

# Emerald Ash Borer (EAB) Insecticide Treatments



## TREATMENT OVERVIEW

The emerald ash borer (EAB) is a destructive, invasive beetle that infests and kills ash trees (*Fraxinus spp.*). EAB adults lay their eggs on ash trees, and after hatching, the larvae burrow under the bark to feed on the tree, eventually cutting off its supply of water and nutrients. EAB has spread to many U.S. states since it was first detected in Michigan in 2002, killing nearly all ash trees in its path. Unfortunately, EAB cannot be eradicated; once it arrives in an area, it doesn't go away. EAB was confirmed in Forest Grove, Oregon in June 2022, the first known case on the West Coast. Because ash trees are common in parks, streets, yards, wetlands, and along waterways, their loss will have wide-reaching effects on health, environment, and economy. Properly treating individual ash trees with insecticides is the only way to protect them from an EAB infestation.

Treatment ensures that an established ash tree can continue to provide benefits for many years to come, such as shade, air and stormwater filtration, wildlife habitat, and value to a property or neighborhood. It is best to treat ash trees before they become infested with EAB. However, treatment during early stages of an EAB infestation can also be effective if a tree hasn't lost more than 30% of its canopy. Healthy and large ash trees ( $\geq 6$ " diameter) are the best candidates for treatment because they have the highest chance of survival and because they provide benefits that cannot be readily replaced by a newly planted tree. Given current technology, an ash tree must be treated for the rest of its life to keep it protected from EAB, because EAB remains in the landscape indefinitely.

Treatment is the least expensive option in responding to EAB, at least in the near term. Costs vary by product and application method, but generally a tree can be treated for about 20 years before the financial cost is equal to that of removing and replacing a healthy tree.

A certified arborist can help assess whether an ash tree is a good candidate for treatment. **The most effective treatment option for protecting ash trees from EAB is systemic trunk injection of emamectin benzoate (see page 2 and Table 1).** This, along with many other EAB treatment options, may only be administered by a licensed pesticide applicator (see Table 1). Check your local laws and regulations when selecting a treatment method.



**Figure 1:**

EAB larvae feed on nutritious tissue under ash bark, forming serpentine larval galleries.



**Figure 2:**

Comparison of an ash tree killed by EAB and a street lined by ash trees treated with emamectin benzoate.

Image Credit (Left): William M. Ciesla, Forest Health Management International, Bugwood.org

## APPLICATION METHODS

**Trunk Injection:** Systemic insecticide (a substance used to kill insects as it is transported through plant tissue) is injected directly into the tree trunk at its base. Only apply trunk injections when trees are flush with leaves (April-October). Trunk injections need to be repeated every one to three years, depending on the active ingredient (see Table 1). Make sure to properly water your tree prior to treatment to maximize effectiveness.

**Soil Applications:** Systemic insecticide is applied to the soil near the base of the tree and taken up through its roots. Soil applications can be applied as a liquid or granules that are either poured onto the soil surface (soil drench) or injected below the surface straight into the root zone (soil injection).

**Basal Bark Spray:** Systemic insecticide is sprayed directly onto the bark at the base of the tree trunk. The insecticide is absorbed through the bark and carried throughout the tree. They must be applied once per year when trees are flush with leaves.

**Cover Sprays:** Non-systemic insecticides (substances used to kill insects on plants surfaces only) are sprayed onto to the trunk, branches, and leaves of the tree. Cover sprays primarily control EAB adults feeding on the leaves and eggs laid on bark. Cover sprays are not highly effective at controlling for EAB, because they do not affect the larvae feeding underneath the bark.



**Figure 3: Systemic trunk injection system.**

Tiny holes are drilled into the trunk of the tree and small tees are inserted into the holes. The insecticide is injected through the tees with a pump, then absorbed and transported throughout the tree's vascular system.

## TREATMENT EFFECTIVENESS BY ACTIVE INGREDIENT

**Emamectin benzoate** is a systemic trunk injection that is highly toxic to EAB in adult and larval forms. Even at the lowest application rate (amount of insecticide), emamectin benzoate is the most effective EAB treatment in preventing canopy decline and lowering larval densities.<sup>1-4</sup> Emamectin benzoate is applied every two to three years and is most effective when applied in spring, after leaves have emerged.<sup>3</sup> Note: A licensed pesticide applicator is required to administer emamectin benzoate.



**Azadirachtin** is a systemic trunk injection that impedes EAB larval development and disrupts reproduction.<sup>5</sup> Azadirachtin treatments are highly effective when applied annually and can provide effective protection with a two-year treatment cycle when EAB population pressure is low.<sup>6,7</sup> Medium to high application rates of azadirachtin may be necessary for maximum efficacy.<sup>5</sup>

**Imidacloprid and dinotefuran** are neonicotinoids that can be applied as a trunk injection (imidacloprid only), basal trunk spray (dinotefuran only), or soil drench/injection (both). Soil applications of imidacloprid and dinotefuran have shown highly variable results.<sup>4,7,8</sup> Although spring applications are generally more effective than those in fall, annual soil drenches/injections of imidacloprid and dinotefuran have not prevented significant canopy decline.<sup>1,4</sup> Annual basal trunk sprays of dinotefuran effectively protect ash trees from EAB when applied at the highest rate.<sup>2,7</sup> Note: Be sure to check local regulations as neonicotinoids are banned in some parts of the state.

Several active ingredients (bifenthrin, carbaryl, cyfluthrin, and spinosad) can be applied as cover sprays to control EAB. Cover sprays target adult EAB that are actively feeding on treated leaves and newly hatched EAB larvae as they burrow through treated bark, but they do not effectively reduce larval populations.<sup>7,9,10</sup> To maximize efficacy, cover sprays should be applied to the trunk, branches, and leaves twice per year, in the spring with four weeks between applications.<sup>7</sup> Still, cover sprays are among the least effective insecticides for EAB.



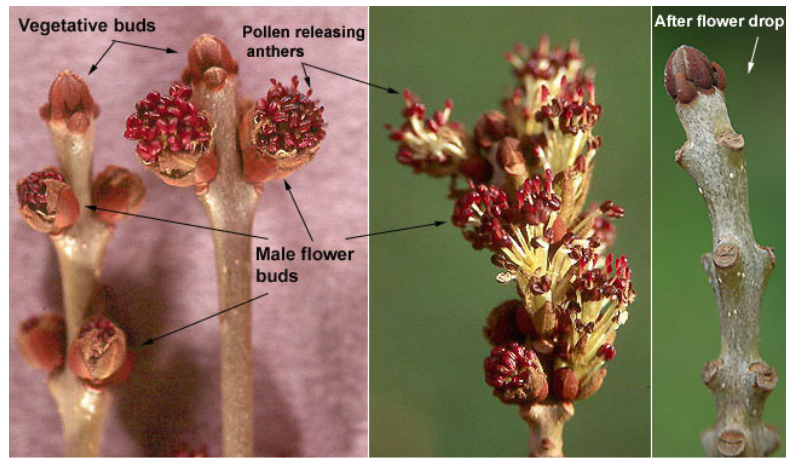
## NONTARGET IMPACTS

Nontarget impacts are the negative consequences a pesticide can have on living things other than EAB, such as pollinators, birds, aquatic organisms, and other insects. It is important to be mindful of these nontarget impacts when making decisions about the use of pesticides.

Systemic trunk injections pose little risk to most nontarget species when properly applied by a licensed pesticide applicator. Because these insecticides are injected directly into the tree, only insects living underneath the bark or feeding on the leaves of a treated tree may be directly affected.<sup>3,11</sup> Woodpeckers, who eat EAB larvae living in ash, are also minimally affected by systemic treatments because they only prey on live larvae, not the dead ones that have been exposed to insecticides.<sup>11</sup> Additionally, research has shown that the chemical accumulation in fallen tree leaves from systemic injections is extremely low and has negligible effects on the organisms who decompose them.<sup>12</sup>

Systemic trunk injections also pose minimal risks to pollinators, like bees and butterflies. By the time ash leaves emerge in spring, flowers are no longer producing pollen.<sup>11</sup> Because trunk injection must occur when leaves are on, insects visiting ash flowers are not likely to be exposed to the chemical. Additionally, ash trees are pollinated by wind and produce flowers that are not particularly attractive to insects. Research has shown that ash makes up only a small percentage of pollen collected by pollinating insects.<sup>12,13</sup>

Other treatment methods pose greater risk to nontarget species because they are less contained than systemic trunk injections. Soil applications can impact organisms living in the soil, such as ground nesting bees, and could be carried further away by stormwater or erosion. Nearby plants could also uptake soil insecticides through their roots and have unintended consequences on their associated insects. Spray applications, such as basal bark sprays and cover sprays, have the potential to drift in the air and encounter nontarget species. Cover sprays carry the greatest risk of all because they are the least direct application method and must be applied multiple times per year to maximize efficacy.



**Figure 4:**

Ash flowers lack petals and nectar, making them unattractive to pollinating insects. Image Credit: Oregon State University

## Figure 5: Timing for Systemic Trunk Injections Relative to Seasonal Ash Tree & EAB Cycles

This figure was adapted from Smitley et al., 2019<sup>14</sup>

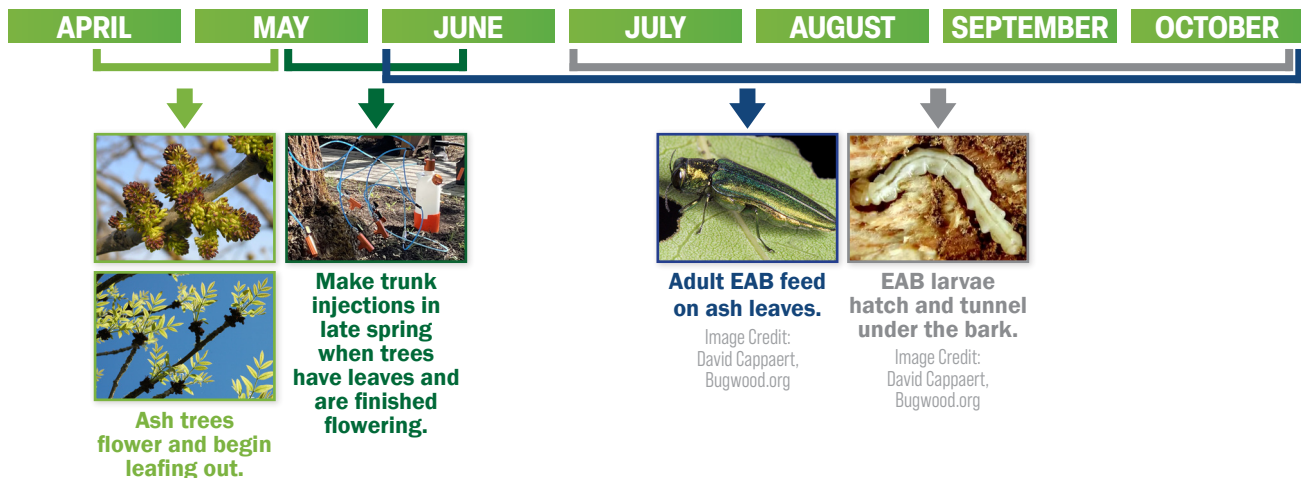


Image Credit (Top): Indiana University-Purdue University Fort Wayne

Image Credit: David Cappaert, Bugwood.org

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**Table 1: Common Insecticides Used to Control Emerald Ash Borer (EAB)**

Application Method	Active Ingredient	Application Frequency/ Timing	Effectiveness	Nontarget Species Impact	Pesticide Applicator License Required?
Systemic Trunk Injection	Emamectin benzoate	Once every 2-3 years in spring <sup>+</sup>	Excellent, most effective treatment option	Low, if properly applied	Yes
	Azadirachtin	Once every 1-2 years in spring <sup>+</sup>	Very good, varies by pest pressure	Low, if properly applied	No
	Imidacloprid (N)	Once every 1-2 years in spring <sup>+</sup>	Inconsistent	Low, if properly applied	Yes
Trunk Spray	Dinotefuran (N)	Once per year in spring <sup>1+</sup>	Very good	Low to moderate if properly applied	No
Soil Injection/ Drench	Dinotefuran (N)	Once per year in spring <sup>1+</sup>	Inconsistent	Moderate to high	No
	Imidacloprid (N)	Once per year in spring <sup>1+</sup>	Inconsistent	Moderate to high	Yes
Cover Spray	Bifenthrin, Spinosad, Cyfluthrin	Two applications 4 weeks apart in late spring <sup>*</sup>	Fair	Moderate to high	Yes - Bifenthrin and Spinosad No - Cyfluthrin

(N) - Neonicotinoid | + Applied after trees have leafed out | \* Spinosad takes only one application per year

Full list of approved EAB treatments in OR: [oregon.gov/oda/shared/Documents/Publications/IPPM/Pesticides-EABList.pdf](https://oregon.gov/oda/shared/Documents/Publications/IPPM/Pesticides-EABList.pdf)

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