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SUBJECT: PRELIMINARY ESTIMATES OF VOLATILE ORGANIC COMPOUND EMISSIONS FROM PESTICIDES IN THE SAN JOAQUIN VALLEY: EMISSIONS FOR 2017

SUMMARY

This document summarizes the preliminary emissions inventory for the San Joaquin Valley based on data reported to or produced by the Department of Pesticide Regulation (DPR) from May 1, 2017 to October 31, 2017, the peak ozone season in California. All Pesticide Use Reports (PUR) reported to counties within the San Joaquin Valley nonattainment area have been submitted from the county agricultural commissioners to DPR (Kimberly Steinmann, pers. comm).

Preliminary estimates of 2017 Volatile Organic Compound (VOC) emissions from nonfumigant products increased 13% (1.507 tons/day (tpd)), from 11.222 tpd in 2016 to 12.729 tpd, while fumigant emissions decreased slightly by <1% (0.020 tpd) from 4.237 tpd in 2016 to 4.217 tpd in 2017. Overall, pesticide VOC emissions increased 10%, from 15.459 tpd in 2016 to 16.947 tpd in 2017, and remain below the 18.1 tpd State Implementation Plan (SIP) goal and the regulatory trigger level of 17.2 tpd (95% of SIP goal). In 2013, DPR's pesticide VOC emissions inventory for the San Joaquin Valley nonattainment area (NAA) exceeded 17.2 tpd. As a result, certain uses of designated high-VOC products were prohibited starting in 2015. The calculated hypothetical emissions for 2016 reached the regulatory trigger level; therefore, the regulations prohibiting certain uses of specified high-VOC products will continue until at least 2019, as stated in Title 3 California Code of Regulations (3 CCR) 6884(c). This preliminary pesticide VOC emissions inventory for 2017 suggests that the current prohibitions put into effect in 2015 have been effective.

While the final 2017 VOC emission estimates may change slightly, it is unlikely that the emissions inventory for this nonattainment area will exceed the SIP goal for 2017.

VOC INVENTORY RESULTS: SAN JOAQUIN VALLEY

PUR data for statewide pesticide use from 2014-2017 were obtained from the PUR database on June 8, 2018 to produce the preliminary VOC emissions estimates for 2017 and update VOC emissions estimates for 2014-2016.

As requested by DPR, registrants provide thermogravimetric analysis (TGA) data for new and existing products subject to the VOC data requirements. Previous inventories have shown that changes in a widely used product's EP can have a significant impact on the adjusted emissions inventory.

Table 1 shows the nonfumigant products that had EP values that changed as a result of a) error corrections or b) the AB1011 process. The AB1011 process allows DPR to consider previous data evaluations to support new and amended pesticide product registrations and to maintain product registrations. Changes to estimated EP values that resulted from corrected formulation codes and associated changes to assigned default median EP values are not included in Table 1. The table also includes the changes in VOC emissions within the San Joaquin Valley NAA during the 2017 ozone season that occurred as a result of the changes of the EP values for these products. The EP value for Galigan 2E Herbicide (66222-28-ZA) was changed to correct an error in previous inventories, and the EP value for Abba Ultra Miticide/Insecticide (5481-621-AA) was changed through the AB1011 process.

In the San Joaquin Valley NAA, total VOC emissions increased 10% (1.488 tpd), from 15.459 tpd in 2016 to 16.947 tpd in 2017, and were 6% (1.153 tpd) below the SIP goal of 18.1 tpd and 1% (0.253 tpd) below the SIP trigger level of 17.2 tpd (Table 2, Figure 1). Nonfumigant emissions increased 13% (0.057 tpd), from 11.222 tpd in 2016 to 12.279 tpd in 2017, accounting for 75% of the total VOC emissions in the San Joaquin Valley (Table 3). VOC emissions from emulsifiable concentrate formulations increased by 7% (0.459 tpd), from 6.295 tpd in 2016 to 6.754 tpd in 2017 (Table 4, Figure 2). Emissions from products with emulsifiable concentrate formulations accounted for 40% of the *total* VOC emissions for this NAA. Fumigant emissions remained relatively unchanged and decreased by <1% (0.020 tpd), from 4.237 tpd in 2016 to 4.217 tpd in 2017 (Table 3).

VOC emissions from seven of the top ten active ingredients increased in 2017, while the other three decreased (Table 5). Together, use of the top ten contributing primary active ingredients resulted in approximately 50% of the total VOC emissions in this NAA. Emissions from 1,3-dichloropropene products decreased 8% (0.183 tpd) from 2.169 tpd in 2016 to 1.986 tpd in 2017. 1,3-dichloropropene products continue to be the single biggest contributors to VOC emissions and account for 12% of the total emissions in the San Joaquin Valley NAA (2) (Table 5, Figures 3a, 3b).

Products with the primary active ingredients abamectin, chlorpyrifos, gibberellins, and oxyfluorfen contributed a combined 14% of the *total* VOC emissions in this NAA. Two of these four active ingredients, abamectin and chlorpyrifos, were among the top ten active ingredients contributing to VOC emissions in this NAA (Table 5, Figures 3a, 3b).

VOC emissions from pesticide products applied to the top ten crops/sites are shown in Table 6. Together, use of the top ten contributing crops/sites resulted in 72% of the total VOC emissions in this NAA. Emissions from five of the top ten crops/sites increased in 2017 compared to 2016 levels, while emissions from walnuts remained largely unchanged and emissions from the other four crops/sites declined during the same period (Table 6).

Pesticide applications to almonds remain the largest contributors to VOC emissions (29%) in this NAA and increased 11% (0.496 tpd), from 4.343 tpd in 2016 to 4.840 tpd in 2017. Pesticide applications to cotton increased 59% (0.757 tpd) from 1.286 tpd in 2016 to 2.043 tpd in 2017 and contributed 12% of the total VOC emissions in this NAA. Pistachio pesticide applications resulted in 6% of the total VOC emissions in this NAA and increased 21% (0.170 tpd) from 0.803 tpd in 2016 to 0.973 tpd in 2017. Grapes and wine grapes contributed a combined 7% of the total 2017 VOC emissions in this NAA. VOC emissions from grapes and wine grapes increased 28% (0.153 tpd) and 3% (0.012 tpd) from 2016 levels, respectively (Table 6, Figures 3c and 3d).

Regulations to reduce VOC emissions from certain nonfumigant pesticide products establish criteria to designate certain agricultural products as high-VOC, and these products have restrictions on sales and prohibitions on use when emission limits are triggered. 3 CCR section 6880 establishes the EP thresholds to designate agricultural products as high-VOC or low-VOC.

Table 7 lists the total abamectin, chlorpyrifos, gibberellins and oxyfluorfen contributions to 2017 May-October ozone season VOC emissions in San Joaquin Valley NAA (2). Combined emissions from products containing abamectin and chlorpyrifos increased 22% (0.330 tpd) from 1.512 tpd in 2016 to 1.842 tpd in 2017 and together contributed 11% of the total VOC emissions for this NAA. Emissions from abamectin and chlorpyrifos respectively increased 31% and 13% from 2016 to 2017 levels. Emissions from oxyfluorfen decreased 4% (0.015 tpd) from 0.422 tpd in 2016 to 0.407 tpd in 2017, while gibberellins emissions decreased 36% (0.038 tpd) from 0.105 tpd in 2016 to 0.067 tpd in 2017. Together, these two products contributed 3% of the total VOC emissions in this NAA.

Table 8 and Figure 4 compare the emissions from high-VOC and low-VOC products containing abamectin, chlorpyrifos, gibberellins and oxyfluorfen on all commodities in both 2016 and 2017 when nonfumigant regulations continued to be in effect. In 2017, there were increases in the emissions from high-VOC abamectin and chlorpyrifos products. VOC emissions from high-VOC abamectin products increased 14% (0.016 tpd) from 0.114 tpd abamectin in 2016 to 0.130 tpd in 2017, whereas emissions from high-VOC chlorpyrifos products increased 115% (0.073 tpd) from 0.063 tpd in 2016 to 0.136 tpd in 2017.

The combined total emissions from all four active ingredients increased 14% from 2.040 tpd in 2016 to 2.316 tpd in 2017, with a greater percentage coming from low-VOC products in 2017 compared to 2016. The greatest increase in high-VOC product emissions in 2017 was seen for use of chlorpyrifos on almonds (270%) and cotton (146%). The greatest decrease in emissions from low-VOC products was observed for chlorpyrifos products applied to citrus, which decreased by 14%. Notable increases in low-VOC emissions were observed from use of abamectin products on almonds (38% increase from 0.291 tpd in 2016 to 0.400 tpd in 2017) and cotton (110% increase from 0.067 tpd in 2016 to 0.139 tpd in 2017), as well as for low-VOC emissions from chlorpyrifos on almonds (33% increase from 0.108 tpd in 2016 to 0.144 tpd in 2017) and cotton (42% increase from 0.093 tpd in 2016 to 0.132 tpd in 2017) (Table 9).

Figure 5 shows the change in emissions from abamectin, chlorpyrifos, gibberellins and oxyfluorfen products since 2014. In 2013, emissions in the San Joaquin Valley exceeded the SIP goal and triggered the implementation of nonfumigant regulations in 2015. For each year, between 72% and 90% of emissions from products with these four active ingredients have come from seven crops: alfalfa, almonds, citrus, cotton, grapes, pistachios, and walnuts. Combined total emissions in 2013 were 5.333 tpd, of which 77% came from high-VOC products. Emissions from products with these four active ingredients decreased in 2014, but high-VOC product emissions still accounted for more than three tpd of emissions. As shown in Figure 5, after nonfumigant regulations went in to effect in 2015, emissions from applications of all products with these four active ingredients applied to these seven crops decreased substantially to 0.591 tpd in 2015, and then increased to 1.834 tpd in 2016, and 2.087 tpd in 2017. Emissions from high-VOC focus four products applied to these seven crops in 2017 accounted for 3% (0.536 tpd) of the total emissions from all products on all crops in this NAA, whereas low-VOC focus four products applied to these seven crops contributed 9% (1.551 tpd) of the total emissions in this NAA.

In 2017, over 3.31 million pounds of products containing abamectin, chlorpyrifos, gibberellin and oxyfluorfen active ingredients were used in the San Joaquin Valley nonattainment area, compared to 2.90 million pounds in 2016 (Table 10). For these four active ingredients, the ratio between the pounds of VOC emitted per pound of product used decreased by an average of 0.5% between 2016 and 2017, indicating continued use of low-VOC products. The amount of VOC emissions produced per pound of gibberellins products applied decreased 37% from 2016 levels, whereas the amount of VOC emissions produced per pound of abamectin, chlorpyrifos, and oxyfluorfen products applied increased between 0.6% and 4.1% compared to 2016 levels. These data suggest that the change in nonfumigant emissions in the San Joaquin Valley NAA in 2017 has been abated by the use of lower VOC gibberellins products, as required by the nonfumigant regulations. However, compared to 2016, abamectin, chlorpyrifos, and oxyfluorfen products produced greater amounts of VOC emissions per pound of pesticide product applied.

HYPOTHETICAL VOC EMISSIONS

Hypothetical VOC emissions are calculated for each active ingredient used on each crop specified in 3 CCR section 6884 to see if the emissions comply with the limit specified in 3 CCR section 6452.2(f). The hypothetical emissions are calculated by assuming the relative mixture of high and low-VOC products used in the current year of prohibitions would have been the same as in the most recent year without prohibitions (2014). The VOC emissions are then calculated using that product mixture for the amount of active ingredient used in the current year.

The following formula is used to calculate the hypothetical VOC emissions described above for each pesticide-crop combination:

$$\begin{array}{c}\text{Hypothetical emissions}\\ \text{for a pesticide-crop}\\ \text{combination listed in}\\ \text{section 6884 during}\\ \text{May-Oct for the year of}\\ \text{prohibitions}\\ \textbf{\textit{(Table 11 column D)}}\end{array} = \frac{\begin{array}{c}\text{Emissions for the pesticide-crop}\\ \text{combination during May-Oct for the}\\ \text{most current year without prohibitions}\\ \textbf{\textit{(Table 11 column A)}}\end{array} \times \begin{array}{c}\text{Pounds active ingredient for}\\ \text{the crop during May-Oct for}\\ \text{the year of prohibitions}\\ \textbf{\textit{(Table 11 column B)}}\end{array}}{\begin{array}{c}\text{Pounds active ingredient for the crop during May-Oct for the most current year}\\ \text{without prohibitions}\\ \textbf{\textit{(Table 11 column C)}}\end{array}}$$

Table 11 details the hypothetical emissions for 2017 calculated using the formula above. The total hypothetical emissions for the pesticides and crops listed in section 6880 for 2017 are 19.097 tpd, 13% (2.150 tpd) more than the actual inventory emissions. Total hypothetical VOC emissions equal the sum of the hypothetical emissions for each pesticide-crop combination, plus the actual VOC emissions for the remaining pesticides and crops not listed in section 6880:

Total hypothetical VOC emissions = 4.237 tpd + 14.860 tpd = 19.097 tpd

The total hypothetical VOC emissions for the San Joaquin Valley NAA (2) are 5.51% (0.997 tpd) higher than the VOC regulation benchmark of 18.1 tpd and 11.03% (1.897 tpd) higher than the VOC trigger of 17.2 tpd.

The high-VOC prohibitions went into effect during 2015. The hypothetical emissions for 2016 were calculated to be 17.206 tpd and 19.097 tpd in 2017, which are both greater than the 17.2 trigger level for the San Joaquin Valley NAA (2). Therefore, the high-VOC nonfumigant prohibitions will remain in effect through May-October 2019, as specified in 3 CCR section 6452.2(f).

Although the application of high-VOC abamectin, chlorpyrifos, gibberellins and oxyfluorfen products on alfalfa, almonds, citrus, cotton, grapes, pistachios, and walnuts during the months of May - October has been prohibited in the San Joaquin Valley NAA since 2015, pesticide use reports suggest that prohibition does not always result in annual VOC emission reductions from use of these products on these seven crops within the San Joaquin Valley NAA. Table 12 lists the high-VOC products with the highest reported use in this NAA during 2017. Products with greater than 100 lbs of active ingredient applied during 2017 were included in the table, which together contributed nearly 100% of the total VOC emissions from all High-VOC products applied to these seven crops during the ozone season in this NAA.

In 2017, certain high-VOC products such as ABBA ULTRA MITICIDE/ INSECTICIDE and TIMECTIN 0.15 EC AG INSECTICIDE/MITICIDE (abamectin); DREXEL CHLORPYRIFOS

4E-AG and GOVERN 4E INSECTICIDE (chlorpyrifos); and WILLOWOOD OXYFLO 2 EC (oxyfluorfen) had increases in pounds of product applied to alfalfa, almonds, citrus, cotton, grapes, pistachios, and walnuts during the ozone season, whereas many others showed decreases compared to 2016, presumably as growers switched to low-VOC products (Table 12). The use of high-VOC oxyfluorfen products at a rate of 0.125 pounds per acre or less, and the use of high-VOC chlorpyrifos products to control aphids on cotton are permitted exceptions to use restrictions. Other factors that could contribute to estimated emissions of VOCs from high-VOC products that are subject to the nonfumigant regulations may include: (a) the inventory's limited ability to identify applications of products with emergency or 'special local needs' exemptions, or (b) data entry errors arising from the selection of the incorrect product name or registration number during pesticide use report submission.

REFERENCES

Craig, K., Budahn, A., Wofford, P., Vidrio, E., Pham, M. May 2018. Annual Report on Volatile Organic Compound Emissions from Pesticides: Emissions for 1990 – 2016 https://www.cdpr.ca.gov/docs/emon/vocs/vocproj/2016_annual_rpt_main.pdf

Spurlock, F.S., 1/7/2002. Memo to John Sanders. Methodology for Determining VOC Emission Potentials of Pesticide Products. http://www.cdpr.ca.gov/docs/emon/vocs/vocproj/intro.pdf

Table 1. Nonfumigant products with substantially changed Emission Potential values between the **2016** and **2017** EP databases, and the estimated change in emissions (tpd) for San Joaquin Valley **NAA (2)** during **2017** compared to **2016**.

		EP Database 2016 Inventory		EP Database 2017 Inventory		Change in EP	Change in emissions (tpd)
Product	AI	EP	method	EP	method		
GALIGAN 2E HERBICIDE	OXYFLUORFEN	39.15	default median	66.15	TGA/derived	27	0.002
ABBA ULTRA MITICIDE/INSECTICIDE	ABAMECTIN	39.15	default median	34.18	Derived	-4.97	<0.001

Table 2. May–October (ozone season) *adjusted* pesticide VOC emissions and goals.

	VOC Emissions (tons/day)															
NAA	**1990**	**SIP Goal**	**Trigger Level** †	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
San Joaquin Valley																
Unadjusted (tpd)	22.472	18.1	17.2	29.230	29.532	24.720	23.849	21.005	24.472	26.491	27.625	30.170	26.455	26.544	26.212	27.386
Adjusted (tpd)	20.517	18.1	17.2	20.740	21.305	17.093	14.525	12.965	15.228	16.376	16.921	19.520	16.815	15.385	15.459	16.947
VOC/applied (tons/ton)	0.739	-	-	0.449	0.453	0.445	0.265	0.277	0.286	0.283	0.285	0.290	0.295	0.300	0.283	0.288

† Trigger Level is 95% of SIP Goal

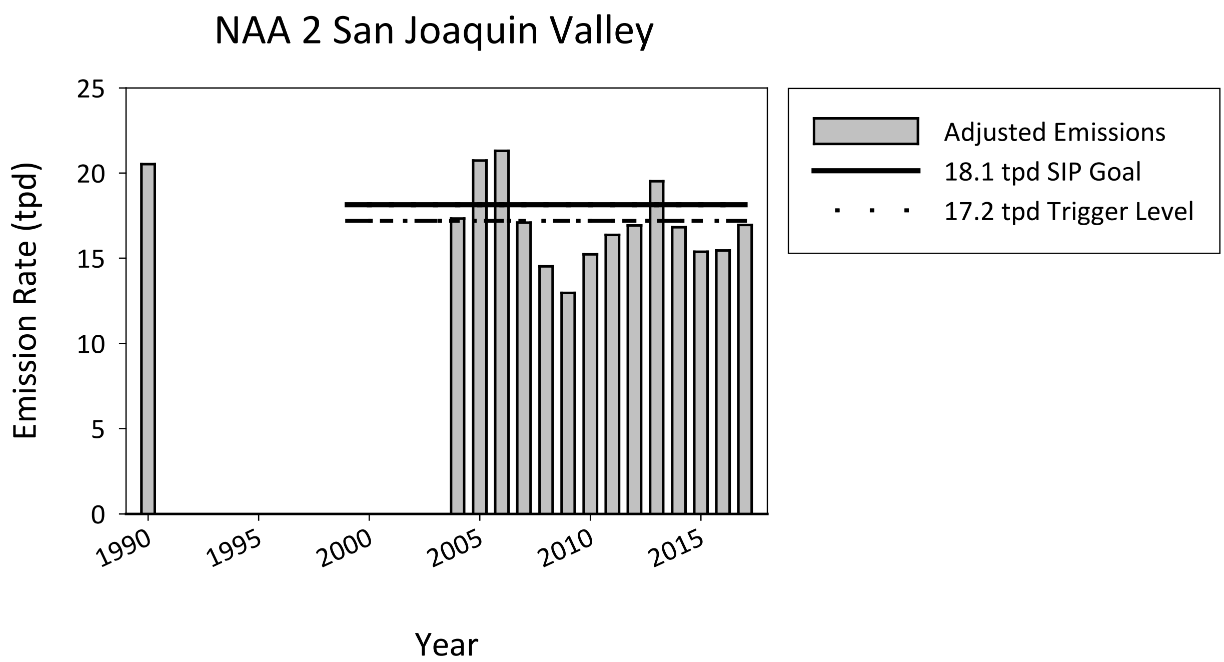

Figure 1. *Adjusted* annual ozone season pesticide VOC emissions in the San Joaquin Valley **NAA (2)**.

Table 3. San Joaquin Valley **NAA (2)** May–October (ozone season) *adjusted* fumigant and nonfumigant pesticide VOC emissions.

NAA	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
San Joaquin Valley														
Fumigants	5.536 (27%)	6.910 (33%)	6.808 (32%)	4.399 (26%)	3.370 (23%)	3.078 (24%)	3.700 (24%)	4.001 (24%)	4.265 (25%)	4.353 (22%)	4.026 (24%)	4.777 (31%)	4.237 (27%)	4.217 (25%)
Nonfumigants	14.981 (73%)	13.831 (67%)	14.498 (68%)	12.375 (74%)	11.154 (77%)	9.887 (76%)	11.528 (76%)	12.375 (76%)	12.656 (75%)	15.167 (78%)	12.789 (76%)	10.607 (69%)	11.222 (73%)	12.729 (75%)

Table 4. San Joaquin Valley **NAA (2)** May-October (ozone season) nonfumigant pesticide VOC emissions derived from Emulsifiable Concentrate formulations (ECs) and all other formulations (Others).

	VOC Emissions tpd (percentage of total)													
NAA	1990	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
San Joaquin Valley														
ECs	12.162 (81%)	10.199 (74%)	10.119 (70%)	7.547 (69%)	7.491 (67%)	5.921 (60%)	6.608 (57%)	6.854 (55%)	7.263 (57%)	8.760 (58%)	7.298 (57%)	6.037 (57%)	6.295 (56%)	6.754 (53%)
Others	2.819 (19%)	3.632 (26%)	4.379 (30%)	3.423 (31%)	3.663 (33%)	3.966 (40%)	4.921 (43%)	5.521 (45%)	5.392 (43%)	6.407 (42%)	5.491 (43%)	4.571 (43%)	4.927 (44%)	5.975 (47%)

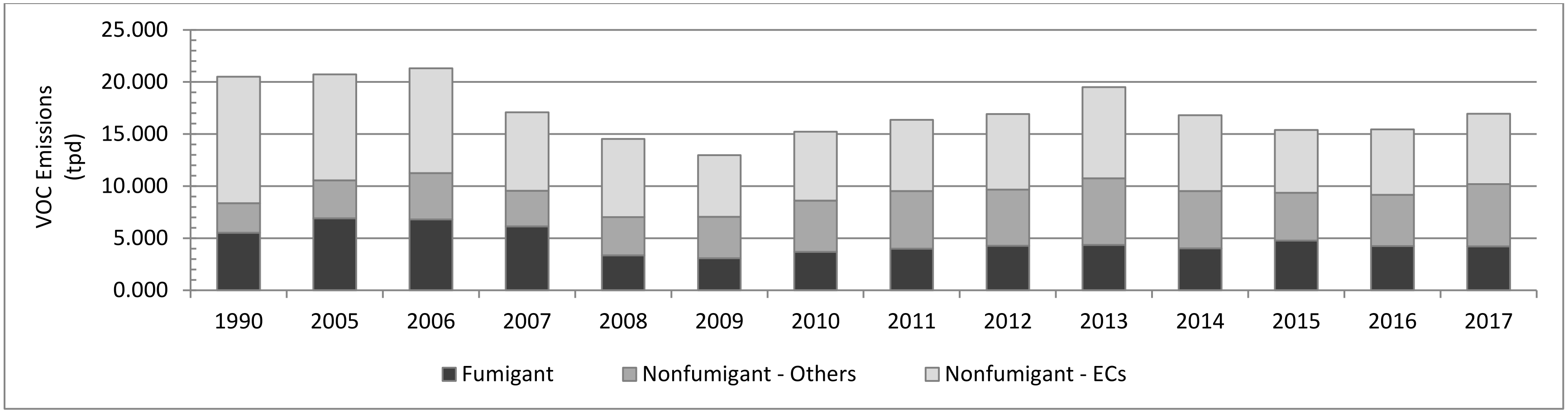

Figure 2. May-October (ozone season) *adjusted* VOC emissions derived from fumigant and nonfumigant pesticides (emulsifiable concentrate formulations (ECs) compared to all others) in the San Joaquin Valley **NAA (2)**.

Table 5. Top ten primary active ingredients contributing to **2017** May-October ozone season *adjusted* VOC emissions in the San Joaquin Valley **NAA (2)**.

Primary AI	2017 Total Product Adjusted Emissions (tpd)	Percent of 2017 Adjusted Emissions	Percent Change from 2016 to 2017
1,3-DICHLOROPROPENE	1.986	11.87	-8
ABAMECTIN	0.991	5.92	31
GLYPHOSATE, ISOPROPYLAMINE SALT	0.909	5.43	30
CHLORPYRIFOS	0.852	5.09	13
POTASSIUM N-METHYLDITHIOCARBAMATE	0.803	4.80	43
BIFENTHRIN	0.719	4.30	10
HEXYTHIAZOX	0.645	3.85	-6
GLUFOSINATE-AMMONIUM	0.635	3.80	25
METHYL BROMIDE	0.546	3.26	-10
MINERAL OIL	0.448	2.68	51

Table 6. Top ten crops/sites contributing to **2017** May-October ozone season *adjusted* pesticide VOC emissions in the San Joaquin Valley **NAA (2)**.

Primary AI	2017 Total Product Adjusted Emissions (tpd)	Percent of 2017 Adjusted Emissions	Percent Change from 2016 to 2017
ALMOND	4.839	28.55	11
COTTON	2.043	12.06	59
PISTACHIO	0.973	5.74	21
CARROTS	0.731	4.31	-12
ORANGE	0.730	4.31	-3
GRAPES	0.709	4.18	28
SOIL APPLICATION, PREPLANT*	0.674	3.98	-8
WALNUT	0.659	3.89	0
TOMATOES, FOR PROCESSING/CANNING	0.473	2.79	-15
GRAPES, WINE	0.450	2.66	3

*Treatment of an area prior to crop planting

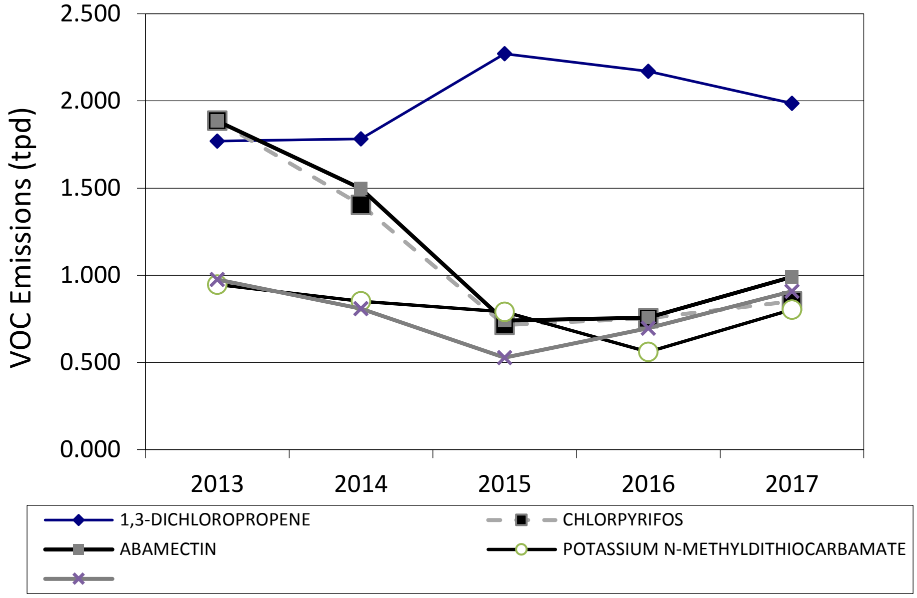

Figure 3a. Changes in *adjusted* emissions of top five AIs in the San Joaquin Valley **NAA (2)** from **2013** to **2017**.

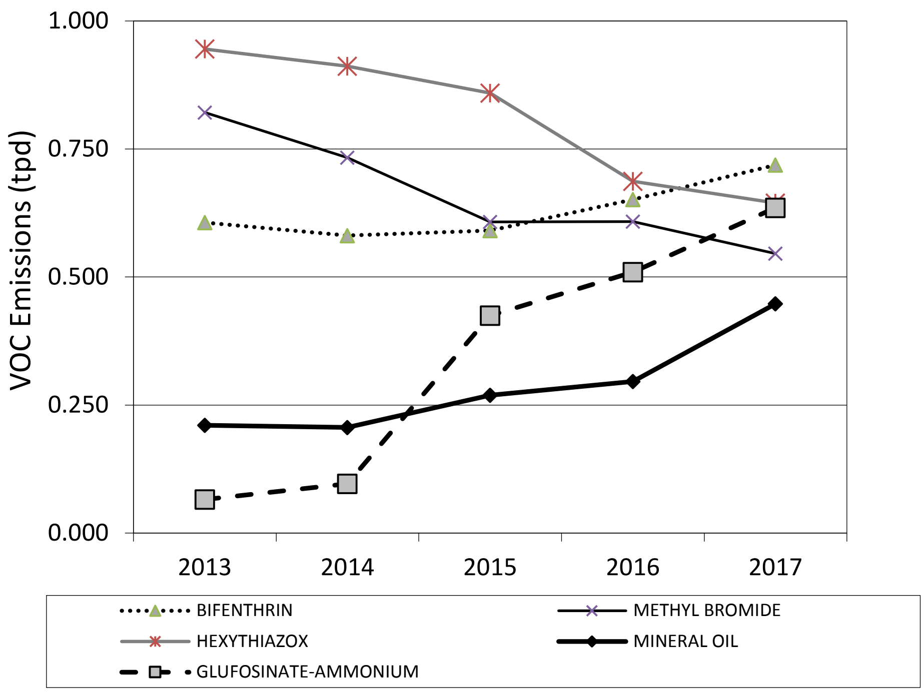

Figure 3b. Changes in *adjusted* emissions of top six to ten active AIs in the San Joaquin Valley **NAA (2)** from **2013** to **2017**.

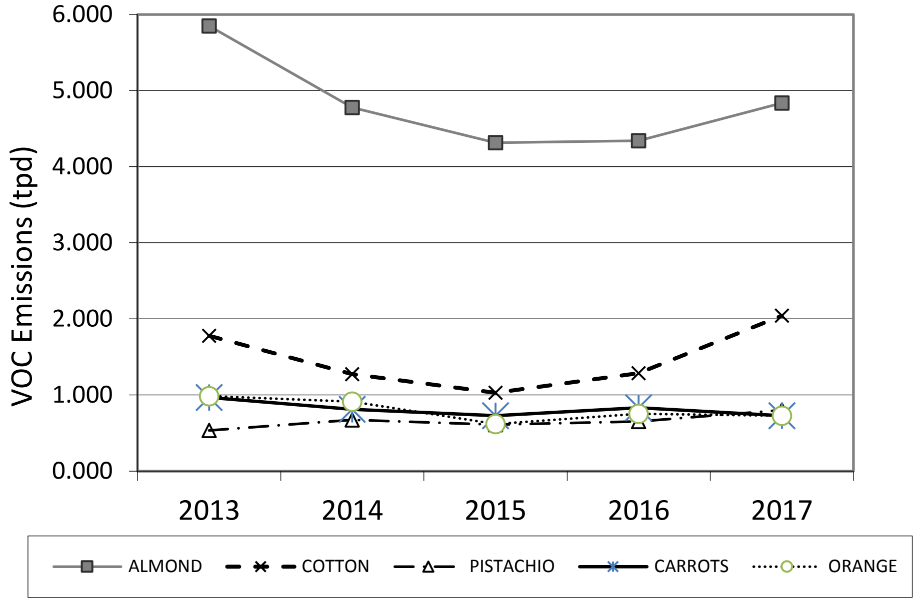

Figure 3c. Changes in *adjusted* emissions of top five crops/sites in the San Joaquin Valley **NAA (2)** from **2013** to **2017**.

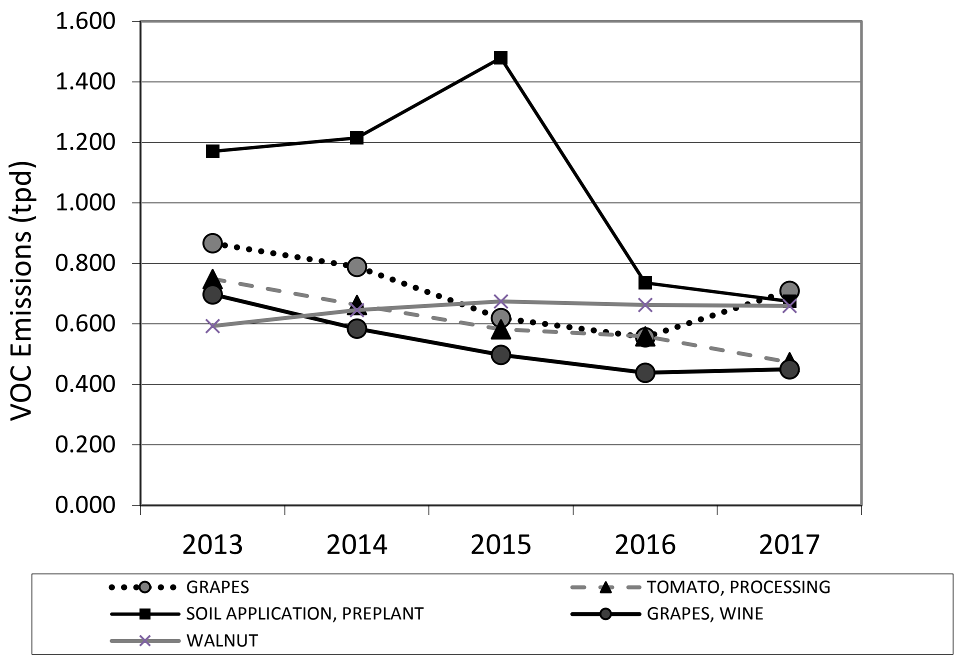

Figure 3d. Changes in *adjusted* emissions of top six to ten crops/sites in the San Joaquin Valley **NAA (2)** from **2013** to **2017**.

Table 7. Abamectin, chlorpyrifos, gibberellins and oxyfluorfen contributions to **2017** May-October ozone season *adjusted* VOC emissions in the San Joaquin Valley **NAA (2)**.

Primary AI	2017 Total Product Adjusted Emissions (tpd)	Percent of 2017 Adjusted Emissions	Percent Change from 2016 to 2017
ABAMECTIN	0.991	5.92	31
CHLORPYRIFOS	0.852	5.09	13
OXYFLUORFEN	0.407	2.43	-4
GIBBERELLINS	0.067	0.40	-36

Table 8. Emissions from **2016** and **2017** applications of high- and low- VOC products containing abamectin, chlorpyrifos, gibberellins and oxyfluorfen on *all* crops/sites in the San Joaquin Valley **NAA (2)**.

Primary AI	Total Emissions (tpd)		Percent of NAA 2 Emissions from All Products with this Active Ingredient		Percent of Total NAA 2 Nonfumigant Emissions	
	2016	2017	2016	2017	2016	2017
ABAMECTIN						
High VOC	0.114	0.130	15.1%	13.1%	1.0%	1.0%
Low VOC	0.643	0.861	84.9%	86.9%	5.7%	6.8%
CHLORPYRIFOS						
High VOC	0.063	0.136	8.4%	15.9%	0.6%	1.1%
Low VOC	0.691	0.716	91.6%	84.1%	6.2%	5.6%
GIBBERELLINS						
High VOC	0.054	0.010	51.0%	14.5%	0.5%	0.1%
Low VOC	0.051	0.057	49.0%	85.5%	0.5%	0.4%
OXYFLUORFEN						
High VOC	0.377	0.367	89.3%	90.3%	3.4%	2.9%
Low VOC	0.045	0.040	10.7%	9.7%	0.4%	0.3%
COMBINED						
High VOC	0.608	0.642	29.8%	27.7%	5.4%	5.0%
Low VOC	1.431	1.674	70.2%	72.3%	12.8%	13.1%

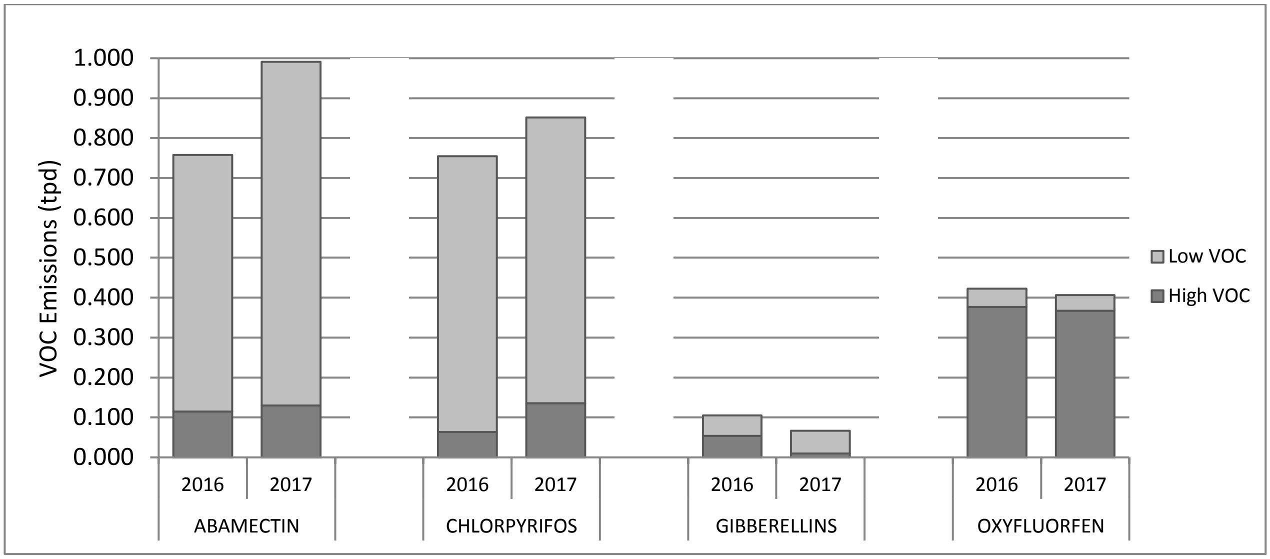

Figure 4. Emissions from **2016** and **2017** applications of high- and low- VOC products containing abamectin, chlorpyrifos, gibberellins and oxyfluorfen on *all* crops/sites in the San Joaquin Valley **NAA (2)**.

Table 9. Emissions from **2016** and **2017** applications of high- and low-VOC products for abamectin, chlorpyrifos, gibberellins and oxyfluorfen on alfalfa, almonds, citrus*, cotton, grapes†, pistachios, walnuts, and total emissions from applications to all crops in the San Joaquin Valley **NAA (2)**.

Primary AI	Total Emissions from High- and Low- VOC Products (tpd)																	
	Alfalfa		Almond		Citrus*		Cotton		Grape†		Pistachio		Walnut		Total		All Crops	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	**2016**	**2017**
High-VOC																		
ABAMECTIN	<0.001	<0.001	0.020	0.023	0.021	0.028	0.004	0.002	0.013	0.012	0.000	0.000	0.001	0.000	0.059	0.066	0.114	0.130
CHLORPYRIFOS	<0.001	0.001	0.006	0.022	0.009	<0.001	0.044	0.108	0	0.000	0	0	0.001	0.001	0.060	0.132	0.063	0.136
GIBBERELLINS	0	0	0	0	0.005	0.001	0	0	0.048	0.008	0	0	0	0	0.053	0.009	0.054	0.010
OXYFLUORFEN	<0.001	<0.001	0.263	0.249	0.001	0.001	0.001	0.002	0.010	0.013	0.029	0.028	0.036	0.037	0.338	0.329	0.377	0.367
TOTAL	**<0.001**	**0.001**	**0.289**	**0.294**	**0.035**	**0.030**	**0.049**	**0.112**	**0.071**	**0.033**	**0.029**	**0.028**	**0.038**	**0.038**	**0.511**	**0.536**	**0.608**	**0.642**
Low-VOC																		
ABAMECTIN	0.000	0.000	0.291	0.400	0.046	0.051	0.067	0.139	0.109	0.121	0.001	0.004	0.053	0.048	0.566	0.764	0.643	0.861
CHLORPYRIFOS	0.058	0.067	0.108	0.144	0.296	0.255	0.093	0.132	0.052	0.053	0	0	0.060	0.048	0.668	0.699	0.691	0.716
GIBBERELLINS	0	0	<0.001	0	0.034	0.038	0	0	0.017	0.017	0	0.000	0	0	0.051	0.055	0.051	0.057
OXYFLUORFEN	0	0	0.021	0.019	<0.001	<0.001	0.001	0.001	0.005	0.006	0.007	0.005	0.003	0.004	0.038	0.034	0.045	0.040
TOTAL	**0.059**	**0.067**	**0.420**	**0.563**	**0.376**	**0.344**	**0.161**	**0.272**	**0.182**	**0.197**	**0.009**	**0.009**	**0.116**	**0.099**	**1.323**	**1.551**	**1.431**	**1.674**

*Citrus comprises the following crops: citrus fruits; grapefruit; lemon; lime; orange; pomelo; tangelo; tangerine (mandarin, satsuma, murcott, etc.).

†Grape comprises the following crops: grapes; grapes, wine.

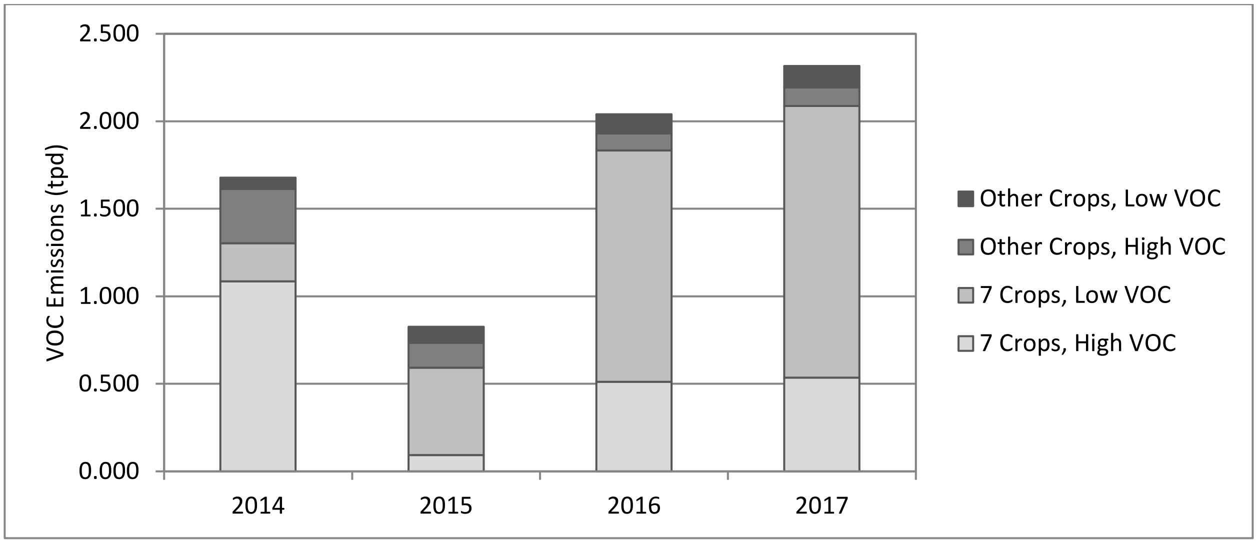

Figure 5. Combined emissions, **2014** through **2017**, from applications of high- and low-VOC products for abamectin, chlorpyrifos, gibberellins and oxyfluorfen on seven crops (alfalfa, almonds, citrus, cotton, grapes, pistachios, and walnuts) and remaining other crops in the San Joaquin Valley **NAA (2)**.

Table 10. Pounds of product and active ingredient (lbs x 10^3) and ratio of the pounds of VOC emissions per pound of product used in the San Joaquin Valley **NAA (2)** from **2016** to **2017**.

Primary AI		2016	2017	Change
ABAMECTIN	Products (lbs x 10^3)	1,027	1,335	309
	Active Ingredient (lbs x 10^3)	25	33	8
	VOC/product (lbs/lb)	0.270	0.272	0.002 (0.6%)
CHLORPYRIFOS	Products (lbs x 10^3)	1,305	1,437	132
	Active Ingredient (lbs x 10^3)	516	574	57
	VOC/product (lbs/lb)	0.212	0.217	0.005 (2.5%)
GIBBERELLINS	Products (lbs x 10^3)	154	155	1
	Active Ingredient (lbs x 10^3)	14	13	-1
	VOC/product (lbs/lb)	0.250	0.158	-0.092 (-36.7%)
OXYFLUORFEN	Products (lbs x 10^3)	418	387	-31
	Active Ingredient (lbs x 10^3)	124	115	-9
	VOC/product (lbs/lb)	0.370	0.385	0.015 (4.1%)
COMBINED	**Products (lbs x 10^3)**	**2,903**	**3,314**	**410**
	Active Ingredient (lbs x 10^3)	**679**	**735**	**56**
	VOC/product applied (lbs/lb)	**0.257**	**0.256**	**-0.001 (-0.5%)**

Table 11. Calculation of hypothetical emissions as described in section 6884(c). (D) = ((A) x (B))/(C).

Active Ingredient	Crop	2014 Emissions (tpd)	2017 Pounds AI (lbs)	2014 Pounds AI (lbs)	2017 Hypothetical Emissions (tpd)	2017 Actual Emissions (tpd)	Difference between Hypothetical and Actual (tpd)
		(A)	(B)	(C)	(D)		
ABAMECTIN	ALFALFA	<0.001	98	69	**<0.001**	<0.001	<0.001
	ALMOND	0.687	15,517	10,282	**1.037**	0.423	0.613
	CITRUS	0.074	2,496	1,151	**0.159**	0.079	0.080
	COTTON	0.107	4,182	1,487	**0.301**	0.142	0.159
	GRAPES	0.325	4,498	4,742	**0.308**	0.133	0.175
	PISTACHIO	0.002	274	25	**0.019**	0.004	0.015
	WALNUT	0.107	2,133	1,703	**0.133**	0.048	0.086
CHLORPYRIFOS	ALFALFA	0.138	32,947	58,994	**0.077**	0.067	0.010
	ALMOND	0.403	117,528	181,926	**0.260**	0.166	0.094
	CITRUS	0.408	178,552	172,834	**0.421**	0.255	0.166
	COTTON	0.255	149,656	95,045	**0.401**	0.240	0.161
	GRAPES	0.025	42,596	20,173	**0.054**	0.054	0
	WALNUT	0.113	35,902	65,398	**0.062**	0.049	0.013
GIBBERELLINS	CITRUS	0.255	5,627	6,287	**0.228**	0.039	0.189
	GRAPES	0.246	6,623	8,702	**0.190**	0.025	0.165
OXYFLUORFEN	ALFALFA	<0.001	10	10	**<0.001**	<0.001	0
	ALMOND	0.469	65,846	80,133	**0.385**	0.268	0.117
	CITRUS	0.002	335	224	**0.002**	0.001	0.001
	COTTON	0.014	1,639	4,752	**0.005**	0.003	0.002
	GRAPES	0.071	12,630	10,302	**0.088**	0.018	0.069
	PISTACHIO	0.063	11,440	17,802	**0.041**	0.032	0.008
	WALNUT	0.065	11,207	11,268	**0.064**	0.041	0.024
TOTAL		**3.827**	**701,737**	**753,484**	**4.237**	**2.087**	**2.150**

Table 12. Highest use of **High**-VOC abamectin, chlorpyrifos, gibberellins and oxyfluorfen products on alfalfa, almonds, citrus, cotton, grapes, pistachios, and walnuts in the San Joaquin Valley **NAA (2)** during **2016** and **2017** (May-October).

Product	Internal product number	Registration number	EP	method	Product inactivity date	Pounds used 2016	Pounds used 2017	Change (%)
ABAMECTIN								
ABBA ULTRA MITICIDE/INSECTICIDE	61871	66222-226-AA	34.18	TGA	NA	7,915	12,258	55%
REAPER CLEARFORM	65921	34704-1078-ZA	31.08	bridged	NA	5,272	6,865	30%
AGRI-MEK SC MITICIDE/INSECTICIDE	62903	100-1351-ZA	5.63	bridged	NA	3,581	5,124	43%
TIMECTIN 0.15 EC AG INSECTICIDE/MITICIDE	58571	84229-2-AA	29.75	TGA	NA	1,401	3,254	132%
ABACUS V	65503	83100-32-AA-83979	27.26	TGA	NA	3,126	1,765	-44%
AGRI-MEK SC MITICIDE/INSECTICIDE	60883	100-1351-AA	5.63	TGA	12/31/2013	1,759	1,566	-11%
ABACUS AGRICULTURAL MITICIDE/INSECTICIDE	56076	83100-4-AA-83979	60.54	TGA	NA	483	726	50%
ABAMEX MITICIDE/INSECTICIDE	68295	228-734-AA	21.4	TGA	NA	0	720	NA
EPI-MEK 0.15 EC MITICIDE/INSECTICIDE	52213	100-1154-AA	55.1	bridged	12/31/2014	468	357	-24%
REAPER 0.15 EC	54067	34704-923-AA	73.33	TGA	NA	127	263	108%
CHLORPYRIFOS								
LORSBAN ADVANCED	58202	62719-591-AA	18.45	TGA	NA	193,016	202,026	5%
WARHAWK CLEARFORM	65612	34704-1077-AA	17.89	TGA	NA	116,850	145,291	24%
VULCAN	63154	66222-233-AA	24.24	TGA	NA	163,737	133,470	-18%
DREXEL CHLORPYRIFOS 4E-AG	56791	19713-520-AA	18.2	TGA	NA	1,252	24,298	1,841%
GOVERN 4E INSECTICIDE	51349	62719-220-AA-55467	50	derived	NA	1,640	17,027	938%
LOCK-ON INSECTICIDE	38835	62719-79-ZA	20.9	derived	NA	12,750	14,029	10%
WHIRLWIND	51491	62719-220-AA-5905	50	derived	NA	10,159	11,819	16%
WARHAWK	52062	34704-857-AA	54.41	TGA	NA	2,248	7,807	247%
LOCK-ON INSECTICIDE	25121	62719-79-AA	20.9	TGA	12/31/2005	4,287	6,131	43%
DREXEL CHLORPYRIFOS 15G	68613	19713-505-AA	3.7	default_median	NA	608	4,207	592%
LORSBAN 4E-HF	29120	62719-220-AA	48.68	TGA	12/31/2005	1,559	2,843	82%

Table 12 (continued). Highest use of **High**-VOC abamectin, chlorpyrifos, gibberellins and oxyfluorfen products on alfalfa, almonds, citrus, cotton, grapes, pistachios, and walnuts in the San Joaquin Valley **NAA (2)** during **2016** and **2017** (May-October).

Product	Internal product number	Registration number	EP	method	Product inactivity date	Pounds used		
						2016	2017	Change (%)
CHLORPYRIFOS (continued)								
CHLORPYRIFOS 4E AG	44024	66222-19-AA-51036	52.9	TGA/derived	12/31/2006	1,625	2,004	23%
LORSBAN-4E	29367	62719-220-ZA	51.32	TGA	NA	160	1,576	885%
LORSBAN 15G GRANULAR INSECTICIDE	38837	62719-34-ZA	5.33	derived	NA	2,654	395	-85%
LORSBAN 75WG	51010	62719-301-AA	3.7	default_median	NA	0	203	NA
LORSBAN 50-W	33688	62719-221-AA-10163	3.03	derived	12/31/2011	0	199	NA
WARHAWK	51399	62719-220-AA-34704	50	derived	12/31/2012	0	183	NA
GIBBERELLINS								
PROGIBB LV PLUS PLANT GROWTH REGULATOR SOLUTION	66308	73049-498-AA	11.54	TGA	NA	4,333	5,629	30%
PROGIBB 40% PLANT GROWTH REGULATOR WATER SOLUBLE G	61609	73049-1-ZA	3.7	default_median	NA	3,481	3,212	-8%
FALGRO 2X LV	66024	62097-32-AA-82917	22.95	TGA	NA	2,561	2,444	-5%
PROGIBB 40% WATER SOLUBLE GRANULES	44822	73049-1-AA	3.7	default_median	12/31/2011	2,132	1,529	-28%
PRO-GIBB 4% PLANT GROWTH REGULATOR SOLUTION	45678	73049-15-AA	94.13	TGA/derived	NA	812	118	-85%
OXYLFUORFEN								
GOALTENDER	51277	62719-447-ZA	8.28	TGA	NA	63,817	54,706	-14%
GOAL 2XL	48484	62719-424-AA	62.3	TGA/derived	NA	46,475	42,931	-8%
PINDAR GT	60833	62719-611-AA	10.6	TGA	NA	5,069	6,177	22%
WILLOWOOD OXYFLO 4 SC	61301	87290-10-AA	6.76	TGA	NA	3,862	4,287	11%
WILLOWOOD OXYFLO 2 EC	61287	87290-8-AA	60	TGA	NA	468	2,445	423%
GOAL 4F	51278	62719-447-AA	8.28	derived	9/15/2006	1,846	1,540	-17%
OXYSTAR 2E	56469	42750-136-AA	73.09	TGA	NA	419	1,210	189%

Table 12 (continued). Highest use of **High**-VOC abamectin, chlorpyrifos, gibberellins and oxyfluorfen products on alfalfa, almonds, citrus, cotton, grapes, pistachios, and walnuts in the San Joaquin Valley **NAA (2)** during **2016** and **2017** (May-October).

Product	Internal product number	Registration number	EP	method	Product inactivity date	Pounds used 2016	Pounds used 2017	Change (%)
OXYLFUORFEN (continued)								
GALIGAN 2E OXYFLUORFEN HERBICIDE	44923	66222-28-AA	66.15	TGA/derived	12/31/2014	774	491	-37%
GOAL 2XL HERBICIDE	32909	707-243-AA	39.15	default_median	12/31/2004	390	331	-15%
OXYSTAR 4L	59632	42750-199-AA	10.63	TGA	NA	167	329	97%
GALIGAN 2E HERBICIDE	65078	66222-28-ZA	66.15	TGA/derived	NA	728	321	-56%
CLEANTRAXX	68955	62719-702-AA	10.6	TGA	NA	0	182	NA
GOAL 1.6E HERBICIDE	4145	707-174-AA	65.5	TGA	12/31/2004	3	161	4915%
PROGROW ORNAMENTAL HERBICIDE 2	3441	538-172-AA	9.17	TGA	12/31/2014	263	146	-44%