	-9	-186,189	-7
Fumigants	3,071,054	9	12,857	5
Groundwater Contaminants	-44,294	-13	-116,574	-26
Reproductive Toxins	9,411	0.13	-233,247	-6
Toxic Air Contaminants	2,653,704	7	45,258	2

[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: Pesticide use trends spanning multiple years offer a broader overview of change in use over time compared to the annual changes from one year to the next. Since 2011, acres treated with lower risk biopesticides and oils increased by 64 and 30 percent, respectively, while use of relatively higher risk categories decreased by 14 to 70 percent. Similarly, the pounds of biopesticides and oils applied increased during this ten-year period by 95 and 39 percent, respectively, while the pounds of higher risk pesticide categories decreased by 5 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 2011 to 2020.

Category	Change in Pounds Applied	Percent Change Pounds	Change in Acres Treated	Percent Change Acres
Biopesticides	4,212,915	95	3,531,785	64
Oils	12,475,074	39	1,292,502	30
Carcinogens	-2,208,674	-5	-1,353,348	-14
Cholinesterase Inhibitors	-1,568,668	-35	-1,678,556	-41
Fumigants	-3,792,220	-9	-143,107	-37
Groundwater Contaminants	-971,386	-77	-745,531	-70
Reproductive Toxins	-10,479,981	-58	-1,222,115	-24
Toxic Air Contaminants	-5,560,326	-12	-1,572,966	-42

The AIs with highest total reported pounds applied in 2020 were sulfur (fungicide/insecticide), petroleum and mineral oils (fungicide/insecticide), glyphosate (herbicide), 1,3-dichloropropene (fumigant), 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 cumulative acres treated were sulfur, glyphosate, petroleum and mineral oils, abamectin (miticide/insecticide) and lambda-cyhalothrin (insecticide).

2020 TOP FIVE

Top 5 AIs by Pounds Applied

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

Top 5 AIs by Acres Treated

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

2020 Regulatory Highlights

In 2020, DPR took the following actions to mitigate human health and environmental risks associated with a number of active ingredients:

Carbaryl Expanded Designation as a Restricted Material
A rule restricting general consumer use of pesticides containing carbaryl went into effect on August 1, 2020. Carbaryl is a cholinesterase inhibitor which can negatively impact human health when used incorrectly. By designating nearly all carbaryl products as "restricted materials," the regulation effectively limits the use of most carbaryl pesticides (except agricultural use baits) to professionals with proper training and licensing.

Second Generation Anticoagulant Rodenticides (SGARs) Reevaluation
On September 29, 2020, Governor Newsom signed Assembly Bill (AB) 1788 (Chapter 250, Statutes of 2020) prohibiting the use of SGARs with limited exceptions until DPR completes its SGAR reevaluation, adopts necessary restrictions, and certifies that certain legal conditions have been met. DPR initiated a reevaluation of SGARs in 2019, after investigating reported non-target wildlife exposures.

Chlorpyrifos Prohibition and Reevaluation
DPR reached an agreement with manufacturers to end virtually all chlorpyrifos sales by February 6, 2020, with virtually all use and possession prohibited after December 31, 2020. DPR's action followed "mounting evidence that chlorpyrifos is associated with serious health effects in children and other sensitive populations at lower levels of exposure than previously understood, including impaired brain and neurological development."

1,3-D Pilot Project
In late 2020, DPR initiated a pilot program to evaluate the efficacy and practicality of new application methods of 1,3-dichloropropene (1,3-D) that provide a comparable degree of health protection as totally impermeable film (TIF) tarpaulins.

Neonicotinoid Reevaluation
In August 2020, DPR held two workshops to gather feedback from the public and other stakeholders on draft proposed mitigation measures to protect pollinator health from neonicotinoid risks identified in DPR's 2018 risk determination.

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) < https://www.cdpr.ca.gov/docs/pur/pur_references_definitions.pdf >.

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

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.

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 results in large variation in the total number of applications for very similar pesticide applications, especially in 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 2020 data submitted to DPR as of February 18, 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 February 18, 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.

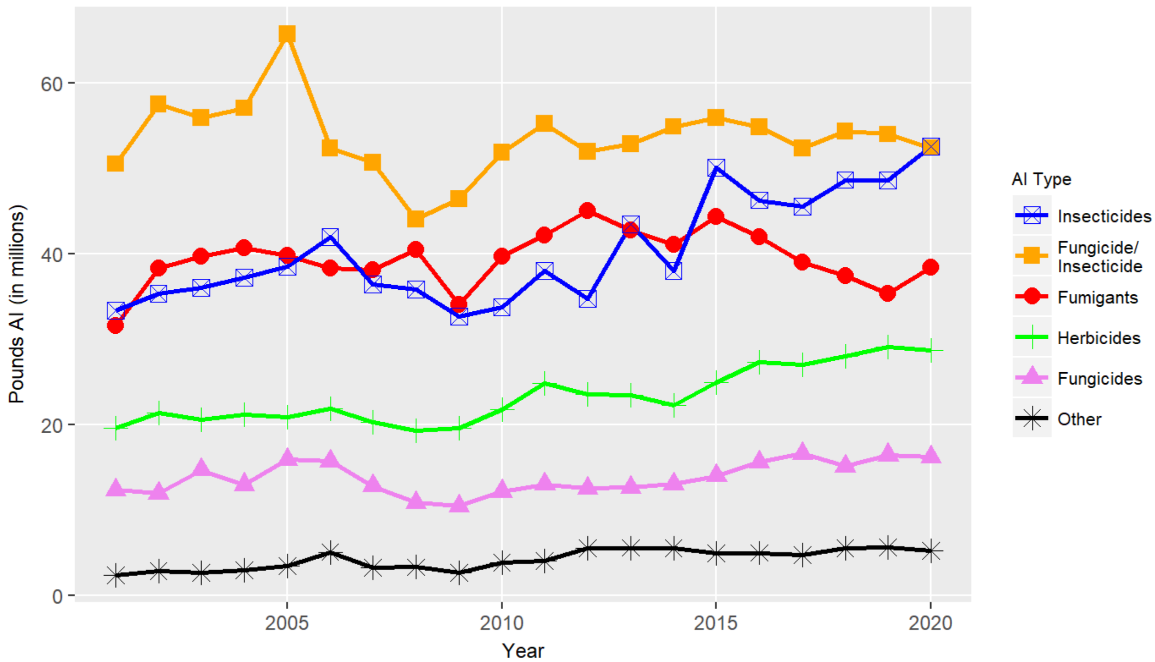


Figure 1. P Pounds applied of all AIs in the major types of pesticides from 2001 to 2020, where "Other" includes pesticides such as rodenticides, molluscicides, algaecides, repellents, antimicrobials, antifoulants, disinfectants, and biocides. [Text files of data](https://files.cdpr.ca.gov/pub/outgoing/pur/data/) are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

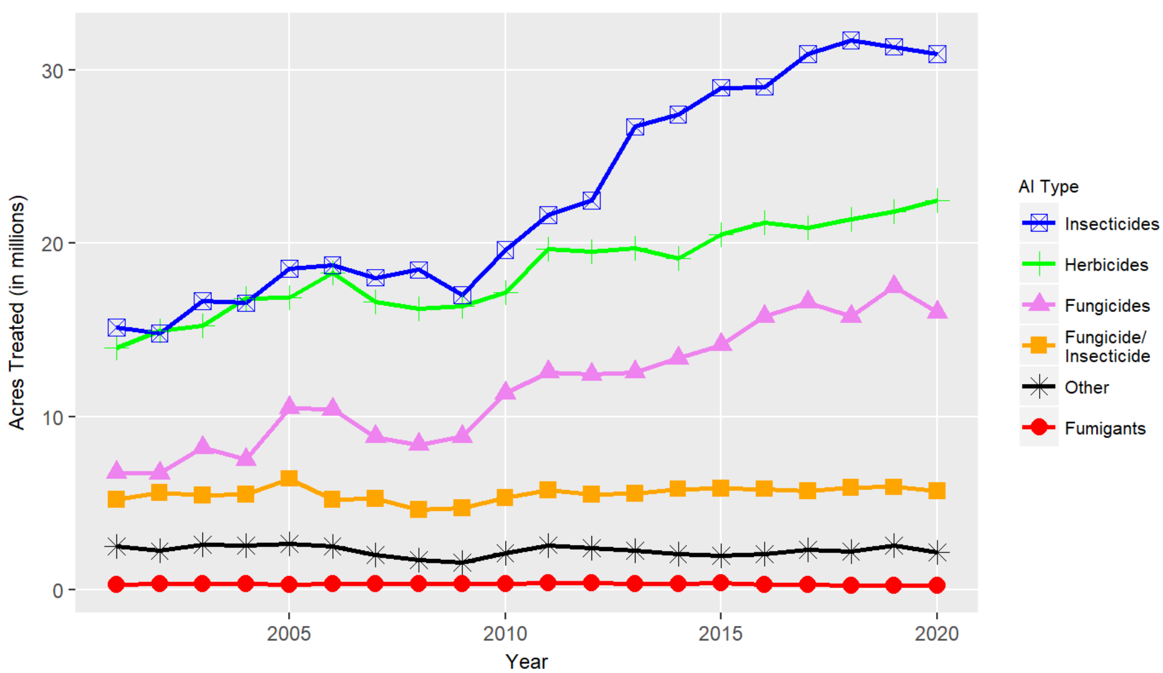


Figure 2. . Acres treated by all AIs in the major types of pesticides from 2001 to 2020, where "Other" includes pesticides such as rodenticides, molluscicides, algaecides, repellents, antimicrobials, antifoulants, disinfectants, and biocides. [Text files of data](https://files.cdpr.ca.gov/pub/outgoing/pur/data/) 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 in 2020 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 insect growth regulator methoxyfenozide also ranked in the top five under both measures. The pyrethroid lambda-cyhalothrin, the botanical miticide abamectin, and the anthranilic diamide chlorantraniliprole were the remaining three of the top five insecticide AIs by acres treated. The microbial *Bacillus thuringiensis*, boric acid, and the microbial bacterium *Burkholderia spp*. Strain A396 Cells and Fermentation Media ("*Burkholderia spp*.") 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 cumulative acres treated for 2020.

Top Five	Acres Treated
Oil	5,455,897
Lambda-Cyhalothrin	2,727,184
Abamectin	2,570,906
Chlorantraniliprole	2,323,460
Methoxyfenozide	2,086,056

Table 4. Top five insecticides in California by pounds applied for 2020.

Top Five	Pounds Applied
Oil	43,921,721
Boric Acid	737,092
Methoxyfenozide	599,667
Bacillus Thuringiensis	560,943
Burkholderia spp.	552,149

Fungicide

The inorganic fungicide copper was the most used fungicide when ranked by either acres treated or pounds applied. Three strobilurin fungicides (azoxystrobin, pyraclostrobin, and trifloxystrobin) and the pyradine fluopyram 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 2020.

Top Five	Acres Treated
Copper	2,389,955
Azoxystrobin	1,486,588
Fluopyram	1,294,899
Pyraclostrobin	1,045,506
Trifloxystrobin	892,722

Table 6. Top five fungicides in California by pounds applied for 2020.

Top 5	Pounds Applied
Copper	7,238,991
Mancozeb	1,557,453
Potassium Phosphite	1,408,631
Chlorothalonil	1,149,169
Ziram	542,925

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 —botanical clarified hydrophobic extract of neem oil ("Neem oil") and margosa 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 2020.

Top Five	Acres Treated
Sulfur	5,481,278
Lime-Sulfur	86,341
Kaolin	79,887
Neem Oil	52,375
Margosa Oil	37,307

Table 8. Top five fungicide/insecticides in California by pounds applied for 2020.

Top Five	Pounds Applied
Sulfur	47,313,370
Kaolin	2,957,863
Lime-Sulfur	1,399,158
Disodium Octaborate Tetrahydrate	280,137
Borax	211,119

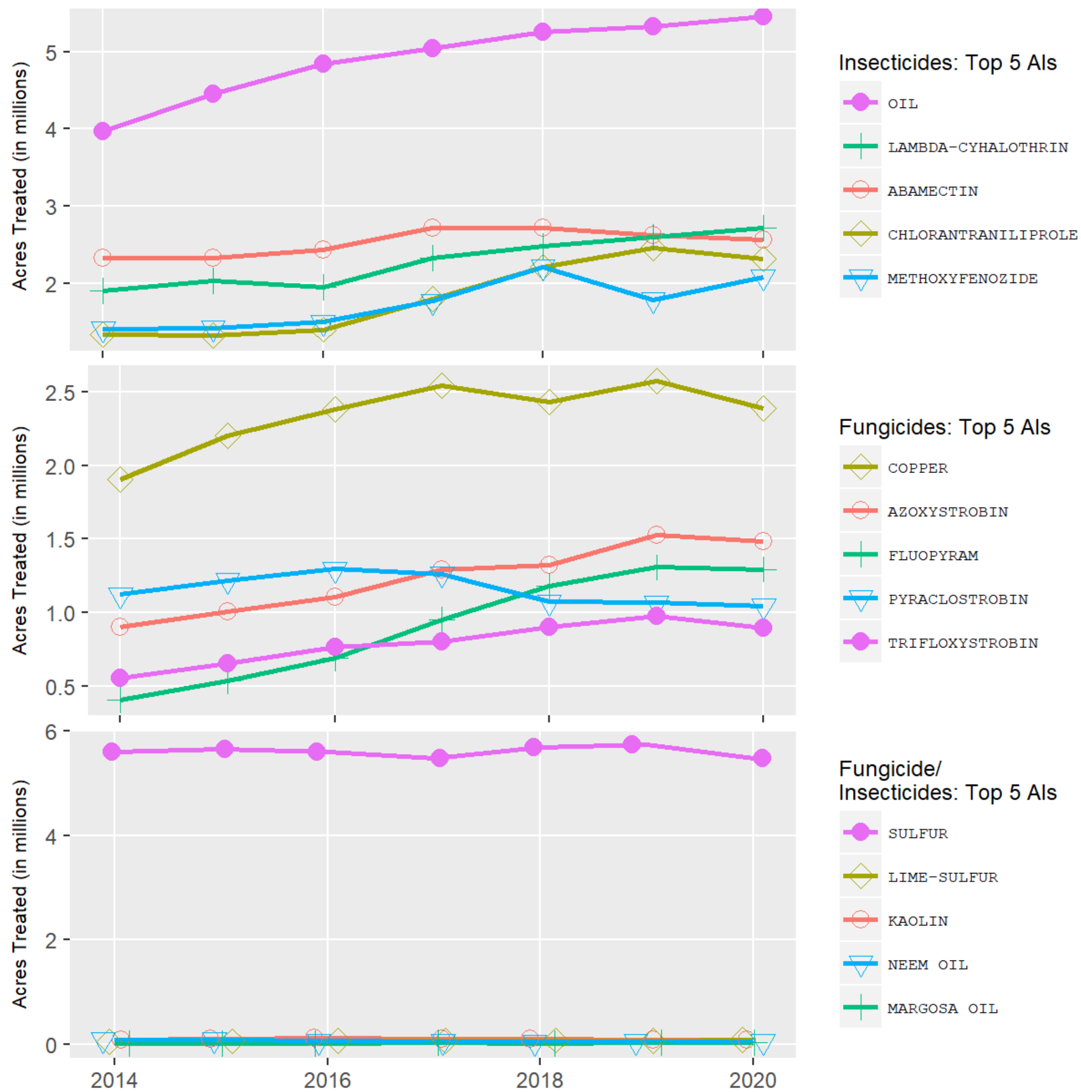


Figure 3. Acres treated by the top five AIs in each of the major types of pesticides from 2014 to 2020. [Text files of data](https://files.cdpr.ca.gov/pub/outgoing/pur/data/) are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Herbicides

Glyphosate, pendimethalin, and glufosinate-ammonium ranked in the top five herbicide AIs when measured by both acres treated and by pounds applied. Oxyfluorfen and saflufenacil made up the remaining two top five herbicides by acres treated, while propanil and copper made up the remaining top five when ranked by pounds applied. Copper is used as an herbicide in a number of pesticide products that claim to control or suppress weeds in aquatic sites (Figure 4, Table 9, and Table 10).

Table 9. Top five herbicides in California by acres treated for 2020.

Top Five	Acres Treated
Glyphosate	5,575,753
Glufosinate-Ammonium	2,335,289
Oxyfluorfen	2,231,517
Pendimethalin	1,144,074
Saflufenacil	988,622

Table 10. Top five herbicides in California by pounds applied for 2020.

Top Five	Pounds Applied
Glyphosate	12,412,792
Glufosinate-Ammonium	2,457,481
Pendimethalin	2,440,989
Propanil	2,065,019
Copper	1,547,226

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 2020.

Top Five	Acres Treated
1,3-Dichloropropene	63,497
Aluminum Phosphide	53,241
Chloropicrin	47,302
Metam-potassium	45,567
Zinc Phosphide	34,151

Table 12. Top five fumigants in California by pounds applied for 2020.

Top Five	Pounds Applied
1,3-Dichloropropene	11,678,006
Metam-potassium	9,000,088
Chloropicrin	8,370,636
Metam-Sodium	4,326,370
Sulfuryl Fluoride	2,817,782

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

Table 13. Top five "Others" in California by acres treated for 2020.

Top Five	Acres Treated
Gibberellins	507,540
Ethephon	417,833
Thidiazuron	206,532
Hydrogen Peroxide	201,048
Peroxyacetic Acid	195,053

Table 14. Top five "Others" in California by pounds applied for 2020.

Top Five	Pounds Applied
Sodium Hypochlorite	1,178,846
Hydrogen Cyanamide	639,731
Hydrogen Peroxide	564,035
Ethephon	348,493
Sodium Bromide	298,269

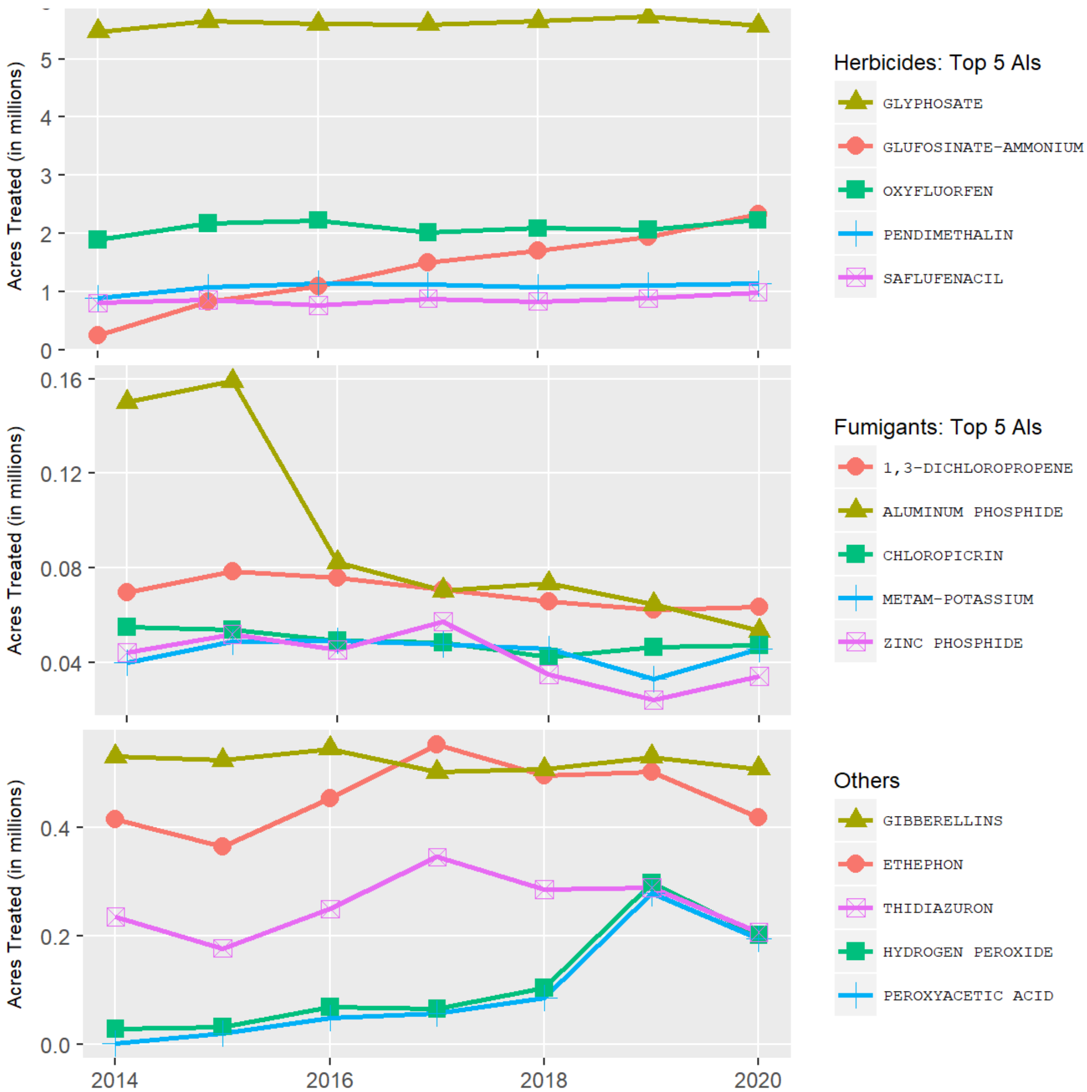


Figure 4. Acres treated by the top five AIs in each of the major types of pesticides from 2014 to 2020. [Text files of data](https://files.cdpr.ca.gov/pub/outgoing/pur/data/) are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Pesticide Use by County

In 2020, 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 51 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 2019 and 2020, ordered by 2020 rank, descending. Shaded rows show the counties where pounds applied decreased. N/A stands for Not Applicable. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

County	2019 Lbs Applied	2019 Rank	2020 Lbs Applied	2020 Rank	Percent Change
Fresno	35,469,977	1	36,333,598	1	2
Kern	30,109,635	2	29,102,904	2	-3
Tulare	20,038,372	3	19,885,671	3	-1
San Joaquin	13,897,152	4	14,376,758	4	3
Madera	9,539,985	5	10,910,837	5	14
Merced	9,401,553	6	10,098,996	6	7
Monterey	8,990,373	8	9,794,257	7	9
Stanislaus	9,056,198	7	8,530,917	8	-6
Kings	7,911,585	9	7,839,028	9	-1
Ventura	5,441,512	11	5,900,855	10	8
Imperial	6,294,080	10	5,748,387	11	-9
Santa Barbara	5,179,534	12	5,645,601	12	9
Sacramento	4,531,293	13	4,287,601	13	-5
Yolo	4,202,602	14	3,965,011	14	-6
Butte	2,937,624	17	3,430,585	15	17
Riverside	2,987,210	16	3,405,365	16	14
Sutter	3,319,032	15	3,307,533	17	-0.3
Colusa	2,517,605	20	2,990,541	18	19
San Luis Obispo	2,700,815	18	2,945,702	19	9
Los Angeles	1,983,239	23	2,685,149	20	35
Sonoma	2,615,477	19	2,676,585	21	2
Glenn	2,409,069	21	2,553,032	22	6
Mendocino	2,271,100	22	2,276,309	23	0.2
Solano	1,476,364	25	1,699,176	24	15
Tehama	1,473,891	26	1,652,341	25	12
Napa	1,563,693	24	1,421,552	26	-9
San Diego	1,415,888	27	1,392,792	27	-2
Siskiyou	1,313,140	29	1,323,649	28	1
Santa Cruz	1,332,031	28	1,315,648	29	-1
Yuba	1,254,588	30	1,263,034	30	1
Orange	1,119,821	31	930,210	31	-17
Lake	828,995	32	787,961	32	-5

County	2019 Lbs Applied	2019 Rank	2020 Lbs Applied	2020 Rank	Percent Change
Santa Clara	747,204	33	749,594	33	0.3
San Benito	648,832	34	743,719	34	15
San Bernardino	549,100	36	559,602	35	2
Contra Costa	564,087	35	481,993	36	-15
Placer	410,874	37	385,888	37	-6
Shasta	292,904	38	334,006	38	14
Del Norte	228,105	40	289,366	39	27
Alameda	284,598	39	252,348	40	-11
El Dorado	194,260	41	246,360	41	27
Lassen	156,500	44	204,877	42	31
San Mateo	167,509	43	186,053	43	11
Modoc	178,034	42	147,920	44	-17
Amador	136,349	45	110,582	45	-19
Marin	72,727	46	88,265	46	21
Calaveras	61,220	47	73,915	47	21
Tuolumne	40,999	50	68,119	48	66
Nevada	53,046	48	54,539	49	3
Trinity	45,881	49	51,107	50	11
Humboldt	33,938	51	45,737	51	35
Inyo	9,095	56	35,328	52	288
Mariposa	15,230	54	25,820	53	70
Plumas	29,203	52	22,250	54	-24
San Francisco	24,238	53	19,197	55	-21
Mono	11,468	55	11,245	56	-2
Sierra	2,819	57	5,433	57	93
Alpine	466	58	1,889	58	305
Total	**210,542,119**	**N/A**	**215,672,737**	**N/A**	**2.4**

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 (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 2020, 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 2020, 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 2020, production agriculture and post-harvest pesticide pounds applied increased by 3 and 23 percent, respectively, while structural pesticide, landscape maintenance, and all other uses ("All Others") decreased by 2, 8, and 10 percent, respectively.

Table 16. Pounds applied (in millions) of pesticide active ingredients, from 2001 to 2020, 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
2001	142.76	1.46	4.92	1.29	6.33	156.76
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	10.35	209.90
2017	188.88	1.67	3.64	1.58	10.32	206.10
2018	191.84	1.50	3.46	1.52	11.91	210.23
2019	190.77	1.60	3.37	2.29	12.51	210.54
2020	197.06	1.97	3.29	2.10	11.25	215.67

Trends in Use for Select Pesticide Categories

Pesticide use is summarized for the following eight different 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 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 2011, acres treated with biopesticides and oils increased by 64 and 30 percent, respectively, while use of all other categories has decreased by 14 to 70 percent. Similarly, the pounds applied of biopesticides and oils increased by 94 and 39 percent, respectively, while the use of higher risk pesticide categories decreased by 5 to 77 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 2020 Summary Data website <https://www.cdpr.ca.gov/docs/pur/pur20rep/20_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 2019 to 2020.

Category	2019 Pounds Applied	2020 Pounds Applied	Change	Percent Change
Biopesticides	8,648,896	8,614,408	-34,488	-0.4
Oils	40,515,925	44,149,008	3,633,083	9
Carcinogens	39,585,207	42,110,472	2,525,266	6
Cholinesterase inhibitors	3,205,313	2,925,005	-280,308	-9
Fumigants	35,345,844	38,416,898	3,071,054	9
Ground water contaminants	330,072	285,778	-44,294	-13
Reproductive toxins	7,433,543	7,442,954	9,411	0.1
Toxic air contaminants	38,914,141	41,567,845	2,653,704	7

Table 18. The total acres treated for eight different pesticide categories with the change and percent change from 2019 to 2020.

Category	2019 Acres Treated	2020 Acres Treated	Change	Percent Change
Biopesticides	9,591,040	9,030,696	-560,344	-6
Oils	5,552,376	5,639,693	87,317	2
Carcinogens	8,714,117	8,477,319	-236,798	-3
Cholinesterase inhibitors	2,573,759	2,387,570	-186,189	-7
Fumigants	235,574	248,432	12,857	5
Ground water contaminants	441,617	325,043	-116,574	-26
Reproductive toxins	4,107,096	3,873,849	-233,247	-6
Toxic air contaminants	2,153,152	2,198,409	45,258	2

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 34 thousand pounds applied (0.4 percent decrease) and by 560 thousand acres treated (6 percent decrease) between 2019 and 2020. Most of the decrease in pounds applied was due to less use of the fungicides potassium phosphite and potassium bicarbonate, which decreased by 244 thousand pounds applied (15 percent decrease) and 157 thousand pounds applied (33 percent decrease), respectively. The decline in acres treated was largely due to 139 thousand fewer acres treated (11 percent decrease) with the adjuvant propylene glycol and 117 thousand fewer acres treated (23 percent decrease) with the adjuvant vegetable oil. In addition, there were 97 thousand fewer acres treated with the microbiocide hydrogen peroxide (33 percent decrease), 77 thousand fewer acres treated with the fungicide potassium phosphite (14 percent decrease), and 50 thousand less acres treated with the fungicide potassium bicarbonate (32 percent decrease) (Figure 5).

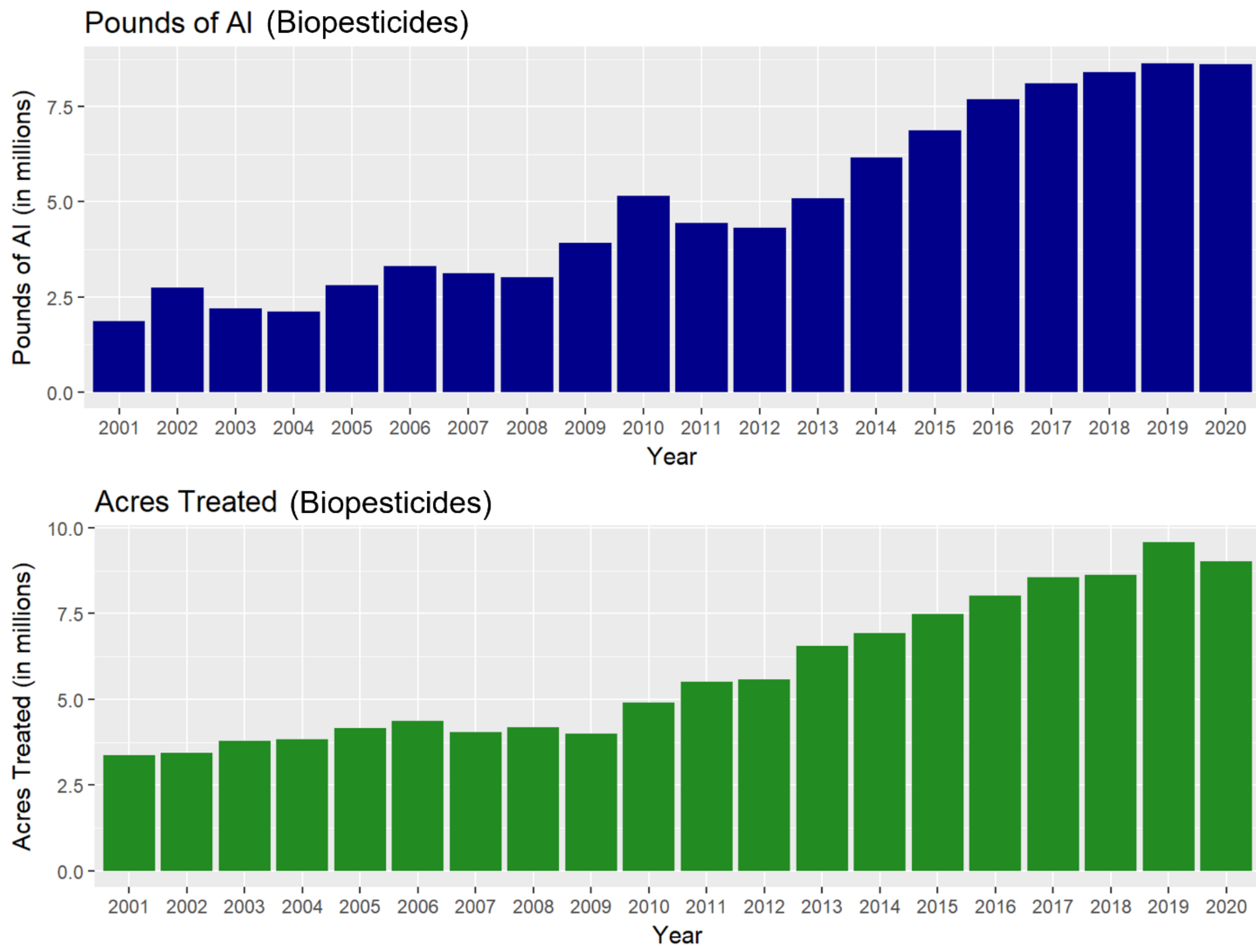


Figure 5. Use trends of pesticides that are biopesticides. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

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 known to be used as pesticides in California.. Some highly refined petroleum-based oils are used by organic growers. Use of oil pesticides increased in amount by 3.6 million pounds applied (9 percent increase) and increased in acres treated by 87 thousand acres treated (2 percent increase). Only oil AIs derived from petroleum distillation are included in these totals (Figure 6).

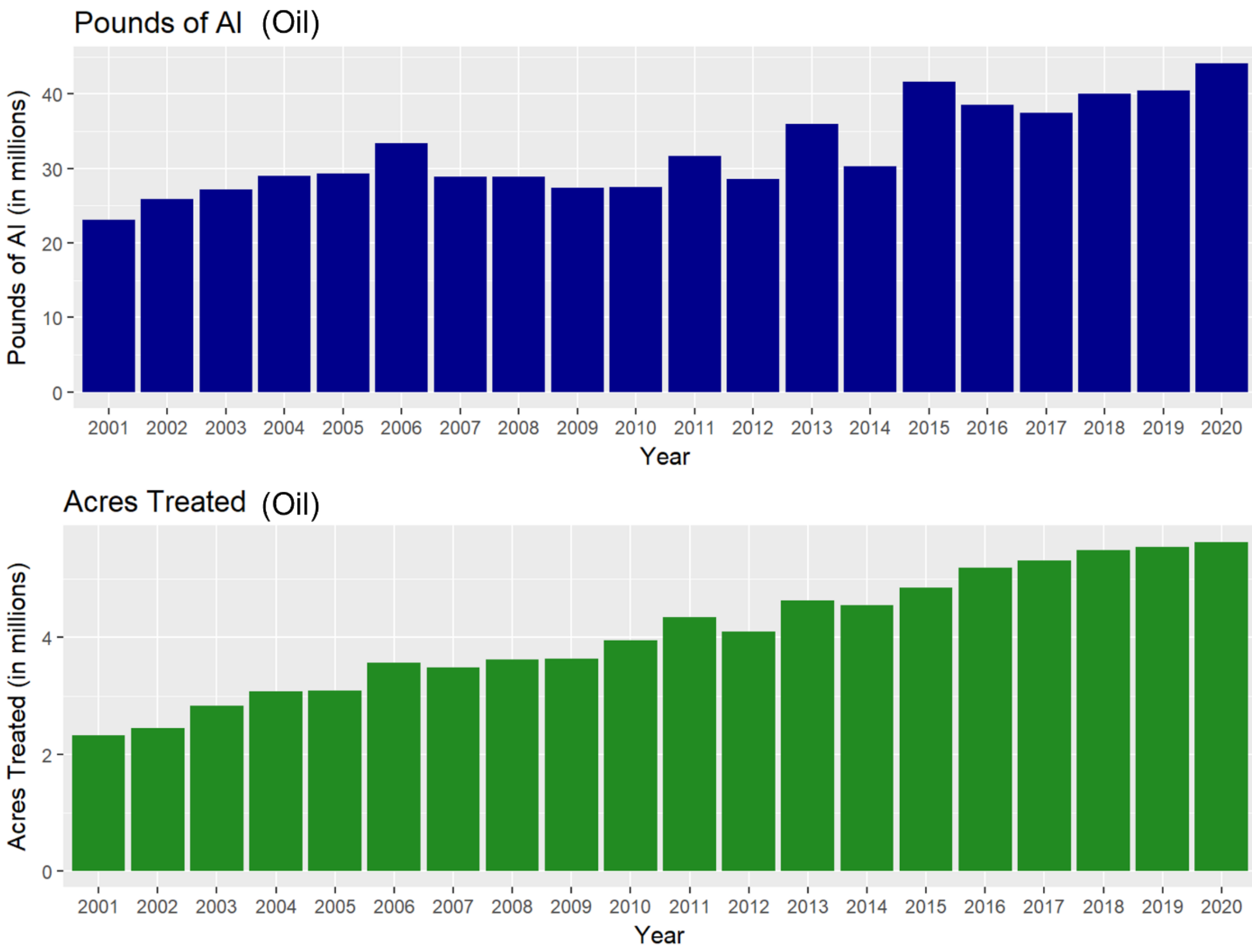


Figure 6. Use trends of pesticides that are oils. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

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 increased by 2.5 million pounds applied from 2019 to 2020 (6 percent increase), nearly reversing the 5 percent decrease that occurred from 2018 to 2019. The acres treated decreased by 237 thousand acres (3 percent decrease) in 2020, nearly reversing the 2 percent increase from the previous years. The increase in pounds applied was largely due to more use of the fumigant potassium n-methyldithiocarbamate (metam-potassium), which increased by 2.4 million pounds applied (36 percent increase). The decrease in acres treated was mostly due less acreage treated with the herbicide glyphosate (glyphosate, isopropylamine salt, decreased by 162 thousand acres treated [7 percent decrease], and glyphosate, potassium salt, decreased by 17 thousand acres treated [1 percent decrease]). The fungicides mancozeb and chlorothalonil also contributed to the decrease in acres treated, with 45 thousand (5 percent decrease) and 17 thousand (3 percent decrease) less acres treated, respectively. (Figure 7).

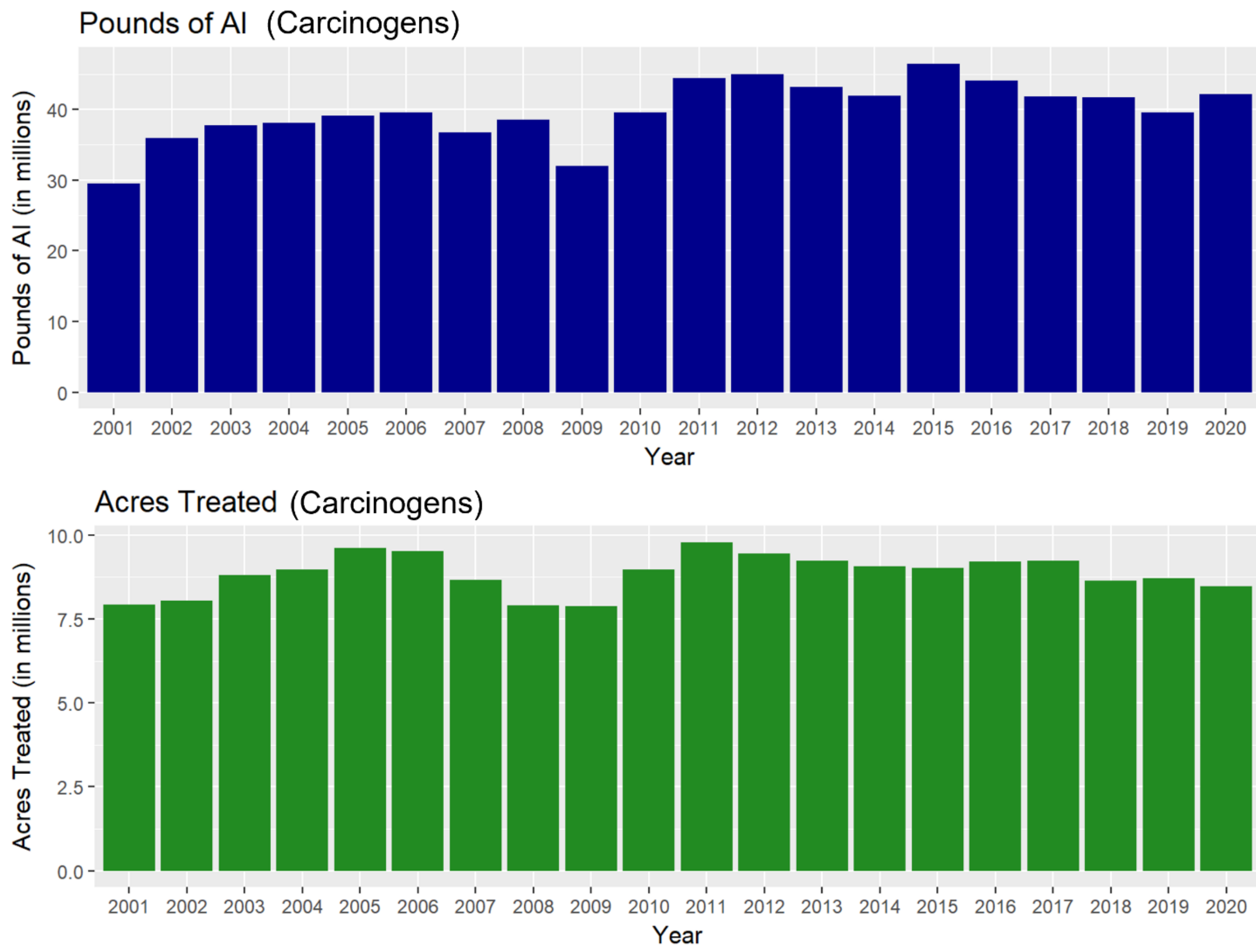
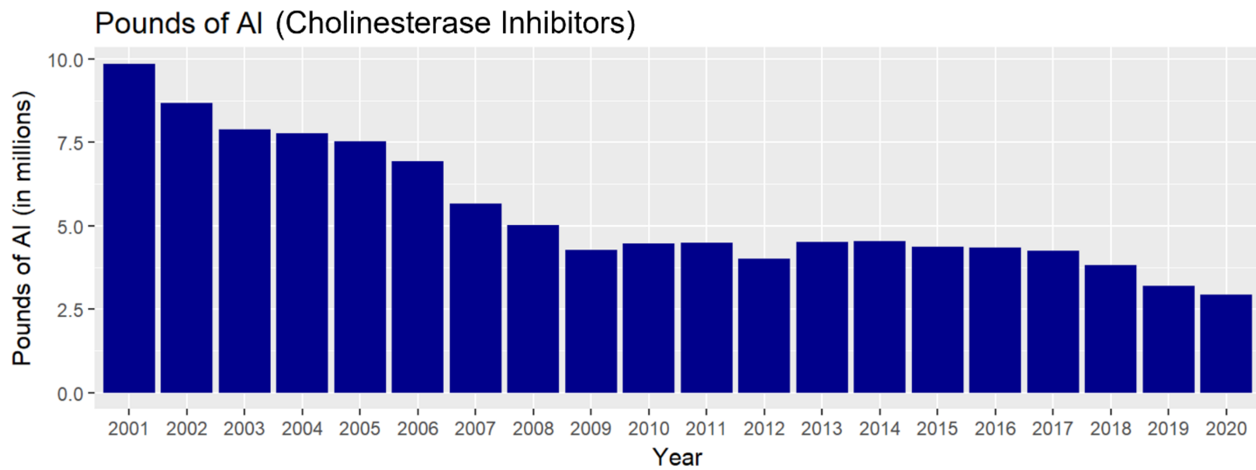


Figure 7. Use trends of pesticides that are listed on the State's Proposition 65 list of chemicals that are "known to cause cancer" or identified by U.S. EPA as "carcinogens," "probable carcinogens," or "possible carcinogens." Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Cholinesterase inhibitors

Use of organophosphorus and carbamate cholinesterase-inhibiting pesticides in 2020 decreased from the previous year by 280 thousand pounds applied (9 percent decrease) and by 186 thousand acres treated (7 percent decrease). The decrease in pounds applied and acres treated was primarily due to less use of six pesticides: the insecticide naled decreased by 115 thousand pounds applied (36 percent decrease) and 75 thousand acres treated (34 percent decrease); the plant growth regulator ethephon decreased by 97 thousand pounds applied (22 percent decrease) and 84 thousand acres treated (17 percent decrease); the herbicide thiobencarb decreased by 59 thousand pounds applied (9 percent decrease) and 13 thousand acres treated (7 percent decrease); the insecticide acephate decreased by 35 thousand pounds applied (22 percent decrease) and 27 thousand acres treated (17 percent decrease); the herbicide EPTC decreased by 14 thousand pounds applied (7 percent decrease) and 5 thousand acres treated (7 percent decrease); and the insecticide dimethoate decreased by 12 thousand pounds applied (7 percent decrease) and 27 thousand acres treated (6 percent decrease). (Figure 8).



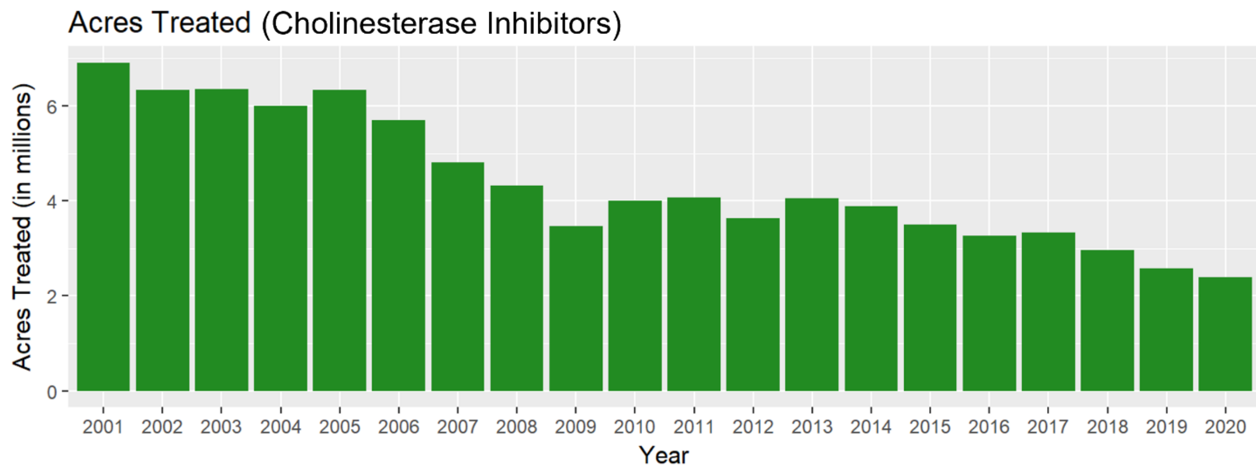


Figure 8. Use trends of pesticides that are organophosphorus or carbamate cholinesterase-inhibiting pesticides. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Fumigants

The use of fumigant AIs rose by 3.1 million pounds applied (9 percent increase) and by 13 thousand acres treated (5 percent increase) between 2019 and 2020. The increase in pounds applied can be largely attributed to a 2.3-million-pound increase in potassium N-methyldithiocarbamate (metam-potassium) (36 percent increase). Much of the increase in acres treated was due to 10 thousand more acres treated with zinc phosphide (42 percent increase) and 13 thousand more acres treated with potassium N-methyldithiocarbamate (39 percent increase) (Figure 9).

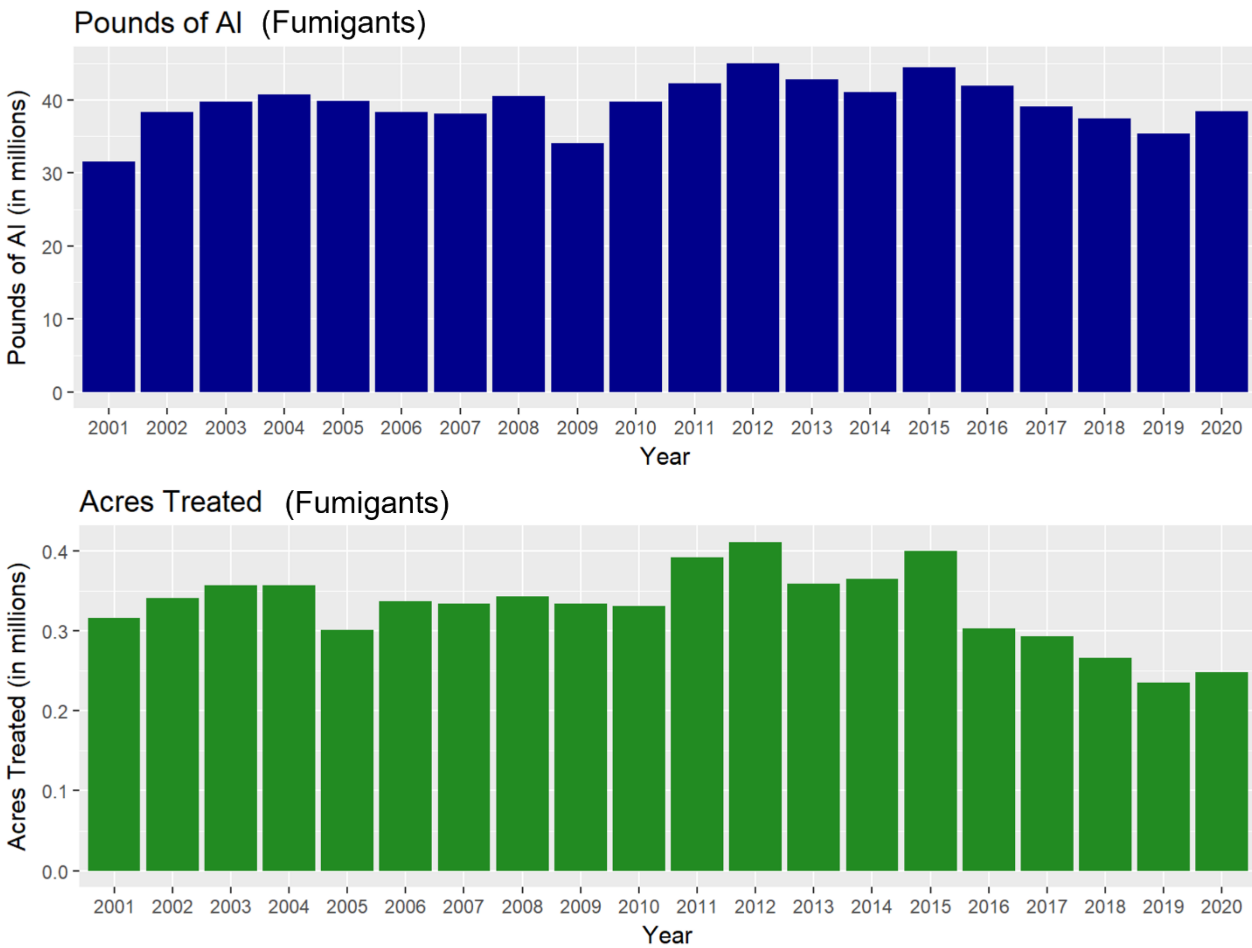


Figure 9. Use trends of pesticides that are fumigants. Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

Groundwater contaminants

Groundwater contaminants are defined as the 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 44 thousand pounds applied (13 percent decrease) and by 117 thousand acres treated (26 percent decrease) between 2019 and 2020. The reduction was largely due to less use of the herbicides simazine and diuron. Simazine decreased by 30 thousand acres treated (29 percent decrease), while diuron decreased by 8 thousand acres treated (5 percent decrease) (Figure 10).

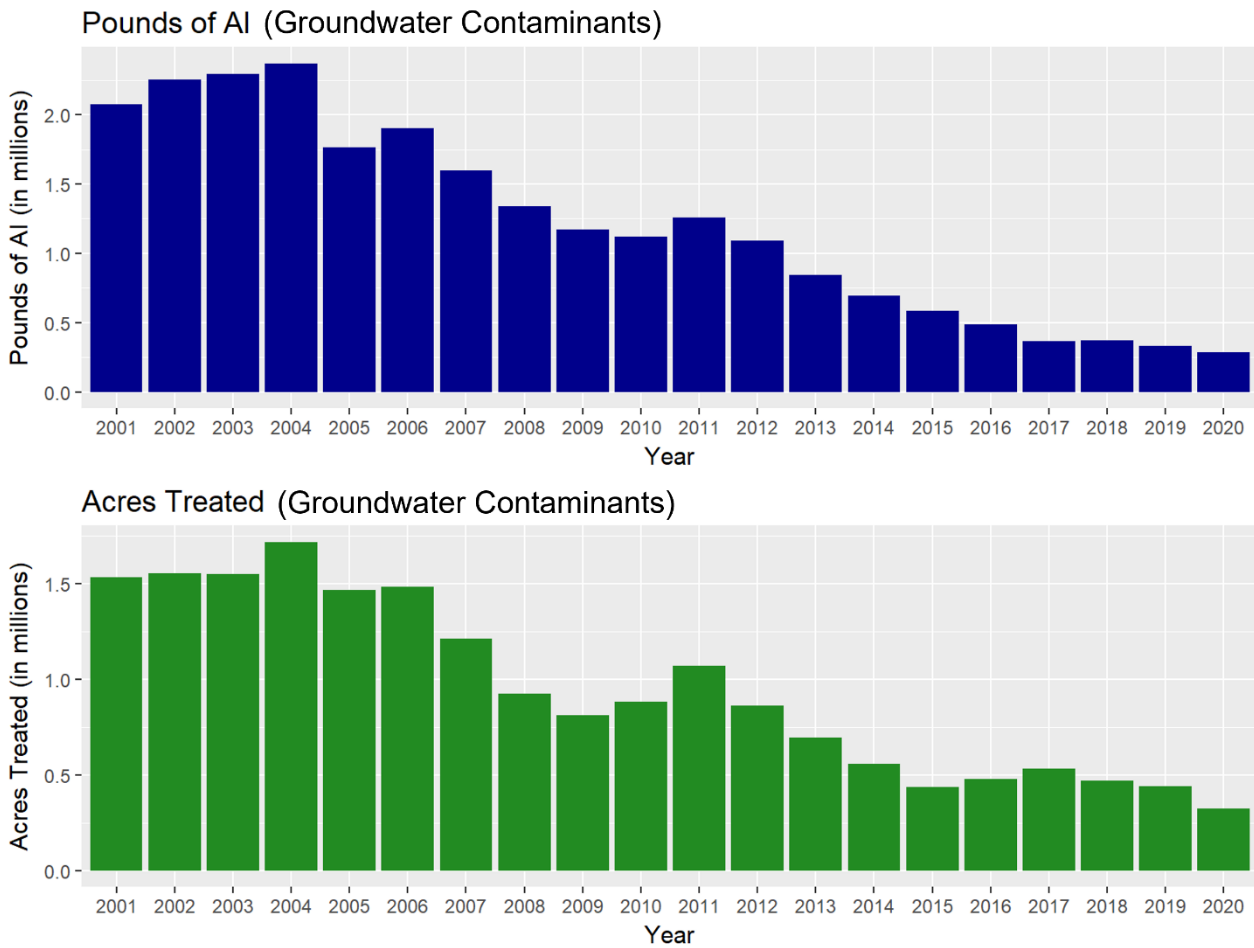


Figure 10. Use trends of pesticides from DPR's groundwater protection list. [Text files of data](https://files.cdpr.ca.gov/pub/outgoing/pur/data/) are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

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 slightly increased by 9 thousand pounds applied (0.1 percent increase) but decreased by 233 thousand acres treated (6 percent decrease) between 2019 and 2020. The change in pounds applied was mostly due to increased use of the fumigants methyl bromide and metam-sodium by 46 thousand pounds applied (3 percent increase) and 19 thousand pounds applied (0.4 percent increase), respectively. These increases were offset by decreases in use of the fungicides thiophanate-methyl and myclobutanil, which decreased by 21 thousand pounds applied (33 percent decrease) and 36 thousand pounds applied (18 percent decrease), respectively. The decrease in acres treated was largely due to 60 thousand fewer acres treated with the fungicide myclobutanil (15 percent decrease), 58 thousand fewer acres treated with the fungicide thiophanate-methyl (26 percent decrease), and 54 thousand fewer acres treated with the insecticide abamectin (2 percent decrease) (Figure 11).

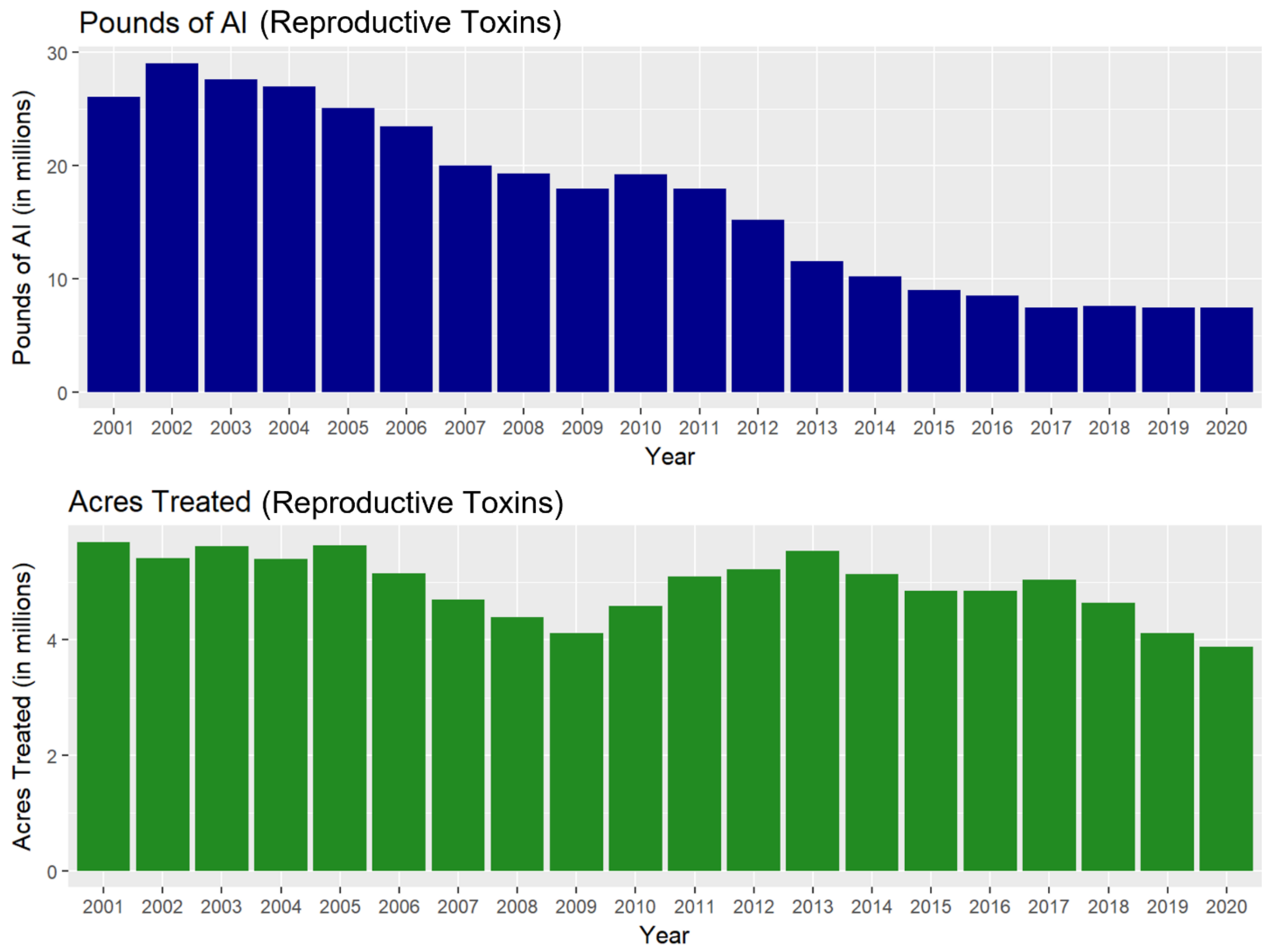
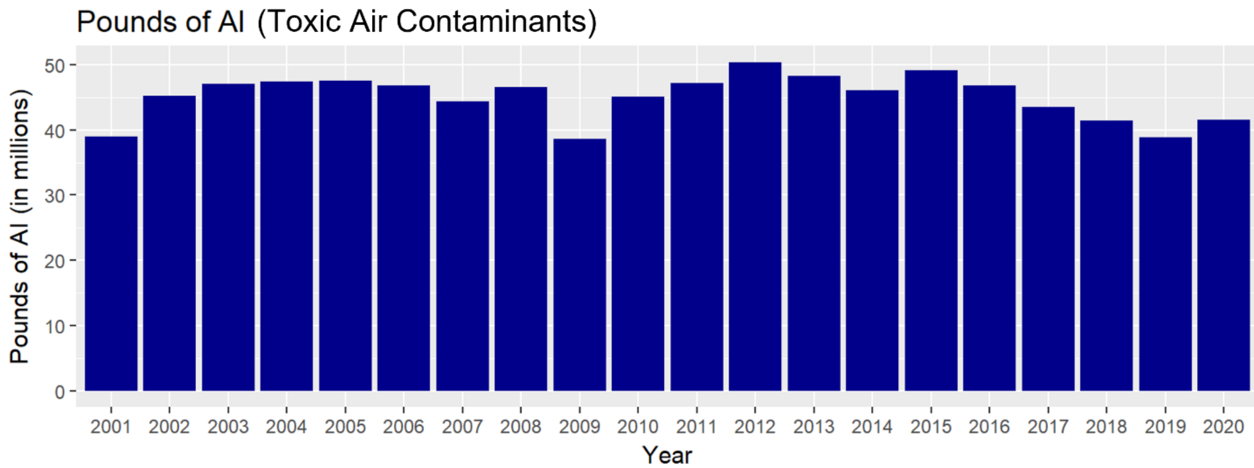


Figure 11. Use trends of pesticides that are on the State's Proposition 65 list of chemicals that are "known to cause reproductive toxicity." Text files of data are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

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 increased in pounds applied by 2.7 million pounds applied (7 percent increase) and increased in acres treated by 45 thousand acres treated (2 percent increase) between 2019 and 2020. Most of the change in pounds applied was due to a 1.9-million-pound increase in use of potassium N-methyldithiocarbamate (metam-potassium) (36 percent increase). The increase in acres treated was largely due to more acreage treated with the fungicides captan and "captan, other related," which increased by 33 thousand (16 percent increase) and 46 thousand acres treated (54 percent increase), respectively (AIs with "other related" following their name indicate naturally occurring impurities or impurities formed during the synthesis of the chemical compound. An impurity is a substance within a confined amount of a sample that differs from the chemical composition of the original AI). (Figure 12).



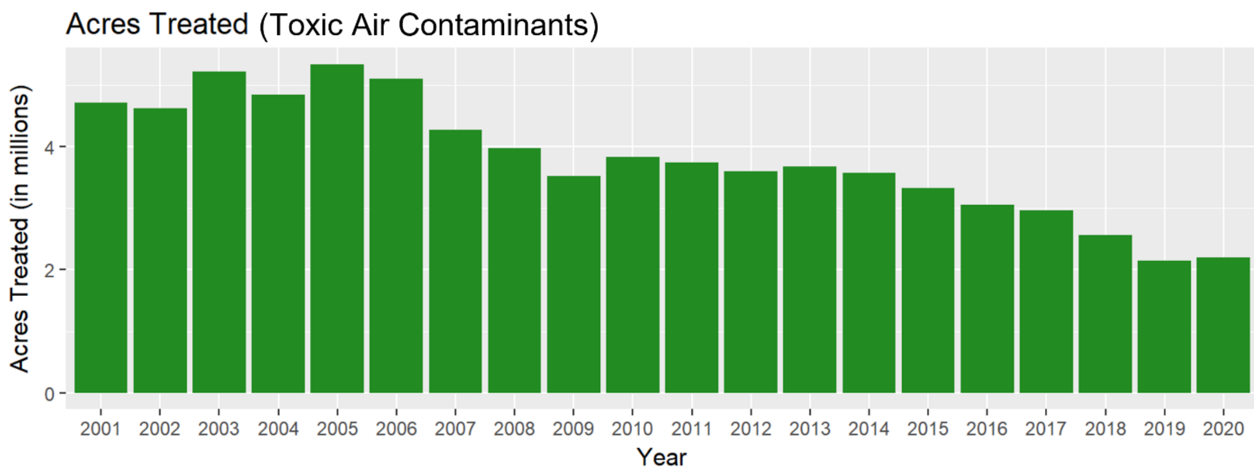


Figure 12. Use trends of pesticides that are on DPR's toxic air contaminants list. [Text files of data](https://files.cdpr.ca.gov/pub/outgoing/pur/data/) are available at <https://files.cdpr.ca.gov/pub/outgoing/pur/data/>.

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 is determined by complex ecological interactions. Weather is a critically important factor and affects different pest species in different ways. However, sometimes the causes of pest outbreaks are unknown.

Crops treated with the highest total pounds applied of pesticides in 2020 were:

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

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 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 2019 to 2020 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
Almond	6,129,786	70,000	16	6
Strawberry	1,529,751	-1,000	15	-3
Rice	789,341	14,000	17	3
Carrot	561,497	-2,200	10	-4
Pistachio	536,274	32,000	9	9

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
Wine Grape	-2,179,307	-10,000	-7	-2
Cotton	-1,107,180	-77,000	-31	-30
Table and Raisin Grape	-673,342	-6,000	-4	-2
Orange	-561,026	-2,000	-5	-1
Water (Industrial)	-558,846	NA	-27	NA

Crops or sites with the greatest percentage *increase* in the pounds applied from 2019 to 2020 included almond, strawberry, rice, carrot, and pistachio. Almond, rice, and pistachio increased in acreage as well as pesticide use, while strawberry and rice increased in pesticide use despite a decrease in acreage (Table 19a).

Crops or sites with the greatest percentage *decrease* in the pounds applied included wine grape, cotton, table and raisin grape, orange, and water (industrial). Wine grape, cotton, table and raising grape, and orange all had decreasing pounds applied accompanied by decreasing 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 2020. Thirteen commodities[1] were chosen based on these criteria, listed here in descending order by pounds applied:

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

Collectively, the pesticides used on these commodities represent 74 percent of the total amount used (pounds applied) and 77 percent of the acres treated in 2020 (Table 20).

Table 20. Pounds applied and acres treated of the top 13 crops, sorted by descending pounds applied, for 2020.

Crop	Million Pounds Applied	Million Acres Treated
Almond	43.95	27.49
Wine Grape	28.59	10.17
Orange and Tangerine	15.5	4.01
Table and Raisin Grape	14.65	5.86
Strawberry	11.54	2.63
Processing Tomato	10.85	2.79
Walnut	7.37	5.7
Pistachio	6.47	7.15
Carrot	5.97	0.54

[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

Crop	Million Pounds Applied	Million Acres Treated
Rice	5.32	3.33
Peach and Nectarine	4.29	1.55
Alfalfa	2.84	5.09
Cotton	2.45	5.45

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 increase in pounds of AIs applied for pistachio, strawberry, peach and nectarine, and orange and tangerine is likely due, at least in part, to increases in total acreage from 2019 to 2020. Similarly, the decrease in pounds applied for alfalfa, rice, and processing tomato may be due in part to less acreage in production in 2020 compared to 2019. Table and raisin grape, cotton, and wine grape had increases in pounds applied despite small decreases or no change in total acreage, while the pounds applied to walnut, almond, and carrot 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

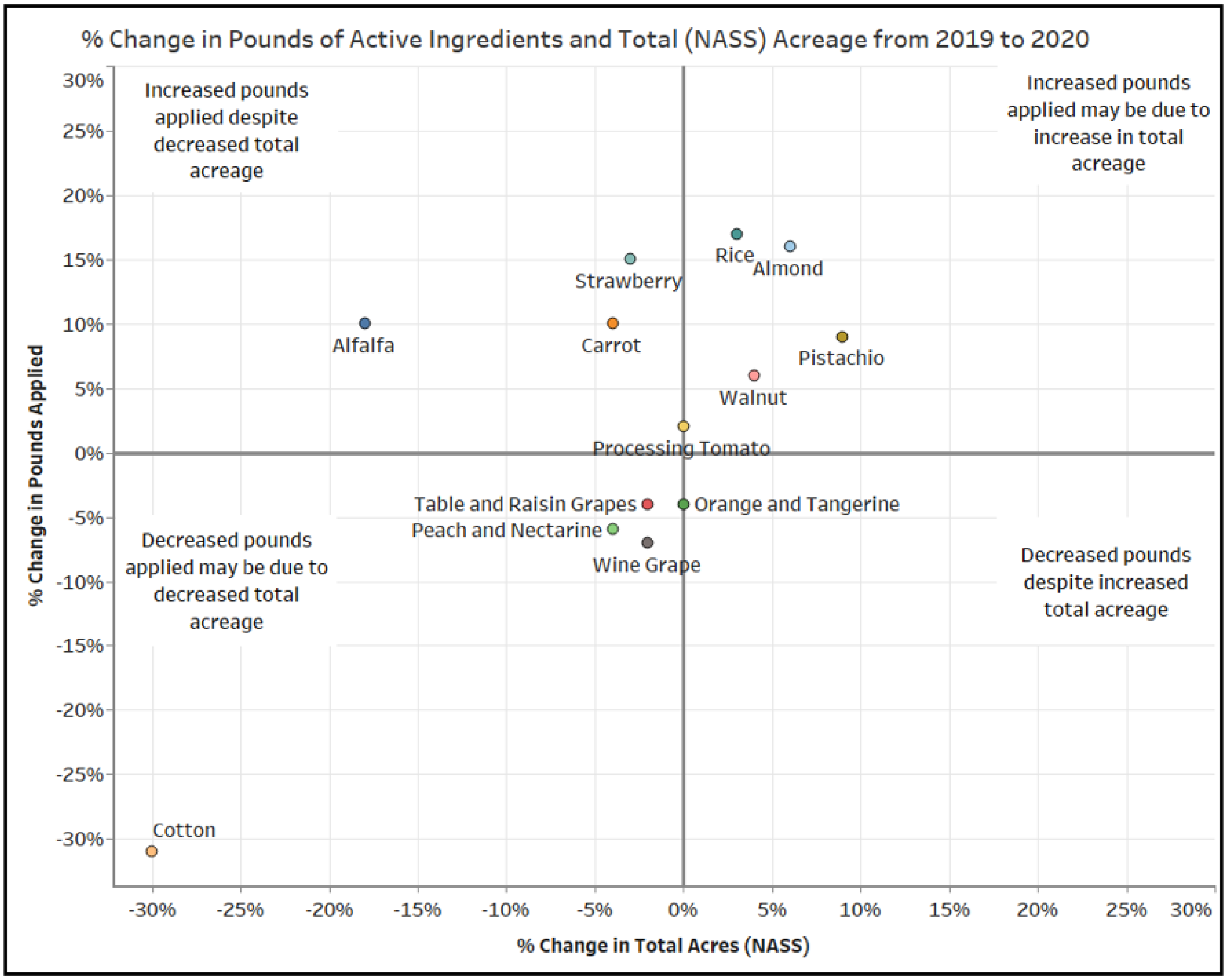


Figure 13. Graph showing percentage change in pounds of active ingredients applied from 2019 to 2020 against the change in the total acreage of the commodity. Pounds applied is determined from the PUR data while the total acreage comes from the Quick Stats database, USDA National Agricultural Statistics 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 an 18 percent decrease in harvested acreage in 2020,[1] pesticide use on alfalfa increased (Figure 13). In 2020, there were 2.8 million pounds of AI applied to alfalfa compared to 2.6 million pounds applied in 2019 (10 percent increase). Similarly, the acres treated also increased, going from 4.7 million acres treated in 2019 to 5.1 million in 2020 (8 percent increase).

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 dimethoate, 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 2020 top five AIs by acres treated in alfalfa.

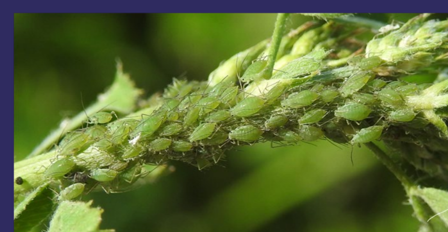
Top 5	Type	Acres Treated
Lambda-cyhalothrin	Insecticide	401,722
Pendimethalin	Herbicide	266,247
Glyphosate	Herbicide	254,323
Clethodim	Herbicide	246,137
Dimethoate	Insecticide	211,294

Table 22. The 2020 top five AIs by pounds applied to alfalfa. Fung/Insect = Fungicide/Insecticide

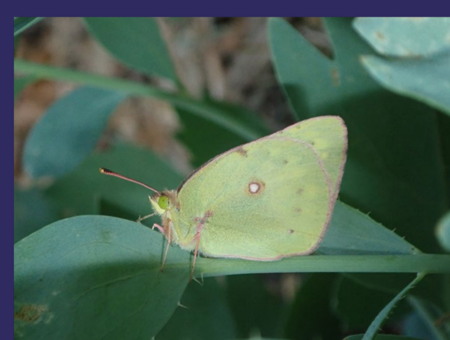
Top 5	Type	Pounds Applied
Pendimethalin	Herbicide	564,481
Glyphosate	Herbicide	411,069
Sulfur	Fung/Insect	287,971
Trifluralin	Herbicide	123,503
EPTC	Herbicide	104,328

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 2019 to 2020 (Figure 13). The pounds of AI applied to almonds increased from 37.8 million in 2019 to 44 million in 2020 (16 percent increase). The acres treated with AIs increased from 27.1 million acres treated to 27.5 million acres treated (1 percent increase).

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 and methoxyfenozide, and the herbicide glufosinate-ammonium. The remaining top five AIs by pounds applied included the fumigant 1,3-dichloropropene, the fungicide/insecticide sulfur, and the fungicide copper (Table 23, 24).

Table 23. The 2020 top five AIs by acres treated in almond.

Top 5	Type	Acres Treated
Glyphosate	Herbicide	1,809,128
Oil	Many types	1,429,891
Abamectin	Insecticide	1,318,661
Methoxyfenozide	Insecticide	1,082,333
Glufosinate-Ammonium	Herbicide	1,038,952

Table 24. The 2020 top five AIs by pounds applied to almond. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Oil	Many types	22,051,673
Glyphosate	Herbicide	3,480,140
1,3-Dichloropropene	Fumigant	3,040,042
Sulfur	Fung/Insect	1,350,258
Copper	Fungicide	1,229,618

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 4 percent in 2020[1] (Figure 13). Despite fewer planted acres, the pounds of AI applied and the acres treated both increased. In 2020, 6 million pounds were applied compared to 2019 with 5.4 million pounds were applied (10 percent increase). The amount of carrot acres treated with AIs increased from 483 thousand acres treated in 2019 to 536 thousand acres treated in 2020 (11 percent increase).

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 pyraclostrobin 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 2020 top five AIs by acres treated in carrot. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Acres Treated
Sulfur	Fung/Insect	110,944
Mefenoxam	Fungicide	58,702
Linuron	Herbicide	52,691
Pyraclostrobin	Fungicide	22,326
Pendimethalin	Herbicide	21,485

Table 26. The 2020 top five AIs by pounds applied to carrot. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Metam-Potassium	Fumigant	2,879,408
Metam-Sodium	Fumigant	1,442,799
1,3-Dichloropropene	Fumigant	761,269
Sulfur	Fung/Insect	662,674
Linuron	Herbicide	37,342

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 2020, likely due in part to a decrease in the total acres planted[1] by 30 percent (Figure 13). Pounds of AI applied decreased from 3.6 million pounds applied in 2019 to 2.5 million in 2020 (31 percent decrease). Acres treated decreased from 7.8 million acres treated in 2019 to 5.5 million acres treated in 2020 (31 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, paraquat dichloride, and sodium chlorate were the remaining three top five AIs by pounds applied (Table 27, 28).

Table 27. The 2020 top five AIs by acres treated in cotton. PGR = Plant Growth Regulator. Herb/Def = Herbicide/Defoliant

Top 5	Type	Acres Treated
Glyphosate	Herbicide	351,068
Flonicamid	Insecticide	263,177
Thidiazuron	Defoliant	206,466
Ethephon	PGR	205,294
Diuron	Herbicide	199,361

Table 28. The 2020 top five AIs by pounds applied to cotton.

Top 5	Type	Pounds Applied
Glyphosate	Herbicide	518,170
Urea Dihydrogen Sulfate	Herb/Def	267,610
Ethephon	PGR	187,313
Paraquat Dichloride	Herb/Def	122,248
Sodium Chlorate	Herb/Def	107,268

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. Total statewide bearing acreage for orange and tangerine combined remained at 211,000 acres from 2019 to 2020 (Figure 13).[1] Pounds of AI applied decreased from 16.2 million pounds applied to 15.5 million (4 percent increase). The acres treated decreased from 4.2 million to 4 million acres treated (4 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 cumulative 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 2020 top five AIs by acres treated in orange and tangerine.

Top 5	Type	Acres Treated
Oil	Many types	416,647
Copper	Fungicide	208,126
Glyphosate	Herbicide	203,385
Abamectin	Insecticide	171,561
2,4-D	Herbicide	137,694

Table 30. The 2020 top five AIs by pounds applied to orange and tangerine. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Oil	Many types	7,716,391
Copper	Fungicide	838,331
Kaolin	Fung/Insect	737,384
Glyphosate	Herbicide	300,083
1,3-Dichloropropene	Fumigant	215,440

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 4 percent decrease[1] in statewide bearing acreage of peaches and nectarines may explain part of why pounds applied declined from 4.6 million in 2019 to 4.3 million in 2020 (6 percent decrease) (Figure 13). Similarly, the acres treated decreased in 2020, going from 1.62 million acres treated in 2019 to 1.55 million in 2020 (4 percent decrease).

Oil, the fungicide copper, 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 and the herbicide glyphosate were the remaining two AIs in the top five list when ranked by cumulative acres treated, while sulfur and the fumigant 1,3-dichloropropene ranked in the top five when measured by pounds applied (Table 31, 32).

Table 31. The 2020 top five AIs by acres treated in peach and nectarine.

Top 5	Type	Acres Treated
Oil	Many types	153,375
Propiconazole	Fungicide	65,958
Sulfur	Fung/Insect	54,050
Glyphosate	Herbicide	51,373
Ziram	Fungicide	47,298

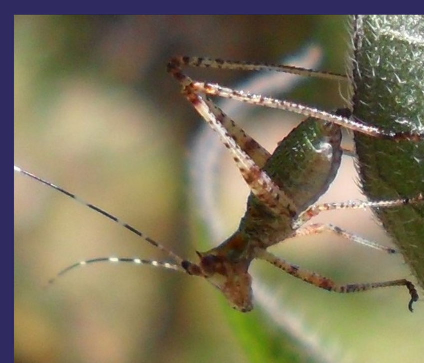
Table 32. The 2020 top five AIs by pounds applied to peach and nectarine. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Oil	Many types	2,703,184
Ziram	Fungicide	263,303
Sulfur	Fung/Insect	261,011
1,3-Dichloropropene	Fumigant	215,305
Copper	Fungicide	157,683

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 9 percent in 2020[1], which may in part account for the increase in pesticide use (Figure 13). Pounds of AI applied to pistachio increased from 5.9 million pounds applied in 2019 to 6.5 million pounds applied in 2020 (9 percent increase). Acres treated increased from 6.4 million acres treated in 2019 to 7.2 million acres treated in 2020 (13 percent increase).

The herbicides glyphosate and glufosinate-ammonium made the top five AIs when ranked by both pounds applied and by acres treated. Three insecticides – lambda cyhalothrin, bifenthrin, and chlorantraniliprole – completed the top five when measured by acres treated, while sulfur, oil and the herbicide pendimethalin made up the top five when measured by pounds applied (Table 33, 34).

Table 33. The 2020 top five AIs by acres treated in pistachio. Fung/Insect = Fungicide/Insecticide

Top 5	Type	Acres Treated
Glyphosate	Herbicide	548,751
Lambda-Cyhalothrin	Insecticide	470,960
Chlorantraniliprole	Insecticide	331,484
Bifenthrin	Insecticide	330,170
Glufosinate-Ammonium	Herbicide	295,027

Table 34. The 2020 top five AIs by pounds applied to pistachio.

Top 5	Type	Pounds Applied
Sulfur	Fung/Insect	1,522,936
Glyphosate	Herbicide	1,137,249
Oil	Many types	431,624
Glufosinate-Ammonium	Herbicide	311,164
Pendimethalin	Herbicide	243,023

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 slightly by 0.4 percent in 2020[1] (Figure 13). Pounds of AI applied in 2020 rose from 10.6 million pounds applied in 2019 to 10.9 million pounds applied in 2020 (2 percent increase). In contrast, the acres treated decreased from 3.1 million acres treated in 2019 to 2.8 million acres treated in 2020 (9 percent decrease).

Sulfur was ranked as the most-used AI in terms of both pounds applied and acres treated. Chlorothalonil, a fungicide, also ranked in the top five 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 two fumigants, potassium N-methyldithiocarbamate (metam-potassium) and metam-sodium, ranked in the top five by pounds applied (Table 35, 36).

Table 35. The 2020 top five AIs by cumulative acres treated in processing tomato. Fung/Insect = Fungicide/Insecticide

Top 5	Type	Acres Treated
Sulfur	Fung/Insect	7,247,746
Imidacloprid	Insecticide	138,256
Chlorothalonil	Fungicide	125,756
Lambda-Cyhalothrin	Insecticide	118,729
Chlorantraniliprole	Insecticide	105,970

Table 36. The 2020 top five AIs by pounds applied to processing tomato. Fung/Insect = Fungicide/Insecticide

Top 5	Type	Pounds Applied
Sulfur	Fung/Insect	7,270,096
Metam-Potassium	Fumigant	1,608,100
Metam-Sodium	Fumigant	379,517
Kaolin	Fung/Insect	278,359
Chlorothalonil	Fungicide	238,586

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 increased by 3 percent in 2020[1] (Figure 13). This increase may explain the rise in the pounds of AI applied to rice in 2020, going from 4.5 million pounds applied in 2019 to 5.3 million pounds applied in 2020 (17 percent increase). The acres treated with AIs increased from 3 million acres treated in 2019 to 3.3 million acres treated in 2020 (11 percent increase).

The herbicides propanil and triclopyr (triethylamine salt) ranked in the top five AIs by both acres treated and pounds applied. The fungicide azoxystrobin, the insecticide lambda cyhalothrin, and the herbicide halosulfuron-methyl 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 2020 top five AIs by acres treated in rice.

Top 5	Type	Acres Treated
Propanil	Herbicide	408,790
Triclopyr, Triethylamine Salt	Herbicide	348,137
Azoxystrobin	Fungicide	303,821
Lambda-Cyhalothrin	Insecticide	187,152
Halosulfuron-Methyl	Herbicide	186,558

Table 38. The 2020 top five AIs by pounds applied to rice.

Top 5	Type	Pounds Applied
Propanil	Herbicide	2,065,014
Copper	Fungicide	1,143,946
Thiobencarb	Herbicide	595,147
Sodium Carbonate Peroxyhydrate	Algaecide	203,578
Triclopyr, Triethylamine Salt	Herbicide	67,545

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

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.

Strawberry

The total planted acreage of strawberry in California decreased by 3 percent in 2020[1] (Figure 13). The pounds applied increased from 10 million pounds applied in 2019 to 11.5 million pounds applied in 2020 (15 percent increase). The acres treated increased from 2.4 million acres treated in 2019 to 2.6 million acres treated in 2020 (11 percent increase).

Captan, a fungicide, and sulfur, a fungicide/insecticide, ranked in the top five by both pounds applied and acres treated. The insecticide novaluron and the fungicide cyprodinil rounded off the top five by acres treated, while the fumigants chloropicrin, 1,3-dichloropropene, and potassium N-methyldithiocarbamate (metam-potassium) were in the top five AIs by pounds applied (Table 39, 40).

Table 39. The 2020 top five AIs by acres treated in strawberry. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Acres Treated
Captan	Fungicide	192,023
Sulfur	Fung/Insect	175,732
Captan, Other Related	Fungicide	103,851
Novaluron	Insecticide	82,369
Cyprodinil	Fungicide	67,368

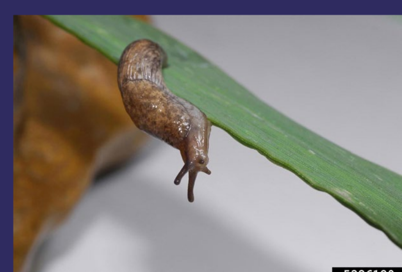
Table 40. The 2020 top five AIs by pounds applied to strawberry. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Chloropicrin	Fumigant	6,481,364
1,3-Dichloropropene	Fumigant	1,524,461
Metam-Potassium	Fumigant	859,304
Sulfur	Fung/Insect	704,731
Captan	Fungicide	333,879

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 2020, possibly due to a decline in total bearing acreage by 2 percent in 2020[1] (Figure 13). The pounds of AI applied decreased from 15.2 million pounds applied in 2019 to 14.7 million pounds applied in 2020 (4 percent decrease). The acres treated also decreased, declining from 6.6 million acres treated in 2019 to 5.9 million acres treated in 2020 (11 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 2020 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	1,654,666
Copper	Fungicide	368,195
Gibberellins	PGR	317,576
Glufosinate-Ammonium	Herbicide	136,064
Imidacloprid	Insecticide	120,388

Table 42. The 2020 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	10,266,535
1,3-Dichloropropene	Fumigant	650,715
Lime-Sulfur	Fung/Insect	621,377
Copper	Fungicide	430,661
Hydrogen Cyanamide	PGR	397,800

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 4 percent in 2020[1] (Figure 13). Similarly, pounds of AI applied increased from 6.9 million pounds applied in 2019 to 7.4 million pounds applied in 2020 (6 percent increase). Acres treated increased from 5.1 million in 2019 to 5.7 million acres treated in 2020 (11 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 2020 top five AIs by acres treated in walnut.

Top 5	Type	Acres Treated
Copper	Fungicide	482,695
Mancozeb	Fungicide	430,837
Glyphosate	Herbicide	359,290
Oxyfluorfen	Herbicide	189,479
Chlorantraniliprole	Insecticide	186,568

Table 44. The 2020 top five AIs by pounds applied to walnut. Fung/Insect = Fungicide/Insecticide

Top 5	Type	Pounds Applied
Copper	Fungicide	1,898,531
Mancozeb	Fungicide	762,559
Glyphosate	Herbicide	694,175
Kaolin	Fung/Insect	693,356
1,3-Dichloropropene	Fumigant	404,549

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 2019 to 2020 (Figure 13).[1] Pounds of AI applied decreased from 30.8 million pounds applied in 2019 to 28.6 million pounds applied in 2020 (7 percent decrease). The cumulative acres treated decreased from 11 million acres treated in 2019 to 10.2 million acres treated in 2020 (7 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 2020 top five AIs by acres treated in wine grape. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Acres Treated
Sulfur	Fung/Insect	2,536,210
Copper	Fungicide	383,138
Glufosinate-Ammonium	Herbicide	356,788
Oil	Many	301,226
Glyphosate	Herbicide	295,103

Table 46. The 2020 top five AIs by pounds applied to wine grape. Fung/Insect = Fungicide/Insecticide.

Top 5	Type	Pounds Applied
Sulfur	Fung/Insect	22,223,365
Oil	Many	1,855,762
1,3-Dichloropropene	Fumigant	556,356
Glyphosate	Herbicide	542,737
Lime-Sulfur	Fung/Insect	453,668

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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