MINNESOTA DEPARTMENT OF AGRICULTURE
PESTICIDE AND FERTILIZER MANAGEMENT

Special Registration Review of Common Insecticides Used to Control Emerald Ash Borer in Minnesota

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Introduction

The Minnesota Department of Agriculture (MDA) administers and enforces state and federal pesticide laws and regulations under the Pesticide Control Law, Chapter 18B. The MDA has initiated a process to review a select number of pesticides each year and, if necessary, consider appropriate additional state-specific restrictions, limitations on use as a condition of registration, or registration without state-specific restrictions. The MDA has selected insecticides used to control emerald ash borer (EAB) as a group of pesticides to go through this special registration review process. MDA registration reviews are conducted to prevent "unreasonable adverse effects on the environment" [Minn. Stat. § 18B.26 subd. 5(b)] from these insecticides. "Unreasonable adverse effects on the environment" means "any unreasonable risk to humans or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide" [Minn. Stat. § 18B.01 subd. 31]. Registration reviews are also conducted to resolve problems with label interpretation, compliance and enforcement and to review state registered labels for accuracy with labels approved by the U.S. Environmental Protection Agency (USEPA). This process is not intended to be redundant of analyses and decisions reached by the USEPA during federal pesticide registration.

The MDA has completed a special registration review for the following insecticide active ingredients: **imidacloprid**, **dinotefuran**, and **emamectin benzoate**. These three insecticides were selected because they are widely used by homeowners and professionals and are currently the pesticides of choice for EAB control by numerous municipalities. Since the emergence of EAB in Minnesota and the use of insecticide treatments for its control, concerns have been raised about imidacloprid label use directions, label use limits, label compliance and enforcement, and the accuracy of state registered labels compared to USEPA stamped approved labels. These or other concerns could also apply to dinotefuran and emamectin benzoate. Concerns have also been raised about the potential longer-term impact of all three insecticides on water resources and non-target organisms (mainly pollinators) where treatments will occur. Therefore, the primary objective of the review was to ensure the safe and legal use of insecticides as Minnesotans struggle to control EAB, save trees and protect the environment. The review focused on exploring or completing three main tasks: 1) Improve use guidance for common EAB insecticides; 2) Review insecticide labels for registration consistency; and 3) Continue to develop outreach and education materials for both professional applicators and homeowners. An additional, longer-term objective was to begin establishing capabilities to track potential impacts to water quality and to consider impacts to non-target organisms from current and future insecticide applications to control EAB in Minnesota.

The MDA began conducting a number of Minnesota-specific EAB insecticide management and registration activities in 2010, prompted in part by recommendations from the Minnesota EAB Science Advisory Group, stakeholder environmental concerns, and insecticide product misuse complaints (Minnesota Emerald Ash Borer Science Advisory Group, 2008). To assist homeowners, the MDA in partnership with the Department of Natural Resources (DNR) and University of Minnesota Extension developed a guide that describes treatment options, as well as key factors to consider before deciding to conduct an insecticide treatment. The guide, titled *Emerald Ash Borer: Homeowner Guide to Insecticide Selection, Use, and Environmental Protection*, is available to download on MDA's website at http://www.mda.state.mn.us/eab. To assist professional pesticide applicators, the MDA created technical or compliance-based outreach materials for specific insecticides. A fact sheet was developed for TREE-äge, notifying applicators of its new classification as a Restricted Use Pesticide (RUP). In June 2010, and after conferring with the USEPA, the MDA sent notification to over 1,900 commercial pesticide applicators regarding how to comply with EAB insecticide labels for products containing the active ingredient imidacloprid. In the notification, the MDA outlined a basic approach to complying with application limits, using one-acre units of property as a guide. Refer to Table 1 for a more complete chronology of MDA activities related to EAB management and insecticide product registration activities.

The special registration review provides information to the Commissioner of Agriculture to assess which, if any, additional non-regulatory and/or regulatory actions are warranted for the registration of insecticides used to control EAB in Minnesota.

Table 1 - Chronology of MDA Activities Related to EAB Management and Insecticide Product Registration

Month/ Year	Subject	Details
June 2009	MDA EAB news release	EAB is discovered for the first time in Minnesota. MDA shares tips on EAB control options, including information on insecticide treatment timing, site selection, and label interpretation and compliance guidance.
February 2010	Imidacloprid 24(c) request	MDA begins to explore options for an imidacloprid 24(c) request to increase the maximum allowable amount of imidacloprid use per acre per year from 0.4 lbs to 0.8 lbs of active ingredient.
March 2010	Imidacloprid monitoring	Imidacloprid is confirmed as a routine MDA laboratory analyte using the new LCMS/MS method.
	MDA conducts quick EAB insecticide shelf survey	MDA surveys a few hardware and garden center stores in St. Paul for pesticide products marketed to control EAB.
April 2010	Imidacloprid monitoring	MDA develops an initial plan to monitor imidacloprid in streams and lakes within the 15 mile EAB treatment buffer in the Twin Cities Metro. In addition to the established MDA Tier 1 and 2 monitoring sites, four new urban stream sampling sites and five lakes are added to the monitoring plan for the 2010 sampling season.
	Imidacloprid 24(c) request	MDA receives a request to process a Special Local Needs [FIFRA § 24(c)] application for doubling the annual per acre application rate of imidacloprid to help control EAB. The MDA reviews the basis for the request, as well as label consistency and clarity issues. The MDA also considers the potential for adverse effects on the environment from the increased application rate. The registrant then requests that the MDA not process the application.
	Imidacloprid monitoring	The MDA monitoring season begins on April 16th and includes imidacloprid as a target analyte.
May 2010	MDA TREE-äge fact sheet	MDA develops a fact sheet for TREE-äge, notifying pesticide applicators that it is now classified as a Restricted Use Pesticide (RUP). As a result, any person using this product in the state of Minnesota is required to be a licensed or certified pesticide applicator.
	MDA releases 4-page homeowner guide	MDA releases a guide to homeowners on insecticide selection, use, and environmental protection titled, "Emerald Ash Borer: Homeowner Guide to Insecticide Selection, Use, and Environmental Protection"
June 2010	MDA releases label guidance for imidacloprid-based EAB products	The MDA sent notification to pesticide applicators to assist them in the proper use of imidacloprid products. Notification informs applicators that products explicitly limit the amount of imidacloprid that can be used to control EAB to 0.4 lbs per acre per year.
	MDA explores research opportunities with the University of Minnesota.	The MDA meets with researchers from the U of M and Rainbow Treecare Scientific to discuss opportunities to collaborate on research on the environmental fate of imidacloprid applied as a surface or sub-surface soil drench.

Month/ Year	Subject	Details
August 2010	MDA meets with representatives of the landscape industry to discuss label compliance	The MDA meets with a representative of the Minnesota Nursery & Landscape Association (MNLA) along with 2 representatives from the treecare industry to discuss the label compliance MDA developed for the proper use of imidacloprid to protect ash trees against EAB.
	MDA meets with primary registrant of dinotefuran to discuss homeowner guide, label compliance, and risk assessment	The MDA meets with representatives from Valent along with Rainbow Treecare Scientific and a consultant to discuss the 25-ft application setback recommendation in MDA's homeowner guide along with details on label compliance and risks to water quality from the use of EAB insecticides.
September 2010	MDA agrees to collaborate with a university scientist on non-target insecticide impacts research	A University of Minnesota research scientist discusses with the MDA an interest in examining the impacts to non-target organisms from the increased use of insecticides to control EAB, and requests MDA collaboration on a proposal submitted to the Legislative-Citizen Commission on Minnesota Resources.
March 2011	MDA seeks comment on draft use guidance	In 2011, the MDA began to build off of the June 2010 notification, and developed draft use guidance that offered additional advice to help applicators comply with EPA label use limits. In March, the MDA sought comment on the draft guidance, distributing it to organizations engaged in marketing, application, or outreach related to EAB control.
May 2011	MDA meets with tree care industry stakeholders	Representatives of the landscape industry requested a meeting with MDA to discuss the draft use guidance for applicators. The purpose of the meeting was to listen to industry concerns about the appropriateness of the guidance and related messaging about EAB insecticide impacts to the environment.
July – August 2011	MDA news releases	In July, EAB is discovered in Shoreview, Minnesota, at some distance from previously detected EAB detections in Ramsey County. Then in August, MDA confirms new infestations in Winona County and Houston County.

Background

The non-native invasive forest pest emerald ash borer (EAB; *Agrilus planipennis*) was first discovered in Minnesota in May, 2009, in a St. Paul neighborhood. This invasive beetle now threatens the health and survival of millions of ash in natural and urban areas throughout Minnesota. Ash trees provide significant environmental and economic benefits to communities across the state. Residents value ash trees because they have the potential to reduce heating and cooling costs, increase property value, increase habitat for wildlife, reduce stormwater run-off, and provide other aesthetic values (Sydnor, Bumgardner, & Todd, 2007). Widespread ash mortality has the potential to cause devastating environmental and economic impacts; EAB is predicted to cause $10-20 billion in losses to urban forests throughout the U.S. over the next 10 years (Coalition for Urban Ash Tree Conservation, 2011).

Three systemic insecticides are the focus of this review: **dinotefuran** (Safari; Transtect), **emamectin benzoate** (TREE-äge), and **imidacloprid** (Merit; Xytect; Ima-Jet)[1]. These insecticides are "systemic" because they are translocated within the plant through the xylem, moving from the point of application (i.e., roots or trunk) upward into the canopy, thus, making them useful for targeting insects, such as EAB, that feed in the interior trunk and leaf tissues of ash trees. Products containing imidacloprid or dinotefuran are readily available for purchase by both homeowners and professional applicators and are most commonly applied directly to the soil surface (i.e., soil drench) in granular or liquid forms, or injected a few inches beneath the soil surface (i.e., soil injection). Soil drench and soil injection

[1] Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement is implied. A more complete list of products associated with each of these active ingredients can be found in Table 2.

application methods are typically referred to as soil-applied application methods. These methods of application are popular because they are non-invasive to the tree, quick to apply, and operationally predictable (Cowles, 2010). Dinotefuran can also be applied by spraying the bark on the lower 1.5 m (5 ft) of the trunk (i.e., basal trunk spray). Emamectin benzoate and certain formulations of imidacloprid are injected directly into the trunk of the tree (i.e., tree injection). The EAB control product TREE-äge, containing emamectin benzoate, is a Restricted Use Pesticide (RUP), meaning any person using this product in Minnesota is required to be a licensed or certified pesticide applicator. Table 2 provides a summary of these insecticide treatment options, products and application methods.

Table 2- The Most Common EAB Insecticide Treatment Options

Insecticide Active Ingredient (CAS #)	Examples of Products[a] (Registrant)	Primary Product Market	Treatment Frequency and Timing	Application Methods
Dinotefuran (165252-70-0)	Safari (Valent) Transtect (Rainbow TreeCare Science)	Professional	Once per year (bark spray) 1-2 times per year (other methods) Early May to mid-June	Basal trunk spray, soil-applied
	Green Light Tree and Shrub Insect Control (Green Light)	Homeowner	Once per year Early May to mid-June	Granular soil applied drench
Emamectin benzoate (137512-74-4)	TREE-äge (Arborjet)	Professional Restricted Use Pesticide[b]	Every 2 years During growing season[c]	Trunk injection
Imidacloprid (105827-78-9)	Merit products (Bayer) Xytect (Optrol) products (Rainbow TreeCare Science) Ima-jet (Arborjet) Imicide (Mauget)	Professional	1-2 times per year Mid- to late spring and/or mid-fall	Soil-applied or trunk injection
	Bayer Advanced products (Bayer) Ferti-lome Systemic Insect Drench (Fertilome) Bonide Systemic products (Bonide Product Inc.)	Homeowner	Once per year Mid- to late spring or mid-fall	Soil-applied or granular soil applied drench

a. Professionals have access to some products that are not available to homeowners. This document does not endorse the listed insecticide products over other options, active ingredients are listed in alphabetical order. Other products with the same a.i.s may be available to control EAB.
b. Any person using this product is required to be a licensed or certified pesticide applicator.
c. When the tree is actively transpiring.

Insecticide treatments are a useful tool to protect and preserve high value ash trees from EAB, and there are many economic and practical considerations to make before choosing to use an insecticide. Treatment doses are directly related to the diameter of the tree trunk – as trees increase in size they require higher insecticide dosing for full protection. It is possible that some treatments can result in more than one year of control; nevertheless, it is likely that EAB will continue to be a significant threat to ash trees, and with no other advances in controlling EAB, it is likely that protective insecticide treatments will be needed for the rest of the tree's life at some cost to property owners or municipalities. It may be more cost effective to replace a small or struggling ash tree with a non-ash alternative. In addition, trees in poor health are not likely to respond well to treatments; thus, EAB experts recommend treatment before infestation reaches 40-50% of the ash tree.

The cost of removing and replacing larger, high value trees may be more than the cost of treatment. Purdue University has an EAB Cost Calculator[2] that compares the annual and cumulative costs over a 25 year period for any management strategy that includes a mixture of tree removal, replacement and insecticide treatment. Legacy or high value ash trees[3] are most likely to receive insecticide treatments. The MDA recommends treating high value ash trees within 15 miles of confirmed infestations; however, insecticide treatments are not restricted to these boundaries and will likely occur outside these boundaries. MDA's Interactive EAB Survey Map is a good resource to track current infestations in Minnesota: http://gis.mda.state.mn.us/kml/MN_EAB_Finds.kml.

Along with the insecticides addressed in this review, there are additional insecticide options for protecting ash trees; however, they are not expected to become widely used in Minnesota and were not the focus of this review. Available information on EAB insecticide options may reference the use of cover sprays with broad spectrum insecticides, such as the pyrethroid bifenthrin[4]. It is important to always read the label before using a canopy spray because only a limited number of products list emerald ash borer on the label.[5] Sprays registered for EAB control are designed to kill adult insects before they lay eggs and have no effect on EAB larvae already under the bark. While cover sprays may be effective in some settings, it can be difficult to adequately cover the upper canopy of large trees with spray, where adults are most likely to emerge in the initial stages of an infestation. The use of cover sprays is also likely to result in insecticide drift, effecting property residents, neighbors, pollinators, beneficial predatory insects and other non-target species (MCullough, 2011). Additional active ingredients that are registered but which are not currently used in significant amounts include azadirachtin (TreeAzin; EPA Reg. No. 82996-1) and acephate (ACE-jet; EPA Reg. No. 74578-2). Although the MDA does not anticipate the widespread use of these treatment options in Minnesota, the MDA will continue to follow the use of these insecticides closely.

The current EAB infestation in Minnesota is a relatively new occurrence. Pest management challenges along with potential solutions will continue to evolve as the problem likely gets worse and EAB populations increase. Observations from other infested states indicate that EAB populations initially build very slowly, but later increase rapidly. EAB insecticide use may increase as more trees become infested. Prior to the availability of multiple EAB insecticides, some states explored or issued special registrations to increase the use of certain EAB insecticides. As EAB populations reach their peak, it is likely that many ash trees will decline and die. As untreated ash trees in the area succumb, the local EAB population will eventually decrease. Over time, EAB insecticide treatments could eventually decrease as pest pressure declines (Herms, McCullough, Smitley, Sadof, Williamson, & Nixon, 2009).

In summary, EAB is present in Minnesota and will threaten the health of ash tree populations for many years. There are limited options for control of EAB, and the use of insecticides will be needed, especially

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[2] http://extension.entm.purdue.edu/treecomputer/

[3] These are trees that cannot be easily replaced and are often larger than 15 inches DBH. Individuals may also want to protect smaller ash trees, while other surrounding trees grow in size and contribute to canopy development.

[4] The bifenthrin products UP-Star EC TT&O (EPA Reg. No. 70506-209) and Onyx (EPA Reg. No. 279-3177) are labeled for control of EAB.

[5] Emerald ash borer must be listed on the label because it is a USDA quarantined pest. The permethrin products Astro (EPA Reg. No. 279-3141) and Tengard (EPA Reg. No. 70506-6), the cyfluthrin product Tempo SC (EPA Reg. No. 432-1363), the bidrin product Inject-A-Cide (EPA Reg. No. 7946-10) and the carbaryl product Sevin SL (EPA Reg. No. 432-1227) are not labeled for control of EAB and cannot be used as such.

for high value trees that have significant environmental, economic, and/or sentimental value. Insecticide treatments may also help mitigate public safety risks associated with a growing number of standing dead ash trees and their removal.

Environmental Issues

The potential for adverse environmental impacts from pesticide products is under constant evaluation and research by the USEPA, USDA Forest Service, entomologists, ecologists and the MDA. The method and timing of insecticide applications, proximity to sensitive aquatic and terrestrial habitat (e.g. streams and flowering plants that are attractive to pollinators), and the amount of soil organic matter and soil moisture near the site of application are a few of the variables that have the potential to influence the environmental fate and potential ecological effects from EAB insecticide use. Table 3 provides a summary of the most critical environmental issues and Table 4 provides environmental fate parameters for the most common EAB insecticides. For most situations where soil-applied and trunk injected treatment methods are used, carefully following product label directions will minimize impacts to human health and the environment while protecting investments in private and public property landscapes and eco-systems. Unlike spray treatments, these methods facilitate targeted uptake of an insecticide and minimize environmental impacts. The continuing development of outreach materials for homeowners and professional applicators also has potential to mitigate any environmental concerns from the use of these insecticides.

Table 3- The Environmental Profile of Common EAB Insecticides

Insecticide Active Ingredient	Label Application Methods	Leaching Potential	Risk to Aquatic Communities	Risk to Pollinators[a]
Dinotefuran	Basal trunk spray or soil-applied	Very high, groundwater monitoring recommended on label	Potential exposure to adjacent water bodies through runoff from soil-applied treatments or bark spray; highly water soluble but not toxic to freshwater aquatic life.	Potential exposure through spray drift to nearby flowering plants; highly toxic to pollinators.
Emamectin benzoate	Trunk injection	N/A	Minimal potential for exposure to surface water (unless spilled). If exposed, highly toxic to fish and aquatic invertebrates.	Minimal potential for exposure (unless spilled); highly toxic to pollinators.
Imidacloprid	Soil-applied, trunk injection, foliar spray	High, especially in areas with low organic matter	Potential exposure to adjacent water bodies through runoff from soil-applied treatments; highly toxic to aquatic invertebrates.	Potential exposure to adjacent flowering plants, much higher potential for exposure from spray drift (associated with foliar sprays); highly toxic to pollinators.

a. Ash tree flowers are wind pollinated, and thus rarely visited by bees and other pollinators; however, it is important to use caution when applying these products to ash trees located around other flowering plants that are visited by pollinators.

Table 4- Environmental Fate Parameters for EAB Insecticides

Insecticide Active Ingredient	Solubility (ppm)	Adsorption (Koc)	Half-life Days	Leaching potential	Soluble runoff potential	Persistence
Dinotefuran[a]	39,830	6 – 45	Aerobic Soil (90th percentile value) 138.4 (parent) 459.3 (MNG degradate) Aerobic Aquatic (90th percentile value) 80.8 (parent) 918.6 (MNG degradate)	Very High	High	Relatively persistent
Emamectin[b] **benzoate**	24	25,363 - 730,000	Aerobic Soil 193.4 (sandy soil)	N/A	Very low	Persistent
Imidacloprid[c]	580	178	Aerobic Soil (90% percentile value) 520 Aerobic Aquatic (2x the aerobic soil input value, per EFED guidance document) 1040	High	High	Persistent

a. **(USEPA, 2004)**
b. **(Durkin, 2010)**
c. **(USEPA, 2008a)**

Water Quality Monitoring: Laboratory Analytical Capabilities

Dinotefuran

Dinotefuran labels recommend periodic monitoring of shallow groundwater. However, the MDA does not currently have the ability to conduct laboratory analysis of groundwater, surface water, plant tissue, soil samples or other sample media for dinotefuran or any primary degradates, nor does it have analytical standards to perform such work. An immunoassay method appears to be available for monitoring dinotefuran and its primary degradate MNG[6].

Emamectin benzoate

Emamectin benzoate is injected directly into trees, and there is relatively little information available on its potential to enter surface and groundwater following such treatments. As such, there may be lesser justification to develop analytical methods and monitor potential impacts from emamectin benzoate compared with other EAB insecticides.

Imidacloprid

Imidacloprid is now a routine analyte for MDA groundwater and surface water monitoring. In April 2010, the MDA expanded surface water monitoring at current MDA Tier 1 and 2 sites in the Twin Cities Metro to include sampling for imidacloprid. The MDA also selected four new urban stream sampling sites along with five lake sites within the 15-mile EAB treatment buffer zone to sample for imidacloprid during the 2010 sampling season.

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[6] SmartAssay Series Dinotefuran test kit, cat. #9107001200USA; Horiba, 2 Miyanohigashi, Kisshoin, Kyoto, 601-8510 Japan (Toscano, Byrne, & Weber, 2008)

Groundwater: Environmental Fate, Potential Contamination Risk and Monitoring

As noted in Tables 3 and 4, the environmental fate of EAB insecticides varies with active ingredient and method of application. When soil-applied, solubility characteristics play an important role in insecticide availability for uptake to tree roots and, ultimately, their effectiveness at EAB control. However, these characteristics also present a risk for groundwater contamination through leaching when the residual insecticide is not taken up by the tree or does not otherwise degrade. This is of specific concern in sandy soils with low organic matter, and where the groundwater table is shallow. Unless spilled during use, trunk injected insecticides pose little to no risk to groundwater.

Dinotefuran

According to USEPA, labeled use of dinotefuran on ash trees may result in groundwater contamination. Monitoring for this compound and its degradates is recommended on the pesticide label:

> *"Dinotefuran and its degradate, MNG, have the properties and characteristics associated with chemicals detected in groundwater. The high water solubility of dinotefuran, and its degradate, MNG, coupled with its very high mobility, and resistance to biodegradation indicates that this compound has a strong potential to leach to the subsurface under certain conditions as a result of labeled use. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination. Periodic monitoring of shallow groundwater in the use area is recommended."*

This USEPA-approved environmental hazard statement resulted from the initial registration of dinotefuran in the U.S., where a variety of toxicity tests, use pattern projections, field testing, computer modeling and risk-benefit assumptions were all considered when developing the final product label.

USEPA's estimated concentrations of dinotefuran in shallow groundwater (and in surface waters used as drinking water reservoirs) were below the Drinking Water Level of Comparison (DWLOC) established using toxicity data from tests designed to assess human health risks.

Dinotefuran benchmarks and water quality concentration estimates for drinking water risk screening are provided in Table 5. The MDA is unaware of groundwater sampling studies reporting results for dinotefuran.

Emamectin Benzoate

Emamectin benzoate is inherently less water soluble and is trunk injected, meaning if applied properly it has little if any leaching potential. There is relatively little information available on the fate and transport of emamectin benzoate once it is in an ash tree following injection (Durkin, 2010). This lack of information on the movement of emamectin benzoate following injection imposes limitations on any environmental assessment.

Emamectin benzoate is trunk injected and, when used according to the label, represents a low risk for groundwater contamination. USEPA's estimated concentrations of emamectin benzoate in shallow groundwater (and in surface waters used as drinking water reservoirs) were below the Drinking Water Level of Comparison (DWLOC) established using toxicity data from tests designed to assess human health risks.

Emamectin benzoate benchmarks and water quality concentration estimates for drinking water risk screening are provided in Table 5. The MDA is unaware of groundwater sampling studies reporting results for emamectin benzoate.

Imidacloprid

The potential of imidacloprid to contaminate groundwater has been a concern since it was initially registered in 1994. According to USEPA, imidacloprid is mobile and persistent and has potential to leach to groundwater. The USEPA's original concerns about imidacloprid persistence and possible groundwater contamination led to the following labeling groundwater advisory statement (USEPA, 1994):

> "*This chemical demonstrates the properties and characteristics associated with chemicals detected in ground water. The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground water contamination*."

More research is needed to determine the most likely circumstances that will lead to leaching to groundwater. The soil sorption issues surrounding soil-applied applications to the base of trees are complicated. The persistence of imidacloprid may lead to the accumulation of residues from repeat applications. If the binding capacity of the soil is reached, imidacloprid or its associated degradates may leach to groundwater.

Trunk injecting imidacloprid will have a much lower risk for groundwater contamination than soil-applied methods of application.

Solubility also has the potential to play a role in the loss of imidacloprid to surface waters via runoff from soil drenches and granular formulations that are insufficiently incorporated or watered-in after application.

USEPA's estimated concentrations of imidacloprid in shallow groundwater (and in surface waters used as drinking water reservoirs) were below the Drinking Water Level of Comparison (DWLOC) established using toxicity data from tests designed to assess human health risks. USEPA estimated concentrations were established by modeling use patterns and application rates associated with agricultural and turf settings. As such, estimated concentrations associated with soil applications to individual or multiple trees in a treatment area as part of widespread EAB control may differ.

Imidacloprid benchmarks and water quality concentration estimates for drinking water risk screening are provided in Table 5. A limited number of surveys have been conducted in the U.S. to monitor for imidacloprid in surface and groundwater. Results from reviewed surveys indicate that imidacloprid is detected in surface and ground water in mostly agricultural areas (Table 4). Detections occur at very low concentrations relative to USEPA drinking water benchmarks. Groundwater detections have generally occurred in areas where the soil was sandy with little organic matter and/or where the water table was high. Imidacloprid breaks down very slowly in water if there is no light, meaning that it could potentially persist in groundwater for some time. Examples of groundwater sampling studies and reported results for imidacloprid are provided in Table 6.

Table 5. Analytical Method and Benchmarks for Drinking Water Risk Screening

Insecticide Active Ingredient	MDA Analytical Method	USEPA-OPP Estimated Concentration; ppb		Drinking Water Risk Benchmark; ppb	
		Surface Water (index reservoir)	Groundwater (shallow)	Acute	Chronic
Dinotefuran[a]	No	75.78 (acute) 20.97 (chronic)	5.06 (acute) 5.06 (chronic)	43,000 ($DWLOC_{adult}$) 12,000 ($DWLOC_{infants < 1 yr}$)	640 ($DWLOC_{adult}$) 180 ($DWLOC_{children 3\text{-}5 yrs}$)
Emamectin Benzoate	No	*Trunk injected. Not applicable under EAB use pattern.*			
Imidacloprid[b]	Yes Method Reporting Limit: 20 ppt (0.02 ppb)	36.04 (acute) 17.24 (chronic)	2.09 (acute) 2.09 (chronic)	3,625 ($DWLOC_{adult}$) 472 ($DWLOC_{children 1\text{-}2 yrs}$)	1,755 ($DWLOC_{adult}$) 353 ($DWLOC_{children 1\text{-}2 yrs}$) 400 (HBSL)

a. Highest and lowest values shown for non-regulatory USEPA Drinking Water Level of Comparison (DWLOC). Values based on non-cancer reference dose of 1.25 mg/kg/d (acute) and 0.02 mg/kg/d (USEPA, 2004).

b. Highest and lowest values shown for non-regulatory USEPA DWLOC (USEPA, 2005). *United States Geological Survey (USGS) non-regulatory Health Based Screening Level (HBSL) utilizes USEPA Office of Water methods for calculating non-regulatory chronic Lifetime Health Advisories* (Toccalino, 2008). *Values based on non-cancer reference dose of 0.14 mg/kg/d (acute) and 0.057 mg/kg/d (chronic).*

Table 6. Groundwater Sampling Results for Imidacloprid[a]

Sampling Study	Maximum; ppb	Additional Information and Method Reporting Limit (MRL) or Limit of Quantitation (LOQ) if reported; ppb
Minnesota Department of Agriculture: Ag land use Detections in 11 of 256 samples distributed among 9 statewide monitoring regions (2010)	1.36	MRL = 0.02
USGS: Land use ag, urban, mixed (Arthur, Chalmers, Heintzelman, & Sabbagh, 2009)	0.11 – 0.93	Median = LOQ of 0.02
Arizona Department of Environmental Quality: Detections in 16 of 88 samples (Arthur, Chalmers, Heintzelman, & Sabbagh, 2009)	0.05 – 4.1	Median = LOQ of 0.02
California Department of Pesticide Regulation (Bergin & Nordmark, 2009)	No detects	
State of Florida: Highly vulnerable soils; 7% frequency of detection > 0.3 ppb (Arthur, Chalmers, Heintzelman, & Sabbagh, 2009)	< 0.3 – 60	Median < LOQ of 0.3
Nevada Department of Agriculture (Arthur, Chalmers, Heintzelman, & Sabbagh, 2009)	No detects	MRL = 0.5
Michigan Prospective Ground Water Study: potatoes acreage (USEPA, 2008a)	3.35	*"most samples were around 0.1 ppb"*
New York Department of Environmental Conservation (USEPA, 2008a)	0.2 – 7	
Quebec, Canada: 2003, potato fields; Detections of parent and metabolites in 35% of samples (CCME, 2007)	6.4	MRL = 0.001

a. The MDA is unaware of groundwater sampling studies reporting results for dinotefuran or emamectin benzoate.

Surface Water: Environmental Fate, Potential Contamination Risk and Monitoring

As with groundwater risks, loss of EAB insecticides to surface water varies with active ingredient and method of application (Tables 3 and 4). Insecticide characteristics can present a risk for surface water through runoff. This is especially true for surface applied products that are not watered-in and followed by a rainfall event that mobilizes products in soluble or insoluble form which then wash overland into lakes, streams or rivers, or move directly to storm water drains or outfalls into surface waters. Unless spilled during use, trunk injected insecticides pose little to no risk to surface water.

Each of the active ingredients reviewed vary in their toxicity to aquatic communities.

Dinotefuran

According to the USEPA, surface waters are vulnerable to dinotefuran impacts through surface water runoff, soil erosion, and off-target spray drift. Dinotefuran's solubility has the potential to play a role in its loss to surface waters via runoff from soil drenches and granular applications that are insufficiently incorporated or watered-in after application. Due to the low adsorption potential of dinotefuran (K_{oc}values < 45), the exposure to surface water is expected to be high. The degradates that are most likely to be observed in adjacent water bodies are MNG and DN (USEPA, 2004).

Dinotefuran is practically nontoxic on an acute basis to freshwater invertebrates and fish. Chronic toxicity testing on freshwater invertebrates showed no treatment related effects. The degradate MNG was tested on invertebrates (daphnids) and does not appear to be toxic (USEPA, 2004).

Aquatic life benchmarks for dinotefuran are provided in Table 7. The MDA is unaware of surface water sampling studies reporting results for dinotefuran.

Emamectin benzoate

Emamectin benzoate is highly toxic to fish and aquatic invertebrates; however risk of exposure from tree injection cannot be estimated. There is not sufficient information about the movement of emamectin benzoate in ash trees to conduct a reasonable assessment of its expected concentrations in surface water following tree injection (Durkin, 2010). As a result, the environmental hazards[7] on the pesticide label would be most relevant to a scenario where the applicator did not properly follow the use directions (i.e. product spills from the injection site). Small amounts of emamectin benzoate could also enter the water via soil erosion or directly from falling leaves or other tree parts. However, there currently is no data on the rate of translocation or decay of this insecticide after injection; methods of exposure and risk based on fate transport, binding to the soil, and persistence are still being evaluated by USEPA[8] (USEPA, 2009a).

Aquatic life benchmarks for emamectin benzoate are provided in Table 7. The MDA is unaware of surface water sampling studies reporting results for emamectin benzoate.

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[7] The Environmental Hazard Statement on the label is the following: *This product is highly toxic to fish, mammals, and aquatic invertebrates. Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwater. This product is highly toxic to bees exposed to direct treatment or residues on blooming trees.*

[8] USEPA has requested a study on the kinetics of emamectin benzoate in trees following tree injection. According to a USDA Forest Service risk assessment, the registrant has submitted a study on residues of emamectin benzoate in pollen of cherry trees following tree injection, however, no further information is available on this study (Durkin, 2010).

Imidacloprid

USEPA has registered imidacloprid using toxicity test results for fish, aquatic invertebrates, and aquatic plants. Based on those results, the lowest benchmark reported is for chronic effects on *Chironomus tentans* (midge) at 1.05 ppb, an estimated No Observable Adverse Effects Concentration (NOAEC) from invertebrate life-cycle tests (typically 21 days or more in duration) based on the acute-to-chronic ratio for *Daphnia magna* (USEPA, 2008a). As such, USEPA classifies imidacloprid as very highly toxic to aquatic invertebrates.

Other regulatory entities may evaluate or regulate imidacloprid aquatic toxicity using different testing protocols, reporting methods, endpoint thresholds, and database uncertainty/safety factors based on unique regulatory requirements or policy objectives. The Canadian Interim Water Quality Guideline for imidacloprid effects on Freshwater Aquatic Life utilizes the Lowest Observable Effects Concentration (LOEC) of 2.25 ppb for effects measured on 15% of the test subjects (EC15), *Chironomus riparius*, and a 28-day test duration. This value is then multiplied by a safety factor of 0.1, to arrive at the interim guideline of 0.23 ppb (CCME, 2007)

Imidacloprid is considered to be practically non-toxic to fish (USEPA, 2008a).

Aquatic life benchmarks for imidacloprid are provided in Table 7. Examples of surface water sampling studies and reported results for imidacloprid are provided in Table 8.

Table 7. Analytical Method and Benchmarks for Aquatic Life Risk Screening

Insecticide Active Ingredient	MDA Analytical Method	Aquatic Life Risk Benchmark; ppb	
		Acute	Chronic
Dinotefuran[a]	No	Fish: > 49,550 Invertebrates: > 484,150 Nonvascular Plants: > 97,600 Vascular Plants: > 110,000	Fish: Data not available[c] Invertebrates: > 95,300
Emamectin Benzoate[a]	No	Fish: 87 Invertebrates: 0.5 Nonvascular Plants: > 3.9 Vascular Plants: > 94	Fish: 6.5 Invertebrates: 0.088
Imidacloprid[b]	Yes Method Reporting Limit: 20 ppt (0.02 ppb)	Fish: > 41,500 Invertebrates: 35 Nonvascular Plants: > 10,000 Vascular Plants: Data not available[c]	Fish: 1,200 Invertebrates: 1.05

a. *Aquatic Life Benchmarks for dinotefuran and emamectin benzoate are taken from USEPA's Office of Pesticide Programs (OPP) Pesticide Ecotoxicity Database. Database available online at http://www.ipmcenters.org/Ecotox/, revised May 2010, accessed April 2011. Database values adjusted using Level of Concern criteria established by OPP's Environmental Fate and Effects Division for determining potential risk to non-target organisms. See http://www.epa.gov/oppfead1/endanger/consultation/ecorisk-overview.pdf*

b. *Aquatic Life Benchmarks for imidacloprid are taken from USEPA's Office of Pesticide Programs' Aquatic Life Benchmarks webpage, available online at http://www.epa.gov/oppefed1/ecorisk_ders/aquatic_life_benchmark.htm revised February 2011, accessed April 2011.*

c. *The MDA will work with USEPA as necessary to better understand the lack of toxicity data for these endpoints.*

Table 8. Surface Water Sampling Results for Imidacloprid[a]

Sampling Study	Maximum; ppb	Additional Information and Method Reporting Limit (MRL) or Limit of Quantification (LOQ) if reported; ppb
Minnesota Department of Agriculture Detections in 2 urban stream samples of a total 52 grab samples distributed throughout the state in both urban and ag areas, and in 3 of 100 continuous samples in select urban or rural watersheds. (2010)	0.0522	MRL = 0.02
USGS: Land use agricultural, urban, mixed (Arthur, Chalmers, Heintzelman, & Sabbagh, 2009)	0.24 – 1.32	Median < LOQ of 0.02
California Department of Pesticide Regulation: 2000-05; 91 samples (Arthur, Chalmers, Heintzelman, & Sabbagh, 2009)	0.2	Median < LOQ of 0.0068
Nevada Department of Agriculture (Arthur, Chalmers, Heintzelman, & Sabbagh, 2009)	No detects	MRL = 0.5
North Dakota: Surface monitoring study 2008-10 (Orr & Gray, 2008) (Johnson & Gray, 2009) (Johnson & Gray, 2010)	No detects	MRL = 0.3
New Brunswick, Canada: 2003-05, potato field; Detections in 2 of 57 samples (CCME, 2007)	0.3	MRL = 0.2
Ontario, Canada: 2004, urban and agricultural streams; 167 samples (CCME, 2007)	No detects	LOQ = 13

a. The MDA is unaware of surface water sampling studies reporting results for dinotefuran or emamectin benzoate.

Risk to Pollinators

Ash trees are wind-pollinated and observations indicate that ash flowers are rarely visited by bees or other pollinators. Furthermore, it is unclear how much, if any, insecticide actually moves into the ash flowers. Ash flowers are produced early in the growing season and are present for only a limited number of days; thus, it is unlikely that bees would be exposed to systemic insecticide applications to control EAB on ash trees (Hahn, Herms, & McCullough, 2011).

Nevertheless, imidacloprid, dinotefuran, and emamectin benzoate are all highly toxic to bees. Studies with ornamental plants have shown that imidacloprid translocates from the soil to pollen and nectar of flowering plants (USEPA, 2010b). In these studies with ornamentals, detectable residues were found in flowers and leaves as long as 540 days after application to the soil (USEPA, 2008a). In July 2010, the USEPA amended its data requirements and the Final Work Plan (FWP) for the registration review of imidacloprid to include protocol-based exposure data in pollen, nectar, and leaves on various crops. These studies are intended to provide information on the levels of imidacloprid that may be found in different plant parts and which may lead to exposure to insect pollinators (USEPA, 2010b). To accommodate these additional studies, the USEPA amended the registration review schedule for imidacloprid. A final registration decision on imidacloprid is now expected Jan-Mar. 2016 (USEPA, 2010a).

Although potential pollinator exposure is always a concern, it may be greatest when insecticides are applied as a canopy foliar spray. Most neonicotinoid insecticide products (i.e., imidacloprid and dinotefuran) labeled for EAB control restrict the use of any canopy foliar sprays; however some labels may still list this use in the marketplace. Canopy foliar spray products containing the pyrethroid, bifenthrin, may also list EAB. Pesticide applicators can lessen any risk to pollinators by avoiding foliar sprays around flowering plants that are highly attractive to pollinators. Flowering plants that are pollinated by bees or other insects should not be planted immediately adjacent to (or should be removed from nearby) ash or other trees that will be treated with systemic insecticides applied to the soil, as they may absorb insecticide. (Hahn, Herms, & McCullough, 2011). Many current labels for EAB insecticide products include bee hazard statements that prohibit applications when plants are flowering and bees are in the area. It is important to read all pesticide labels carefully for language on how to protect pollinators. The USEPA has established a Pollinator Protection Team and developed a strategic plan to help coordinate and organize federal efforts.[9]

There has also been concern recently about the potential role of neonicotinoid insecticides in colony collapse disorder (CCD). Research is ongoing by the USEPA and USDA to investigate the relative effects of pesticides, bee pathogens and parasites, and nutrition on honey bee health;[10] as of yet no single definitive cause of CCD has been identified (Hahn, Herms, & McCullough, 2011). Furthermore, the extent to which pesticides such as imidacloprid may be involved in CCD is uncertain. Diseases and varroa mites continue to be the predominate factors associated with declines in managed honeybee populations (USEPA, 2011c). The USEPA continues to advance its regulatory and scientific approaches to ensure that honey bees and other pollinators are protected, and if scientific information shows a particular pesticide is posing unreasonable risk to pollinators, the USEPA is prepared to take necessary regulatory action. Given the concern about the neonicotinoid class of pesticides and protection of bees, the USEPA has accelerated the re-evaluation of these pesticides in the registration review program (USEPA, 2011a).

Risk to other Terrestrial Non-target Organisms

There is potential for risks from the use of EAB insecticides to other terrestrial non-target organisms (e.g. birds, mammals, and terrestrial invertebrates). The USEPA has conducted standard risk assessments for soil-applied and spray applications of imidacloprid and dinotefuran.

According to USEPA's most recent review, imidacloprid appears to be moderately toxic to birds on an acute level (152.3 mg/kg). Chronic toxicity data show that imidacloprid exposure can result in egg shell thinning and a decrease in adult weight (USEPA, 2008a). Current USEPA risk assessment data does not provide any additional insight into the potential risks for birds from soil-applied imidacloprid treatments on ash trees. Systemic insecticides are transported within the vascular system of the tree, reducing drift to non-target sites, resulting in minimal exposure to non-target organisms such a birds.

There is currently no approved risk assessment model or standard methodology that would allow the USEPA's Environmental Fate and Effects Division (EFED) to estimate animal exposure to a pesticide resulting from ingestion of material from tree injected insecticides. Research in this area, however, is attempting to quantify such exposures and their ecological significance.

The most likely exposures to non-target organisms following injection of emamectin benzoate to ash trees would involve the consumption of bark, stem tissue, seeds, or leaves (Durkin, 2010). A recent EFED ecological risk assessment for emamectin benzoate used as a tree injection insecticide indentified

[9] See http://www.epa.gov/opp00001/ecosystem/pollinator/plan.html
[10] See http://www.epa.gov/pesticides/about/intheworks/honeybee.htm

potential risks to birds, mammals, and terrestrial invertebrates, suggesting that translocation of a small fraction of insecticide from the site of injection to edible portions of the tree may result in effects that exceed levels of concern. These risk estimates were based on screening-level estimates of exposure and will require submission of multiple studies to refine any risks to terrestrial non-target organisms (USEPA, 2009a).

Label Review

As part of any special registration review, the MDA looks carefully at product labels to gain the best possible understanding of what USEPA has approved of, what product distributors are including in their labels, what applicators are reading, and where there may be opportunities for label clarification, education and outreach. For this review, the MDA focused on label enforcement and compliance concerns for insecticides labeled for EAB control containing imidacloprid, dinotefuran or emamectin benzoate. Problems were also identified with label interpretation, consistency, and compliance, including multiple inconsistencies with distributor labels.

Label Restrictions, Compliance and Use Guidance

The MDA has fielded a number of questions from certified pesticide applicators, arborists and tree care professionals in regard to understanding the use limits provided on EAB insecticide product labels. Pesticide applicators have also requested pesticide misuse investigations regarding annual per acre use limits on labels. Other parties have contacted MDA regarding potential environmental impacts from EAB insecticide use, expressing concerns over potential misuse in Minnesota. All of this has given rise to confusion over how to comply with federal labels for common EAB insecticides. Since 2009, the MDA has sought to offer clarification over these questions and concerns.

Imidacloprid and dinotefuran product labels explicitly limit the amount of active ingredient (a.i.) that can be applied per acre in a given year[11] when using soil-applied or basal trunk spray application methods, as follows:

- <u>Label language for soil and basal trunk applied **dinotefuran** products:</u>
  Do not apply more than 0.54 lb of active ingredient per acre of nursery, landscape or forest per year.

- <u>Label language for soil applied[12] **imidacloprid** products:</u>
  Do not apply more than 0.4 lb of active ingredient per acre per year.

The MDA has confirmed with the USEPA that the annual per acre use limit included on soil-applied products covers all sites and use patterns associated with product use as noted on USEPA-approved labels (USEPA, 2009c) (USEPA, 2010c) (USEPA, 2011b). The USEPA also confirmed that label directions and restrictions for per tree use limits are related to the individual tree. The USEPA confirmed that applicators are responsible for reading and following the label, including restrictions pertaining to use on/in a treatment area and the establishment of individual acre (or fraction thereof) treatment areas by using legal boundaries of a property. Although the label does not clearly outline specific compliance strategies, USEPA confirmed that annual per acre and per tree use limits cannot be increased based on

[11] Non-professional/ homeowner products containing imidacloprid or dinotefuran may not limit the amount applied per acre per year. Read individual product labels carefully before use.
[12] Excludes tree injection products.

documented or assumed use of a product on adjacent or non-adjacent properties and trees. The MDA is charged with enforcing federal labels and cannot be less restrictive than USEPA in enforcing annual per acre use limits, regardless of perceived need, convenience, or operational efficiency of various treatment methods.

These limits were established by USEPA as a result of proposed product use, and are supported by ecological risk assessments (aquatic organisms and non-target terrestrial animals, including pollinators) and human health risk assessments (drinking water, food tolerances from all imidacloprid uses, and applicator exposure) based on registrant-submitted data and negotiated risk mitigation during label development. Labels containing annual per acre use limits for soil applications have included these limits since initial product registration.

The MDA periodically reviews pesticide labels in response to applicator concerns about compliance and occasional confusion regarding the intent of federal labels. These label reviews often result in the development of additional compliance communications and guidance meant to help applicators and educators. In developing these compliance communications, it is MDA's intention that they not be viewed as labeling, or be consulted by applicators as an alternative to reading the label. Additionally, MDA guidance does not contain additional use restrictions beyond those approved by the USEPA during product registration. Rather, guidance offers examples, illustrations, definitions and suggested approaches, based on discussions with USEPA, to complying with the label.

The MDA began reviewing EAB insecticide product labels and use requirements in early 2010. In June 2010, after conferring with the USEPA, the MDA sent notification to over 1,900 commercial pesticide applicators regarding how to comply with EAB insecticide labels for products containing the active ingredient imidacloprid. In the notification, the MDA outlined a basic approach to complying with application limits, using one-acre units of property as a guide.

In 2011, in response to requests from applicators, the MDA began to build off of the June 2010 notification, and developed draft use guidance that offered additional advice to help applicators comply with USEPA label use limits. While there might be multiple ways for an applicator to comply with label instructions, the guidance provides helpful illustrations of how an applicator might achieve label compliance, including how one-acre units can be defined. The guidance also assists applicators with calculations and conversions that do not accompany the federal or state registered labels.

On March 9, 2011 the MDA sought comment on the draft guidance, distributing it to organizations engaged in marketing, application, or outreach related to EAB control. After a two-week comment period, the MDA received comments both supportive and critical of the guidance. During this time, the MDA also had conversations with tree care industry personnel, educators, federal agencies and regulators. Comments were received from arborists and representatives of the tree care industry (including registrants of products mentioned in the draft guidance). Comments were also submitted by university extension personnel, federal agency staff, city foresters and others.

In May 2011, the MDA met with stakeholders interested in sharing their concerns about the draft guidance. Subsequent communications between MDA and members of the tree care industry have led to potential consideration of additional refinements to the draft guidance.

The MDA will continue to develop this and other use guidance, as applicators continue to approach the MDA with compliance questions.

Distributor Label Consistency Issues

As a component of this special registration review, labels for EAB pesticide products containing dinotefuran, emamectin benzoate and imidacloprid were reviewed for consistency and compliance. Recent container labels, including labels on file with MDA, were compared with the most current stamped EPA labels available on EPA's pesticide product label system (PPLS). The majority of issues identified were for products containing imidacloprid.

An initial search of imidacloprid product labels discovered that there were two reoccurring inconsistencies with labels where EAB is listed as a target pest: (1) Differences between labels catalogued in USEPA's pesticide product label system (PPLS) and labels catalogued by MDA as part of state registration procedures, and (2) The listing of EAB under foliar spray applications.

Initially, all pesticides in MDA's database that listed imidacloprid as an active ingredient on the label were reviewed. Labels from both USEPA's PPLS database and MDA's database were first examined for the inclusion of EAB as a pest controlled, and then if EAB was listed under foliar spray applications. The results of this search are summarized below.

Inclusion of Emerald Ash Borer on Imidacloprid Labels

The PPLS label database contains 62 imidacloprid products labeled for EAB control, while the MDA label database has 60 products that are labeled for EAB control.

There are 10 instances in which EAB is listed in the PPLS label, but not listed in the MDA label database. If the USEPA approves the listing of EAB on a label, it is not a requirement for registrants to include that listing. The concern for the MDA is the following: If registrants have updated their USEPA approved label, but have not updated their MDA registered label, there is a potential for confusion during compliance and enforcement activities. Of the 10 labels that have EAB listed on the PPLS label and not on the MDA registered label, a cursory internet search has shown that three of these labels have EAB listed on a newer version of the label.

There are eight instances in which EAB is listed on the MDA registered label, but not listed on the PPLS label. These discrepancies are of greater concern, since the labels on file with MDA could be considered out of compliance with USEPA-approved labels. If EAB isn't listed on a USEPA-approved label, it cannot be listed on the MDA registered label. In two of the eight instances, an internet search shows a new label without EAB listed. Two other instances of this discrepancy are from labels that are most likely not being updated by the manufacturer or distributor because they are likely no longer being marketed in Minnesota. The remaining four products are potentially out of compliance, as no internet search has revealed an updated label compared to the label found in MDA's database.

It is incumbent on the registrant to submit updated labels to the MDA. The MDA must have labels on file that are consistent with the USEPA PPLS database.

Application of a foliar spray to control EAB

USEPA has requested that certain product labels be amended to remove foliar spray applications for the treatment of EAB. In a July 2010 letter to a pesticide registrant, USEPA states:

Foliar applications are not appropriate for the treatment of borers.[13] *These pests may be retained within the SOIL APPLICATION section of the label.*

There is one PPLS label and three MDA labels that list EAB under foliar applications. Of the three MDA labels, there is only one that is compliant with the PPLS label. The other two MDA labels do not match the language in the PPLS label and thus could be considered out of compliance.

Labels for dinotefuran and emamectin benzoate were also searched, but there were no major discrepancies found.

EAB Pesticide Product Marketing Materials

There is a legal requirement that all pesticide product marketing materials, including those distributed online, be consistent with USEPA stamped labels. The MDA has begun a review of EAB marketing materials and has already identified materials in potential need of adjustment to be legally compliant with state and federal regulations

Conclusions of Review and Opportunities for Action

The emergence of EAB in Minnesota presents enormous environmental and economic challenges to preserving and protecting ash trees. With the emergence of new invasive insects accompanied by the available number of insecticide options, protecting all high value trees in an area can be challenging. A variety of available insecticides and application methods can help arborists and homeowners manage EAB within the framework of legal product use while accounting for annual per acre use limits.

The MDA takes seriously its responsibility to consider important, defensible scientific research in the regulation and review of pesticides. Therefore, in developing conclusions for this review, the MDA conducted extensive literature reviews and worked with researchers, regulators and educators. The MDA will continue to work with agency partners to evaluate potential adverse effects from the widespread use of EAB insecticides, as described in this review. As EAB research progresses, costs and methods of treating trees will continue to change. The MDA is committed to staying current on these treatment options, associated pesticide labels and USEPA registration review decisions. Additionally, the MDA will continue to evaluate the potential for unreasonable adverse effects on man and the environment as a result of EAB insecticide use.

To conclude this registration review, the MDA has identified the following issues related to the prevention, evaluation, and mitigation of EAB insecticide impacts:

- State registered insecticide labels, collateral labeling and online pesticide product marketing materials are not always consistent with USEPA stamped labels and are in need of review for accuracy to be legally compliant with state and federal regulations.

- Many EAB insecticide products containing imidacloprid and dinotefuran have annual use limits and use directions that are not readily understood by applicators. Continued development of use guidance will help applicators and others comply with label directions and minimize environmental impacts, all while meeting tree treatment objectives.

[13] Borers include Emerald Ash borer, Two-lined Chestnut borer, Bronze birch borer, and Asian longhorned beetle.

- Education and outreach materials for both homeowners and professional applicators on EAB control and potential environmental impacts would help to protect water resources and pollinators. The MDA will continue to examine what types of application scenarios will most likely lead to water quality impacts and pollinator exposure.

- The MDA Laboratory Services Division does not currently have an analytical method for dinotefuran and its degradate MNG, despite label recommendations to periodically monitor shallow groundwater in the use area. Dinotefuran sales and use can be reviewed to assess the need for MDA analytical method development or other analytical solutions.

- Continued water monitoring for imidacloprid in urban streams will be helpful in evaluating any impacts from any increased use of imidacloprid EAB insecticide products.

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