Chlorpyrifos Alternatives in California

Chlorpyrifos is a neurotoxic organophosphate (OP) insecticide used in the production of fruits and vegetables throughout the U.S.

Because of research showing direct impacts on children's health, chlorpyrifos was banned for indoor home use in 2001. However, the U.S. Environmental Protection Agency (EPA) has continued to allow its use in agricultural fields, with an estimated 8 million pounds applied annually.

Undermining children's health

Many studies have linked chlorpyrifos exposure to health harms, particularly for children. Prenatal exposure can also have negative, long-lasting impacts on children's brain development,[1] including impaired perceptual reasoning[2] and working memory[3] — and undermined intellectual development by age seven.[4]

Chlorpyrifos exposure from pesticide drift and through food residues affects children across California, with Latino communities disproportionately impacted. A 2014 study found that Latino children in California were 91% more likely than white children to attend schools near the highest use of the most hazardous pesticides, including chlorpyrifos.[5]

California field use

California accounts for over 14% of chlorpyrifos use nationwide. In 2015, growers in the state used more than 1.1 million pounds of the insecticide on 56 different crops,[6] with the top crops listed (thousands of pounds of active ingredients) as almonds (311), oranges (145), walnuts (133), alfalfa (123), cotton (85) and table grapes (71). See Table 1.

TABLE 1 Chlorpyrifos Use on Crops in California

Crops	Amount used*	Target pests
Almond[7]	311,028	Ants, European fruit lecanium, fuller rose beetle, Leaf rollers, leaffooted bug, navel orangeworm, oriental fruit moth, peach twig borer, San Jose scale, stink bugs, ten-lined beetle, tree borers.
Orange[8]	145,395	Sugar-feeding and protein-feeding ants, Asian citrus psyllid, black scale, broad mite, California red scale, citricola scale, citrus bud mite, citrus leafminer, citrus rust mite, earwigs, false chinch bug, fuller rose beetle, katydids, mealybugs.
Walnuts[9]	133,194	Walnut aphid, Ducky-veined aphid, Codling moth, frosted scale, European Fruit Lecanium, San Jose Scale, Walnut husk fly, walnut scale.
Alfalfa[10]	123,455	Alfalfa caterpillar, alfalfa weevil, beet armyworm, blue alfalfa aphid, cowpea aphid, cutworm, leafhoppers, pea aphid, spotted alfalfa aphid, webworm, yellow-striped armyworm.
Cotton[11]	85,867	Beet armyworm, brown stink bug, cotton aphid, cutworm, lygus, pink bollworm, seedcorn maggot, sweet potato whitefly, wireworm.
Grapes[12]	71,278	Ants (six species), vine mealybug.

** pounds of active ingredients applied in 2015*

Alternatives to chlorpyrifos

Farmers can eliminate their use of chlorpyrifos and reduce reliance on other harmful pesticides by adopting integrated or ecological pest management practices. These practices are currently in use throughout California.

Integrated Pest Management (IPM)

IPM is an ecosystem-based strategy for managing the crop and its pests that focuses on the long-term prevention of economically significant pest damage. Growers employ a combination of techniques to keep pest populations down such as biological control, habitat manipulation, cultural practices, planting resistant varieties and mechanical or physical control. Pesticides are used only as a last resort, and applied only in ways that minimize risks to human health, non-target organisms and the environment. Least-toxic products such as those approved for organic production[13] are preferred over more toxic synthetic chemical pesticides that may interfere with other IPM measures and generate other costs to human health and the environment. Highly toxic insecticides (such as chlorpyrifos) are avoided wherever possible; products likely to harm natural enemies are considered incompatible with an IPM approach.

The best management practices within IPM are often referred to as Ecological Pest Management (EPM). EPM takes a holistic, whole-farm or even landscape approach to growing healthy crops and emphasizes least possible disruption of the agro-ecosystem. EPM begins with building and maintaining healthy soil to support vigorous plant growth with the greatest resistance to pests and disease. Best management practices include crop rotation, legume and non-legume cover crops, intercropping, application of compost or other organic soil amendments, zero-tillage or conservation tillage, and establishment of habitat for natural enemies and pollinators. EPM is place-based and knowledge-intensive. As such, EPM fits within the broad discipline of agroecology — a systems-based ecological approach to ensuring sustainable agricultural production within the environmental, social and political context in which it takes place.

Ecological alternatives in key crops

Every crop in which chlorpyrifos is currently used is grown organically in the state of California. Thus, farmers have been able to employ IPM or EPM practices successfully, without relying on chlorpyrifos.

Some EPM practices for pests that are conventionally controlled with chlorpyrifos are described in more detail in Box 1.

Box 1 Common elements of ecological pest management

Monitoring

- ✓ Systematic scouting of crops for pests and natural enemies, either regularly or at susceptible times, sometimes involving the use of sweep nets, sticky traps and pheromone traps.
- ✓ Accurate identification of both pests and beneficial insects and knowledge of their life cycles, habitats and periods of population expansion and vulnerability.
- ✓ Determination of pest level from population numbers collected in scouting and comparison to economic thresholds, *if* such thresholds have already been determined.

Habitat management

- ✓ Diversifying the agroecosystem to provide food and habitat, including overwintering and reproductive sites, for beneficial insects.
- ✓ Minimizing dust that inhibits parasitism.

Mechanical or physical control methods

- ✓ Use of light traps, water traps, fruit fly traps, sweepnets, bird perches, sticky board traps, soil baits, soil traps, bagging of fruit and hand-removal.
- ✓ Use of pheromone traps to trap insects and pheromone dispensers to disrupt mating.
- ✓ Post harvest high pressure washing e.g. of citrus to remove scale.
- ✓ Steam sanitize equipment contaminated with pests such as vine mealybug.

Cultural controls

- ✓ Cultural practices that encourage healthy soils and hence healthy plants. These include fallowing, conservation tillage, mulching, and use of animal manures, green manures, vermicasts, composts, liquid bio-fertilizers and enhanced beneficial micro-organisms.
- ✓ Crop rotation to disrupt pest life cycles and overwintering.
- ✓ Intercropping to disrupt pests' ability to find host plants; cover cropping to prevent ant infestations; companion planting to deter pests; border or trap cropping to attract pests away from a crop into other plants that can then be harvested or removed.
- ✓ Intercropping or crop rotations to favor a diversity of beneficial soil organisms.
- ✓ Varying times of sowing, planting and harvesting, adjusting row width and appropriate pruning, removal of alternate plant hosts to create unfavorable conditions for pest survival and reproduction.
- ✓ Use of resistant, including heirloom or indigenous, crop varieties.
- ✓ Field sanitation, removing infested plant material including crop residues to reduce carryover of pests from one planting to the next, skirt pruning to prevent ground-dwelling pests from climbing fruit trees.

Organic insecticides (examples)

- ✓ Azadirachtin (Neemix), neem oil (Trilogy), and pyrethrin (PyGanic).
- ✓ Entrust formulation of spinosad.

Biological control

- ✓ Enhancing habitats for, and populations of, natural enemies such as predators (insects, spiders, birds), parasitoids (insects that parasitize insect pests) and fungal pathogens (of the pests).
- ✓ Predators of many pests for which chlorpyrifos is used include aphid midges, big-eyed bugs, carabid beetles, damselflies, ground beetles, lacewings, ladybird beetles, minute pirate bugs, praying mantis, predatory mites, rove beetles, syrphid flies and spiders.

Economic benefits of ecological pest management

The economic benefits of shifting to ecological pest management practices may be significant. Where organic certification is achieved, for example, high market premiums, commonly around 30%, may provide substantial benefits.[14] California organic farmers produce 43% of the organic commodities sold in the U.S. From 2013 to 2014 California Certified Organic Farmers (CCOF) added 139,450 acres, a 6.4% increase, with almonds among the crops with the largest increases; and citrus acreage alone increased 18%.[15]

Box 2 | California Case Studies: Successfully managing pests without chlorpyrifos

Almonds. The Burroughs Family Farm near Merced, CA includes a 950-acre almond and olive operation. From 2006 to 2015 the Burroughs transitioned their almond acreage to organic production, sections at a time. Their diversified farming systems include hedgerows of more than 80 varieties of native plants to provide habitat for pollinators and other beneficial insects. On-farm manure, with onion and garlic skins provide 50% of applied nutrients; they have diverse cover crops, including N-providing legumes, throughout the orchards. Chickens mow the grass and fertilize trees.

Walnuts. Dixon Ridge Farms located in Winters, CA is a vertically integrated farming operation that raises, hulls, dries, shells, sorts, stores, packages and sells organic walnuts. The farming system is one designed to enhance and work with and protect the many natural predators and parasites already there. They take a systems approach that looks at fertility overall, rather than just nitrogen; diverse cover crops supply fertility and suppress weeds, conserve soil moisture, attract and keep beneficial insects, cool the orchard, and supply cover crop seed for next year. Cover crops are either their “Rich Mix” where irrigation is available to 100% of the soil, or their “micro-sprinkler mix” for earlier seed and nitrogen production for use where micro-sprinklers or drip lines are used. Soil is managed as a living, dynamic supplier of micronutrients, microorganisms, carbon, nutrients, water, minerals — the basic building blocks of life. They mow the cover crop early enough to allow decomposition prior to harvest. Harvest is done in a conventional manner, requiring bare ground, thus mowing and allowing for decomposition are a matter of great importance. Throughout the farming operation, they look for ways of maximizing resources while minimizing inputs; and by doing so, maximize their net income, rather than gross income.

Oranges. HomeGrown Organic Farms represents over 60 different growers with a total of more than 3,500 acres in organic farming. For example, HGOF growers understand predator-prey relationships for pest control; minimizing dust maximizes photosynthesis and reduces tree stress and vulnerability to pests and disease.

Box 3 — **Case Studies: Chlorpyrifos-free wine grapes**

Frey Vineyards (Redwood Valley, CA) creates a bio-diverse farm landscape that encourages natural predators, thereby eliminating the need for insecticides. Cover crops include a diverse variety of grasses, legumes and mustards that protect the soil from erosion, fix nitrogen into the soils and offer a habitat for many beneficial insects. Frey traces organic grape growing in Mendocino County back to the early Italian immigrants in the late 1800s when most agriculture was essentially organic.

Tablas Creek Vineyard (Paso Robles, CA) employs a variety of production practices including cover crops, mulch, beneficial insects and composting. Their organic pest control is done primarily by encouraging a sustainable population of a diverse array of insects, including lacewings, ladybugs, predatory wasps, thrips and insectivorous mites.

Policies to support ecological pest management & protect community health

The continued, widespread use of chlorpyrifos endangers the health of California communities, particularly children living, learning and playing near farm fields. Federal policymakers are failing to take decisive action on this important issue, so it's time for California to step up.

The state Department of Pesticide Regulation (DPR) must take the following immediate actions to supporting farmers in the transition to implementing alternatives to chlorpyrifos:

- ✓ Commit to a timeline by the end of 2017 for phasing out chlorpyrifos and supporting transition to safe replacements.
- ✓ Establish an ongoing program to support growers to transition to safe replacements for chlorpyrifos, including identifying funding sources for a competitive grant program that funds research, extension and direct support for growers, as necessary.
- ✓ Fund research into those pests, such as the Asian citrus psyllid, where non-chemical or least-toxic alternatives to chlorpyrifos show promise (e.g. the use of parasitic Tamarixia wasps) but may require additional research and development as a viable pest management tool.

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For more information on chlorpyrifos, see www.panna.org/resources/chlorpyrifos-facts.

Additional details can be found at www.pesticideinfo.org and www.whatsonmyfood.org.

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