Estimated Cost of the Withdrawal of the Insecticide Chlorpyrifos for Six Major California Crops

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In May 2019, the CA Department of Pesticide Regulation (DPR) initiated the cancellation of the pesticide chlorpyrifos. This article estimates the economic effects of cancellation on six major California crops. Statewide annual revenue losses are estimated at $11.5 million, averaged across acreage and pesticide use for three base years (2015–2017): $1.6 million for alfalfa, $0.6 million for almonds, $1 million for citrus, $7.1 million for cotton, $4.3 million for grapes, and $3.2 million for walnuts. In addition, gross revenue losses due to reduced cotton yields are estimated to be $6.3 million. Importantly, estimated losses are for only six crops. The total cost to California agriculture will be greater.

Chlorpyrifos is an organophosphate insecticide that is effective against a broad range of pests. Growers often choose it over other insecticides because it has a broad spectrum of control, and a single chlorpyrifos treatment controls multiple pests. In alfalfa, chlorpyrifos is crucial for aphid control and the management of several other pests such as weevils. Chlorpyrifos is mostly used for leaffooted bugs and stink bugs in almonds. In citrus, the control of liquid sugar-feeding ants, bud mites, and scale insects relies on chlorpyrifos. The management of two pests in cotton, cotton aphid and sweet potato whitefly, are considered critical uses with no or few alternatives besides chlorpyrifos. Essentially all chlorpyrifos use in grapes is directly or indirectly for vine mealybug. In walnut production, chlorpyrifos is often used to control multiple pests, including codling moth and walnut husk fly.

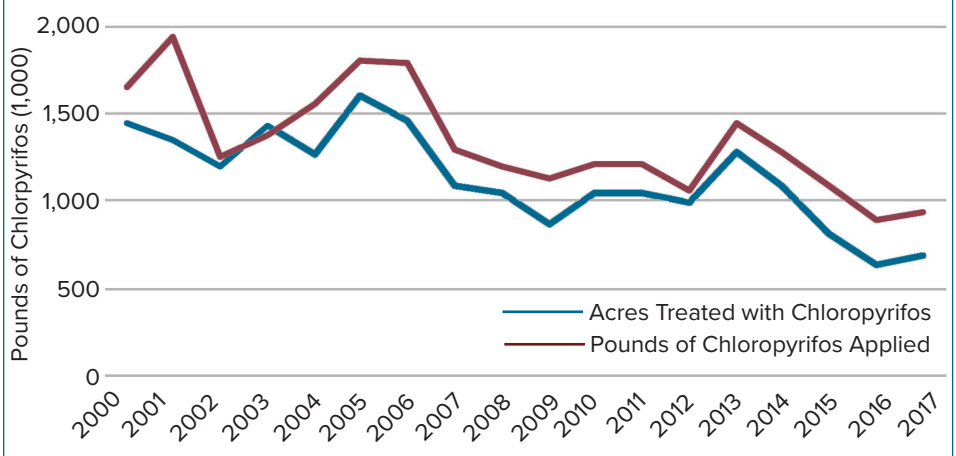
While chlorpyrifos has benefits for managing pests, it also has hazards to human health. Exposure is associated with inhibition of acetylcholine hydrolyzing activity in human plasma, which causes developmental neurotoxicity. Workers chronically exposed to chlorpyrifos reported impaired memory, disorientation, speech difficulties, nausea, and weakness. There were 246 cases of pesticide exposure involving chlorpyrifos documented in the Pesticide Illness Surveillance Program from 2004 to 2014. The majority of illnesses were due to pesticide drift.

Due to evidence identified in its risk assessment, in April 2019, the DPR listed chlorpyrifos as a toxic air contaminant. The listing requires DPR to develop control measures to protect the health of farm workers and others living and working near where the pesticide is applied. As a result, DPR announced that virtually all use of chlorpyrifos products would end by December 31, 2020, following an agreement with Dow AgroSciences and several other registrants. (Only granular chlorpyrifos products are not canceled, which represent less than 2% of the pounds of chlorpyrifos used in California from 2015–2017.)

As shown in Figure 1, chlorpyrifos use statewide has generally decreased since 2005. In 2015, DPR designated chlorpyrifos a restricted material. The purchase and use of chlorpyrifos products are restricted to certified commercial and private applicators, with a permit issued by the County Agricultural Commissioner. In 2018 and 2019, DPR further restricted the use of chlorpyrifos.

We estimate the economic impacts of the withdrawal of chlorpyrifos for six crops: alfalfa, almonds, citrus, cotton, grapes, and walnuts. Crops were chosen based on their use of chlorpyrifos relative to their harvested acreage, their chlorpyrifos use relative to other crops, and their economic importance to California agriculture. These six crops accounted for 86% of chlorpyrifos use and 48% of the value of California's field, fruit, nut, vegetable, and melon production in 2017. Table 1

Figure 1. Statewide Chlorpyrifos Use: 2000–2017



Source: Pesticide Use Reporting Data, CA Dept. of Pesticide Regulation (authors' calculations).

Table 1. Chlorpyrifos Use by Pounds Applied and Acres Treated: 2015–2017

	Pounds Chlorpyrifos Applied			Acres Treated		
	2015	2016	2017	2015	2016	2017
Alfalfa	123,748	67,413	75,642	223,051	137,455	153,607
Almond	308,957	142,621	186,885	167,805	79,245	103,447
Citrus	228,524	259,321	225,835	69,867	70,759	67,280
Cotton	85,773	95,958	152,079	90,743	100,210	153,881
Grape						
Raisin and Table	71,466	65,842	59,824	39,505	37,084	35,424
Wine	46,811	47,545	49,416	25,767	26,032	26,340
Walnut	133,270	125,761	103,278	73,234	67,444	55,266
Total	**998,549**	**804,461**	**852,959**	**689,972**	**518,229**	**595,245**

Source: Pesticide Use Reporting Data, CA Dept. of Pesticide Regulation (authors' calculations).

provides details on annual chlorpyrifos use for the six crops for three base years, 2015–2017.

We consider two economic impacts: changes in pest management costs due to replacing chlorpyrifos with alternative pesticides and reductions in gross revenue due to yield losses. No changes in yields are anticipated for five of the six crops considered here given the availability of alternative active ingredients (AI). Cotton is the exception; there is the possibility that marketable yield for cotton could decline.

Increases in Pest Management Costs

We determined the expected change in pest management costs for each crop based on the acres treated with chlorpyrifos, available alternatives, and the cost per acre of the representative products. For each focal crop, alternative AI to replace chlorpyrifos are determined based on resistance management, secondary pest outbreaks, and regional differences. To estimate the cost of the withdrawal of chlorpyrifos, we identified a representative product for each AI and determined its price. We assigned all the acres that had been treated with chlorpyrifos to the alternative AI in proportion to their historical usage. Based on the results, we compared net annual revenues under the status quo to net revenues if chlorpyrifos were withdrawn.

Table 2 reports the annual increase in pest management costs for each crop using alternative AI. Total pest management costs for the six crops are estimated to increase by $10.9 million to $12.5 million, depending on the base year used for acreage.

For alfalfa, the pest management costs increase by $10 per treated acre due to replacing chlorpyrifos with alternatives. This was 0.9% of $1,175 gross revenues per acre. The associated total annual cost increase is $1.5 million to $2.1 million.

A relatively small increase in cost, $5 per treated acre, is expected for almonds because relatively few almond acres are treated with chlorpyrifos. This increase represented 0.1% of the $5,786 gross revenue per acre for almonds. The total pest management costs increase ranges from $0.4 million to $0.9 million annually.

For citrus, the cost increase per treated acre for using alternatives is $14.09. This is a small share of gross revenues per acre, which ranged from $5,790 for navel oranges to $15,269 for lemons in 2016–17. Annual pest management costs in citrus were expected to increase by around $1 million, if all chlorpyrifos uses were banned.

Pest management costs increase $0.6 million to $1.1 million for cotton when growers used alternatives instead of chlorpyrifos. The cost increase per treated acre is $7 and the gross revenue per acre is $1,563 for cotton. In addition to pest management costs, gross revenues may change because of yield loss. Cotton aphid and sweet potato whitefly are particularly difficult to control without chlorpyrifos because even small populations can be very damaging in the late season, resulting in sticky cotton. Sticky cotton is not marketable and if a region consistently produces sticky cotton, growers may receive lower prices or be barred from selling to specific processors.

In grapes, chlorpyrifos is used as a delayed dormant spray (when the vines have no leaves) to control vine mealybug populations. There is no drop-in replacement for that purpose. Without access to chlorpyrifos, growers would likely apply an extra application of both imidacloprid and spirotetramat during the growing season and maintain the rest of practices on their current vine mealybug treatment program, including mating disruption using pheromones. Withdrawal of chlorpyrifos in table, raisin, and wine grapes would result in a combined $4.2 million to $4.3 million annual cost increase. The cost increase per treated acre is $54 for table and raisin grapes and $63 for wine grapes. The gross revenue per acre for table, raisin, and wine grapes are $14,555, $3,104, and $6,109 respectively.

For walnuts, treatment costs would increase by $48.89 per acre, representing 1% of $4,758 gross revenues per acre. Withdrawal of chlorpyrifos in walnuts would result in a $2.7 million to $3.6 million annual increase in insecticide costs, based on 2015–2017 use. Only 0.1% of walnut acres were treated with granular chlorpyrifos products. The estimated costs from this analysis might be a slight overestimate as that small percentage of use will continue to be allowed.

Gross Revenue Losses: Cotton

We evaluated estimated yield losses of 25% for Pima cotton and 15% for Upland cotton. We assumed that all acreage that was treated with chlorpyrifos sustains these yield losses, and used 2018 average prices. We assume that demand for California cotton is perfectly elastic, so that price is unchanged when the quantity of California cotton decreases. This case would apply if California was a relatively small supplier of cotton, for example, or if there were many good substitutes for California cotton. Averaged across years, annual gross revenue losses would be $6.3 million. While this number seems relatively small compared to the value of the 2017 California cotton crop, acreage treated with chlorpyrifos was lower than planted acreage in all three years, and 2015 cotton acreage was only slightly more than half 2017 acreage.

Table 2. Estimated Increase in Pest Management Costs by Crop and Year ($1,000)

Crop	2015	2016	2017
Alfalfa	2,116.80	1,304.50	1,457.70
Almond	892.2	421.3	550
Citrus	900.2	1,006.00	952.3
Cotton			
Pima	458.6	504.2	773.1
Upland	181.8	203	312.9
Grape			
Raisin and Table	2,509.60	2,355.80	2,250.30
Wine	1,873.50	1,892.70	1,915.20
Walnut	3,580.60	3,297.50	2,702.10
Total	**12,513.30**	**10,985.00**	**10,913.60**

Source: Authors' calculations.

Caveats

There are a number of important caveats for this analysis. First, the study time period, 2015 to 2017, is based on the three most recent years of pesticide use data released by DPR. These years may not represent production conditions in current and future years owing to differences in weather, invasive species that became pests after 2017, and other factors that vary over time. Second, additional use restrictions for chlorpyrifos were implemented in 2018 and 2019, which likely reduced its use and affected acres. Third, the objective of this study was to estimate the costs for six major California crops. We did not consider the costs to other crops, nor did we consider the value of potential benefits to the chlorpyrifos ban. We did not consider the possibility that growers may adjust their crop choices in response to the ban. Finally, the analysis assumed that alternative AI would remain available under their current use regulations and current efficacy. Currently, CDPR is reviewing four nitroguanidine-substituted neonicotinoid insecticides that in some cases are alternatives to chlorpyrifos. In addition, reduced ability to rotate AI could lead to higher likelihood of insecticide resistance and loss of formerly effective AI. If those AI were not available as effective alternatives, the cost of the withdrawal of chlorpyrifos would likely be higher.

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For additional information, the authors recommend:

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