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

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Now that the emerald ash borer (EAB) has been officially confirmed in Wisconsin, many questions have been asked by homeowners and Green industry professionals regarding the capability and need of insecticides for protecting ash trees from EAB. There has been much confusion surrounding the question of whether insecticides are an effective management option for EAB. Research and experience has shown that insecticides can protect ash trees from being killed by EAB. However, success in not guaranteed! In some university trials, insecticide treatments were effective, but in other trials the same treatments failed. Some studies conducted over multiple years revealed that EAB infestations continued to increase despite ongoing treatment programs. Insecticides are **not** effective in eradicating EAB infestations, which is why they have not been used as an eradication tool by the Cooperative EAB program in other states. Research suggests that best control can be achieved when insecticide treatments are started in the earliest stages of infestation before visible symptoms are present or possibly the year before trees are infested. It is important to understand that insecticide treatments must be repeated each year. Consequently, it may be more cost-effective to remove and replace the ash tree with an alternative tree to increase species diversity.

There are several insecticide options available for those people who want to treat their trees. It is important to understand 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 known natural resistance to this pest. Insecticide research programs are showing 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 products can be purchased and applied by homeowners while other can only be applied by professional applicators. Strategies for their effective use are described below. It is important to note that pesticide labels and registrations may change. It is the pesticide applicator's legal responsibility to read, clearly 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®	Imidaclorprid	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
Safari® + PentraBark®	Dinotefuran	Trunk Spray	Late-April to late-May
Astro®	Permethrin	Preventative Bark and Foliage Cover Sprays	2 applications at 4 week intervals with the first application when black locust is blooming
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
Bonide Bullets®	Acephate	Trunk implant	Mid-May to mid-June

Using Insecticides to Control EAB

Soil-Injection/Drench Systemic Insecticides

Systemic insecticides applied to the soil are taken up by the roots and translocated (moved) throughout the tree. The most widely tested systemic insecticide for control of EAB is imidacloprid. It is available for use by homeowners and professional applicators. The homeowner formulation of imidacloprid is Bayer Advanced™ Tree & Shrub Insect control. Professional use formulations of soil-applied imidacloprid include Merit® 75WP, Merit® 75WSP, and Merit® 2F. 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 both the homeowner and professional formulations of imidacloprid are quite 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. Prior to applying soil drenches, it is important to remove or pull back any mulch or dead leaves so the insecticide solution in poured directly on mineral soil.

Imidacloprid 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. Soil 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 tree canopy. Recent research studies have revealed 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 tree canopy. Density of fine root hairs is very high at the base of the trunk and declines quickly as you move away from the tree. 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 tree canopy.

Optimal timing for imidacloprid soil drenches or injections is mid-April to mid-May (treat on the early side in southern Wisconsin and on the later side in northern Wisconsin), which allows the 4-6 weeks necessary for uptake and distribution of the insecticide before EAB larvae begin to establish in mid- to late June.

EAB larvae damage the vascular system (a.k.a. tree plumbing) as they feed, which interferes with the translocation of systemic insecticides. Soil drench or injections are aimed primarily at preventative treatment applications, however; in some cases, this approach may provide corrective control of low populations of EAB infested ash trees. Studies are ongoing to determine how much injury a tree can sustain before systemic insecticide treatments are no longer effective. Research results suggest that ash trees showing >50 percent dieback are not likely to be salvaged, and any damage can reduce the effectiveness of systemic treatments.

Trunk-Injection/Implant Systemic Insecticides

Several systemic insecticides can be injected or implanted directly into the trunk of ash trees. 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 Arborsystems Wedgle™ Direct-Inject™ injector system. Another option is Mauget Inject-A-Cide B® micro-injection capsules, which contain Bidrin® (dicrotophos). Systemic trunk implants available for purchase and application by homeowners and professionals 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 to mid-June. Research 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 occurred. If the option exists, applications should be made earlier to prevent EAB larval establishment.

Most efficient uptake of trunk-injected insecticides occurs when tree are actively transpiring. Best results will occur 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.

Trunk-Bark Spray Systemic Insecticide

Safari 20 SG is a highly systemic insecticide that will move through the bark and will be translocated upward throughout ash trees. Safari 20 SG + PentraBark should be applied before ash trees are heavily infested with EAB and showing obvious symptoms of decline (i.e., < 40% canopy thinning/dieback). Application to heavily infested ash trees may not prevent the decline or death of ash trees due to existing EAB damage and tree stress. Do NOT apply Sarfari + PentraBark when ash trees are dormant, under drought stress, or not actively taking up water from the soil. Most efficient uptake of trunk-injected insecticides occurs when tree are actively transpiring. Data from field trials indicate that efficacious concentrations of Safari are present within ash trees by 21 days after application, thus the optimal treatment application timing is late-April to late-May.

Protective Bark and Cover Sprays

The objectives of protective bark and cover sprays are to kill newly hatched EAB larvae on the bark before they enter the tree, and depending on the label, adults as they feed on the 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 BontaniGard® (contains spores of the insect-killing fungus *Beauveria bassiana*). Some of these insecticides have been more effective than others (see discussion below).

Protective cover sprays are designed to prevent EAB infestations and must be timed precisely to be effective. Because protective residues must be present on the tree bark before egg hatch to prevent infestation, applications must be timed to coincide with adult emergence and oviposition (egg laying), which is difficult to monitor because

there are no effective pheromone traps for EAB adults. However, first emergence of EAB adults typically corresponds closely with full bloom of black locust (*Robinaia psuedoacacia*), which can serve as a useful phenological indicator for accurately timing applications. Best results with cover sprays have been obtained when two (sequential) applications are made, with the first as black locust reaches full floral bloom (mid-May in southern Wisconsin and late-May to early-June in northern Wisconsin), and the second four weeks later. It is recommended that homeowner hire professional applicators to apply protective bark cover sprays as homeowners typically do not have the appropriate application equipment, especially on larger trees > 15 feet tall.

When Should EAB Treatments Begin?

It is quite difficult to determine exactly when to initiate insecticide treatments. Research suggests that best control of EAB will be obtained when treatments are initiated in the earliest stages of EAB infestation before visible symptoms are present, or perhaps even the year before trees are infested. Treatment programs that begin too early represent an unnecessary expense. We suggest that those who want to protect their ash trees initiate EAB insecticide treatments if they are located within an EAB quarantine, or outside a quarantine but within the immediate vicinity (i.e., 10-12 miles) of a known EAB infestation. Locations of EAB infestations, current quarantine maps, and other important information regarding EAB can be found at the following websites: http://www.aphis.usda.gov/planthealth/plantpestinfo/emeraldashb/downloads/multistateeab.pdf, www.entomology.wisc.edu/emeraldashborer, and http://www.emeraldashborer.wi.gov

How Effective Are Insecticides for Control of EAB?

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

Soil-Injection/Drench 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 soil injections) provided very good control at one site. However, control was poor at another site where the same application protocols were used to treat large caliper (13 inch diameter at breast height [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 (populations) may also have contributed to poor control in the larger 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 tree canopy) provided excellent control at two sites (McCollough et al. 2004). However, at a third site, soil injections applied using the same rate, timing, and application method were completely ineffective, even though the tree size and EAB larval infestation pressure were very similar to those at the other sites where control was excellent. It should be pointed out that recent research studies have shown that Merit soil injections made at the base of the tree trunk resulted in more effective uptake than applications made on grid or circular patterns extending to the dripline of the tree canopy.

Imidacloprid soil drenches have also generated varied results. In one trial, infestation levels of EAB 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 EAB infested ash 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 smaller caliper trees, soil drenches with Merit 75WP and Bayer Advanced Tree & Shrub Insect Control have provided excellent control of EAB when applied in May, June, or October (Smitley et al. 2005b, 2006).

Smitley et al. (205 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 research studies suggest that for larger trees, imidacloprid soil drenches may have to be applied two years consecutively before dependable control can be achieved.

Trunk-Injection/Implant Systemic Insecticides

Imidacloprid trunk injections also provided mixed degrees of control in trials conducted at different sites (McCollough et al. 2004). Degree of control obtained with Mauget Imicide trunk injections varied from 60 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 determine the effects of tree size (8 versus 20 inch DBH) and application date (May 24 versus July 19) on efficacy of Mauget Imicide and Arborjet IMA-jet trunk injections. Several patterns emerged from this study. First, trunk injections made on May 24 were more effective than those made on July 19. Second, the Arborjet IMA-jet trunk injections provided higher levels of control than did the Mauget Imicide trunk injections, likely due to the greater amount of active ingredient injected using the Arborjet method. Finally, they found no definitive pattern

with respect to effect of tree size on efficacy of trunk injections. The Arborjet method provide similar levels of control on small and large caliper trees, possibly because the IMA-jet pesticide label recommends the application rate be increased when treating larger caliper trees. Imicide trunk injections were actually less effective on small compared to large caliper trees, likely due to the intensity of pest pressure as it 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 low EAB pressure. However, they were not effective the second year under more intense EAB pest pressure.

In a discouraging study, McCollough et al. (2005) discovered 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 (6 inch DBH) and large (16 inch DBH) caliper trees. However, in all treatments, EAB larval density increased in treated trees from the first to the second year. In addition, canopy dieback increased by about 67 percent in all treated trees (although substantially less than the increased dieback observed in untreated trees). In another study (D. Smitley, personal communication), infestation levels were also observed to increase 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. These results suggest that even consecutive years of treatments may only slow ahs decline, at least when EAB pest pressure is severe.

Trunk-Bark Spray Systemic Insecticide

Although research into Safari's effectiveness against EAB has been limited, results from Dr. Deb McCullough's trials show Safari 20SG provides up to an 80% mortality rate in adult ash borers within two weeks of application.

Protective Bark and Cover Sprays

McCollough 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 application in late-May and the second in early-June. Orthene was less effective. Astro® (permethrin) has not been evaluated against EAB, 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 it provided good control the first year under relatively low EAB pressure. However, in the second year,

under heavier EAB pressure, it was not effective. BotaniGard® was also ineffective under high EAB pressure (D. Smitley, personal communication).

Summary

Insecticides are valuable tools that have shown potential for protecting trees from EAB, including soil-applied systemic insecticides, trunk-injected 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 must only be applied by professional applicators. It is important to understand that success in **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. Insecticides applications have effectively protected ash trees from EAB. However, in some university research trials, trees have continued to decline from EAB attack despite being treated over consecutive years. In other studies, EAB treatments have failed completely! The bottom line is that research on chemical (insecticide) control of EAB remains in the early stages, and we still do not have enough experience to know under what circumstances insecticides treatments will be effective over the long term.

References

McCollough, D.G., D.R. Smitley, and T.M. Poland. 2004. Evaluation of insecticides to control emerald ash borer adults and larvae. Summary of research conducted in 2003. www.emeraldashborer.info/treatment.cfm. Accessed 7 May 2007.

McCollough, D.G., D. Cappeart, and T.M. Poland. 2005. Evaluation of insecticides for control of emerald ash borer: a summary of 2004 trials. www.emeraldashborer.info/treatment.cfm. Accessed 7 May 2007.

Smitley, D., T. Davis, E. Rebek, and K. Newhouse. 2005a. Troy EAB test results. www.emeraldashborer.info/Research.cfm . Accessed 7 May 2007.

Smitley, D. T. Davis, E. Rebek, and K. Newhouse. 2005b. Imidacloprid soil drench test at Bay Pointe Country Club, 2004. www.emeraldashborer.info/Research.cfm. Accessed 7 May 2007.

Smitley, D. D.A. Herms, and E.J. Rebek. 2006. Timing of imidacloprid soil drenches for emerald ash borer control. In: V. Mastro, R. Reardon, and G. Parra, eds. *Proceedings for Emerald Ash Borer Research and Technology* Development Meeting, p. 26-30. USDA Forest Service Forest Health Technology Enterprise Team FHTET-2005-16, 72pp.

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