

Oxalic Acid Options for Controlling *Varroa destructor*



Overview of *Varroa*

Varroa destructor is a globally distributed ectoparasitic mite that is a leading driver of honey bee colony losses in the United States. *Varroa* was introduced into the US in the 1980s. Since then, these mites have detrimentally impacted honey bee colonies all over the country; direct and indirect effects of *Varroa* infestations are a major contributor to honey bee colony losses each year (Warner et al. 2024). There are two phases in the *Varroa* life cycle: the reproductive phase where they develop inside capped honey bee brood cells, and the dispersal phase where the adult mites are mobile. *Varroa* feed on the hemolymph and fat bodies of developing and adult honey bees (Han et al. 2024; Ramsey et al. 2019) and are vectors of various viruses, such as the deformed wing viruses, acute bee paralysis virus, sacbrood virus, and more. There are inherent challenges with successful *Varroa* management since available options vary in suitability during honey bee population phases such as little to no brood production over winter or prolific brood production in spring (Honey Bee Health Coalition 2022). Therefore, beekeepers should intensively manage their honey bee colonies with various integrated pest management (IPM) tools to keep mite populations below damaging levels (Jack and Ellis 2021). *Varroa destructor* cannot be eradicated, so control measures must be performed using a sustainable, more holistic approach, such as using IPM strategies. This publication aims to focus on one *Varroa* management option, oxalic acid. In addition to describing all currently available, commercial oxalic acid products that have been approved by the United States Environmental Protection Agency (EPA), this publication also compares their delivery methods. Beekeepers can use this publication to make informed *Varroa* mite oxalic acid management decisions.

Oxalic Acid

Oxalic acid is a widely used tool in IPM for *Varroa* control. This natural chemical has been used for several decades to manage *Varroa*, and there have been no reports of miticide resistance to date (Maggi et al. 2017). The mode of action for oxalic acid is not yet fully understood, but contact with oxalic acid kills *Varroa*, and since adult bees groom more often in presence of oxalic acid, increased grooming may aid in dislodging mites from adult honey bees (Schneider et al. 2011; Jack and Ellis 2021). Oxalic acid will not penetrate through capped brood cells and reach mites, so it is most effective during broodless periods. Several reapplications over a period of multiple weeks may be required to align with the development time of emerging bees from brood cells to expose the mites during the dispersal phase. Through commercially available products, oxalic acid can legally be applied in several ways: vaporization, a solution method also referred to as dribbling, spraying, or via fiberboard strips.

Please note that oxalic acid is only one management option and should be used in combination with additional cultural or mechanical IPM tools and rotation of other chemicals with different modes of action to reduce chances of developing resistant mite populations. For more comprehensive *Varroa* management guidance, please use the [Honey Bee Health Coalition's Tools for Varroa Management Guide](#).

Application Methods

Oxalic acid can legally be applied to honey bee colonies using products registered by the EPA in several ways: solution method, often referred to as dribbling (Figure 1A), fiberboard strips (Figure 1B), vaporization (Figure 1C), and



spraying (Figure 1D). These methods should *not* be used concurrently. Application methods for each product are described below, but adherence to the EPA-approved label is required when applying each product.

Dribbling oxalic acid (Api-Bioxal or EZ-OX) requires preparation of oxalic acid and sugar syrup, filling a syringe with the solution, and slowly squirting the solution between hive frames (Figure 1A). Oxalic acid fiberboard strips (VarroSan) are designed to drape over the top of frames (Figure 1B) and slowly release oxalic acid for periods long enough to cover several life cycles of *Varroa*. The strips should be folded in half and draped over a frame inside the brood area or the bee cluster and left inside the hive from 42 days to 56 days. Oxalic acid vaporization (Api-Bioxal or EZ-OX) requires a specialized tool, a power source, and a respirator (Figure 1C). Oxalic acid vaporization uses heat to turn oxalic acid from a solid to a gas to fumigate the entire hive space. Once vaporized, oxalic acid recrystallizes and adheres to surfaces inside the hive. Beekeepers place a vaporizer in between the bottom board and entrance, seal off any openings, and use a 12- or 110-volt power source to heat the device containing oxalic acid, according to the vaporizer manufacturer's instructions. Lastly, packages of bees (Figure 1D) can be treated with oxalic acid by first spraying them with sugar syrup, then spraying an oxalic acid and sugar syrup solution on them with a squirt bottle before installing them into hive boxes. Spraying with plain sugar syrup before coating them with the oxalic acid and sugar syrup cocktail minimizes consumption of the oxalic acid spray.

Oxalic Acid Registered Products

All oxalic acid options are most effective during times when the colony's brood rearing is decreased, such as early spring, fall, or winter. As of June 2025, there are three oxalic acid products registered by the EPA for *Varroa* control: Api-Bioxal, EZ-OX, and VarroSan (Table 1). As products and product labels are often revised and updated, it is essential that beekeepers check the current label for accurate directions for use for each product and application method, safety information, application timing, use with honey supers, required personal protective equipment (PPE), and product storage and disposal recommendations.

Api-Bioxal is 97% oxalic acid dihydrate and 3% inert ingredients. It can be used as a sugar syrup solution drip (a.k.a., dribbling, drench, or solution method), fumigation, or as a spray on bee packages. For the most recent Api-Bioxal label information, visit the [EPA's Details for API-BIOXAL site](#).

EZ-OX is 97% oxalic acid dihydrate and 3% inert ingredients. It can be used as a sugar syrup drip (a.k.a., dribbling, drench, or solution method), fumigation, or as a spray on packaged bees. This product comes in powder form or one-gram tablets. Tablets are only permitted for use with the vaporization method. For the most recent EZ-OX label information, visit the [EPA's Details for EZ-OX Tablets site](#).

VarroSan is a sustained-release or extended-release fiber strip that contains 18.42% oxalic acid dihydrate and 81.58% inert ingredients. These strips are draped over the hive frames. For the most recent VarroSan label information, visit the [EPA's Details for VARROXSAN site](#).

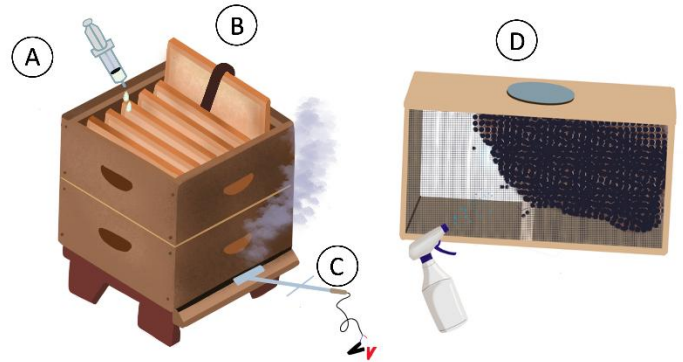


Figure 1. Oxalic acid application method options: dribbling solution on honey bee frames (A), VarroSan fiberboard strips draped over top of honey bee frames (B), vaporizing or fumigating whole honey bee hive (C), and spraying honey bee packages (D). These methods should *not* be used concurrently. Diagram illustrated by Briana Price.

Importance of an Extended-Release Oxalic Acid Option

Oxalic acid works most effectively when colonies have little to no capped brood, since reproducing mites are protected from the treatment while under the wax cappings. Thus, oxalic acid dribble or vaporization methods require repeated applications when capped brood are present, which is labor-intensive and may yield inconsistent mite control. It is possible to eliminate the capped brood by caging the queen for a period of 14 to 21 days to increase the efficacy of a single oxalic acid application (Gregorc et al. 2017). Berry et al. (2022) demonstrated that after seven repeated applications of oxalic acid vaporization at a dose of 1 g per brood chamber every five days that this frequent reapplication of oxalic acid was ineffective in controlling *Varroa* populations during brood rearing periods. Additionally, beekeepers living in warmer regions may have colonies with a longer brood rearing season and might not have periods without brood production, reducing oxalic acid effectiveness.

Table 1. Currently available commercial oxalic acid options that are approved for *Varroa destructor* control in the United States by the Environmental Protection Agency (EPA).

Product & Application	Material	Maximum Amount per Colony
Api-Bioxal Solution (dribble)	Powder	50 ml of solution (prepare solution by dissolving 35 g oxalic acid into 1 L 1:1 sugar:water [weight:volume])
Api-Bioxal Vaporization	Powder	4 g per brood chamber
Api-Bioxal Spray (packages)	Powder	0.1 fl oz (3.0 mL) of 2.8% oxalic acid solution per 1,000 bees (prepare solution by dissolving 35 g oxalic acid into 1 L 1:1 sugar:water [weight:volume])
EZ-OX Solution (dribble)	Powder	50 mL of solution (prepare solution by dissolving 2 g oxalic acid in 59 mL 1:1 sugar:water [weight:volume])
EZ-OX Vaporization	Powder or 1 g tablets	2 g per brood chamber or deep hive box
EZ-OX Spray (packages)	Powder	0.1 fl oz (3.0 mL) of 2.8% oxalic acid solution per 1,000 bees (prepare solution by dissolving 2 g oxalic acid in 59 mL 1:1 sugar:water [weight:volume])
VarroxSan	Fiberboard strips	4 strips per brood chamber

To provide an efficient *Varroa* control strategy for beekeepers in the United States, an extended-release oxalic acid option, VarroxSan, was approved and registered by the EPA in September 2023. Label information indicates this product slowly releases doses of oxalic acid lethal to the mite for about 42 to 56 days in the colony; during this time, mites are exposed to oxalic acid as they emerge from capped brood cells, and this reduces the need for multiple reapplication treatments. The Washington State University Honey Bees + Pollinators Program tested this product’s efficacy for mite control, toxicity to honey bees, and residues in honey over multiyear field trials (2021 to 2023) in summer and fall. Field trials performed at WSU found VarroxSan to be highly effective during fall and early summer applications. There were no significant residues of oxalic acid in the honey, and VarroxSan had negligible effects on egg eclosion in comparison to control colonies, indicating that VarroxSan is nontoxic to developing honey bees (David 2024).

Personal Protective Equipment Required

Personal protective equipment (PPE) is required while using oxalic acid regardless of application method; always check the product’s label for the most up-to-date information and recommendations. *All* oxalic acid

applications require users to wear a National Institute for Occupational Safety and Health-approved particulate filtering facepiece respirator, eye protection (goggles or face shield), chemical-resistant gloves, long sleeves, long pants, socks, and shoes. Follow each product’s manufacturer instructions for cleaning and maintaining PPE.

Reducing Resistance Development

Commonly used synthetic acaricides for *Varroa* control include the organophosphorus compound coumaphos, the formamide amitraz, and pyrethroids *tau*-fluvalinate and flumethrin. Organic compounds (containing carbon), including formic acid, oxalic acid, thymol, and hop beta acids, are also used to control *Varroa*. *Varroa* have developed resistance in some regions to all of these aforementioned synthetic chemical treatments. Resistance to coumaphos (Elzen and Westervelt 2002; Pettis 2004), fluvalinate (Elzen and Westervelt 2004; González-Cabrera et al. 2016; Higes et al. 2020), and amitraz (Elzen et al. 1999; Rinkevich 2020) has been documented. Resistance has likely developed because beekeepers overused products with these active ingredients. Although oxalic acid breaks down in the hive faster than these synthetic chemical treatments, if used repeatedly, mite populations may develop resistance.

Integrated pest management incorporates multiple practices throughout a season based on pest population levels and the pests' biology. According to IPM principles, it is important to monitor mite populations and treat when the population(s) have reached established damaging thresholds (such as 3 mites per 100 bees in fall). The use of cultural or mechanical controls, such as using hygienic queen stock (Boecking and Spivak 1999), screened bottom boards (Liu et al. 2020), robbing screens (Kulhanek et al. 2021), and removing drone brood (Calderone 2005), can help slow mite population buildup. Additionally, it is imperative that beekeepers rotate treatments with different active ingredients to minimize the chances of the development of miticide resistance. Ignoring IPM principles can lead to fewer and less effective options for control of *Varroa destructor*.

For more comprehensive *Varroa* management guidance, a good resource is the [Honey Bee Health Coalition's Tools for Varroa Management Guide](#). Some beekeepers may be using products containing pesticide active ingredients (e.g., oxalic acid, formic acid, amitraz, and thymol) that are not registered products by the EPA or using the registered products improperly to manage *Varroa* populations. It is best to use products that have been thoroughly researched, tested, and approved for use at the state or federal level.

A current list of federally registered pesticide products for *Varroa* control in the United States can be found at the [EPA-Registered Pesticide Products Approved for Use Against Varroa Mites in Bee Hives website](#).

A current list of state registered pesticide products for *Varroa* control in Washington State can be found at WSU's [Pesticide Information Center OnLine Database website](#).

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