Pollinators and Integrated Pest Management (IPM)

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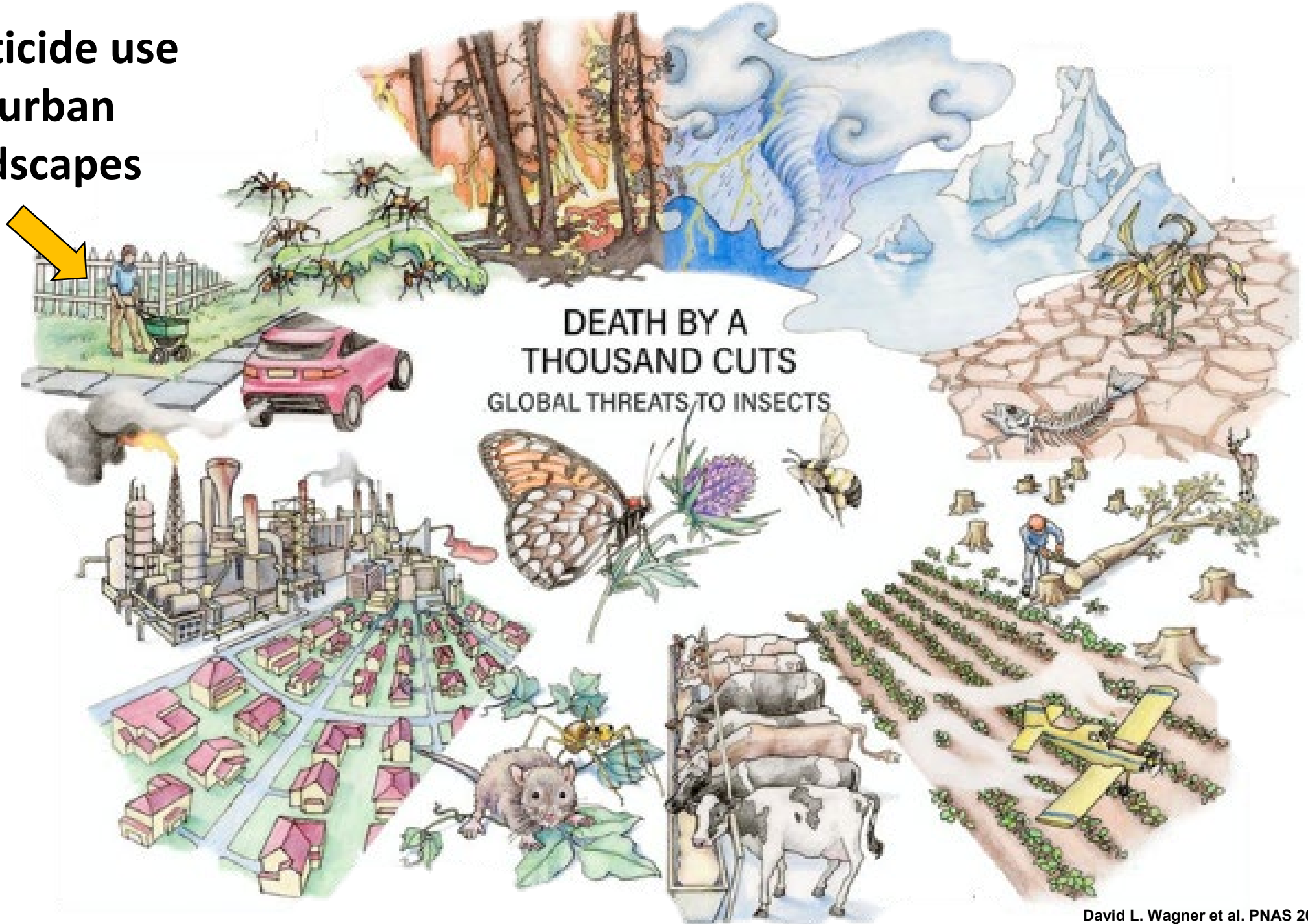
Insecticide use in urban landscapes



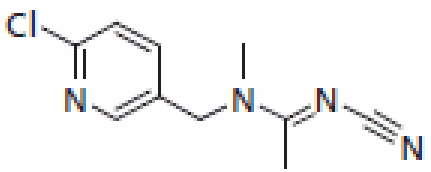
David L. Wagner et al. PNAS 2021;118:2:e2023989118

1. Bees and pesticides in urban landscapes

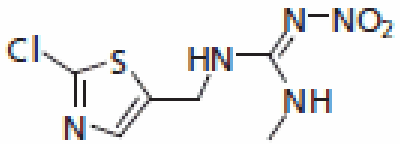
Graduate research conducted at the University of Kentucky Turfgrass & Ornamental Entomology Lab

Green industry is facing public pressure to reduce or eliminate pesticides, especially neonicotinoids

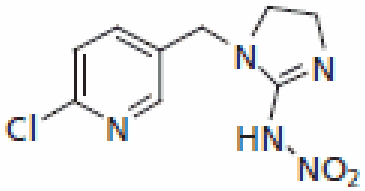
Neonicotinoids are insect-selective neurotoxins



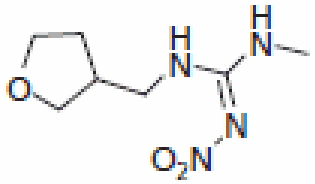
Acetamiprid



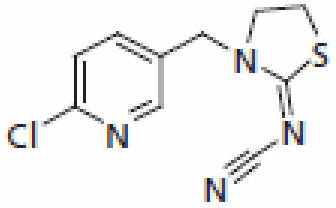
Clothianidin



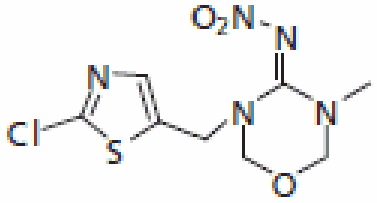
Imidacloprid



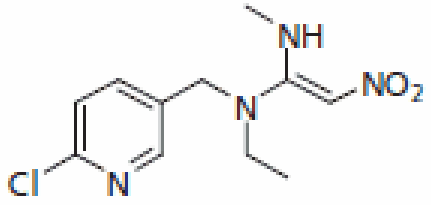
Dinotefuran



Thiacloprid

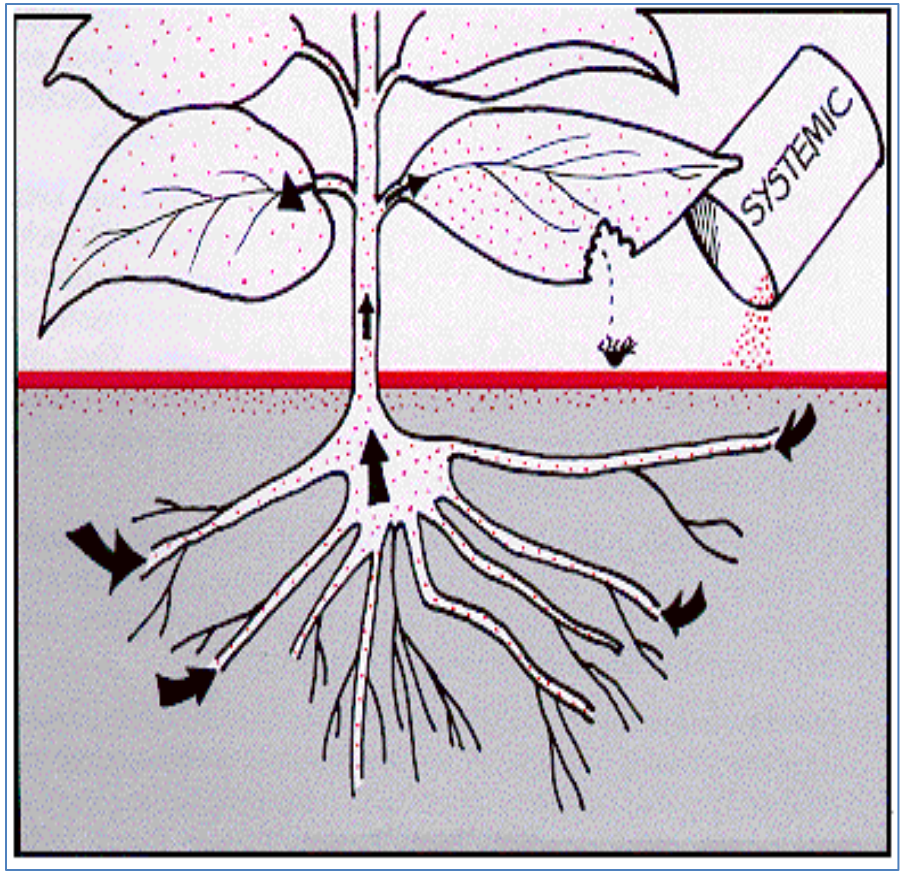


Thiamethoxam



Nitenpyram

Bees can be exposed via direct contact or through pollen and nectar



Neonicotinoids can have serious sub-lethal effects on bees

Trouble navigating and foraging

difficulty with learning and memory

all of which effect hive productivity

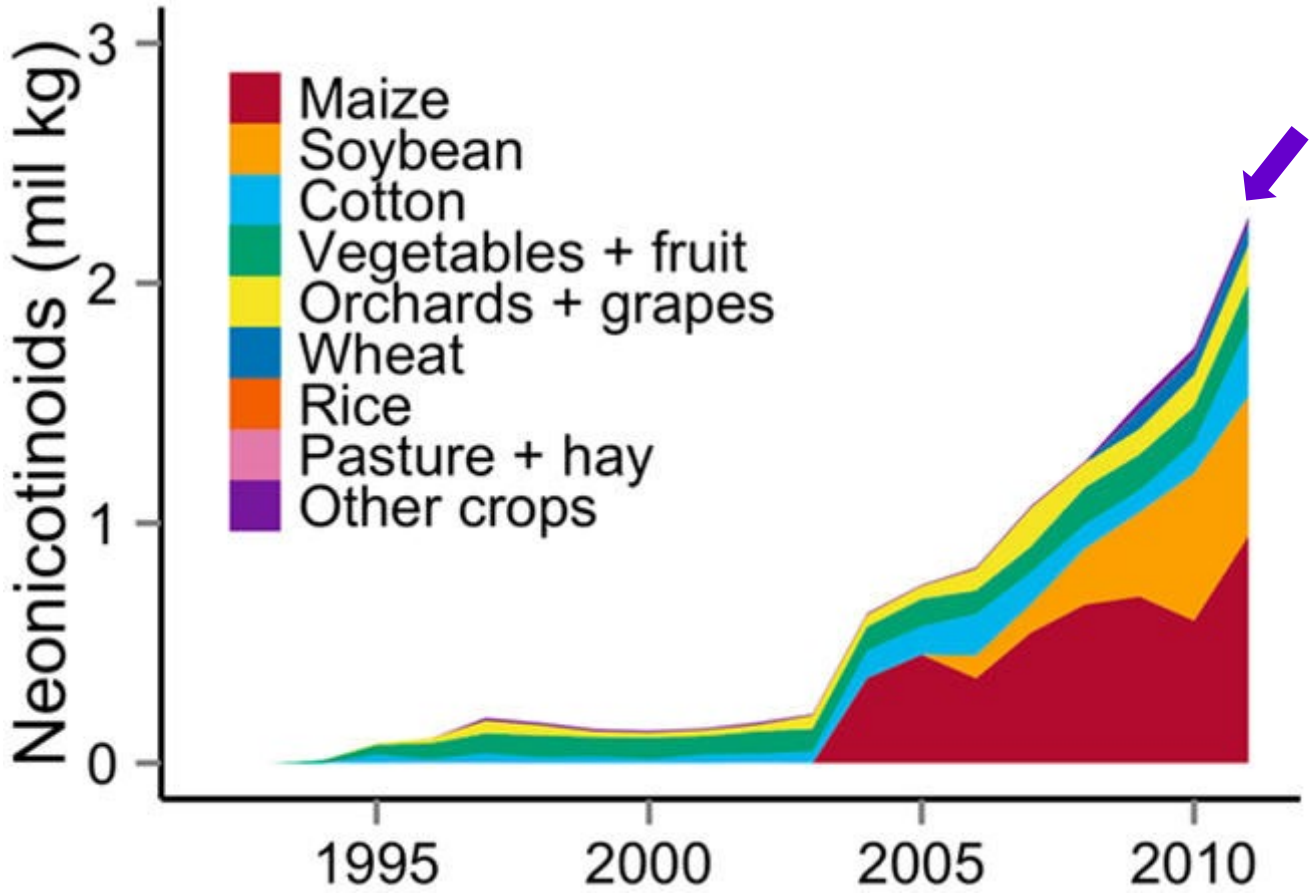
Bumble bee colonies that foraged on neonic-treated weedy turf failed to produce new queens

Non-treated or Acelepryn-treated

Neonicotinoid - treated

Larson et al. 2013 PLOS ONE

Urban landscapes represent a small fraction of neonicotinoid use



Turf, trees, shrubs (purple line)

Douglas & Tooker *Environ. Sci. Technol*. 2015

Not much data on insecticide risk in urban landscapes

Most studies focus on agricultural pesticide use (corn, soybean, etc.)

Growing number of studies on lawn insecticides

Monoculture lawns are probably not where risk to bees is highest, especially if flowering lawn weeds are managed

Flowering landscape plants likely pose the greatest risk to bees

Flowering landscape plants are often the largest floral resource in urban landscapes

Very little is published about uptake and dissipation of insecticides in flowering trees and shrubs

Misapplication of insecticides to flowering trees and shrubs can result in significant bee kills

Research Objectives

1. Compare differences in persistence between different neonicotinoid insecticides

2. Investigate whether manipulating treatment timing can reduce insecticide residues

Foster Holly
Ilex × *attenuata* ‘Fosteri’

Summersweet
Clethra alnifolia

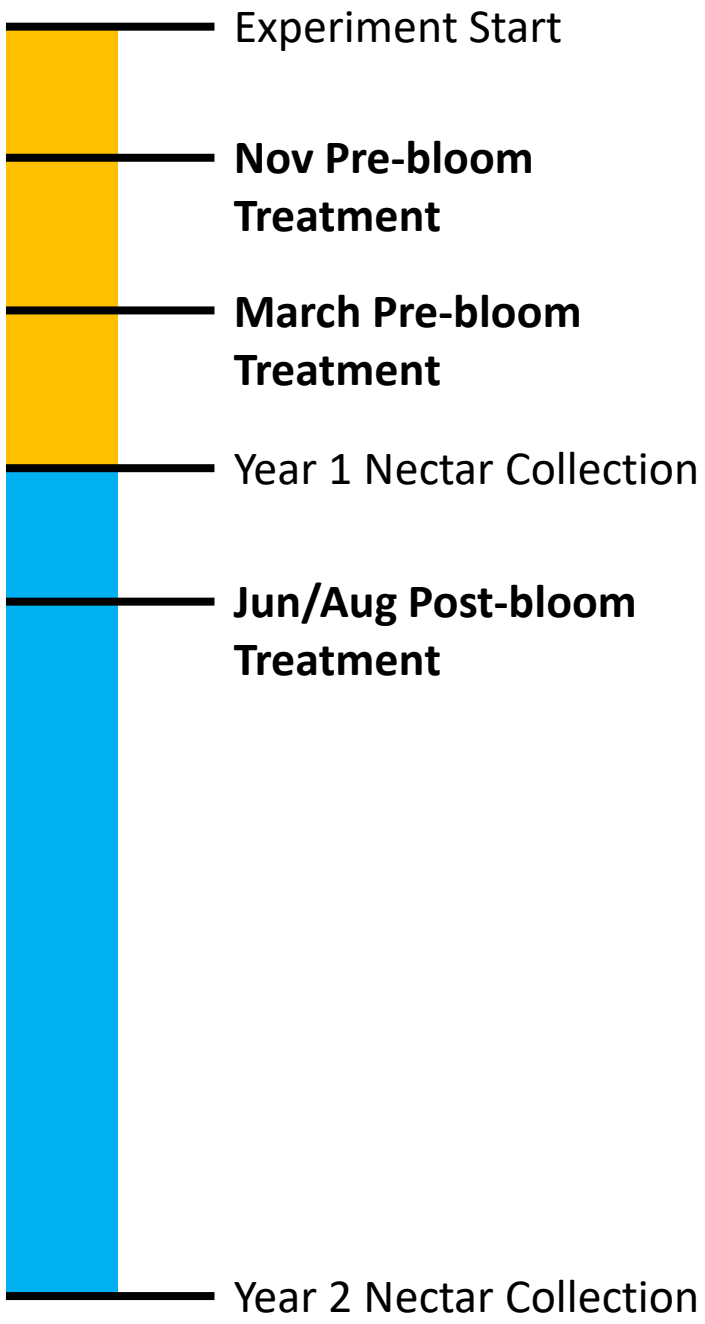
Methods – Products used

Imidacloprid (Merit 2F)

provides multiple years of protection from some foliage-feeding pests

Dinotefuran (Safari)

more water soluble and may show more rapid uptake and dissipation



Three treatment timings

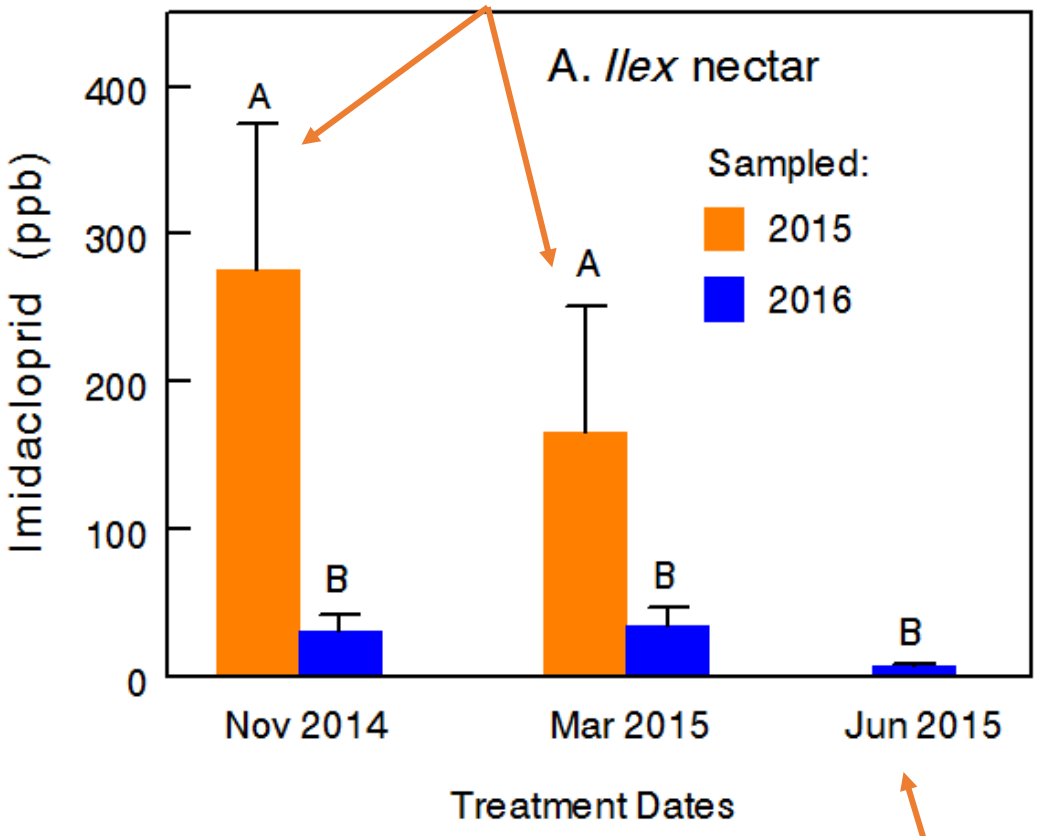
November: before bloom, “end of season” maintenance

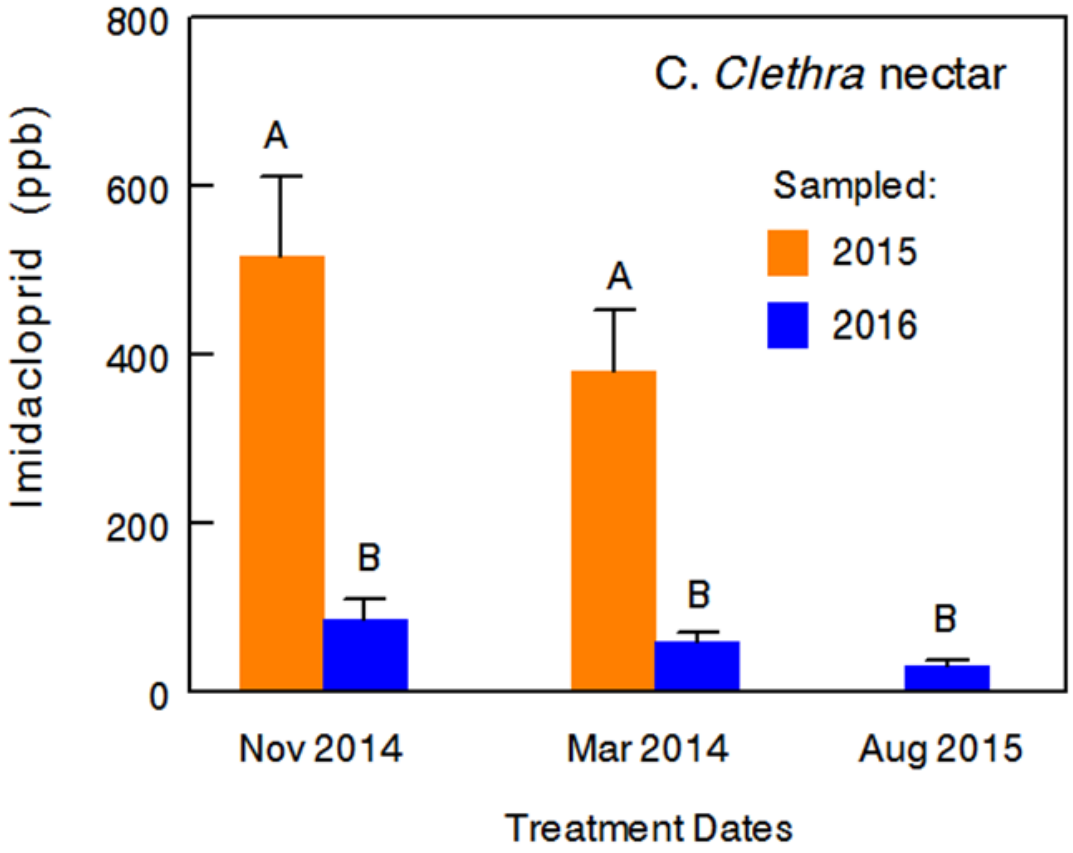
March: before bloom, “worst-case” scenario

June/August: after flowers drop, “best-case” scenario

Post-bloom application reduces imidacloprid in nectar

Autumn or spring treatment: high levels





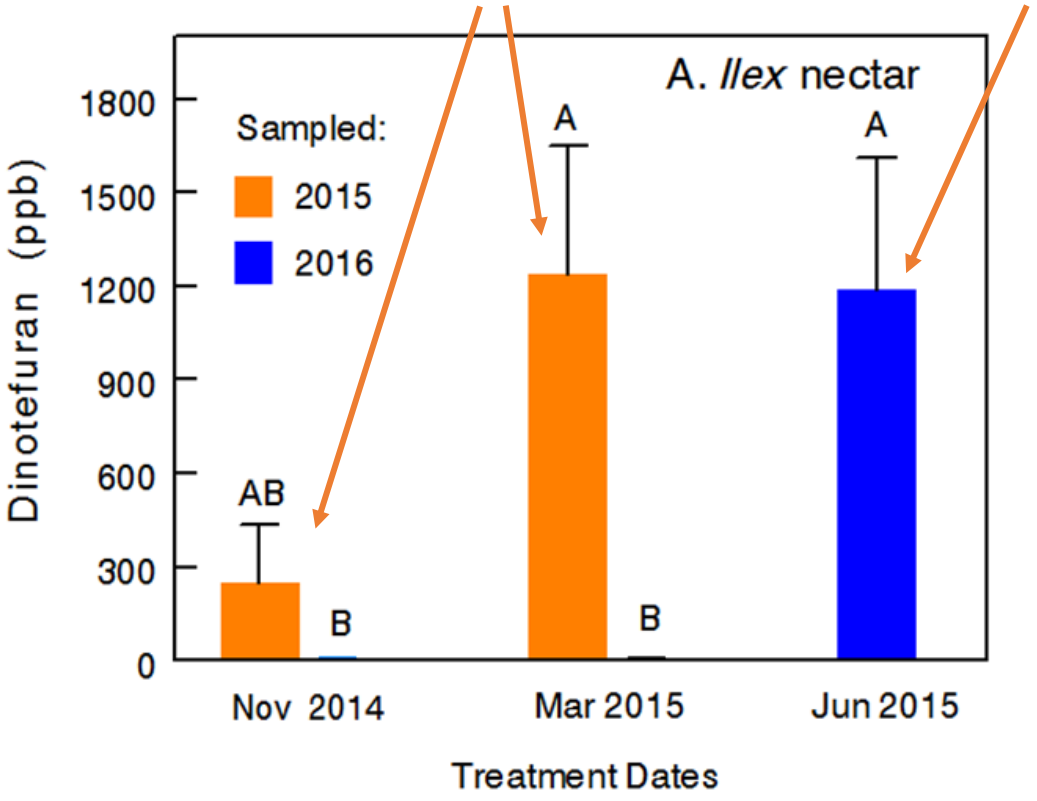
Post-bloom treatment mitigates hazard

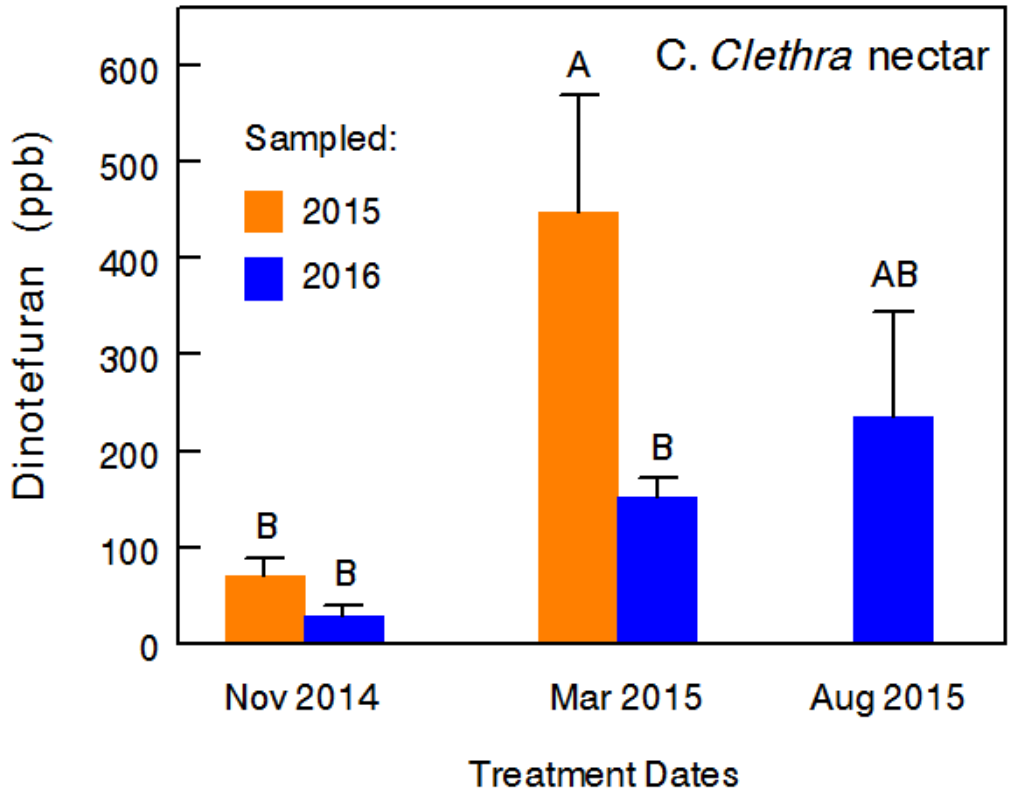
Mach, Bondarenko & Potter; Environ Tox Chem (2017)

Dinotefuran residues in nectar remained high for all treatment timings

Autumn or Spring 2015 = high levels in 2015 nectar

Post-bloom 2015 = high levels in 2016 nectar





Mach, Bondarenko & Potter; Environ Tox Chem (2017)

Key Takeaways

Avoid use on highly bee or pollinator-attractive plants

Treat soon after bloom to maximize time for uptake and dissipation of insecticide residues

When possible, prune to remove flower buds especially if treating close to bloom

Our data indicate that residues in nectar are sufficient to intoxicate individual bees foraging on treated woody plants

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But do such treatments impact pollinator health at the landscape level?

Extrapolating from residue studies to real-world hazard is difficult

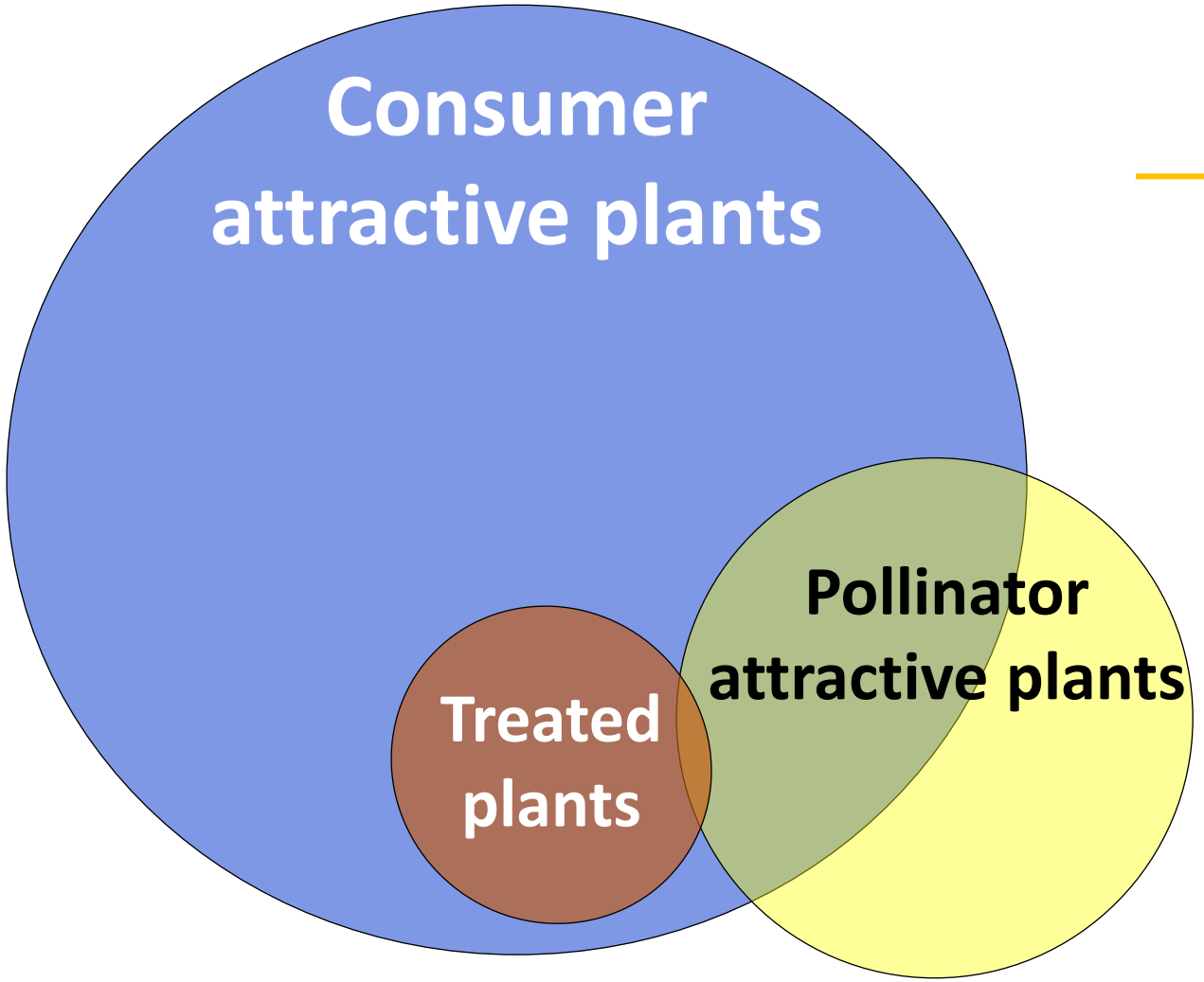
No regulatory limit has been set for residues in landscape plants

Little is known about bees' exposure to treated plants in urban settings

Even less is known about non-bee pollinators

Urban landscapes are complex networks of treated and untreated plants with diverse forage for pollinators

Relatively few plant species meet all three criteria



Many pollinator-attractive plants are relatively pest-free

Even plants with key pests can go untreated if the infestation is never noticed

Identifying high risk plants can help land managers make informed treatment decisions

Why do some pests need to be managed?

Key pests may reduce plant health or outright kill otherwise healthy plants

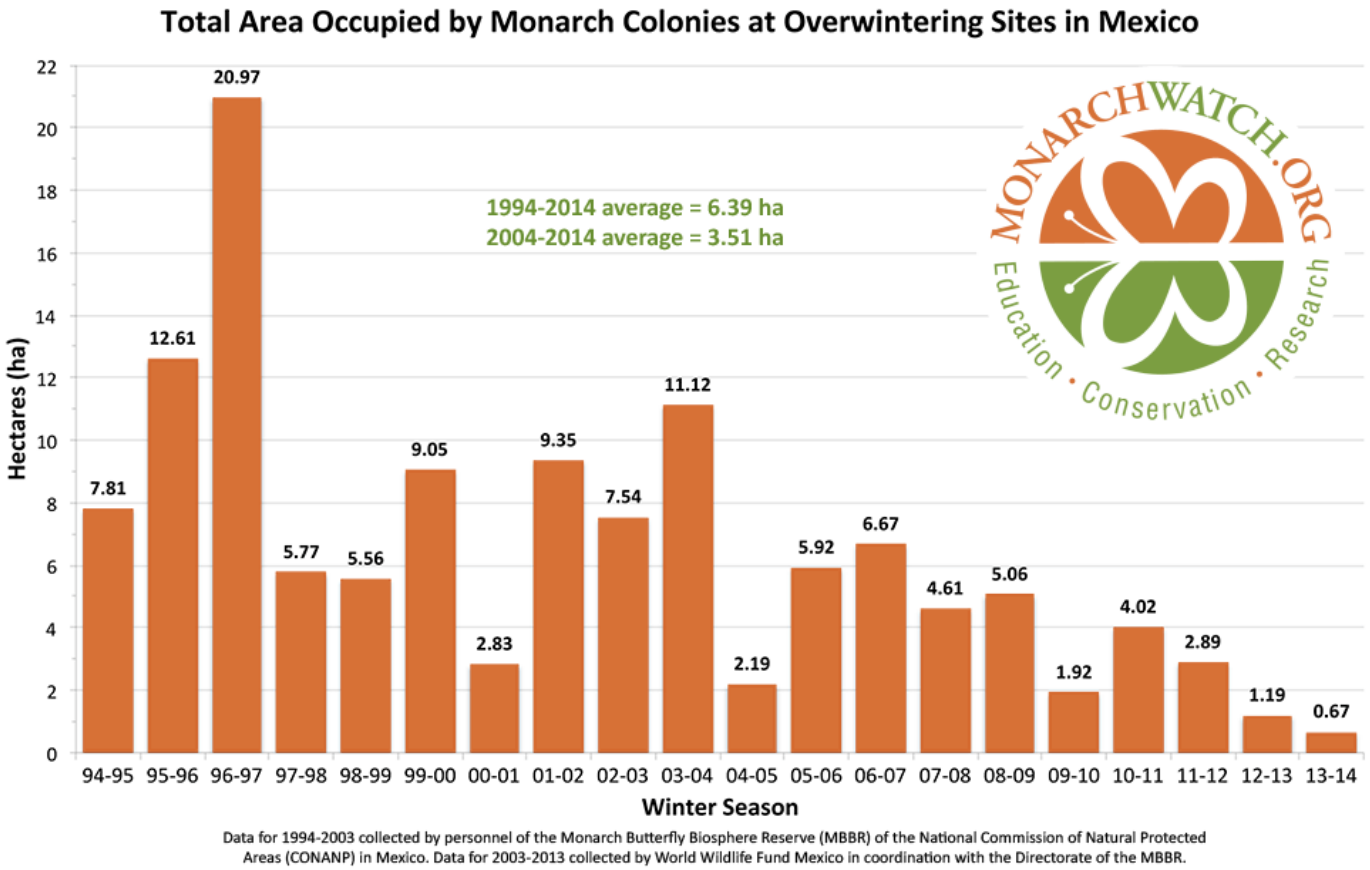
Ornamental landscape plants need to be healthy to provide maximal conservation value to wildlife

Some pests are invasive and need to be suppressed regardless of individual plant health

2. Butterflies, caterpillars, and pesticides

Current research at the University of Florida Turfgrass & Ornamental Entomology Lab

Monarch butterflies are of major conservation concern



Monarch conservation efforts focus on planting milkweed

People are planting milkweed at their homes or businesses throughout the country

Regardless of species, milkweed provides valuable resources for bees and butterflies

However, milkweed attracts key pests

Oleander aphids (*Aphis nerii*) are a key pest of milkweed

Severely reduce plant quality

Cause honeydew, sooty mold, leaf chlorosis, senescence, and plant death

Reduce flower production

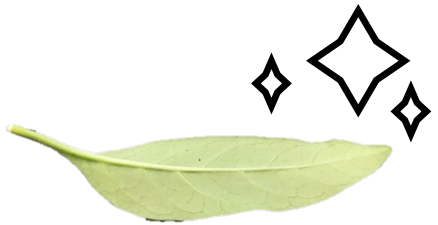
Infested and damaged milkweed is difficult to sell

Do oleander aphids affect monarch conservation efforts?

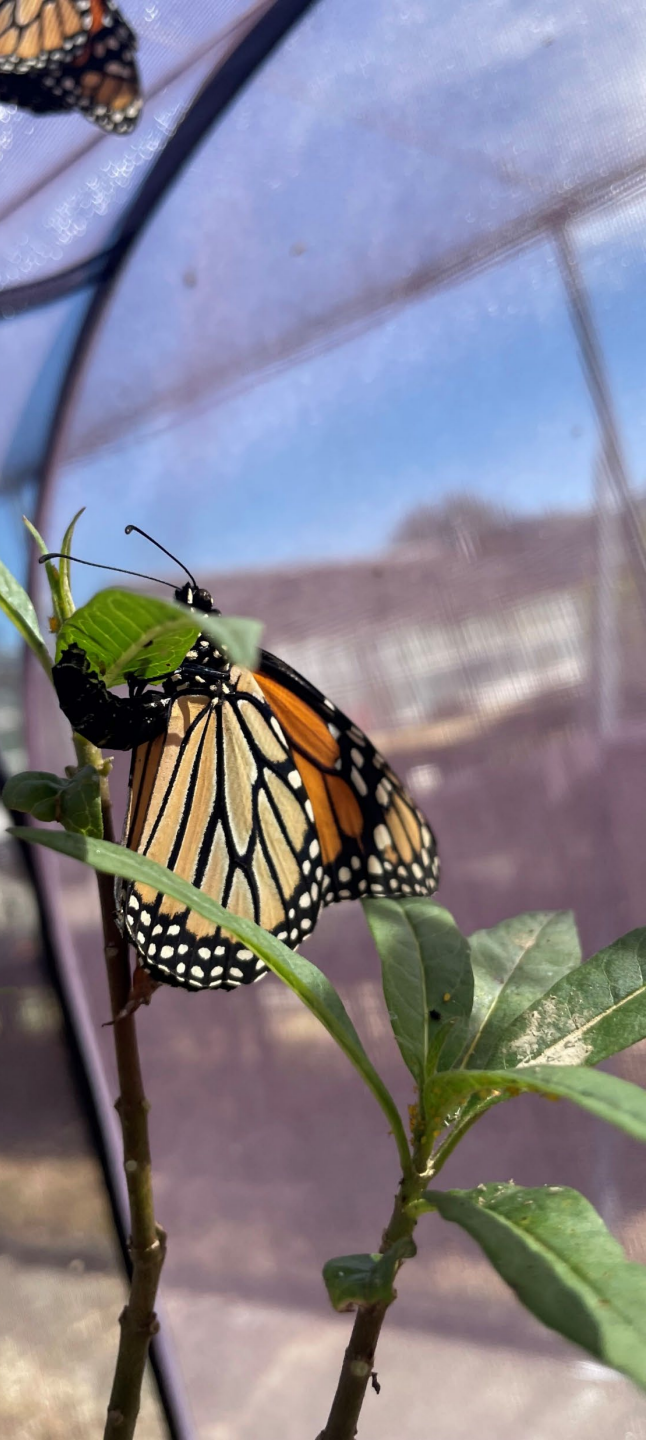
1. Compared monarch larval life history traits when reared on milkweed with:

A. High aphid density

B. High aphid density but cleaned



C. No aphids



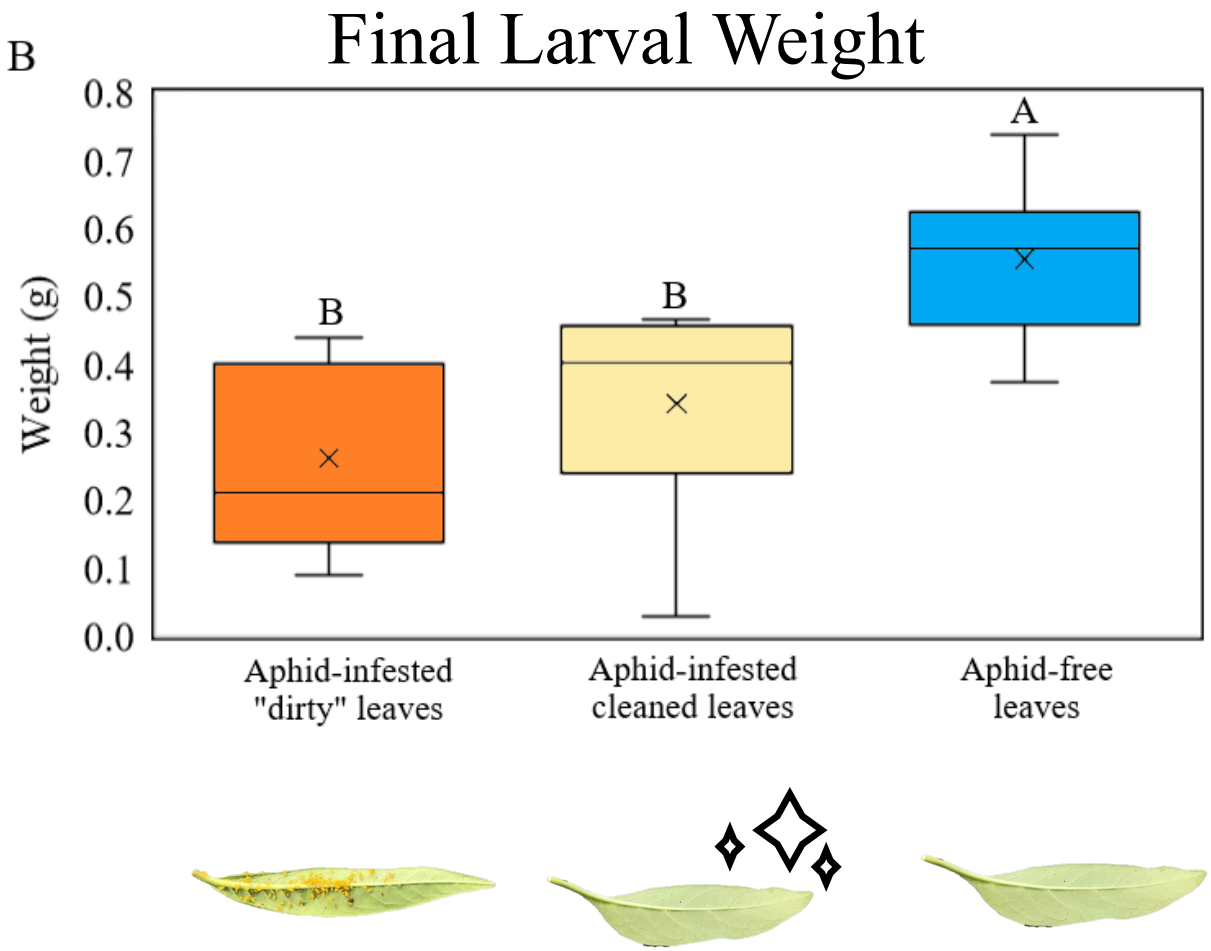
Do oleander aphids affect monarch conservation efforts?

2. Compared number of monarch eggs laid on milkweed with:

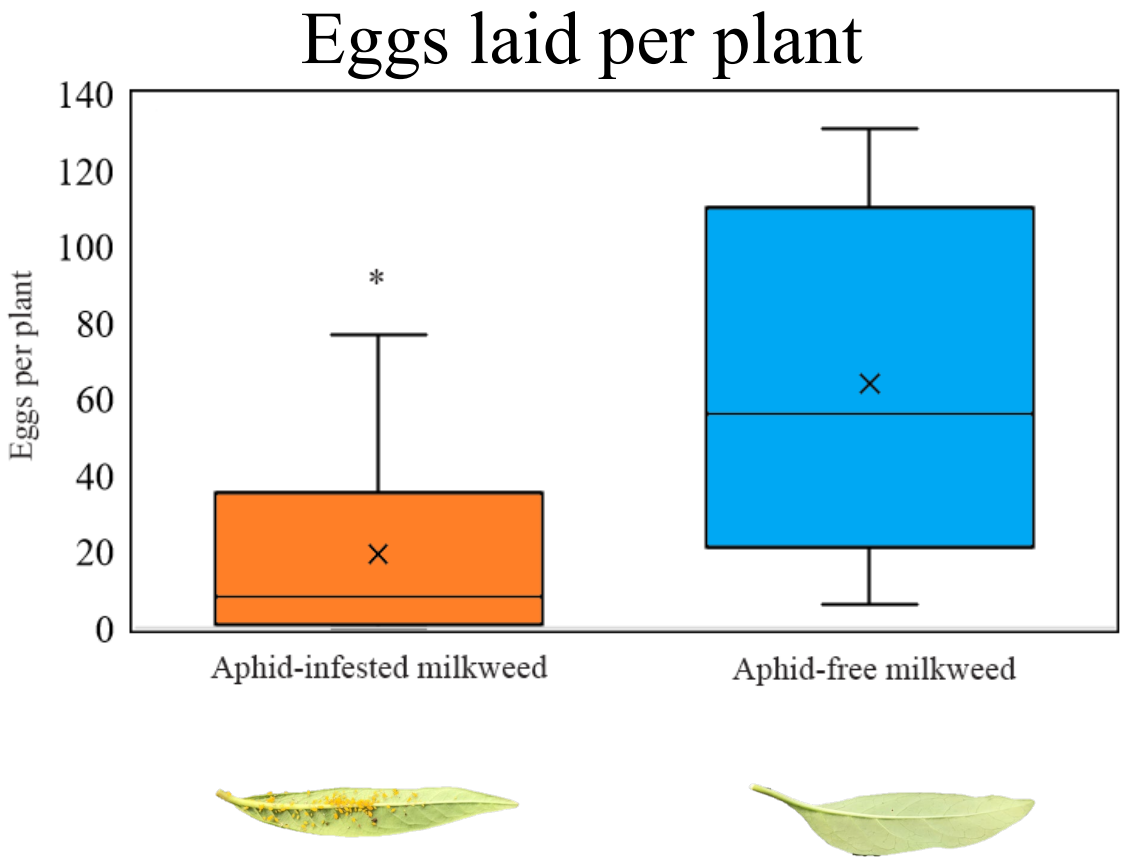
A. High aphid density

B. No aphids

Aphid infestations reduce monarch larval feeding & weight by ~50%



Monarchs lay ~50% fewer eggs on aphid infested milkweed



Summary

Aphid-infested tropical milkweed is not a suitable monarch host plant

Strategies are needed to suppress aphids and promote monarch success

How do we suppress key pests like aphids without harming beneficial wildlife?

Solution 1:
Avoid tropical milkweed & choose native species that don’t show these negative effects

Solution 2:
Find ways to manage aphids on tropical milkweed without harming monarchs

Active ingredient	Reduced risk or low impact
Flonicamid	No
Horticultural oils	Low impact
Carbaryl	No
Imidacloprid	No
Insecticidal soap	Low impact
Spirotetramat	Reduced risk

The nursery industry is already responding to the aphid problem

2017 grower survey by Jaret Daniels identified industry standards for treating tropical milkweed

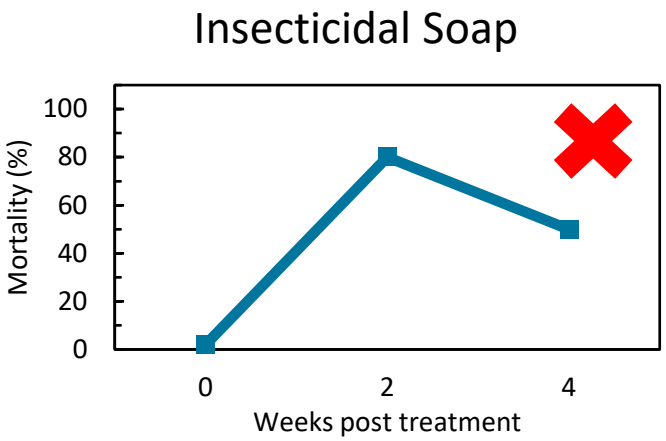
Most widely used insecticides are not low impact or reduced risk

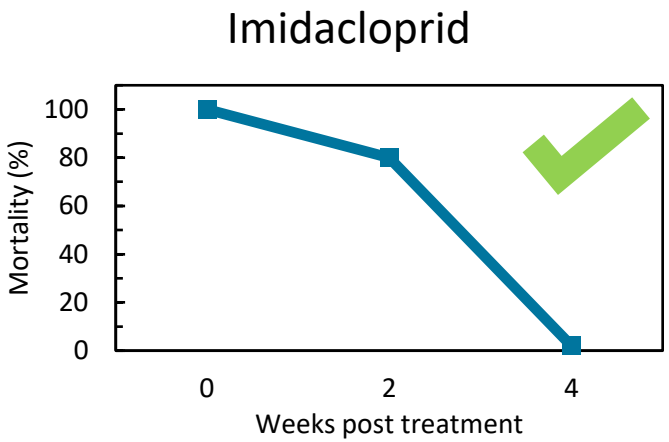
1. Does exposure to industry standard insecticides effect monarch larvae?

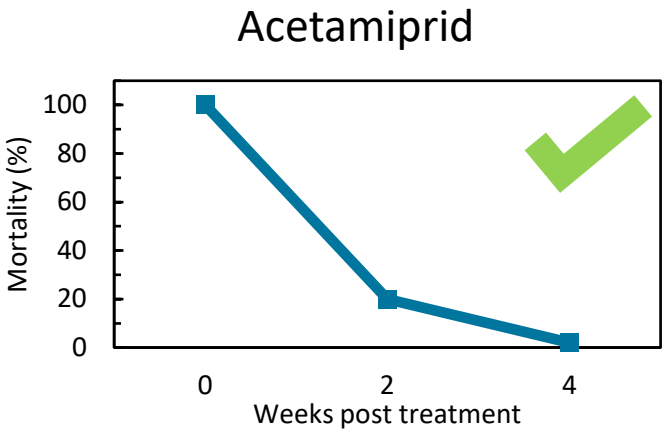
Treated via foliar spray at label rate for aphids

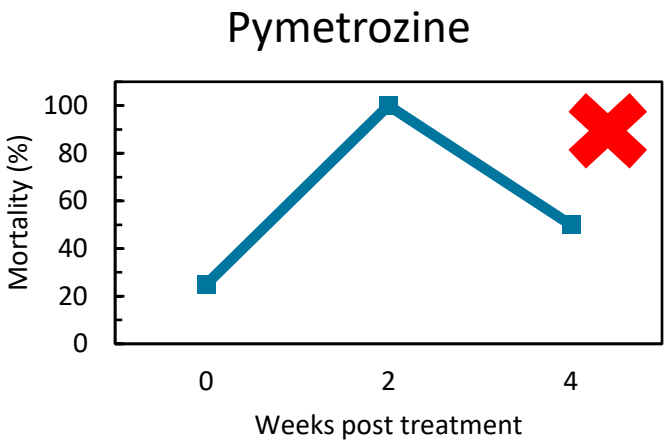
Exposure to field-weathered residues evaluated at 24 hr, 2 weeks, & 4 weeks post-treatment

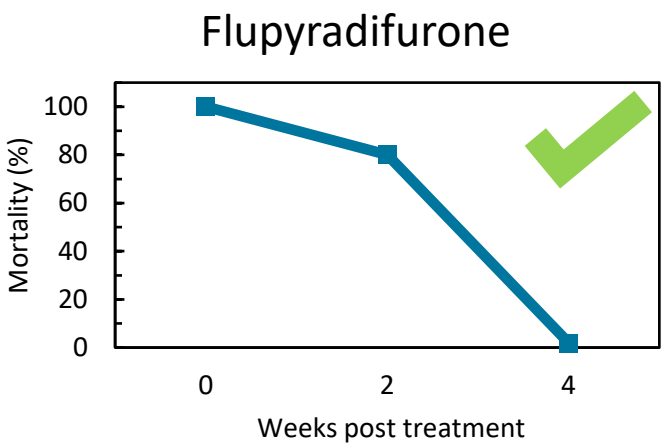
Monitored until death or butterfly

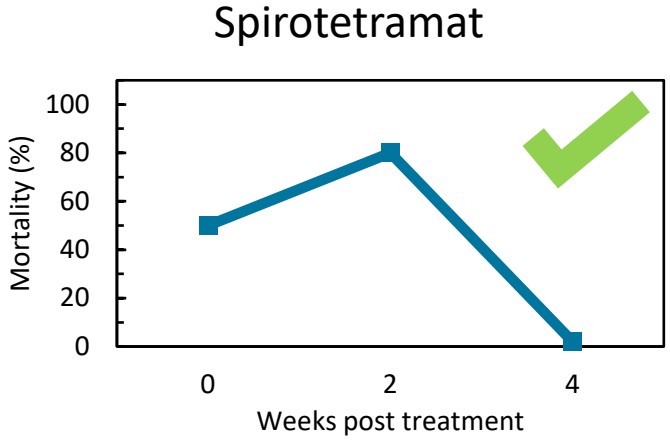












Chronic mortality observed up to 4 weeks post-treatment

Chronic mortality

2. Do industry standard and proposed alternative insecticides suppress aphids?

0 aphids per terminal growth point

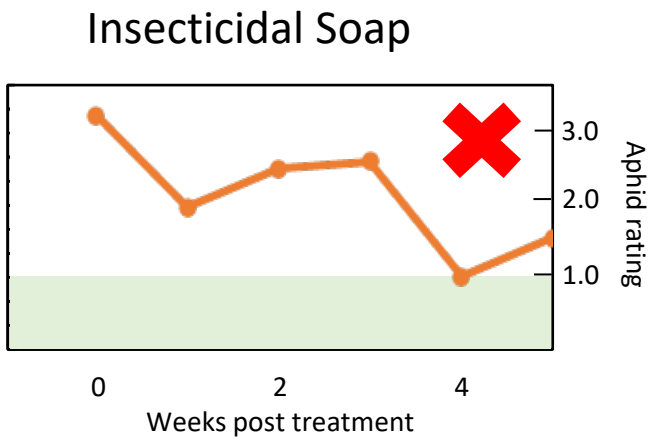
0

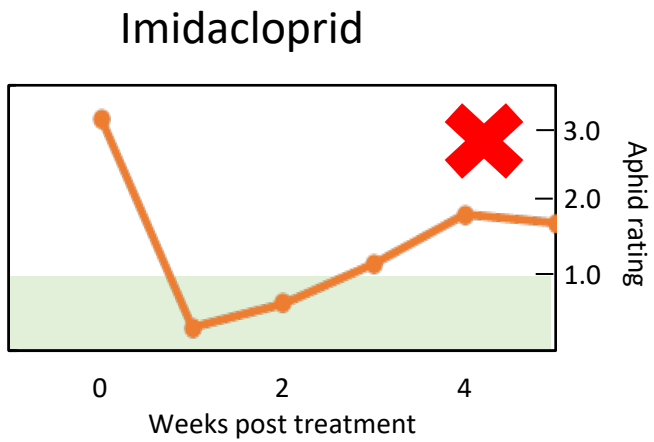
Treatment threshold
< 50 aphids per terminal growth point

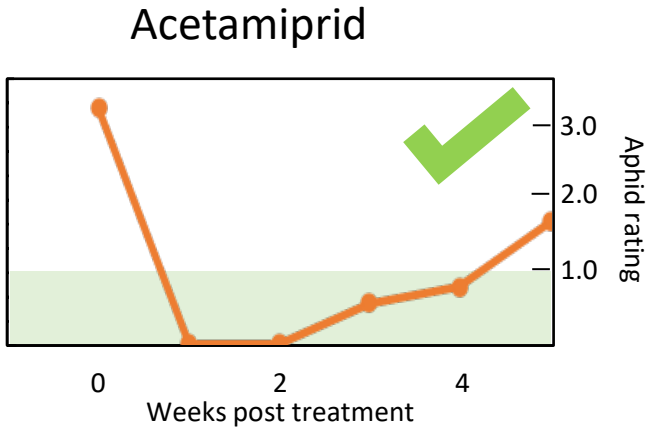
1

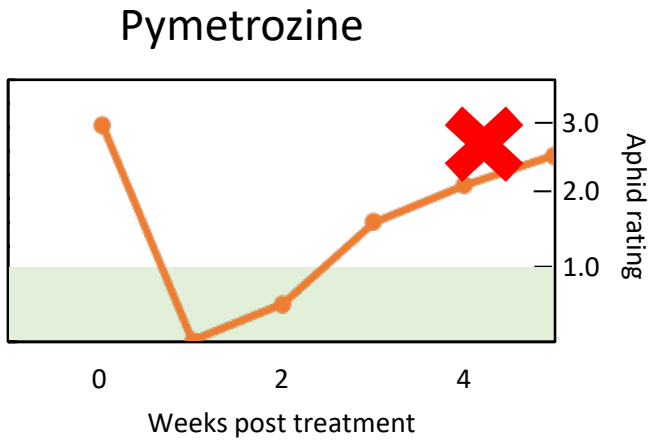
> 150 aphids per terminal growth point

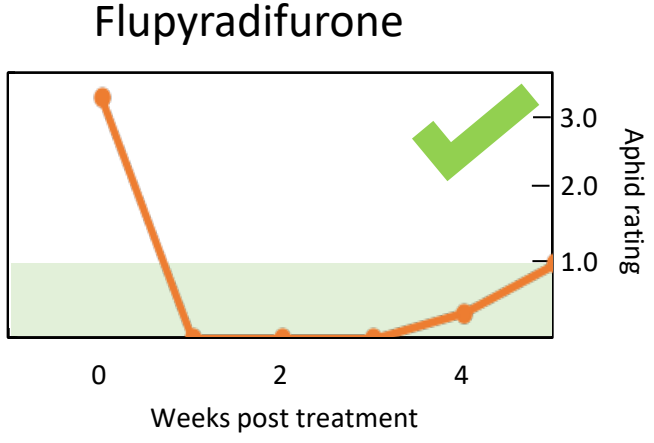
3

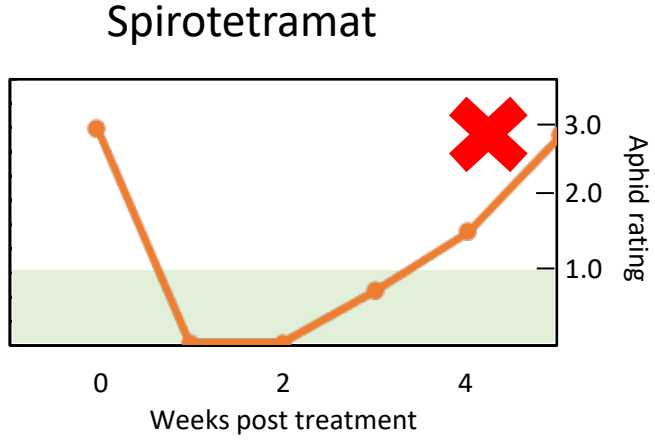




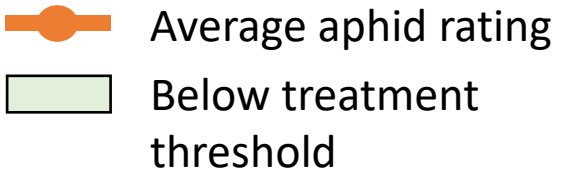


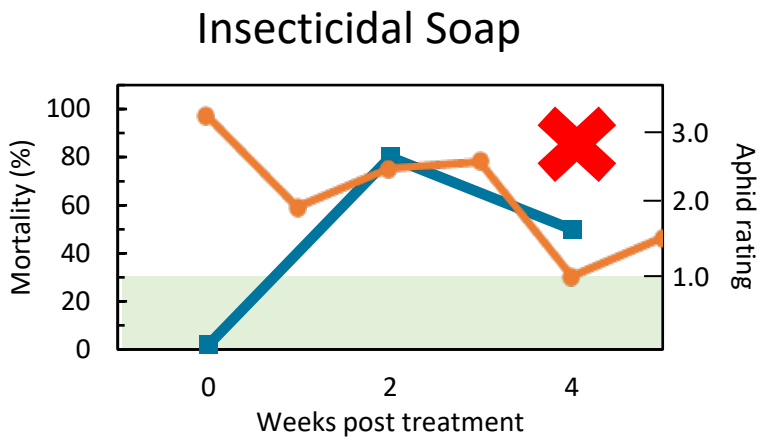


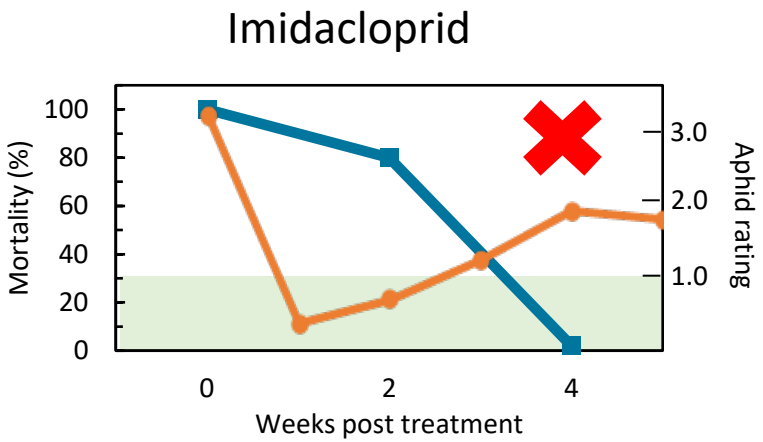


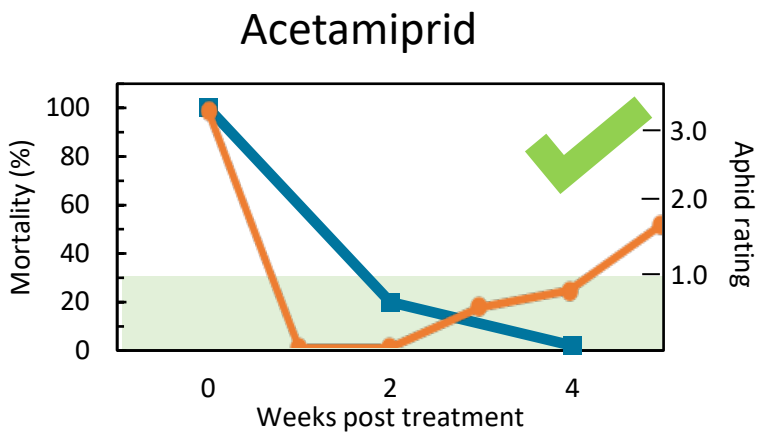


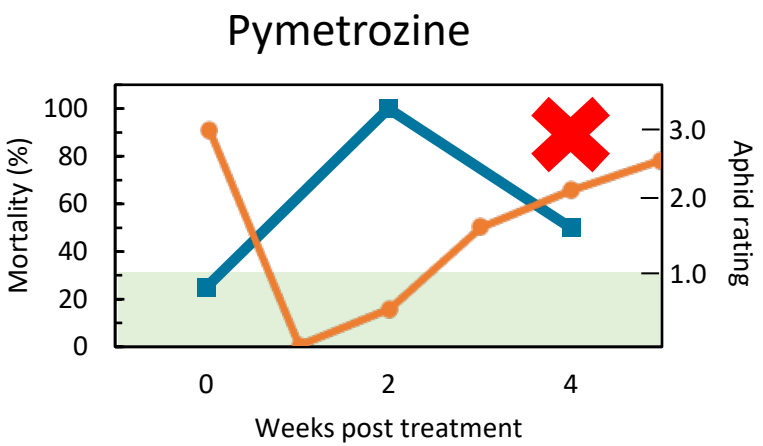
Duration and degree of effective aphid suppression varied greatly

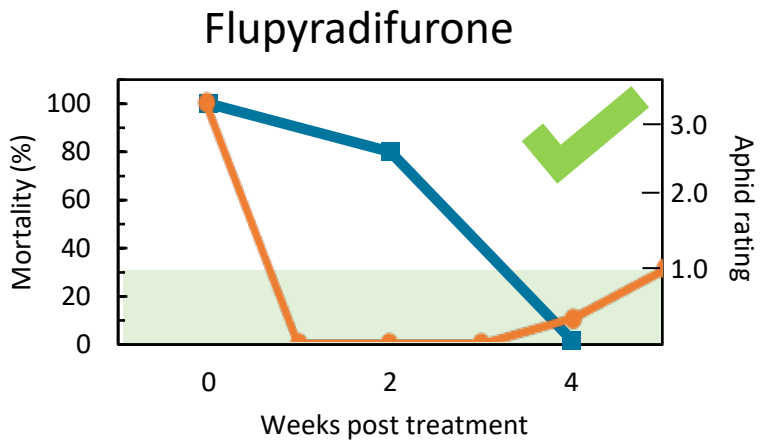


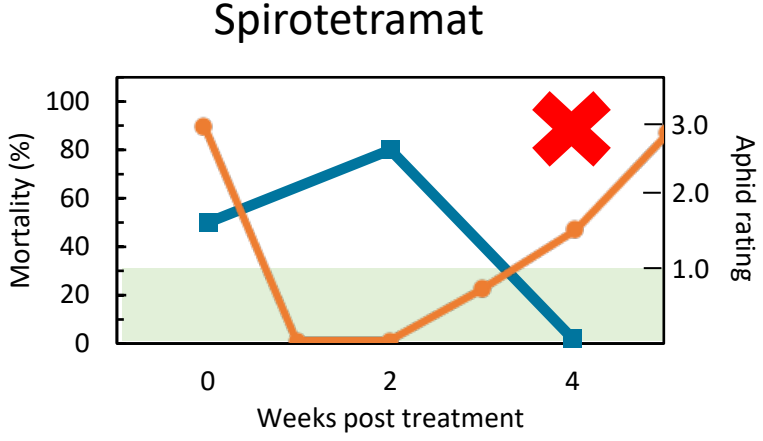




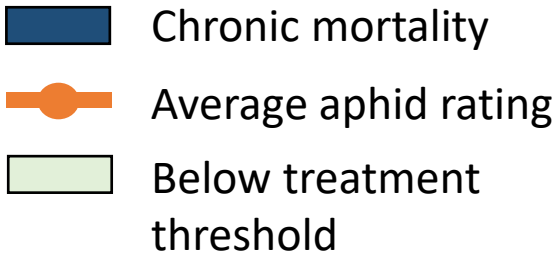








Aphid suppression often shorter than duration of monarch suppression…



Most products had no “safe” period where aphids were suppressed and monarchs unaffected

Lethal effects to monarchs up to 4 weeks after one application

Re-application needed to suppress aphids 3-4 weeks post-treatment

Most monarch mortality occurred at pupation or eclosion as a butterfly (out of sight, out of mind)

How can you help?

Encourage planting native milkweed to avoid negative effects of aphids on monarchs

Educate about products and practices that suppress aphids without suppressing monarchs and other beneficial insects

Emphasize cultural controls (i.e. creating diverse, complex landscapes) to promote natural enemies

Encourage planting of pest-free and wildlife-friendly plants

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Boone County Arboretum

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