Ohio
Emerald
Ash
Borer
Ash Alert Team

The Ohio State University
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fact sheet

Insecticide Options for Protecting Ash Trees from Emerald Ash Borer and Their Effectiveness

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Ohio State University Extension personnel have received many questions from homeowners and Green Industry professionals wondering if there are insecticides capable of protecting ash trees from emerald ash borer (EAB). Research and experience have shown that insecticides can protect trees from EAB. However, success is not assured. Research suggests that best control will be obtained when treatments are initiated in the earliest stages of infestation before visible symptoms are present, or perhaps even the year before trees are infested. It is also important to realize that treatments will have to be repeated each year. In some cases, it may be more cost-effective to remove and replace the tree.

There has been much confusion surrounding the question of whether insecticides are an effective option for EAB. The answer is: “It depends on the objective.” When the objective is to protect trees from being killed, insecticides have been effective. However, when the objective is to eradicate an EAB infestation to keep it from spreading, insecticides are not effective, which is why they have not been used as an eradication tool by the Cooperative EAB Program.

EAB is now firmly established in northwest Ohio and a number of isolated outlier infestations have been detected throughout the state. In response to these developments, members of the OSU Extension Nursery, Landscape, and Turf Team have developed the following recommendation regarding the use of insecticides for controlling EAB in Ohio:

> **Ash trees within Ohio Department of Agriculture’s EAB quarantine, as well as those outside the quarantine but within the vicinity (i.e. 10-15 miles) of a known infestation, are considered to be at risk. Annual insecticide treatments should be considered by those in these areas who want to try to protect their ash trees.**

Trees elsewhere in Ohio are not considered to be immediately threatened, but this will change as EAB spreads and new infestations are discovered, so it is important to stay up-to-date. Locations of infestations, current quarantine maps, and other information about EAB in Ohio can be found at the following websites: www.ohioagriculture.gov/eab and www.ashalert.osu.edu.

For people who elect to treat their trees, there are several insecticide options available. It is important to keep in mind that controlling wood-boring insects with insecticides has always been a difficult proposition. This is especially true with EAB because our native North American ash trees have no natural resistance to this pest. In some university trials, insecticide treatments were effective, but in other trials the same treatments failed. Furthermore, in some studies conducted over multiple years, EAB infestations continued to increase despite ongoing treatment programs. Some arborists are combining treatments to increase the odds of success (e.g. combining a cover spray with a systemic treatment). Insecticide programs show promise, but research on chemical control of EAB is still in early stages. Scientists from universities, government agencies, and companies are conducting intensive studies to understand the circumstances under which insecticide treatments will be most effective.

Insecticide Options for Controlling EAB

Insecticides used for control of EAB fall into three categories: (1) systemic insecticides that are applied as soil injections or drenches; (2) systemic insecticides applied as trunk injections or trunk implants; and (3) protective cover sprays that are applied to the trunk, main branches, and (depending on the label) foliage. Insecticide formulations and application methods that have been evaluated for control of EAB are listed in Table 1. Some can be purchased and applied by homeowners. Others can be applied only by professional applicators. Strategies for their effective use are described below. It is important to note that pesticide labels and registrations change constantly, and can vary from state to state. It is the pesticide applicator's legal responsibility to read, understand, and follow all current label directions for the specific pesticide product being used.

Table 1. Insecticide options for professionals and homeowners for control of EAB

INSECTICIDE FORMULATION	ACTIVE INGREDIENT	APPLICATION METHOD	TIMING
Professional Use Products			
Merit® (75WP, 75WSP, 2F)	Imidacloprid	Soil injection or drench	Mid-April to mid-May
IMA-jet®	Imidacloprid	Trunk injection, Arborjet™	Mid-May to mid-June
Imicide®	Imidacloprid	Trunk injection, Mauget®	Mid-May to mid-June
Pointer™	Imidacloprid	Trunk injection, Wedgle™	Mid-May to mid-June
Inject-A-Cide B®	Bidrin®	Trunk injection, Mauget®	Mid-May to mid-June
Astro®	Permethrin	Preventive bark and foliage cover sprays	2 applications at 4 week intervals with the first when black locust is blooming (early May in southern Ohio and late May in northern Ohio)
Onyx™	Bifenthrin		
Sevin® SL	Carbaryl		
Tempo®	Cyfluthrin		
Homeowner Products			
Bayer Advanced™ Tree & Shrub Insect Control	Imidacloprid	Soil drench	Mid-April to mid-May
ACECAP® 97 Systemic Insecticide Tree Implants	Acephate	Trunk implant	Mid-May to mid-June

Using Insecticides to Control EAB

Soil-applied Systemic Insecticides

Systemic insecticides applied to the soil are taken up by the roots and translocated throughout the tree. The most widely tested systemic insecticide for control of EAB is imidacloprid, which is available for use by professional applicators and homeowners. Professional use formulations of soil-applied imidacloprid include Merit® 75WP, Merit® 75WSP, and Merit® 2F. The homeowner formulation of imidacloprid is Bayer Advanced™ Tree & Shrub Insect Control. Additional formulations of imidacloprid with different brand names are also becoming available.

All imidacloprid formulations can be applied as a drench by mixing it with water and pouring it directly on the soil at the base of the trunk. The application rates for the homeowner and professional formulations of imidacloprid are very similar (1.3 and 1.5 grams of active ingredient per inch of trunk diameter, respectively). Soil drenches offer the advantage of requiring no special equipment to apply (other than a bucket or watering can). However, surface layers of organic matter, such as mulch or leaf litter, can bind the insecticide and reduce uptake. Before applying soil drenches, it is important to remove or pull back any mulch or dead leaves so the insecticide solution is poured directly on the mineral soil.

Merit formulations can also be applied as soil injections, which require special equipment, but offer the advantage of placing the insecticide directly into the root zone. Injections should be made only deep enough (2-3 inches) to place the insecticide under the turf or mulch layer. Soil injections can be made either at the base of the trunk or on a grid pattern extending to the edge of the canopy. Recent studies have found that soil injections made immediately adjacent to the trunk (within 6-18 inches) are more effective than those made on a grid pattern under the canopy. Density of fine roots is very high at the base of the trunk and declines quickly as you move away from the tree because large radial roots diverge like spokes on a wheel prior to branching into smaller roots that ultimately terminate in feeder roots. This pattern of root distribution can be clearly observed on trees that have been recently uprooted in a storm, or when taking soil cores under the canopy, many of which will be devoid of fine roots.

Optimal timing for imidacloprid soil injections and drenches is mid-April to mid-May (treat on the early side in southern Ohio and on the later side in northern Ohio), which allows the 4-6 weeks that are necessary for uptake and distribution of the insecticide before larvae begin to establish in mid- to late June. One study with small trees indicates that imidacloprid soil drenches can also be applied successfully in the fall.

EAB larvae damage the vascular system as they feed, which interferes with translocation of systemic insecticides. Studies are underway to determine how much injury a tree can sustain before systemic insecticide treatments are rendered ineffective. It is probably unlikely to save trees showing more than 50 percent dieback, and any damage can reduce the effectiveness of systemic treatments.

Trunk-applied Systemic Insecticides

Several systemic insecticides can be injected or implanted directly into the trunk of the tree. Some formulations are applied by professionals, while others are available to homeowners. Imidacloprid is available in several professional use formulations that are injected directly into the trunk using various application systems. These include IMA-jet®, which is injected using various Arborjet™ injection systems; Mauget Imicide® micro-injection capsules; and Pointer™, which is injected using the Arborsystems Wedgle™ Direct-Inject™ injector system. Another insecticide option is Mauget Inject-A-Cide B® micro-injection capsules, which contain Bidrin® (dicrotophos). Systemic trunk implants available for purchase and application by homeowners include ACECAP® 97 Systemic Insecticide Tree Implants and Bonide® Systemic Insecticide Bullets, both of which contain acephate as the active ingredient. Both products are applied by inserting insecticide-containing capsules into holes drilled in the base of the tree trunk.

Trunk injections and implants have the advantage of being absorbed by the tree more quickly than soil applications, and can be applied where soil treatments may not be practical or effective, including trees growing on excessively wet, compacted, or restricted soil environments. However, trunk injections and implants do injure the trunk, which may cause long-term damage, especially if treatments are applied annually.

Optimal timing of trunk injections and implants is between mid-May and mid-June. Studies have shown that Inject-A-Cide B injections made as late as August can kill insects in the tree, although substantial feeding damage will have already been done. If the option exists, applications should be made earlier to prevent larval establishment.

Most efficient uptake of trunk-injected insecticides occurs when trees are actively transpiring. Best results will be obtained when injections are made on sunny days in the morning when good soil moisture conditions prevail. Uptake will be slow on cloudy days, during hot afternoons, and when the soil is dry.

Protective Cover Sprays

The objectives of protective bark cover sprays are to kill newly hatched larvae on the bark before they can enter the tree, and depending on the label, adults as they feed on foliage prior to laying eggs. Products that have been evaluated as cover sprays for control of EAB include Onyx™ (bifenthrin), Tempo® (cyfluthrin), Sevin® SL (carbaryl), Orthene® (acephate), and BotaniGard® (contains spores of the insect-infecting fungus *Beauveria bassiana*). Some of these have been much more effective than others in university trials (discussed below).

Protective cover sprays are designed to prevent infestations and must be timed precisely to be effective. Because protective residues must be present on the bark before eggs hatch to prevent infestation, they must be timed to coincide with adult emergence and oviposition, which is difficult to monitor because there are no effective pheromone traps for EAB. However, first emergence of EAB adults corresponds closely with full bloom of black locust (*Robinia psuedoacacia*), which can serve as a useful phenological indicator for accurately timing applications. Best results with cover sprays have been obtained when two applications are made, with the first as black locust reaches full bloom (early May in southern Ohio and late May in northern Ohio), and the second four weeks later.

When Should Treatments Begin?

It is difficult to determine exactly when to initiate insecticide treatments. Research suggests that best control will be obtained when treatments are initiated in the earliest stages of infestation before visible symptoms are present, or perhaps even the year before trees are infested. However, treatment programs that begin too early represent an unnecessary expense. We recommend that those who want to protect their ash trees initiate treatments if they are located within Ohio's EAB quarantine, or outside the quarantine but within the immediate vicinity (i.e. 10-15 miles) of a known infestation. Locations of infestations, current quarantine maps, and other information about EAB in Ohio can be found at the following websites: www.ohioagriculture.gov/eab and www.ashalert.osu.edu.

How Effective Are Insecticides for Control of EAB?

Extensive testing of insecticides for control of EAB has been conducted by researchers at Michigan State University and Ohio State University. Results of many of the Michigan State University trials are posted at the following website: www.emeraldashborer.info.

Soil-applied Systemic Insecticides

Efficacy of imidacloprid soil injections for controlling EAB has been inconsistent, with some trials providing excellent control, and others yielding poor results. Differences in application protocols and conditions of the trials have varied considerably, making it difficult to reach firm conclusions about sources of variation in efficacy. For example, McCullough et al. (2004) found that low-volume soil injections of Merit 75WP applied to small caliper trees (four-inch trunk diameter) using the Kioritz applicator (a hand-held device for making low-volume injections) provided very good control at one site (Airport West). However, control was poor at another site (Kensington) where the same application protocols where used to treat large caliper (13-inch DBH) trees. McCullough et al. (2004) raised the possibility that imidacloprid levels may have been too low in the larger trees to provide adequate control. Much higher pest pressure at the Kensington site also may have contributed to poor control in the large caliper trees.

In the same trials, high pressure soil injections of Merit 75WP (applied in two concentric rings, with one at the base of the tree and the other halfway to the dripline of the canopy) provided excellent control at both sites (McCullough et al. 2004). However, at a third site, soil injections applied using the same rate, timing, and application method were completely ineffective, even though tree size and infestation pressure were very similar to those at the Kensington site where control was excellent. It should be noted that recent studies have shown that Merit soil injections made at the base of the trunk resulted in more effective uptake than applications made on grid or circular patterns extending to the dripline of the canopy.

Imidacloprid soil drenches have also generated mixed results. In one trial, infestation levels in trees (with trunk diameter ranging from 7-24 inches) drenched with Merit 75WP did not differ from untreated control trees (Smitley et al. 2005a). In another study, Merit 75WP soil drenches applied to trees with trunk diameters ranging from 6-30 inches were only slightly more effective, providing 38 percent control (Smitley et al. 2005b). However, control improved after two consecutive years of treatment. In a third study with small trees, soil drenches were very effective. When applied to small caliper trees, soil drenches with Merit 75 WP and Bayer Advanced Tree & Shrub Insect Control have provided excellent control when applied in May, June, or October (Smitley et al. 2005b, 2006).

Smitley et al. (2005 a,b) concluded that a combination of tree size and degree of pest pressure provides the best explanation for variable efficacy of imidacloprid soil drenches, with soil drenches being most effective when applied to smaller trees, and least effective when applied to larger trees experiencing heavy pest pressure. Recent studies suggest that for larger trees, imidacloprid soil drenches may have to be applied two years in a row before dependable control is observed.

Trunk-applied Systemic Insecticides

Imidacloprid trunk injections also provided varying degrees of control in trials conducted at different sites (McCullough et al. 2004). Degree of control obtained with Mauget Imicide injections varied from 60 percent to 96 percent, with no apparent relationship between efficacy and trunk diameter or infestation pressure. In 2004, McCullough et al. (2005) initiated additional trials to evaluate the effects of tree size (8 vs. 20 inch DBH) and application date (May 24 vs. July 19) on efficacy of Mauget Imicide and Arborjet IMA-jet injections. Several patterns emerged from this study. First, injections made on May 24 were more effective than those made on July 19. A second finding was that the Arborjet IMA-jet injections provided higher levels of control than did the Mauget Imicide injections, perhaps because of the greater amount of active ingredient injected using the Arborjet methods. Finally, they found no clear pattern with respect to effect of tree size on efficacy of trunk injections. The two Arborjet methods provided similar levels of control on small and large caliper trees, perhaps because the IMA-jet label calls for the rate to be increased when treating larger caliper trees. Imicide injections were actually less effective on small than on large caliper trees, possibly because the intensity of pest pressure was much higher at the site with small caliper trees.

Smitley et al. (2005a) treated trees with ACECAP 97 Systemic Insecticide Tree Implants for two consecutive years, and found them to be effective the first year under relatively light pressure. However, they were not effective the second year under more intense pest pressure.

In a discouraging study, McCullough et al. (2005) found that ash trees continued to decline from one year to the next despite being treated both years with imidacloprid or bidrin trunk injections. Mauget Imicide, Wedgle Pointer, and Inject-A-Cide B trunk injections all suppressed EAB infestation levels in both years, with Imicide generally providing best control under high pest pressure in both small (six-inch DBH) and large (16-inch DBH) caliper trees. However, in all treatments, larval density increased in treated trees from the first to the second year. Furthermore, canopy dieback increased by at least 67 percent in all treated trees (although this was substantially less than the increased dieback observed in untreated trees). In another study (D. Smitley, personal communication), infestation levels were also observed to build from one year to the next, even though trees had been treated for two consecutive years with Merit soil drenches or IMA-jet trunk injections. Although untreated trees were more severely impacted, these results do suggest that even consecutive years of treatment may only slow ash decline, at least when pest pressure is severe.

Protective Cover Sprays

McCullough et al. (2004) found that one or two applications of Onyx provided good control of EAB. Sevin SL and Tempo also provided good control of EAB when two applications were applied, with the first in late May and the second in early July. Orthene was less effective. Astro® (permethrin) has not been evaluated against EAB in these Michigan tests, but has been extremely effective for controlling other species of wood-borers and bark beetles.

Smitley et al. (2005a) also tested Onyx cover sprays, and found that they gave good control the first year under relatively light pressure. However, in the second year, under heavier pest pressure, they were not effective. BotaniGard® was also ineffective under high pest pressure (D. Smitley, personal communication).

In Summary

Insecticides have shown potential for protecting trees from EAB, including soil-applied systemic insecticides, trunk-applied systemic insecticides, and protective cover sprays applied to the trunk, branches, and (depending on the label) foliage. Some formulations can be purchased and applied by homeowners. Others can be applied only by professional applicators. It is important to realize that success is not assured, and that trees will have to be treated each year. In many cases, it may be more cost-effective to remove and replace the tree. Insecticide applications have effectively protected ash trees from EAB. However, in some research trials, trees have continued to decline from EAB attack despite being treated over successive years. In other trials, treatments have failed completely. The bottom line is that research on chemical control of EAB is still in the early stages, and we still do not have enough experience to know under what circumstances insecticide treatments will be effective over the long term.

References

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