North State Agriculture Bulletin

CSU, Chico College of Agriculture
Agribusiness Institute

Fall 2026

Fumigant Alternatives Research: Impact on Almonds and Walnuts in Butte County and the North State

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Background

The California Department of Pesticide Regulation (DPR) is charged with managing pests "to support the health and resiliency of our food supply and agricultural sector and to protect public health, the environment and our infrastructure" (DPR Website, 2026a). Following the release of the Sustainable Pest Management (SPM) Roadmap, DPR commissioned an independent, peer-reviewed study from the California Council on Science and Technology (CCST) to evaluate fumigant use and available alternatives. The primary agricultural fumigants studied include 1,3-dichloropropene (1,3-D), chloropicrin, methyl bromide, and MITC generators (dazomet, metam-sodium, and metam-potassium).

Use of these fumigants varies based on regulatory status, crop prices, and other economic and agronomic conditions. Several important North State crops, including almonds and walnuts, are among the top ten crops across California which rely on these fumigants. In 2022, almonds were second (after strawberries) and walnuts were ninth, using 10.3% and 2.1%, respectively, of the total pounds of 1,3-D and chloropicrin (CCST, 2025).

The purpose of this paper is to consider the effects of pre-plant fumigants and their alternatives on almonds and walnuts. Pre-plant fumigants are most needed when expanding acreage. There are no "one-size-fits-all" alternatives, which could complicate the recovery of almonds and walnuts as prices and trade restrictions improve.

Production of Almonds and Walnuts in Butte County

According to the Butte County 2024 Crop and Livestock Report, walnuts and almonds were the top two Butte County commodities, with production values of $150,264,360 and $122,569,200, respectively (Quist, 2025). Nursery stock (one of the few ongoing allowable uses for methyl bromide) also generated $18,220,106 in value. Almonds were grown on 38,314 acres in 2024 (34,920 bearing acres; 3,394 non-bearing acres). Walnuts similarly covered 55,631 acres (51,390 bearing acres; 4,241 non-bearing acres).

More broadly, "California produces 100% of the United States' commercial supply of almonds and 80% of the world's supply" (CCST, 2025). California is the second largest producer of walnuts, after China, with approximately one quarter of the world supply (Foreign Agricultural Service, 2026). A large portion of each crop is typically exported.

Table 1: Top Value Commodities in Butte County by Year

	Rank				
	1	2	3	4	5
2024	Walnuts $150,264,360	Almonds $122,569,200	Rice $118,218,390	Prunes $35,987,600	Nursery stock $18,220,106
2023	Rice $163,411,650	Almonds $90,768,000	Walnuts $85,451,960	Prunes $39,720,000	Rice seed $29,662,618
2022	Rice $324,003,490	Almonds $97,035,000	Walnuts $64,420,800	Prunes $34,770,000	Rice seed $21,839,836
2021	Rice $155,067,850	Walnuts $139,983,000	Almonds $115,754,400	Prunes $23,773,200	Timber $23,760,571
2020	Rice $179,098,920	Almonds $147,413,000	Walnuts $128,028,000	Prunes $28,789,500	Nursery stock $16,817,934

Source: 2020-2024 Butte County Crop and Livestock Reports. (https://www.buttecounty.net/Archive.aspx?AMID=47)

Table 2: Almond and Walnut Acreage in Butte County

	Almonds		Walnuts	
	Bearing	Non-bearing	Bearing	Non-bearing
2024	34,920	3,394	51,390	4,241
2023	36,600	3,356	54,428	5,021
2022	35,939	2,483	53,684	3,664
2021	37,247	2,022	53,327	3,541
2020	37,605	2,910	53,345	4,135

Source: 2020-2024 Butte County Crop and Livestock Reports. (https://www.buttecounty.net/Archive.aspx?AMID=47)

Fumigation of Almonds and Walnuts

Fumigation, as well as the use of other pesticides, has greatly increased the possible yields per acre and overall production of many crops, including almonds and walnuts. According to DPR, walnuts rank second and almonds third (after rice) for total pounds of pesticide applied in 2023 in Butte County. For walnuts, 1,3-D is the fourth largest application, with 53,813 pounds applied on 163 acres. For almonds, 1,3-D is the largest pesticide use by pounds, with 46,007 pounds applied on 141 acres, and chloropicrin is the fifth largest use by pounds, with 13,662 pounds applied on 69 acres. (For both walnuts and almonds, because 1,3-D and chloropicrin are primarily pre-plant fumigants, this is a very small portion of the total acres, but a much larger portion of the non-bearing acres, and would only apply to those planted in this year.) In addition, the fourth largest user of pesticides by pounds in Butte County is "uncultivated ag," which could refer to pre-plant use for walnuts or almonds, among other crops, where 1,3-D and chloropicrin are the top two pesticides in terms of pounds applied (DPR Website, 2026b).

Availability and Feasibility of Alternatives

Growers across the state are responding to restrictions (such as the near elimination of methyl bromide) and directives: from 2014 to 2023, the use of biopesticides increased by 46% in pounds (38% in acreage), and the use of fumigants decreased by 22% in pounds (43% in acreage), among other changes that indicate a switch toward "safer, more sustainable lower-toxicity pesticides" (DPR Website 2026b).

In several CCST reports covering a dozen fumigant alternatives, research "did not identify a single fumigant alternative that could serve as a drop-in replacement for methyl bromide or MITC generators across California's major fumigant-reliant systems" (CCST, 2026). Rather, multiple alternatives and tactics will be needed, tailored to individual crops. Many of the available alternatives provide only partial control, so "combining multiple tactics either simultaneously or in sequence is likely to offer the greatest effectiveness, versatility, and duration of soil pest control" (CCST, 2026).

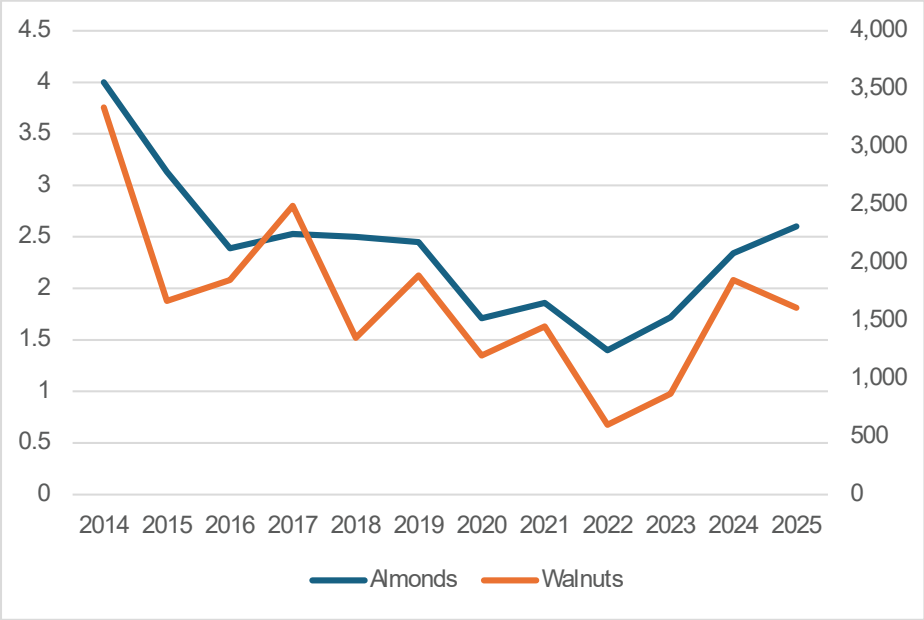
Economic Impact

Almond and walnut producers faced several years of low prices, as well as challenges related to trade and tariffs. Prices for both reached lows in 2022 before beginning to recover in the last few years (Figure 1). Market stabilization, both in terms of domestic prices and international trade, could help growers in upcoming years. However, any recovery could be complicated by further regulation or restrictions on pre-plant fumigants. Non-bearing acres have been increasing after hitting lows in 2021 (Table 2). These are precisely the acres that benefit from pre-plant fumigation.

Although the number of acres using fumigants may appear small, this initial pre-plant fumigation is highly important for controlling a number of pests and diseases: "up to one-third of California's almond and stone fruit acreage is infested with potentially debilitating plant parasitic nematodes, and an even larger portion is affected by Prunus replant disease (PRD)" (CCST, 2025). Almonds are also fumigated to reduce root-knot, root lesion, dagger nematodes, and ring nematodes.

Fumigant use is closely tied to broader economic and regulatory conditions. "Total use of 1,3-D and chloropicrin in almond orchards increased significantly (133%) between 2014 and 2015, likely due to the shift from methyl bromide to 1,3-D. However, this increase can also be explained, in part, by an increase in almond plantings (and hence non-bearing acres), which grew from 170,000 to 240,000 acres over the same time period" (CCST, 2025). However, in 2021 and 2022, non-bearing acres experienced a 15% decline statewide (CCST,

Figure 1: Price Received for Almonds (lbs) and Walnuts (tons)



Source: National Agricultural Statistics Service (NASS). (https://www.nass.usda.gov/Quick_Stats/Lite/index.php)

2025) paralleling the drops in Butte County (see Figure 1), likely related to drought and low prices as well as the availability of 1,3-D.

Protecting human health and the environment while maintaining a robust agricultural industry is very important. Unfortunately, the challenge of reducing reliance on pre-plant fumigants hits producers just as they begin to recover and want to expand their acreage of almonds and walnuts. These major Butte County crops have faced a variety of difficulties in recent years.

Further Information and Acknowledgments

This report is based upon the author's work with the California Council on Science and Technology's (CCST) commission by the California Department of Pesticide Regulation (DPR) to review current fumigant use in California and make an assessment of the available alternatives. This resulted in the peer-reviewed publication of a Phase I Report on 1,3-D and chloropicrin as pre-plant agricultural fumigants, two volumes of a Phase II Report (the first covering sulfuryl fluoride as a structural fumigant and the second covering methyl bromide and MITC generators as pre-plant agricultural fumigants), and a proceedings report on post-harvest commodity fumigation. All reports are available on the CCST website (https://ccst.us/reports/fumigant-use-in-california/).

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