Systemic Insecticides and EAB: Products, Costs and Benefits

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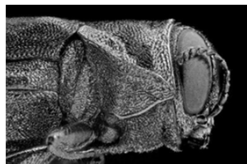Michigan State University

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Special thanks to:

Emerald ash borer is the most destructive & costly forest insect to ever invade North America

≈1990: EAB becomes established in SE Michigan *Siegert et al. 2014*

2002: EAB "discovered" & identified as *Agrilus planipenni*s

2018: EAB in 35 US states & 5 Canadian provinces

www.emeraldashborer.info

US: Economic costs of EAB exceed $1 billion every year

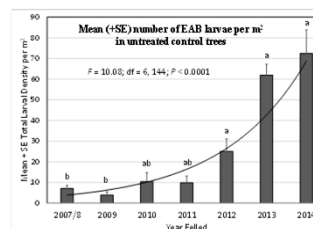Annualized marginal damages in millions of USD

	Government		Households		Timber
	Federal	Local	Spent	Property values	Private land
EAB	38	850	350	380	60
Gypsy moth	33	50	46	120	5
Hemlock adelgid	4	66	44	100	1

Kovacs et al. 2010. Ecol. Econ; Aukema et al. 2011. PLoS One

Municipalities & homeowners bear major economic costs

Ann Arbor, MI   Flint, MI   Kenosha, WI

Lansing, MI   Chicago, IL
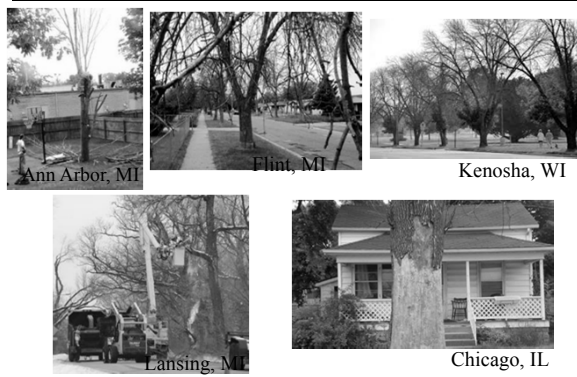
Density of EAB builds slowly, then exponentially. Most ash trees decline & die over 2 to 4 years (the "death spiral")

Mean (+SE) number of EAB larvae per m² in untreated control trees

$F = 10.08; df = 6, 144; P < 0.0001$

Ash are resilient & tolerate low densities of EAB larvae

External signs of EAB at 25-30 EAB larvae per m²
Anulewicz et al. 2007

On average, 89 EAB adults develop per m² ash phloem
McCullough & Siegert 2007

MSU data - 32 ha Jasper site
McCullough et al. 2018

Landscape ash trees that are not protected with effective insecticides are nearly always killed by EAB.
Dead trees are hazards. Tree removal is costly & unpleasant.

Ohio

Michigan

Minnesota

Michigan

Early efforts to protect ash trees from EAB with systemic insecticides yielded inconsistent results.

Few products were available (bidrin, imidacloprid) & application technology was relatively primitive.

Insecticide translocation, distribution or persistence in trees was not well understood.

Treated trees often died 2-3 years after untreated trees.

Our ability to protect ash trees from EAB has improved tremendously in the past 8-10 years

Insecticide products & chemistry

Systemic insecticide options

| Active ingredient	Treat
Emamectin benzoate Ex: TREE-äge - trunk injection (2010) Other products – probably similar (?)	3 years
Azadirachtin TreeAzin, Azasol - trunk injection (2010) Organic material approval	1-2 years
Dinotefuran - basal trunk sprays (2010) Safari, Xytect	1 year
Imidacloprid Many products – but efficacy varies! Usually applied as a soil drench	1 year

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Our ability to protect ash trees from EAB has improved tremendously in the past 8-10 years

Products & chemistry:
    Emamectin benzoate (2010)
    Dinotefuran basal trunk sprays (2010)
    Azidirachtin (2010)
    2x imidacloprid products (2010)

Application methods: trunk injection, basal trunk sprays (dinotefuran), soil drench (imidacloprid, dinotefuran)

Systemic insecticide products & application methods are much improved compared to early days of EAB
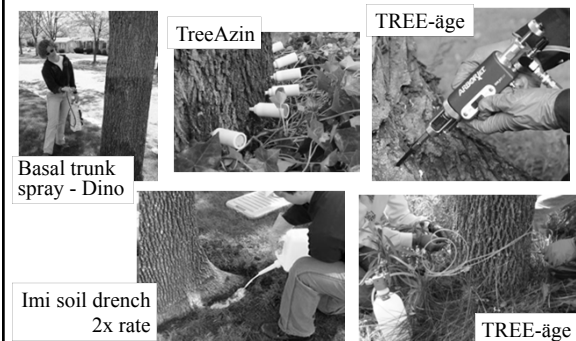
TreeAzin

TREE-äge

Basal trunk spray - Dino

Imi soil drench 2x rate

TREE-äge

Our ability to protect ash trees from EAB has improved tremendously in the past 8-10 years

Products & chemistry:
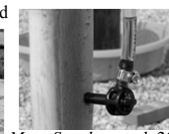   Emamectin benzoate (2010)
      Dinotefuran basal trunk sprays (2010)
      Azidirachtin (2010)
      2x imidacloprid products

Application methods: trunk injection, basal trunk sprays (dinotefuran), soil drench (imidacloprid, dinotefuran)
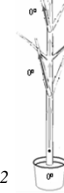
Ash physiology: systemic insecticide transport, distribution & persistence within trees

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Physiology of ash species; response to fertilization & plant growth regulators; Systemic insecticide transport
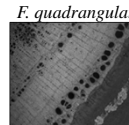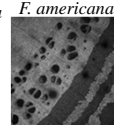
^{14}C labelled imidacloprid
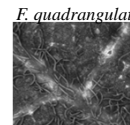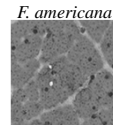

Mota Sanchez et al. 2009

Tanis et al. 2012

F. quadrangulata *F. americana* *F. quadrangulata* *F. americana*

Tanis et al. 2015b

How to exploit EAB life cycle & host preference
(e.g., spring applications control EAB adults + larvae)

Systemic insecticides applied in early summer control EAB adults, as well as larvae


Leaf feeding

➢Beetles feed on ash leaves for 5-7 day before mating begins
➢Females feed another week or so before egg-laying begins.
This provides a key opportunity to control adults before any eggs are produced.
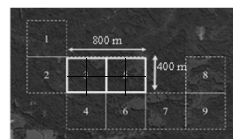

Emamectin benzoate (e.g., TREE-äge): Highly effective for EAB; 3 years of protection at low application rate.
Bick et al. 2017; Lewis & Turcotte 2015; Smitley et al. 2017; McCullough et al. 2011, 2016, 2018, others….

Control

TREE-äge
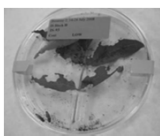
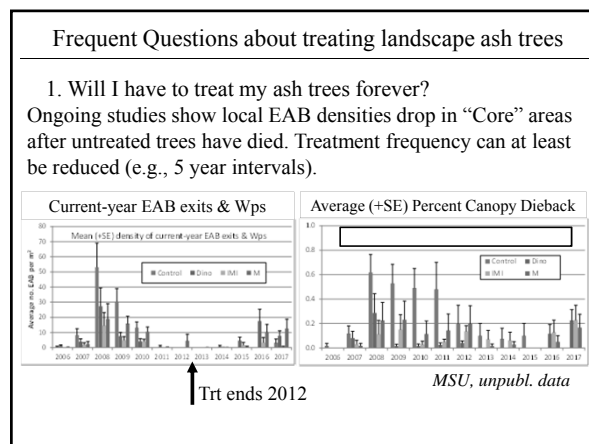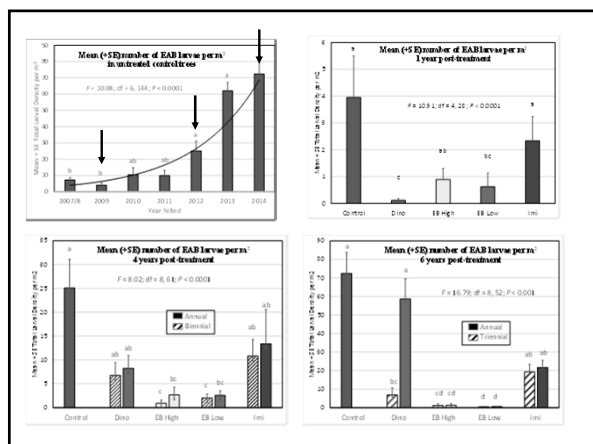
Systemic Insecticides – MSU Jasper Study

➢32 ha forest; 8 blocks; 28 green ash trees per block
➢Trees treated annually, at 2-year intervals or at 3-year intervals for 6 years (2008-2013)
➢Treatments: Controls, Dino trunk spray, Imi (injected),
      EmBen low rate (Quik Jet), EmBen high rate (Tree IV)
➢Trees felled & debarked annually in late winter, 2009 to 2014.

McCullough et al. 2018

1. Will I have to treat my ash trees forever?
Ongoing studies show local EAB densities drop in "Core" areas after untreated trees have died. Treatment frequency can at least be reduced (e.g., 5 year intervals).

Current-year EAB exits & Wps	Average (+SE) Percent Canopy Dieback

Trt ends 2012

MSU, unpubl. data

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2. When is it too late to treat trees?
Once canopy transparency or canopy dieback > 60%, trees are not likely to recover *(MSU 2009-2018 data)*.
Obvious symptoms of EAB on the lower trunk indicate trees are too infested to transport systemic insecticides.

Bark crack & WP hole at eye level

Severe canopy decline

Epicormic sprouts on trunk

Information on insecticides for protecting ash trees from EAB is available for free at www.emeraldashborer.info

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Why consider using insecticides to control EAB?

Economics!

Projected costs of proactive or reactive removal of landscape trees are consistently greater than costs of systemic insecticide treatment (assuming TREE-äge at 2-yr intervals).

✓Kovacs et al. 2014. Res. Energy & Econ.
✓McCullough & Mercader. 2012. Int. J. Pest Mgmt.
✓McKenney et al. 2012. Arboric. & Urban For.
✓Sadof et al. 2017. Arboric. & Urban For.
✓Vannatta et al. 2012. J. Econ Ent.

Treatment versus Removals

Proactive removal: Loss of healthy trees angers residents, Loss of shade trees & urban canopy; Property values & neighborhood aesthetics are diminished

Reactive removal: Declining, dying & dead trees are legal liabilities; Dead ash are dangerous for tree climbers; Rapid rate of ash mortality affects utility companies; Property values & quality of life are diminished.

Recent advances will reduce treatment costs further

➢ 3-year EAB control with emamectin benzoate
➢ ArborJet Quik Jet Air tool
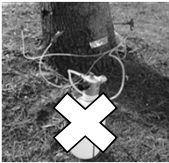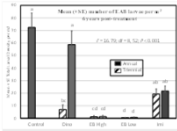
Economics strongly favor treating ash trees; less costly & disruptive than removals

Before   After

Other benefits to consider – Ecosystem Services

Protecting healthy landscape ash trees retains ecosystem services provided by those trees:

   Stormwater capture   Property values   Shade
Pollutant, ozone & carbon capture   Erosion prevention

The larger the tree, the more stormwater it can manage.
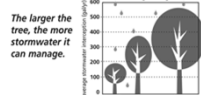
Additional benefits of protecting urban ash trees

Predictable treatment costs allow for long-term planning & labor stability. Avoids catastrophic "ash death curve."

Ash trees can be gradually replaced over 20-30 years to diversify the urban canopy.

Activities, such as pruning & planting, are not neglected.

Wacousta, MI

Detroit, MI

EAB & ash mortality linked to human health

Donovan et al. 2013 Relationship between trees & human health: evidence from the spread of emerald ash borer. Am. J. Prev. Med.

Donovan 2015 Tree loss associated with cardiovascular-disease risk in the Women's Health Initiative? A natural experiment. Health Place.

Jones & McDermott 2015 Linking environmental management to health outcomes: a case study of the EAB. Appl. Econ. Lett.

Jones & McDermott 2017 Health impacts of invasive species through an altered natural environment: assessing air pollution sinks as a causal pathway. Environ. Resour. Econ.

Kondo et al. 2017 Association between urban trees & crime: Evidence from the spread of EAB in Cincinnati. Landsc. Urban Plan.

Other benefits of systemic insecticide treatment

Treating even a tiny proportion of ash trees in forested sites significantly reduces rates of EAB population growth & consequently slows the rate of ash mortality.
   McCullough et al. 2015; Mercader et al. 2011, 2015, 2016

Protecting selected ash trees provides a seed source & conserves genetic diversity (examples: Native American basketmakers, PA Dept. Conservation & Natural Res.)
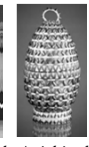
Kelly Church, Anishinabe

Integrated management of EAB increasing in urban areas. Neighborhood, municipal & regional efforts underway.

✓Inventory ash trees (size, species, condition).

✓Identify trees to protect & trees that should be replaced.

✓Trees destined for removal can be girdled in spring & used as trap trees. Intermixing girdled & treated trees is likely to be an especially effective control tactic.

✓Treat valuable trees at 3 year intervals (TREE-äge).

✓Consider classical biocontrol with Asian parasitoids.

What about the pollinators?

Ash are pollinated by wind (except *F. ornus*?)

Short period of ash flowering in early spring occurs before systemic insecticides are applied.

Diverse array of flowering plants are available to pollinators in early spring.

Webinar: EAB Management & Pollinator Safety

Dr. Reed Johnson, Dept of Entomology, Ohio State University
Research focus: Pollinator toxicology & apiculture

Download the webinar from the EAB University YouTube channel at emeraldashborer.info

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FAQs on Systemic Insecticides for EAB Control

Effects of insecticides on ground or surface water?
Impacts on aquatic organisms?

Insecticide residues in leaves that fall in autumn?

Harmful effects on honey bees? Other insects? Woodpeckers?

Do trunk injections injure trees?

Will EAB become resistant to systemic insecticides?

Available for free at emeraldashborer.info

DON'T KISS YOUR ASH GOODBYE