Recent Advances in Pest Management

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Agricultural History

The Green Revolution

- Between 1940's - 1960's
- "saved over a billion people from starvation"
- high-yielding varieties of cereal grains
- Expansion of irrigation infrastructure

Norman Borlaug

- Modernization of management techniques
- Distribution of hybridized seeds, synthetic fertilizers,and pesticides to farmers

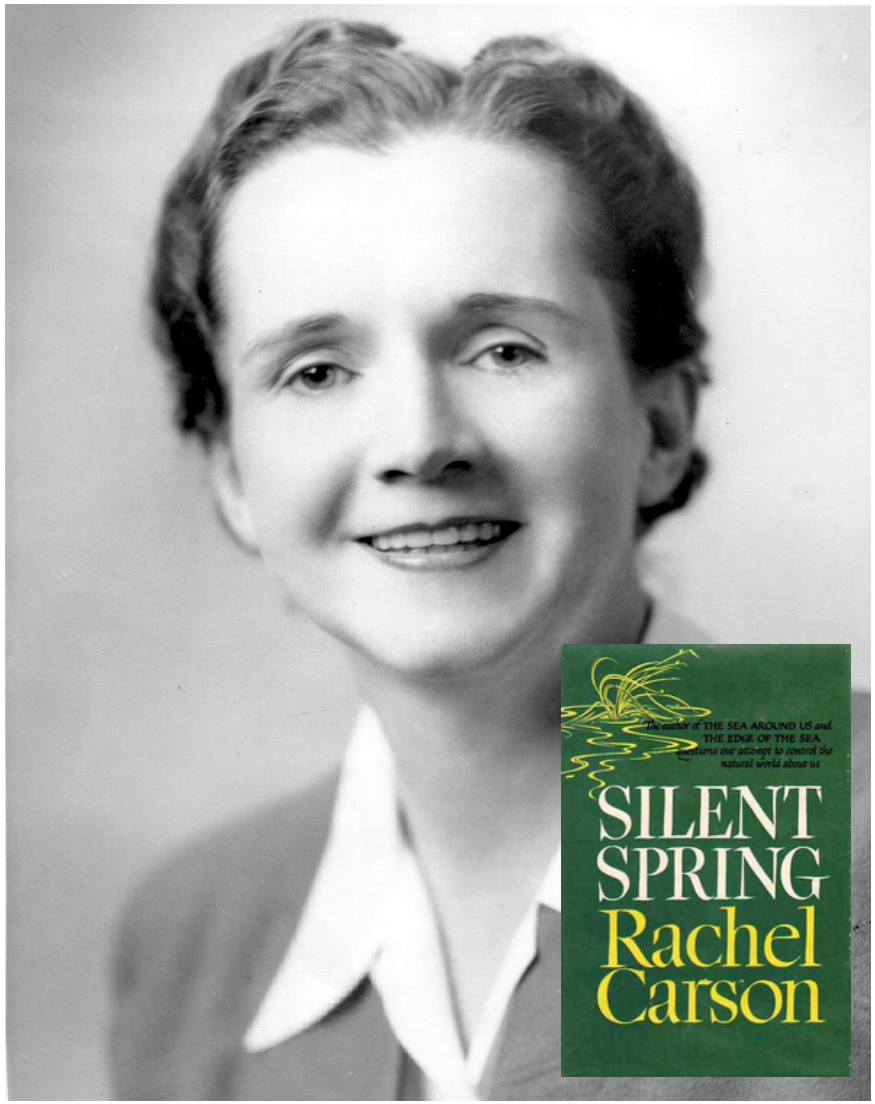
Show
Colours
Filters
26 May 2012 20:00
CO2 151,618 t
Containers 14,196,884
Dry 548,572 kt
Liquids 397,004 kt
Gas 60,750,672 m3
Vehicles 10,297,624 kt
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

502 Records
$ billions in economic impact

Spotted Wing Drosophila
Estimated revenue loss in 2008
$511.3 million

D.D.T.
Powerful Insecticide
Harmless to Humans
TODD

Integrated Pest Management



"WHY SHOULD WE TOLERATE A DIET OF WEAK POISONS, A HOME IN INSIPID SURROUNDINGS, A CIRCLE OF ACQUAINTANCES WHO ARE NOT QUITE OUR ENEMIES, THE NOISE OF MOTORS WITH JUST ENOUGH RELIEF TO PREVENT INSANITY? WHO WOULD WANT TO LIVE IN A WORLD WHICH IS JUST NOT QUITE FATAL?"

Rachel Carson, Silent Spring (1962)

1970's

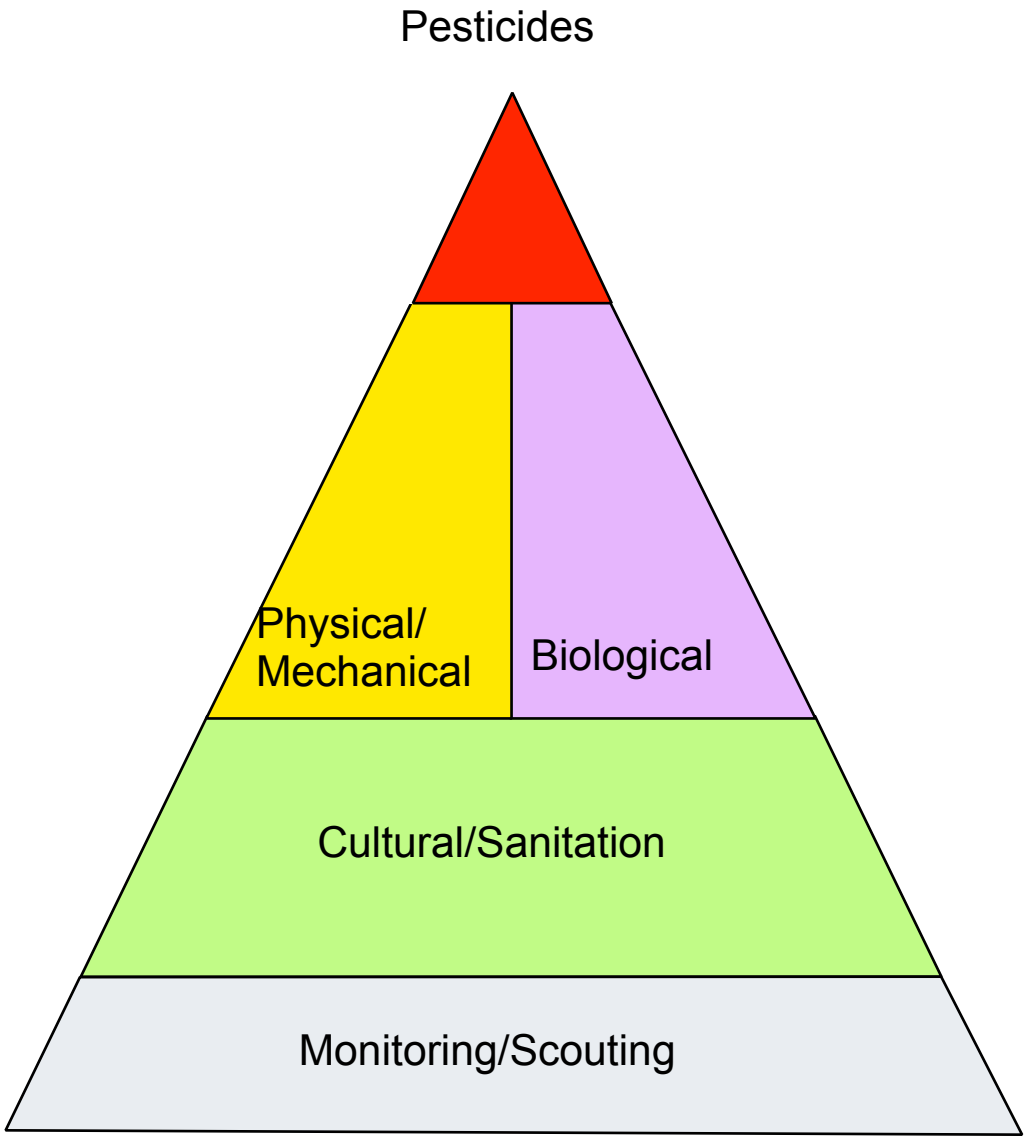
USDA creates nationwide IPM program in Land Grant Universities

TEXAS A&M AGRILIFE EXTENSION

What is IPM?

- Minimize impact on the environment
- Minimize impact on human health
- Maintain or increase soil fertility
- Long-term pest management
- Prevent pesticide-resistant pests
- Strives to maximize long-term returns/savings

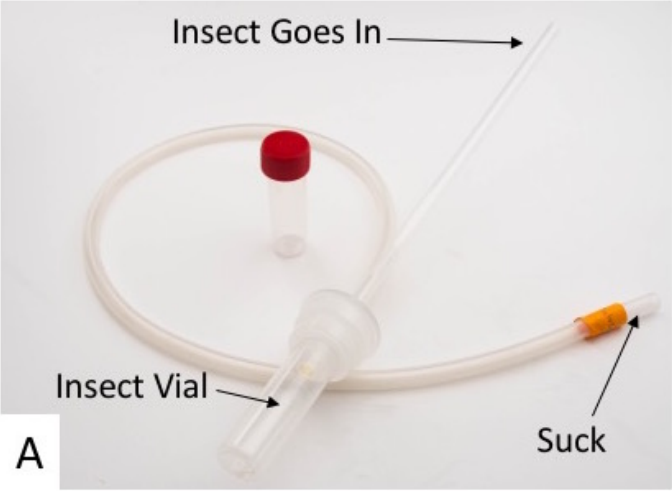
IPM Pyramid



TEXAS A&M AGRILIFE EXTENSION

Monitoring/Scouting

Some Tools of the Trade



Monitoring/Scouting

Some Tools of the Trade

Monitoring/Scouting

Some Tools of the Trade

White piece of paper

Scot Nelson

AGRILIFE EXTENSION

Monitoring/Scouting

Some Tools of the Trade

Pheromone traps

TEXAS A&M AGRILIFE EXTENSION

Monitoring/Scouting

Some Tools of the Trade

Sweep Nets

Figure 15. Proper use of a sweep net.

Photo: NC State University

TEXAS A&M AGRILIFE EXTENSION

Monitoring/Scouting

Why Monitor?

- Determine pest species that attack different crops
- Determine what levels of pest presence/damage becomes *economically* important
  - Catch a pest population before it causes economic damage
- Determine if a pesticide application was effective
- Determine if natural enemies are present
- Determine plant cycle-pest presence relationships
- Determine differences in cultivar attractiveness/susceptibility to specific pests

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Monitoring/Scouting

Recent Advances

ADI

HOME OUR PROJECTS THE TEAM TECHNOLOGY

Sniffing out weevils: How Chili the dog is saving greenhouse peppers

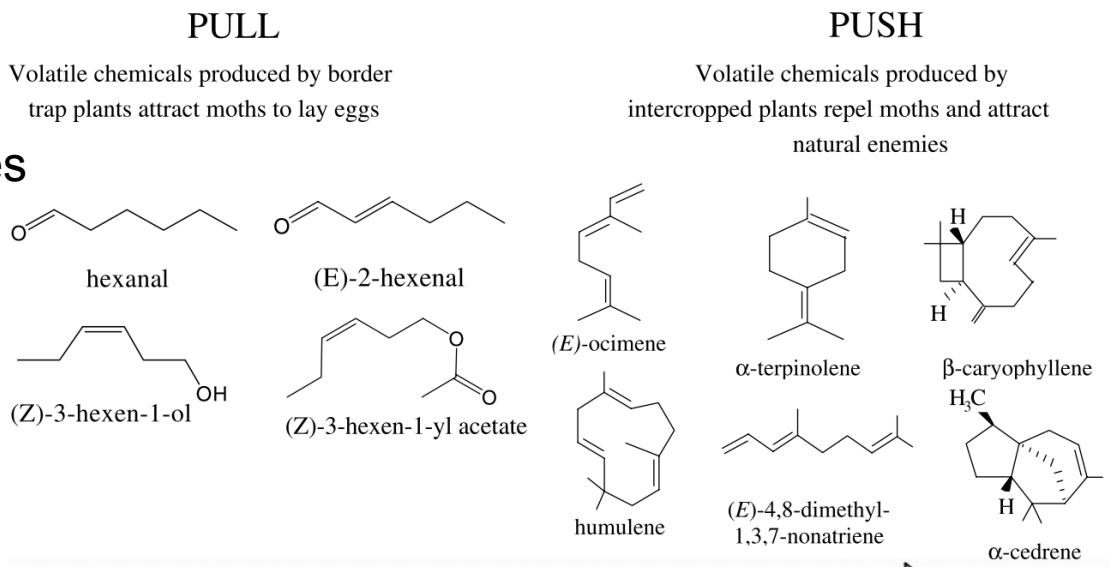
Belgian shepherd is a dog whose nose could save millions of dollars

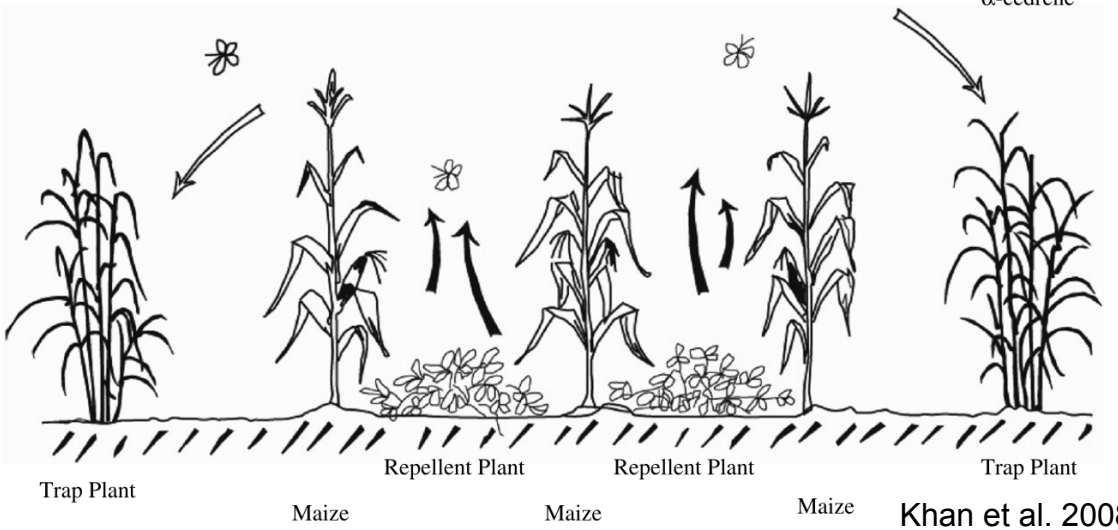
Ron Charles · CBC News · Posted: Jan 01, 2018 5:00 AM ET | Last Updated: January 1

Monitoring/Scouting

Recent Advances

Herbivore-Induced Plant Volatiles (HIPVs)



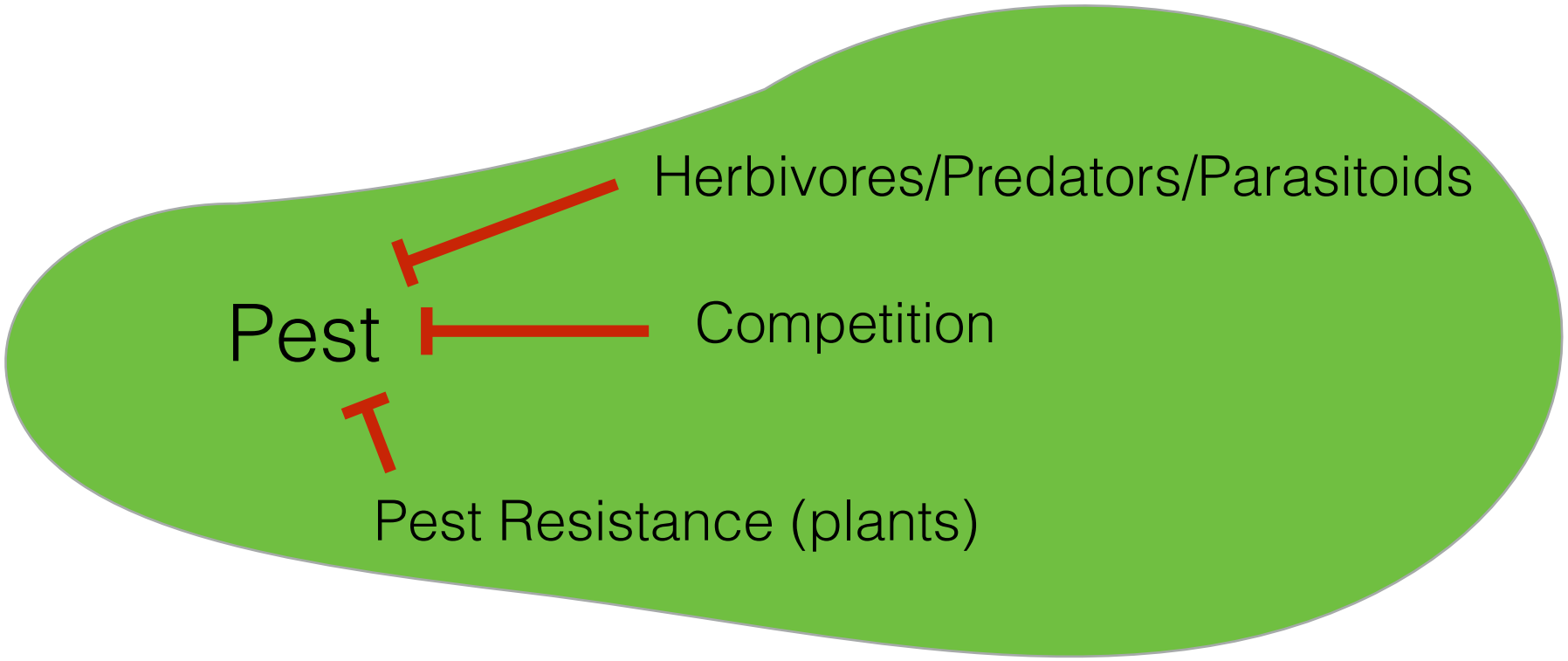


Khan et al. 2008

Fig. 4. A diagrammatic presentation on how 'push–pull' strategy works for control of cereal stemborers.

Monitoring/Scouting

Naturally occurring pest



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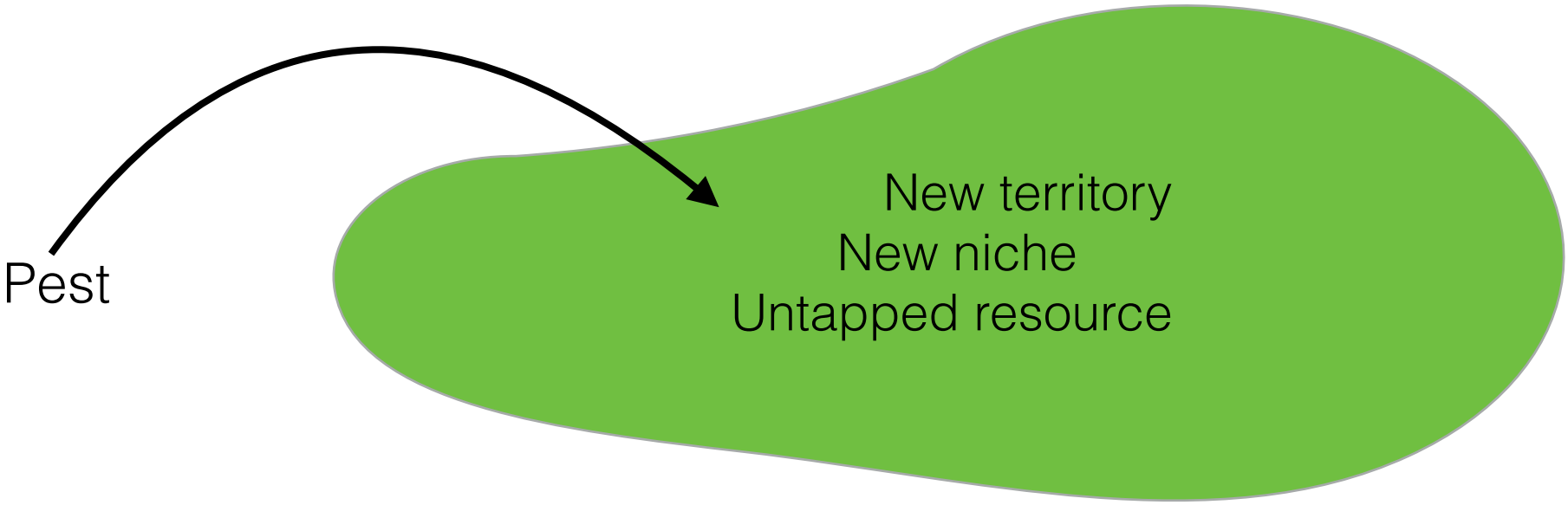
Monitoring/Scouting

Invasives



Predators/parasitoids absent

Plants not best equipped to resist pest

Limited competition for resources

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Monitoring/Scouting | Lantern fly

Invasives

Lawrence Barringer, Pennsylvania Department of Agriculture, Bugwood.org

EXTENSION

Monitoring/Scouting | Lantern fly

Invasives

- *Lycorma delicatula*
- First detected in Pennsylvania in 2014.
  - (2018) also found in Delaware, New Jersey, New York, Pennsylvania and Virginia
  - Introduced from Asia
- Preferred Plant Host: Tree of Heaven (*Ailanthus altissima*)

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Monitoring/Scouting | Lantern fly

Invasives

- Sucking pest
  - Produced honeydew and subsequent sooty mold
- Feeds on over 70 host plants, including grapes, hops, apples, cherry, stone fruits and walnuts

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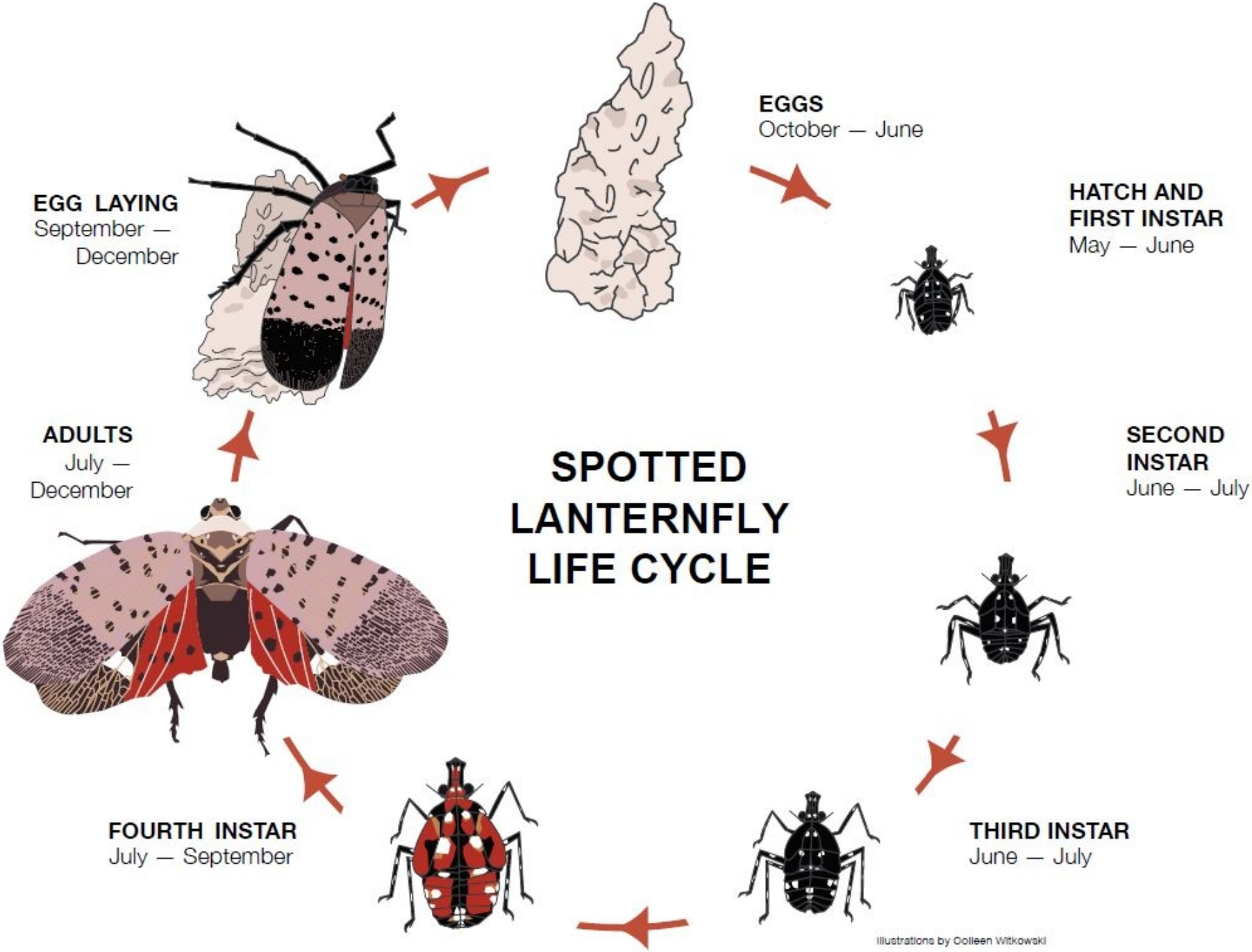
SPOTTED LANTERNFLY LIFE CYCLE



Monitoring/Scouting | Lantern fly

Invasives

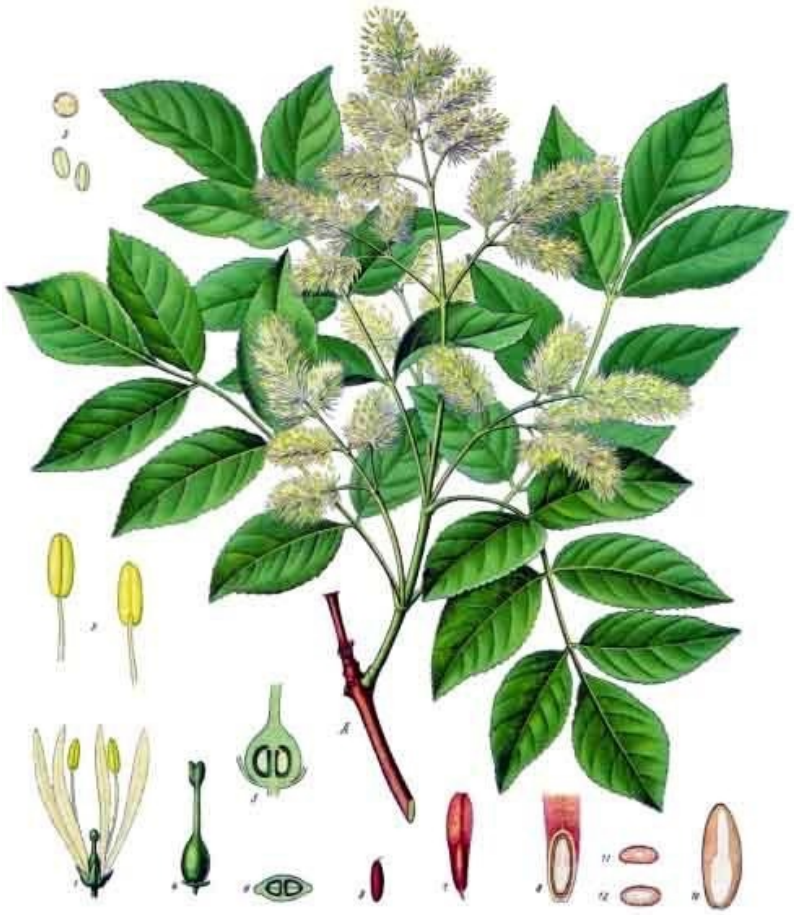
Photograph by Lyle J. Buss, University of Florida.

AGRILIFE EXTENSION

Emerald Ash Borer

Ash in the United States

- *Fraxinus*: genus of flowering trees in family, Oleaceae
- 21 species of trees in North America north of Mexico
- Opposite leaves, usually pinnately compound



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Uses of ash (white ash)

- Baseball bats
- Tool handles
- Oars
- Pallets
- RR ties
- Bows
- Electric guitars
- Firewood
- Furniture
- Seeds used by birds

Emerald ash borer

- *Agrilus planipennis* (Coleoptera: Buprestidae)
- Native of Asia, first detected in Detroit MI in 2002 (prob. had been in MI since early 1990s)
- By 2003 5-7 million dead or dying ash trees in 6 county area of SE Michigan

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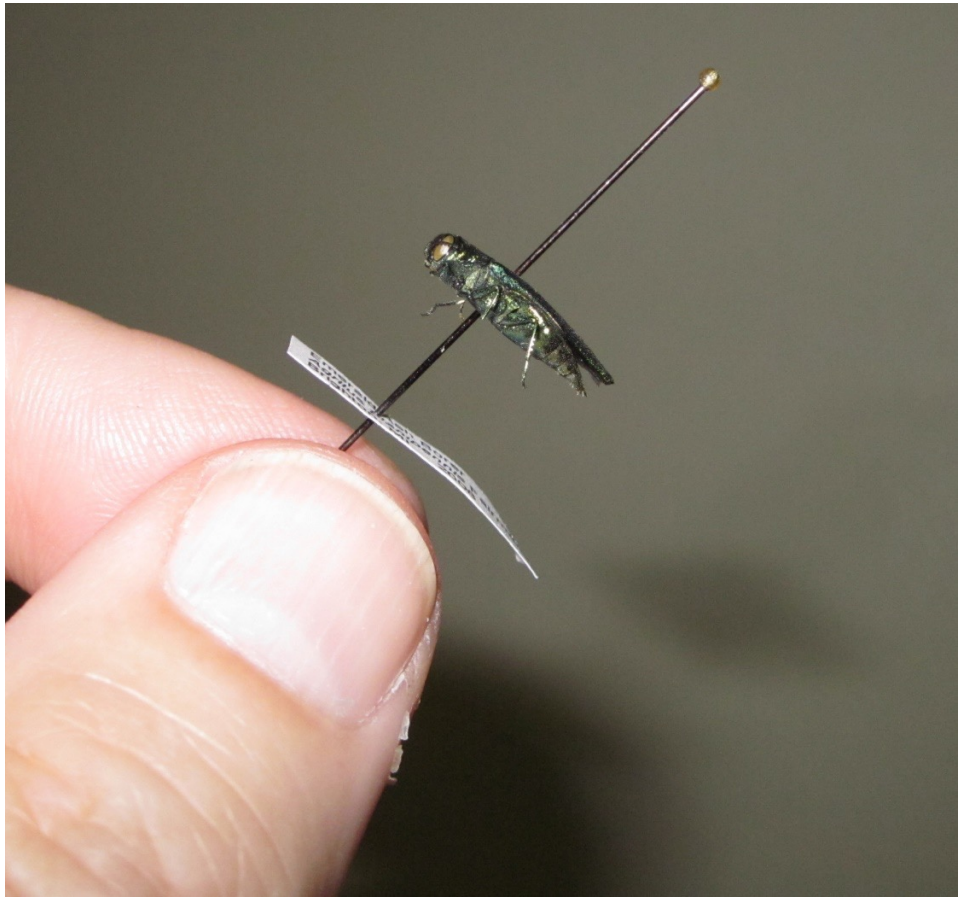
History of EAB in U.S.



- Initially very little known about this insect
- Range from China, Korea, E. Russia
- Two pages in a Chinese textbook and a few taxonomic descriptions in journals

History of ash borer in U.S.

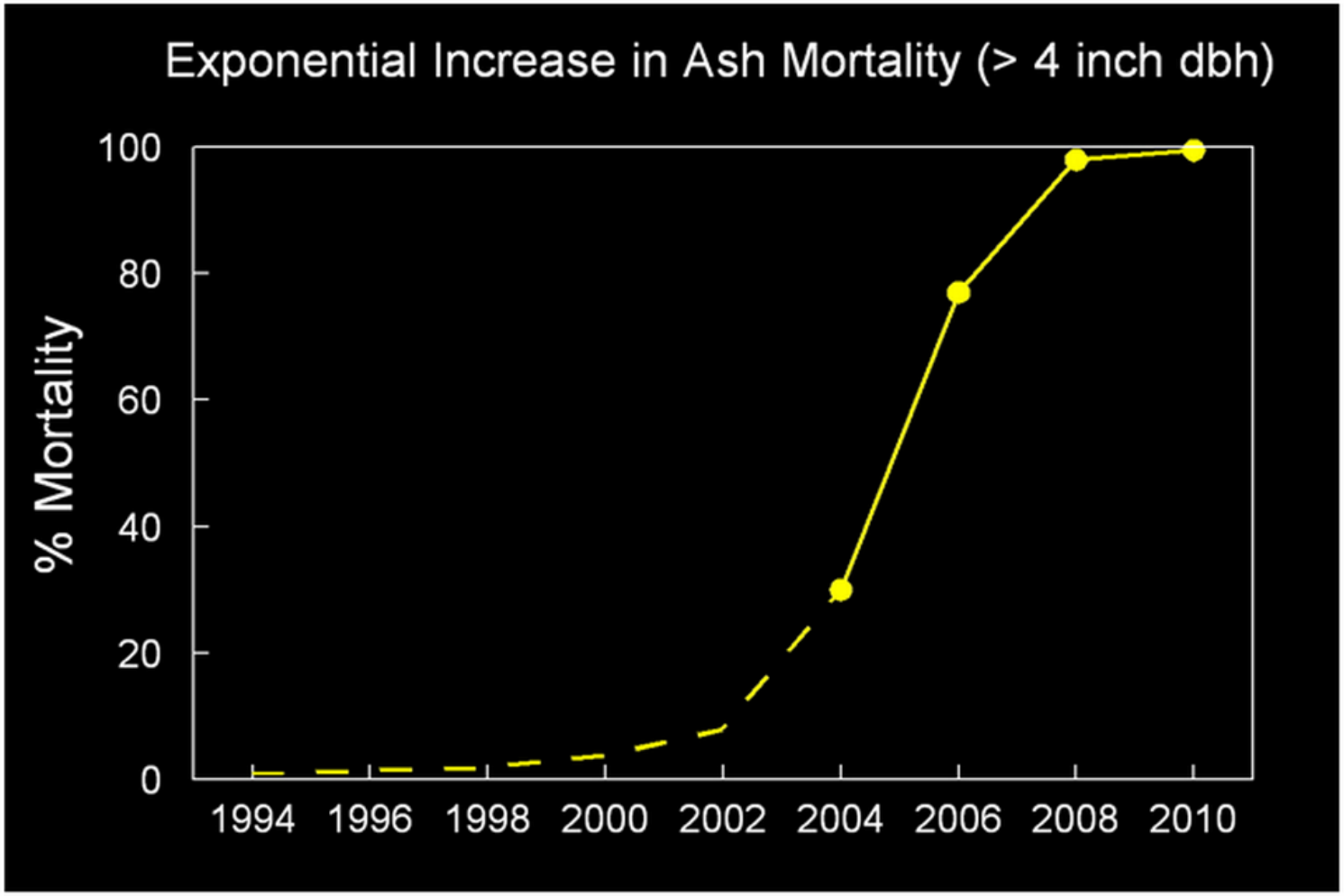
- Attacks all species of ash
- In U.S. attacks not only weakened trees, but heathy trees
- Attacks trees in forests and urban sites
- In MI, more than 99% of forest ash with stems >2.5 cm killed

Impact

- Larvae feed under bark, disrupt transport of water, nutrients
- Healthy trees killed within 1-3 years of first symptoms
- All sized trees attacked

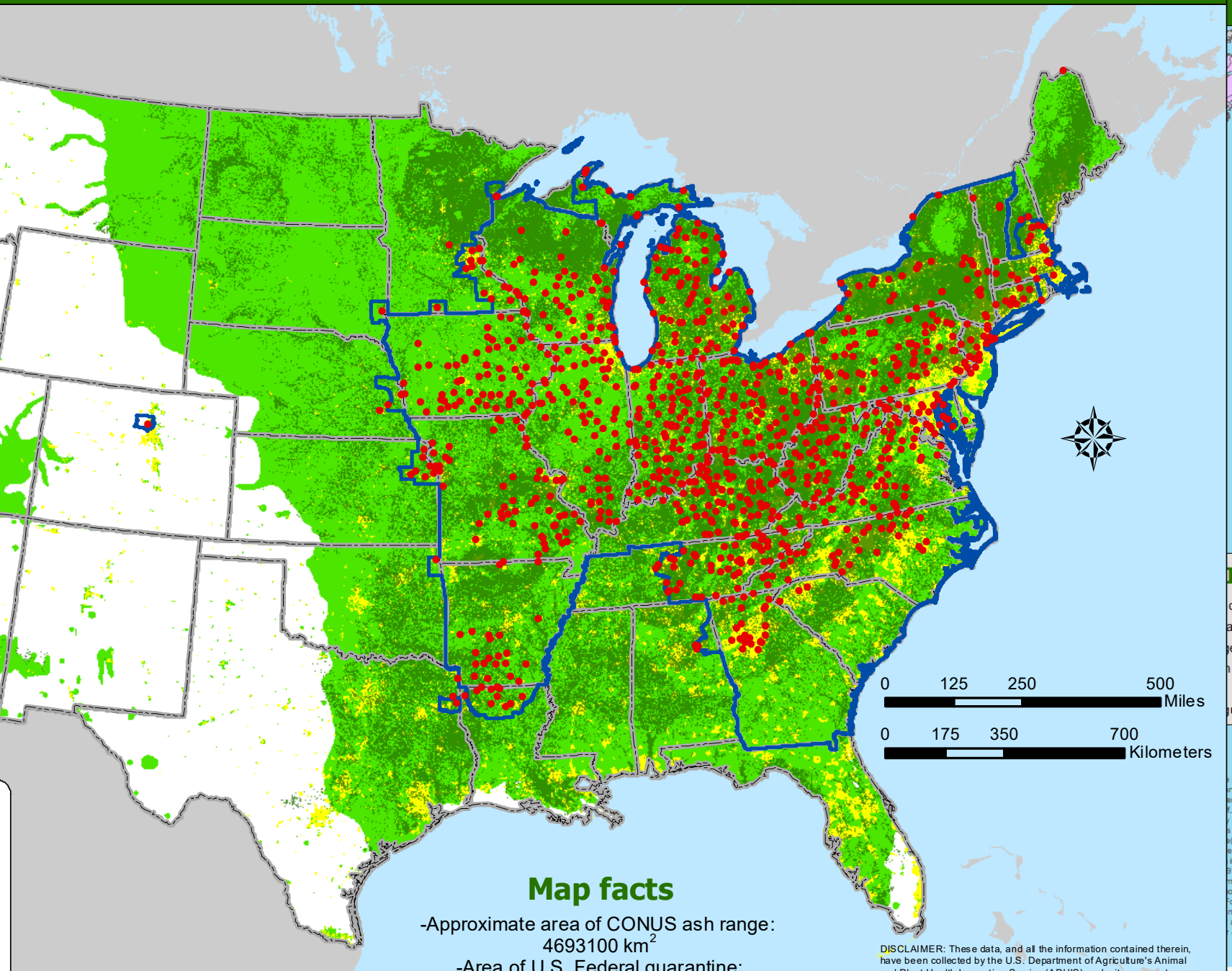
Courtesy Dan Hermes, Ohio State University
Efficacy of insecticide treatments for EAB: they do work! July 2012

EAB-Induced Ash Mortality in the Upper Huron River Watershed, SE Michigan



Approximate range of ash species in the Contiguous U.S. with EAB positives and Federal quarantines

November 1, 2018



Map facts

-Approximate area of CONUS ash range: 4693100 km^2

-Area of U.S. Federal quarantine:

DISCLAIMER: These data, and all the information contained therein, have been collected by the U.S. Department of Agriculture's Animal

2018

Key

detection

antine boundaries

enerally infested area

ulated areas

information contained therein,
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nd other applicable Federal laws
as with the confidentiality or
agreement entered into between

Invasive Ash tree pest found in Fort Worth

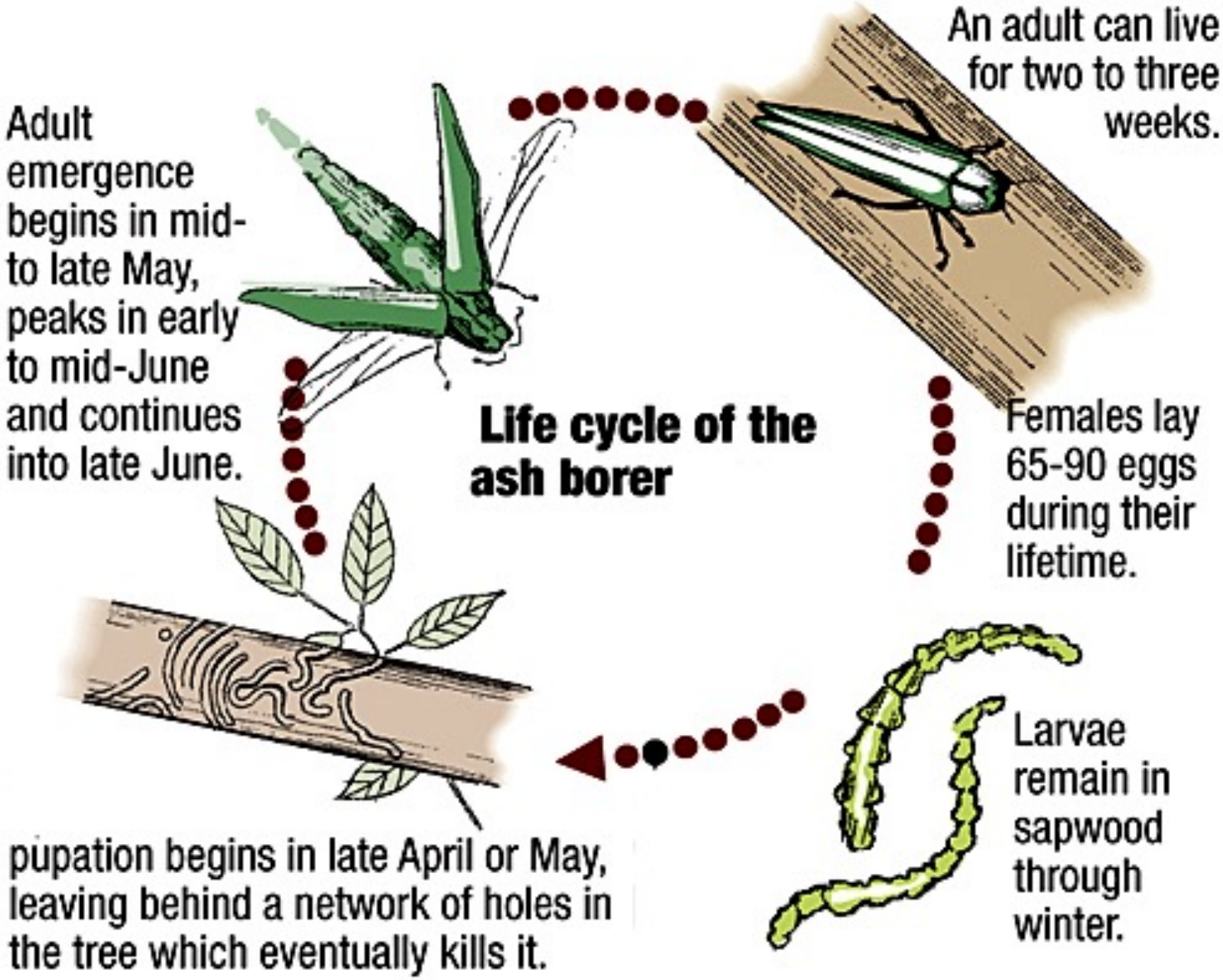
Texas A&M AgriLife News Release Jul 31, 2018

FORT WORTH, Texas — Forest pest experts are investigating reports that the invasive emerald ash borer may have been found in Tarrant County.

Last week, entomologists identified EAB in a photograph submitted to an online nature social network. The photo was taken by a young naturalist, just 10 years old

Spotlight

TEXAS A&M AGRILIFE EXTENSION


Life cycle of the ash borer
An adult can live for two to three weeks.
Females lay 65-90 eggs during their lifetime.
Larvae remain in sapwood through winter.
pupation begins in late April or May, leaving behind a network of holes in the tree which eventually kills it.
Adult emergence begins in mid- to late May, peaks in early to mid-June and continues into late June.

N

Recognizing damage

Emerald Ash Borer Larva

EAB larvae
UGA5016056

Emergence Hole

Courtesy Phil Nixon, University of Illinois

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Serpentine tunnels

Cornelia Schaible E+ Getty Images

EAB-encouraged Woodpecker Damage "flecking"

EAB thinning canopy & epicormic branching

Courtesy Phil Nixon, University of Illinois

TEXAS A&M AGRILIFE EXTENSION

EAB thinning canopy & epicormic branching

Courtesy Phil Nixon, University of Illinois

TEXAS A&M AGRILIFE EXTENSION

Crapemyrtle bark scale

North Amer. First sighting:
2004, Northern Texas

Now found in:
TX, OK,LA, AR, NM, TN, GA, AL, MS, VA and WA

Originally from:
Asia
[*Eriococcus lagerstroemiae* (Hemiptera: Eriococcidae]

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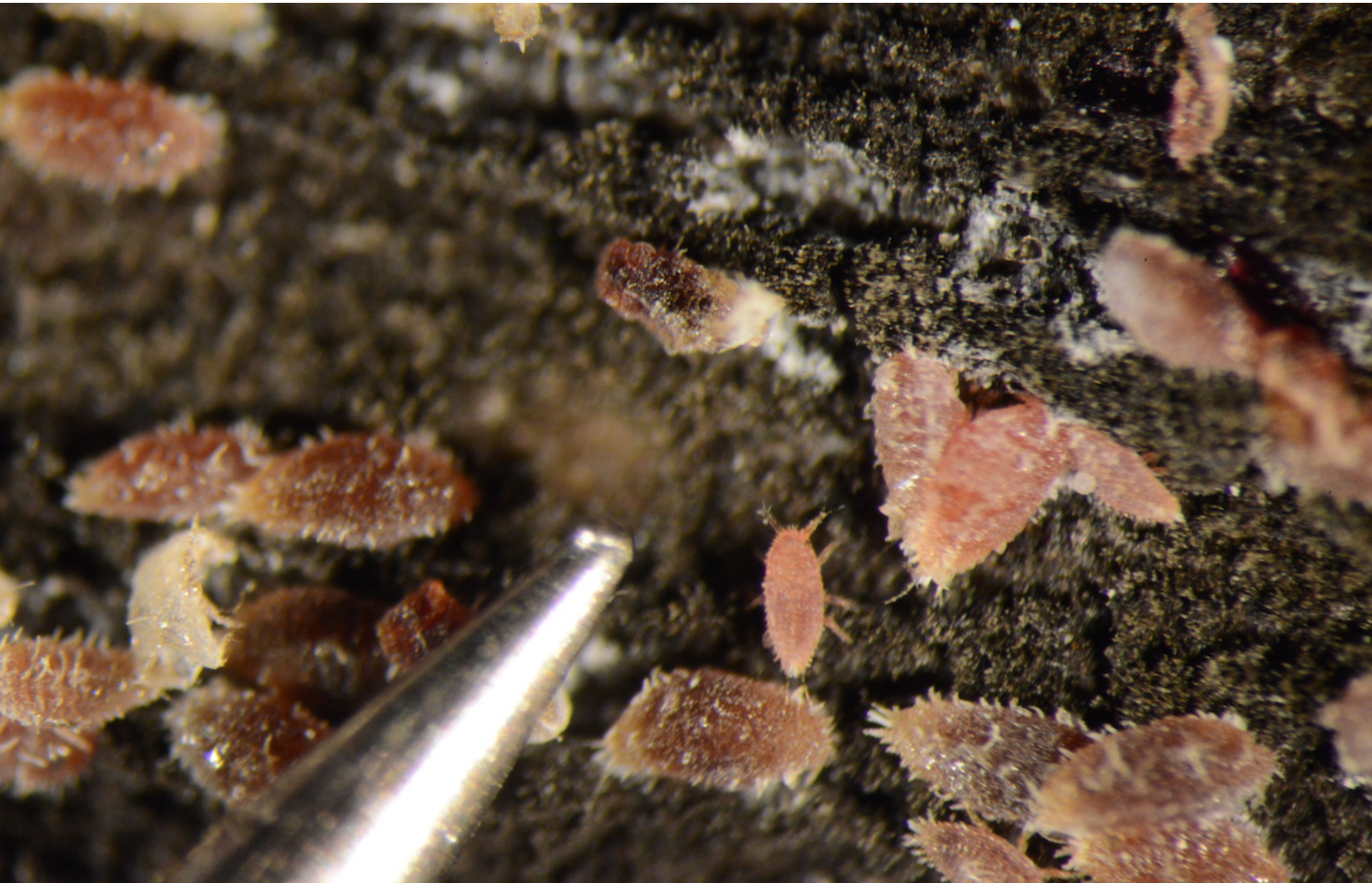
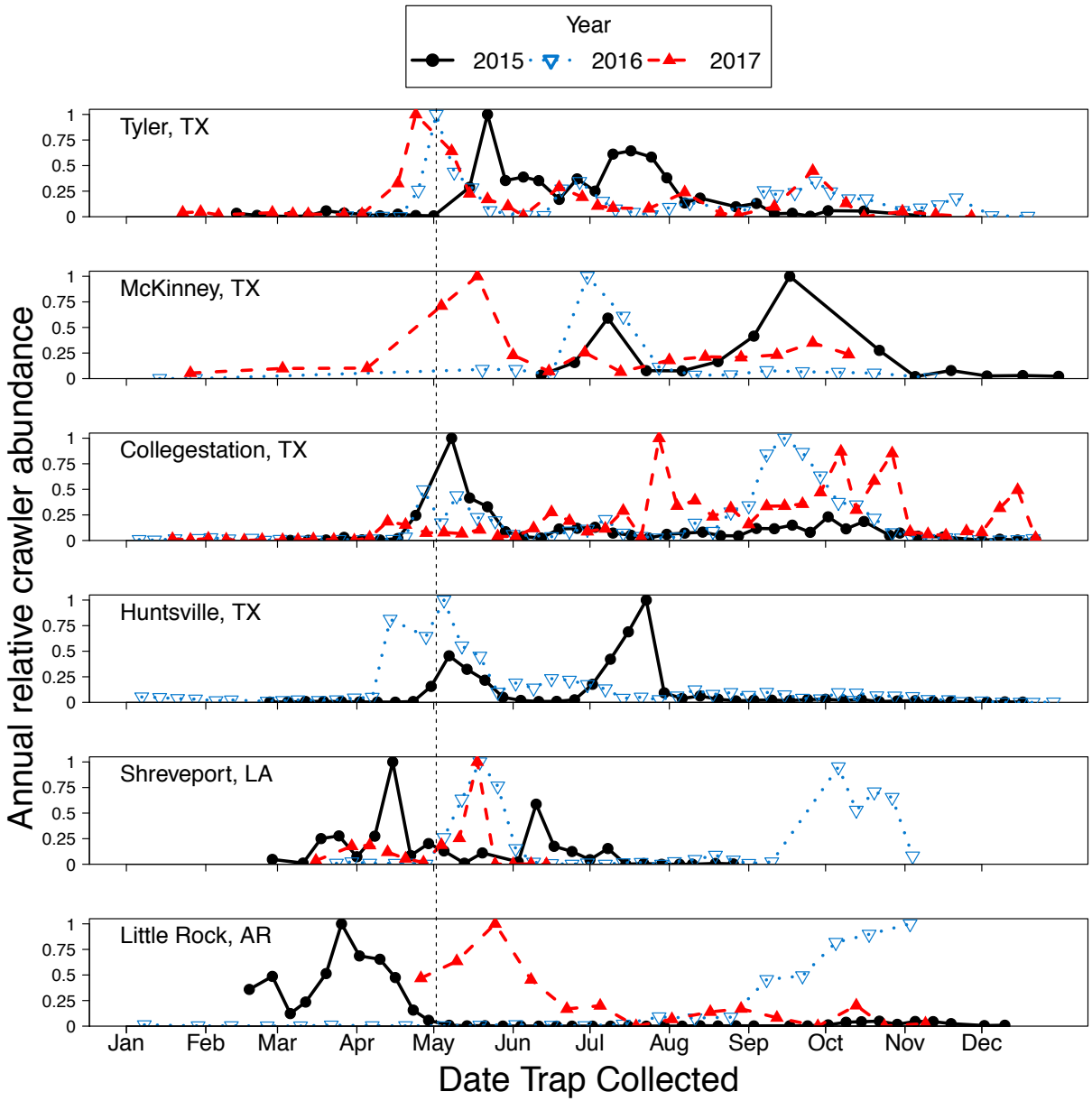
Crapemyrtle bark scale



Crapemyrtle bark scale

Crapemyrtle bark scale

Population Dynamics



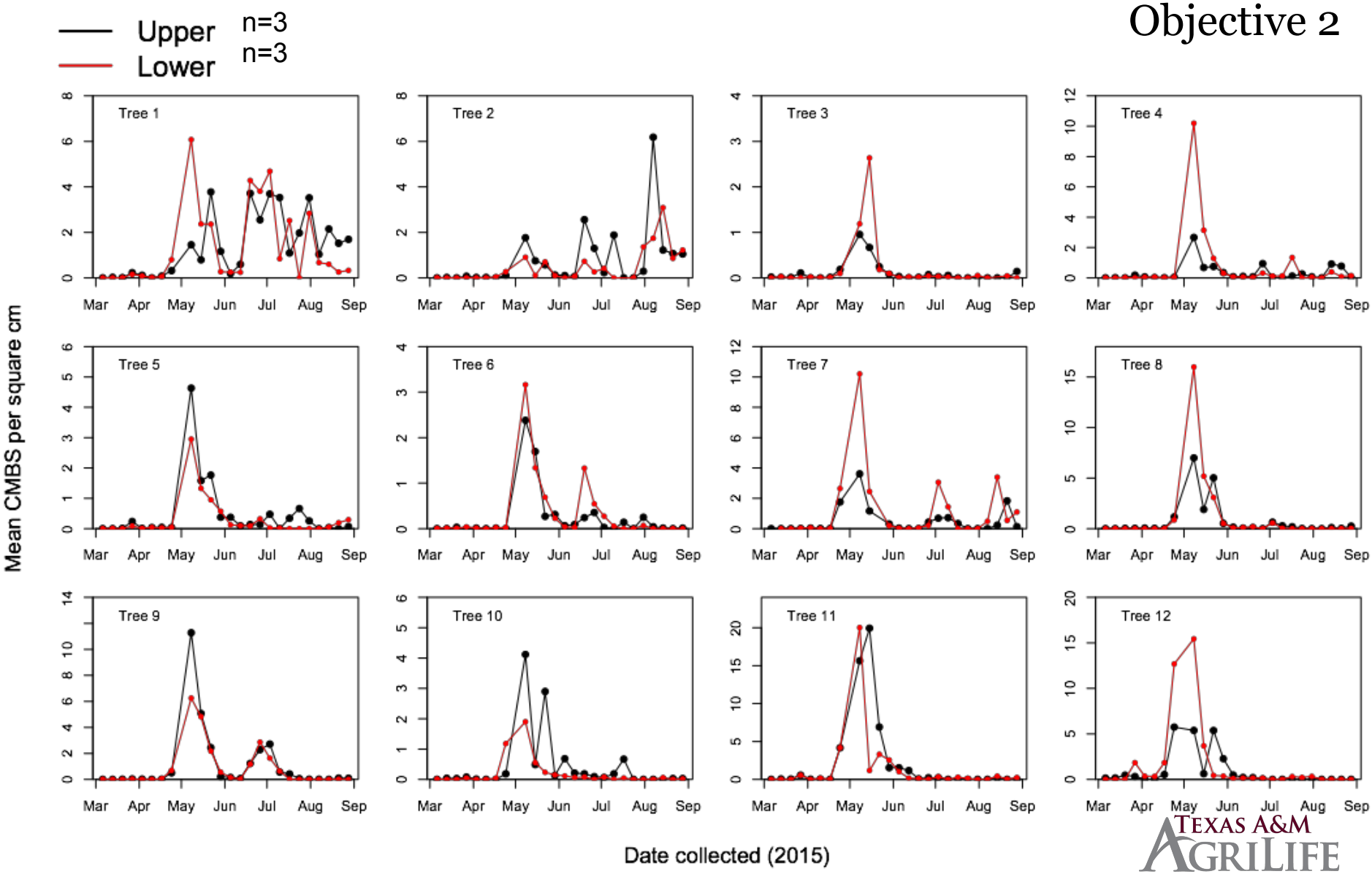
TEXAS A&M AGRILIFE EXTENSION

Upper/Lower Branches

AS A&M
RILIFE
XTENSION

Upper/Lower Branches

Objective 2



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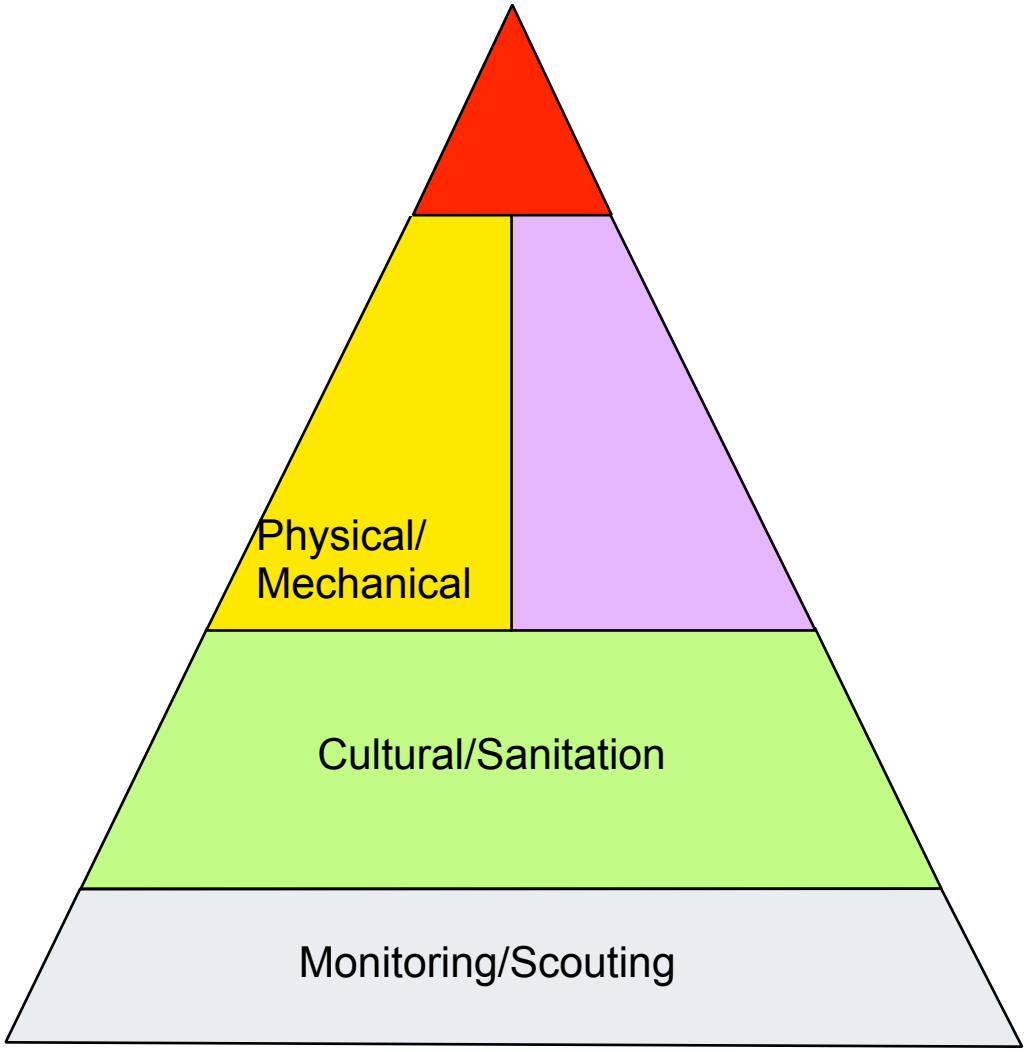
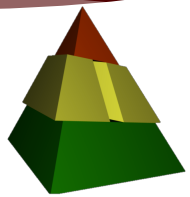
IPM Pyramid



TEXAS A&M AGRILIFE EXTENSION

Cultural/Sanitation



- Keep a clean environment
- Remove weeds/alternative hosts
- Reduce unnecessary moisture
- Companion planting
- Banker Plants
- Trap Plants
- Crop Rotation
- Nutrient management
- Plant defense

Physical/Mechanical

- Hand weed
- Hand remove insect pests
- High pressure water spray
- Exclusion nets and barriers
- Pitfall traps
- Yellow sticky cards

Cultural | MitoGrow

Recent Advances

15G Red Maples
10 top-dressed
10 untreated
Completely randomized design

Treated March 1st
Determined growth on Aug. 31st

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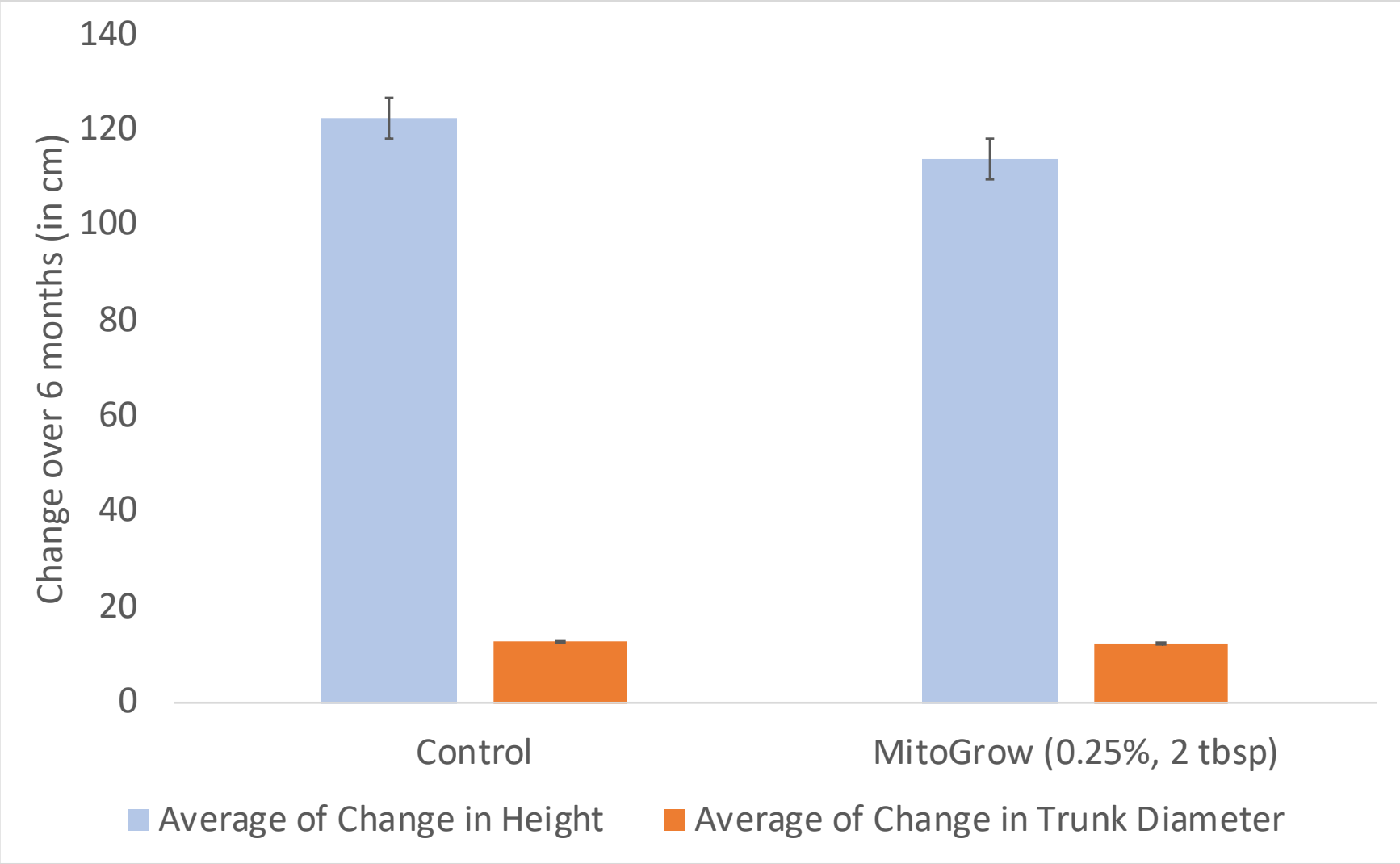
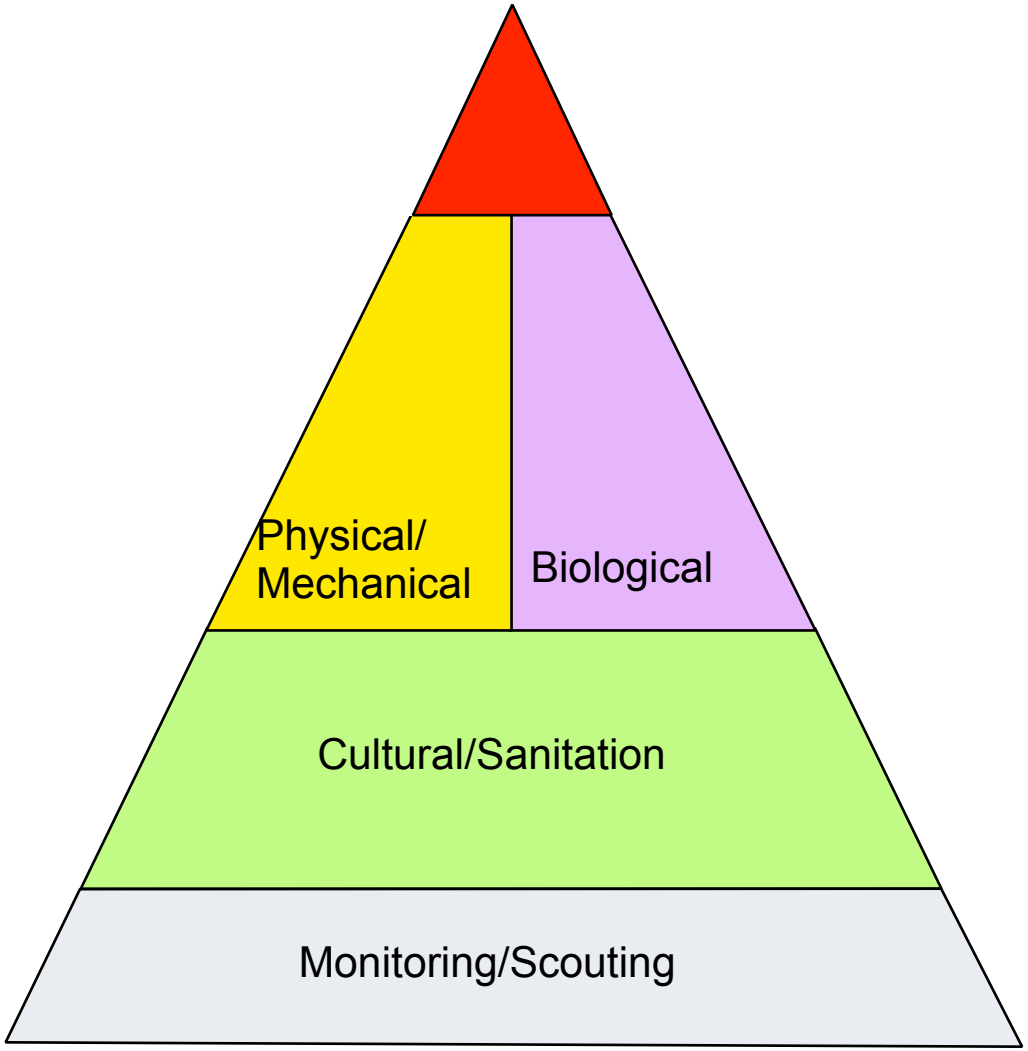
Cultural | MitoGrow

Recent Advances



IPM Pyramid



TEXAS A&M AGRILIFE EXTENSION

Biological Control

Biopesticides

US EPA - “naturally occurring substances that control pests (**biochemical pesticides**), microorganisms that control pests (**microbial pesticides**), and pesticidal substances produced by plants containing added genetic material (**plant-incorporated protectants**) or PIPs”

Biological Control

Biopesticides

US EPA - “naturally occurring substances that control pests (**biochemical pesticides**), microorganisms that control pests (**microbial pesticides**), and pesticidal substances produced by plants containing added genetic material (**plant-incorporated protectants**) or PIPs”

Biochemical pesticides | Horticultural Oils

Microbial pesticides | *Bacillus thuringiensis* (Bt) spray

Plant-incorporated protectants | Bt corn

Biological Control

Table 1
Global biopesticide and synthetic pesticide market. *Source:* BCC Research (2006).

Category	2003 $ millions USD	2004 $ millions USD	2005 $ millions USD	2010 $ millions USD	% Average annual growth
Biopesticides	468	562	672	1075	9.9
Synthetic	27,144	26,600	26,076	24,205	−1.5
Total	27,612	27,162	26,748	25,280	−1.1
Biopesticides as % of total	1.69	2.01	2.57	4.25	

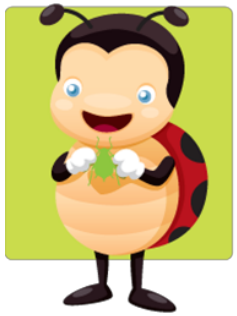
Bailey et al. 2010

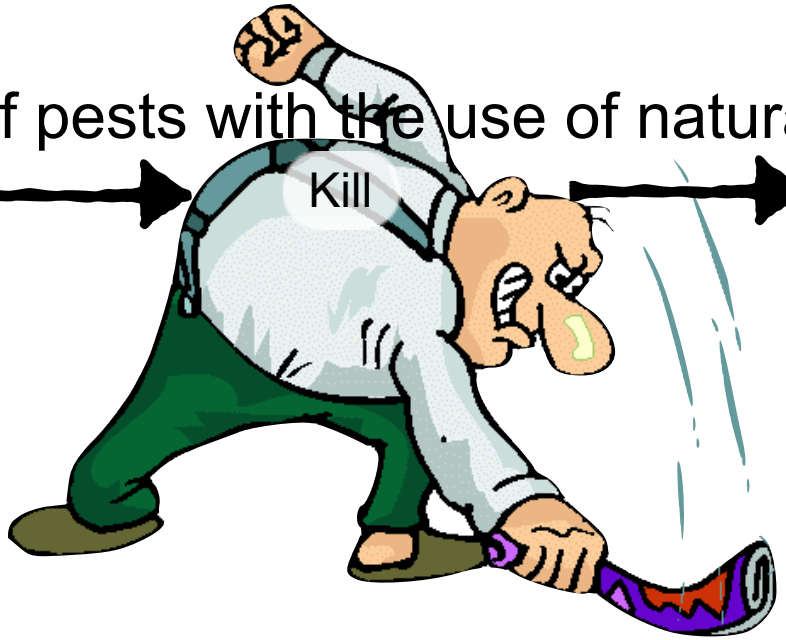
Plant-incorporated protectants | Bt corn

Biological Control

Reduction of pests with the use of natural enemies

Good Bug → Kill → Bad Bug





Why Biological Control?

Advantages

- Reproduce
- Target & find the pest
- Evolve with the pest
- Can be economic
- No environmental toxicity
- Don’t harm other beneficials
- No pesticide residue
- No phytotoxicity
- Insects are super cool!

Why Biological Control?

Disadvantages

- Not immediate
- Requires more human involvement
- Initially more costly; time to establish biocontrol program
- Must tolerate some damage
- Challenging in the face of new invasive pests
- Requires effective monitoring program
- Won’t magically ‘fix’ pest problems

Biological Control

- Many regions of Europe, Canada, and China have adopted, not out of choice, but lack thereof (Murphy et al. 2011)
  - Insecticide resistance, lack of options, more stringent pesticide application requirements, more stringent pesticide residue requirements (Calvo 2015)

Any of the above sound familiar?

Biological Control | Whiteflies

- Mainly *Bemisia tabaci*, the silverleaf whitefly (aka sweetpotato whitefly)
- Sucking damage -> Honeydew -> Sooty mold

Whitefly control I Insecticides

Week	A.I.	Pest
1	Cyromazine	Fungus gnats
2		
3	Pyrifluquinazon + Pymetrozine	Whiteflies
4		
5	Pyrifluquinazon + Pymetrozine	Whiteflies
6	Abamectin	Mites/Whiteflies
7	Cyantraniliprole	Whiteflies/Thrip
8		
9	Spirotetramat + Beauveria bassiana Strain GHA	Whiteflies
10	Acephate + Fenpropathrin	Mites/Whiteflies
11	Azadirachtin + Beauveria bassiana Strain GHA	Whiteflies
12	Pyrifluquinazon + Pymetrozine	Whiteflies
13	Acetamiprid	Whiteflies
14	Pyridaben	Whiteflies
15	Spirotetramat	Whiteflies
16	Dinotefuran	Whiteflies

Current insecticide rotation

Resistance

pesticideresistance.org

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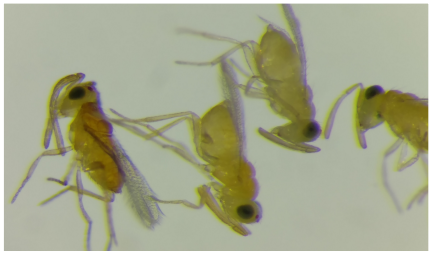
Multiple Natural Enemies

Eretmocerus eremicus Rose (Hymenoptera: Aphelinidae)



Parasitic wasp
Applied weekly, short lifespan
"Seek and destroy", optimized for finding low populations
Oviposit in 2nd and 3rd instar whitefly nymphs (Headrick et al. 1995)
Greater dispersal than mites

Amblyseius swirskii Athias-Henriot (Acari: Phytoseiidae)

Predatory mite
Applied less frequently and can live longer (~30 days)
Serve as a "standing army" approach (Messelink et al. 2016)
Attack eggs and 1st instar (Nomikou et al. 2004)
Limited movement

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XTENSION

Main Objectives

1. Quantify whitefly densities received by growers on poinsettia cuttings.

2. Determine number of whiteflies at various retailers to establish an acceptable whitefly threshold at harvest.

3. Assess whether either or the combination of *E. eremicus* and *A. swirskii* will provide below marketable whitefly thresholds.

Objective 2: retailer threshold

- Dec. 2016: 11 retailers in East Texas
- 20+ poinsettias (6 – 6.5” pots) inspected for adults and immature whiteflies for 60 seconds per pot.
- Retailers categorized as “Big box” (Home Depot, Walmart, Lowes), Grocery Store (Brookeshires, Super 1 Foods), Garden Center, and specialty Florist.

Objective 1: initial infestation

	Mean		Mean proportion infested		
Grower	Adult	Immature	Adult	Immature	n
A	0.04	0.21	0.029	0.025	1215
B	0.00	0.032	0.002	0.003	1202

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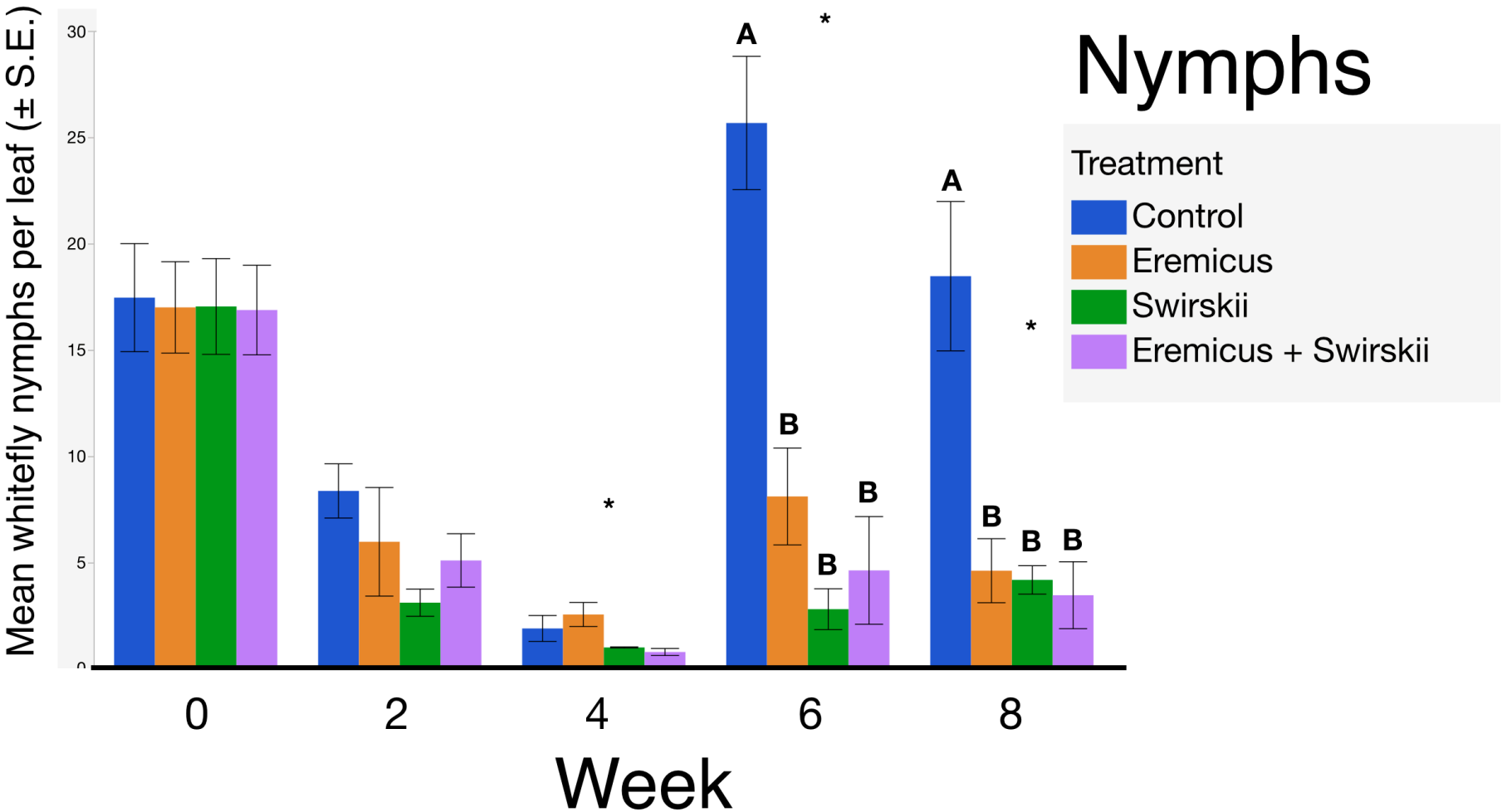
Objective 2: retailer threshold

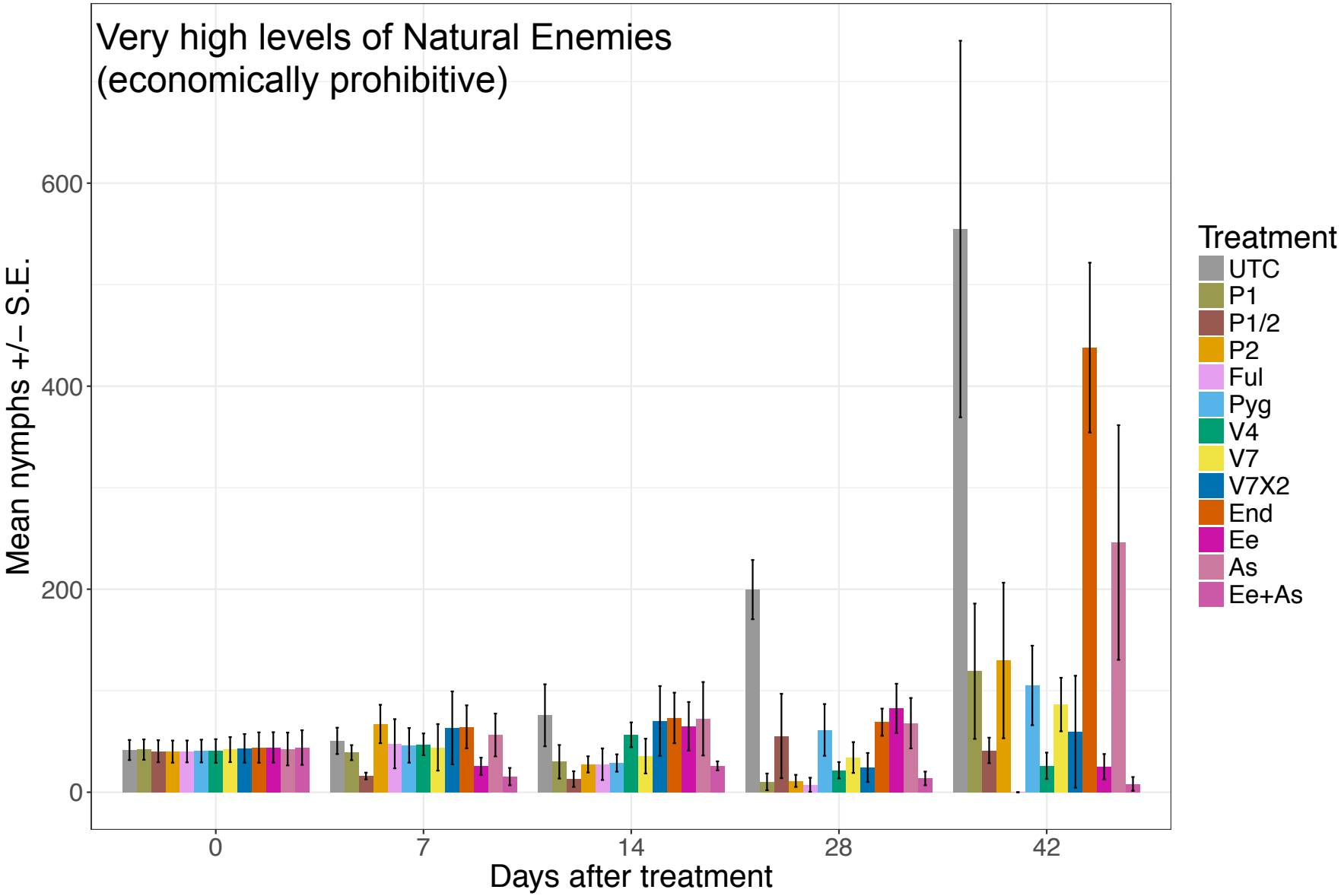
	Mean		Mean prop. infested			
Category	Adult	Immature	Adult	Immature	Stores	n
Big Box	0.19	4.35	0.13	0.43	3	84
Grocery	1.29	31.25	0.24	0.62	6	103
Garden Ctr.	2.47	16.20	0.5	0.63	1	30
Florist	0.80	8.60	0.3	0.4	1	10

Objective 3: Multiple natural enemies

Budget of $0.9 / 6-in poinsettia



Objective 3: Multiple natural enemies



Biological Control | Pesticide Compatibility

Biobest Side Effects

Wax BVBA **Productivity** ★★★★★ 4

Everyone

This app is compatible with some of your devices.

Installed

Side Effects Guide

Koppert Biological Systems **Business** ★★★★½ 23

Everyone

This app is compatible with some of your devices.

Installed

Bioline

The Bioline App

Digital Pie Ltd **Business** ★★★★★ 6

Everyone

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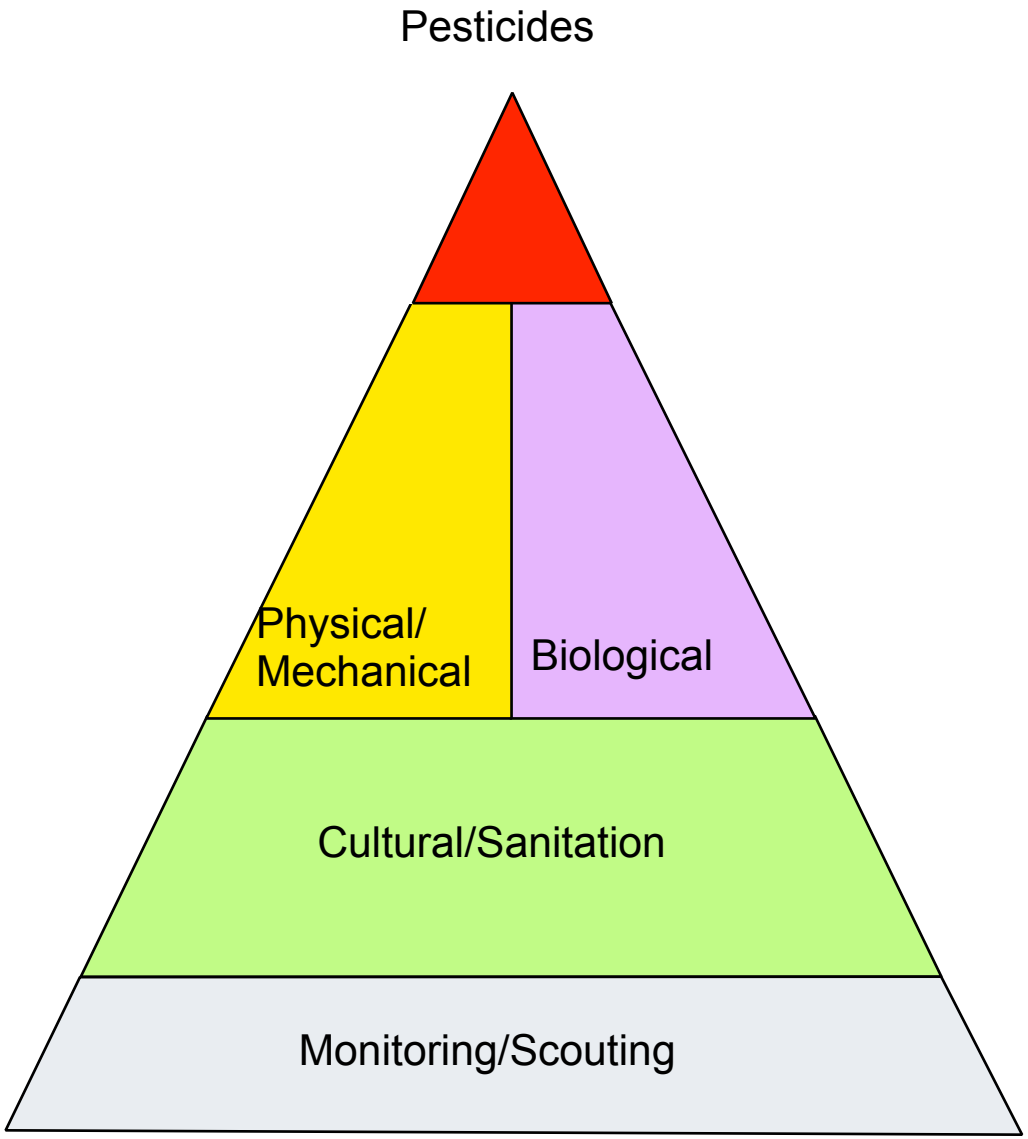
Texas A&M AgriLife Extension

IPM Pyramid



Texas A&M AgriLife Extension

Pesticides

Yes	No
• *Use judiciously based on monitoring data* • *Time sprays to prevent harm to beneficials* • *Time sprays for effectiveness* • *Use low persistence high specificity pesticides* • *Target infestation area only if infestation is localized* • *Rotate chemicals to prevent resistance*	• *Spray based on calendar spray schedule* • *Spray when flowers are in bloom* • *Spray them when you see them* • *Spray with the most effective pesticide over and over again* • *Feed your plants pesticides for breakfast, lunch and dinner (and dessert, if they deserve it).*

Pesticides

OPEN ACCESS Freely available online

PLOS | ONE

Neonicotinoid Insecticides Alter Induced Defenses and Increase Susceptibility to Spider Mites in Distantly Related Crop Plants

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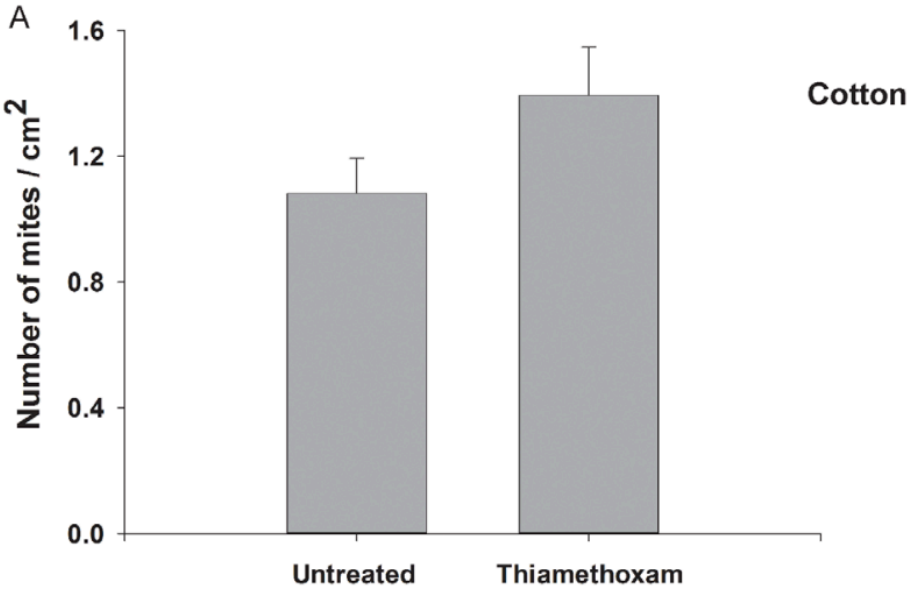
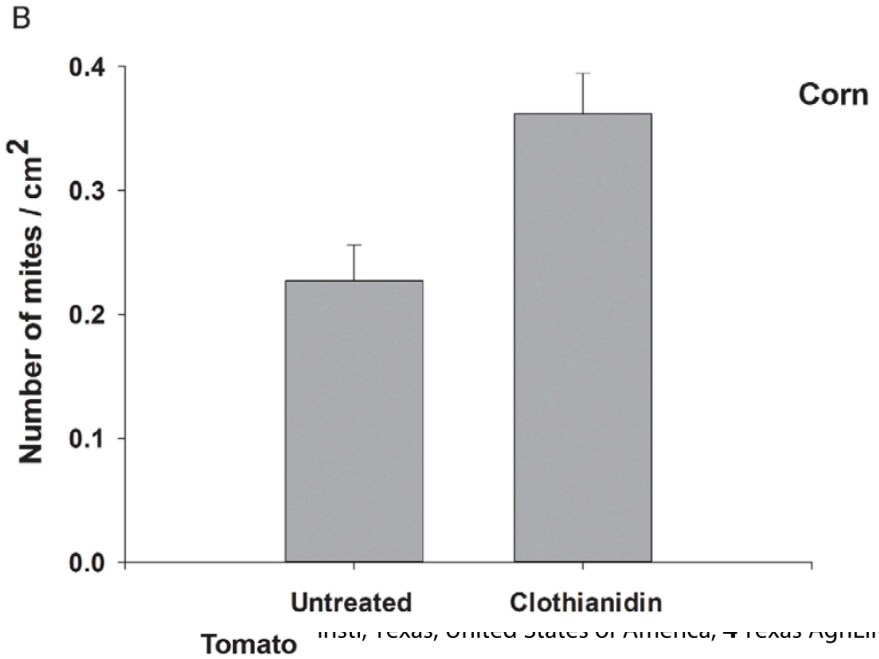
Abstract

Background: Chemical suppression of arthropod herbivores is the most common approach to plant protection. Insecticides, however, can cause unintended, adverse consequences for non-target organisms. Previous studies focused on the effects of pesticides on target and non-target pests, predatory arthropods, and concomitant ecological disruptions. Little research, however, has focused on the direct effects of insecticides on plants. Here we demonstrate that applications of neonicotinoid insecticides, one of the most important insecticide classes worldwide, suppress expression of important plant defense genes, alter levels of phytohormones involved in plant defense, and decrease plant resistance to unsusceptible herbivores, spider mites *Tetranychus urticae* (Acari: Tetranychidae), in multiple, distantly related crop plants.

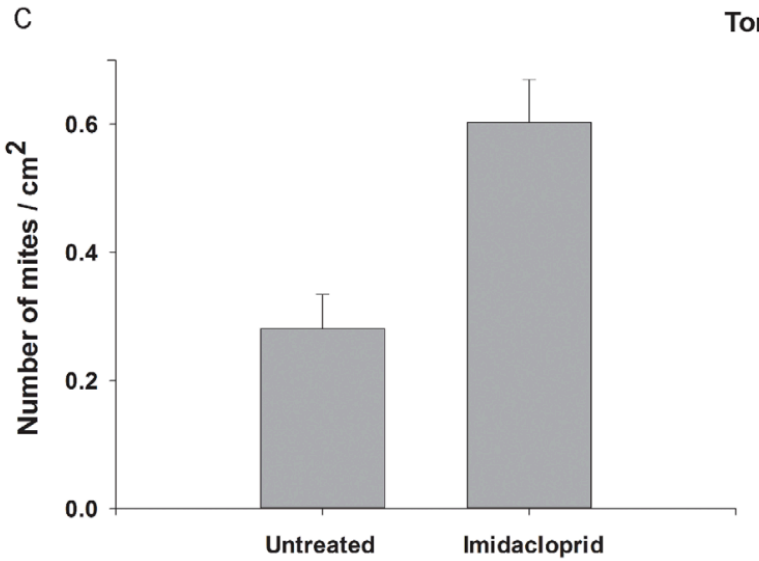
Methodology/Principal Findings: Using cotton (Gossypium hirsutum), corn (Zea mays) and tomato (Solanum lycopersicum) plants, we show that transcription of phenylalanine amonia lyase, coenzyme A ligase, trypsin protease inhibitor and

Pesticides





Maryland, United States of America, 3 ... Texas, United States of America, 4 Texas AgriLife Research and Extension Center, Texa



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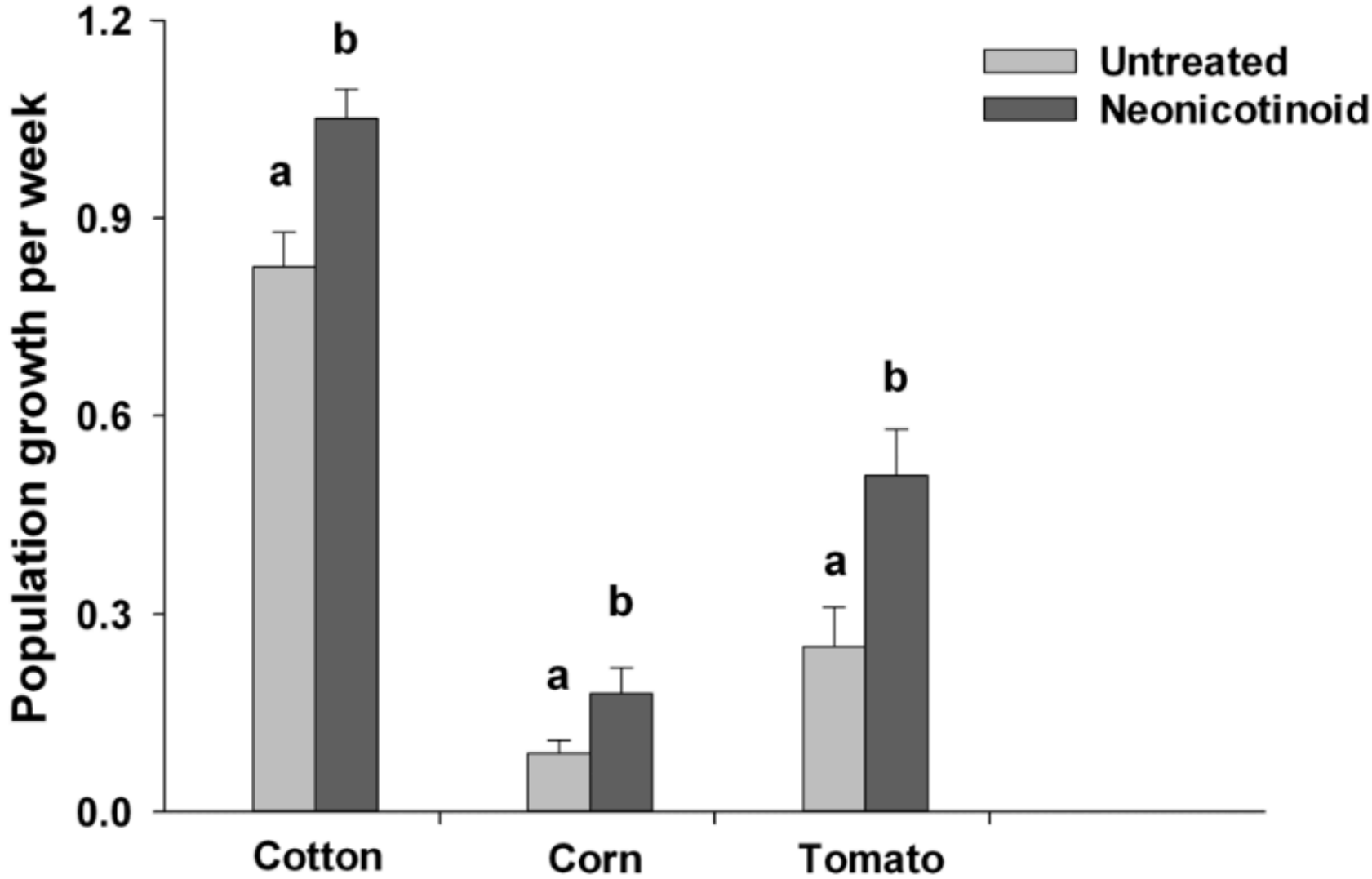
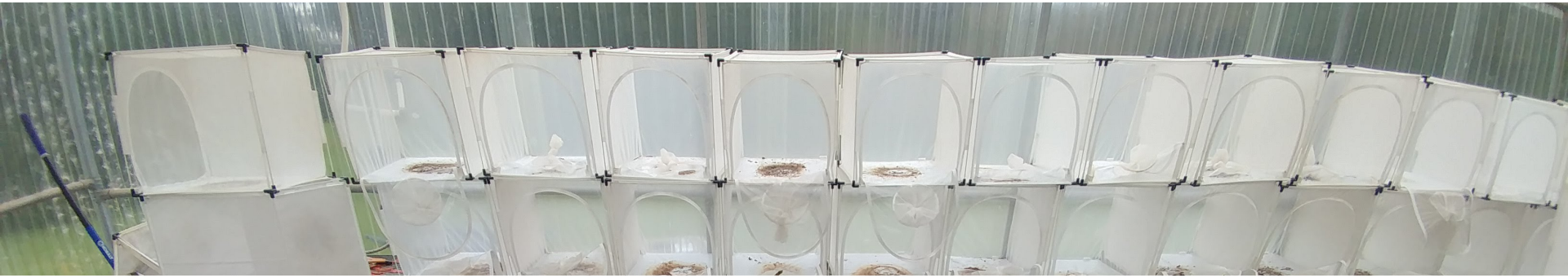
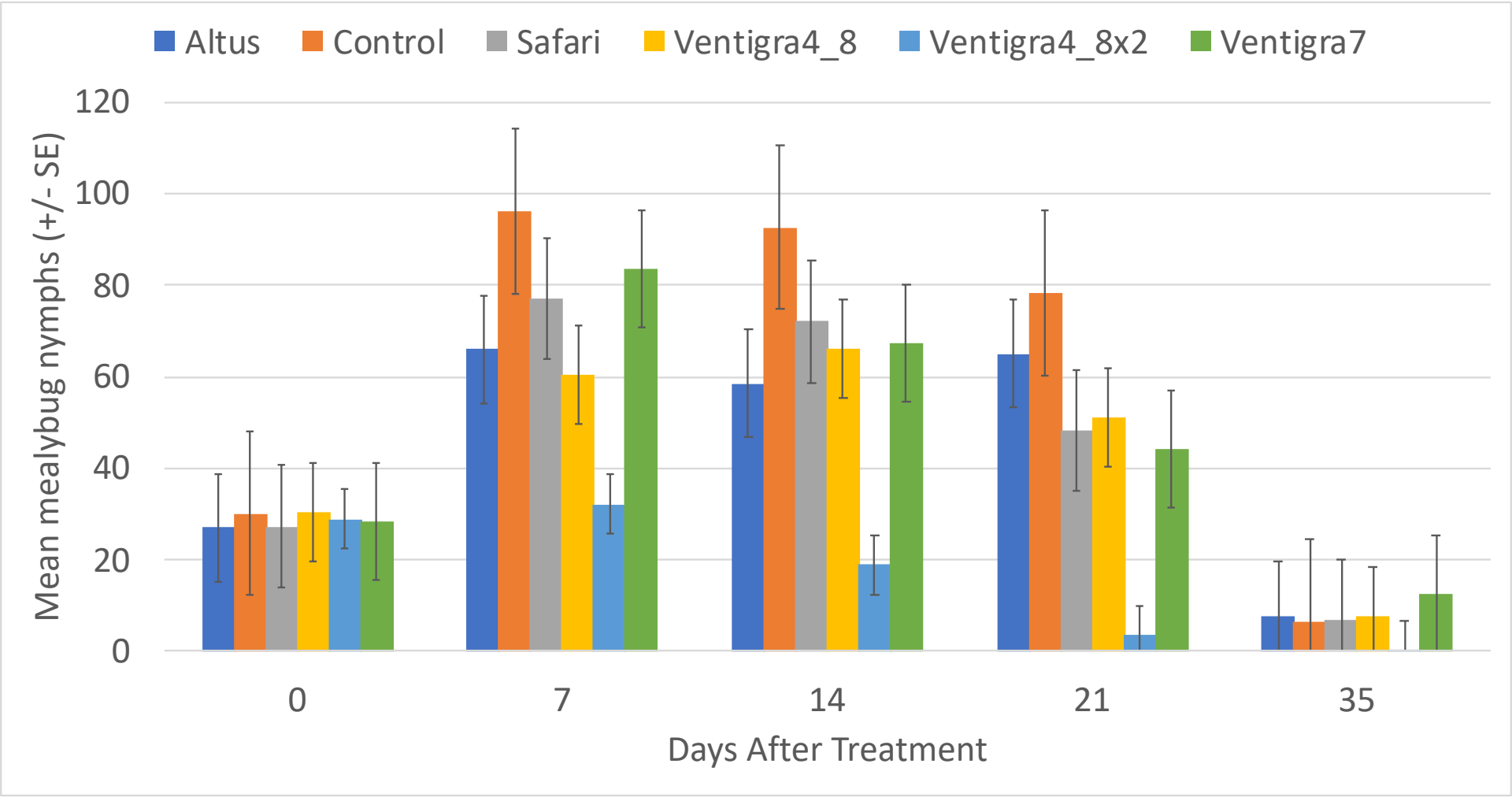
Pesticides


Population growth per week
1.2
0.9
0.6
0.3
0.0
Untreated
Neonicotinoid
a
b
a
b
a
b
Cotton
Corn
Tomato

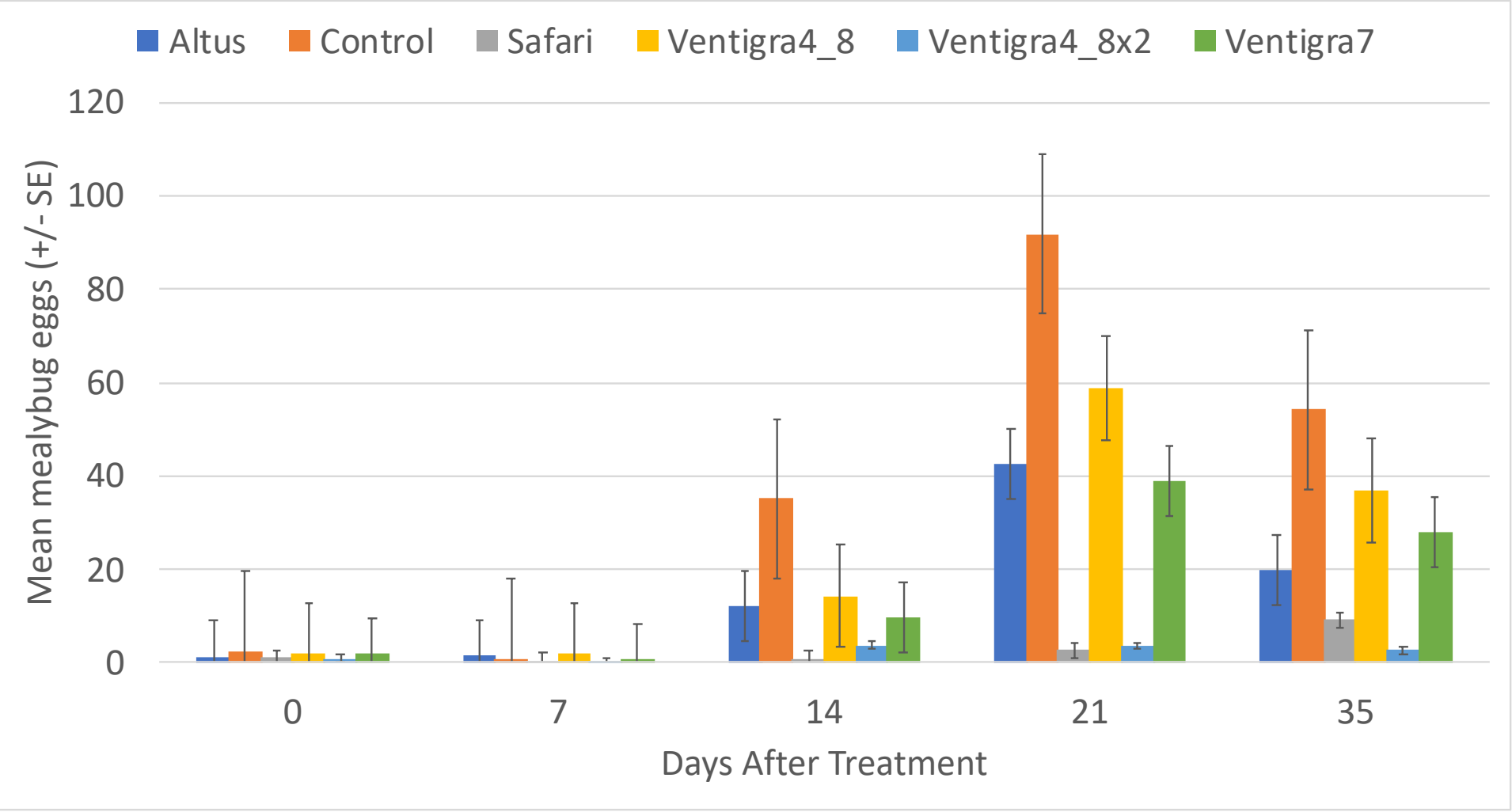
Mealybug Efficacy Trial



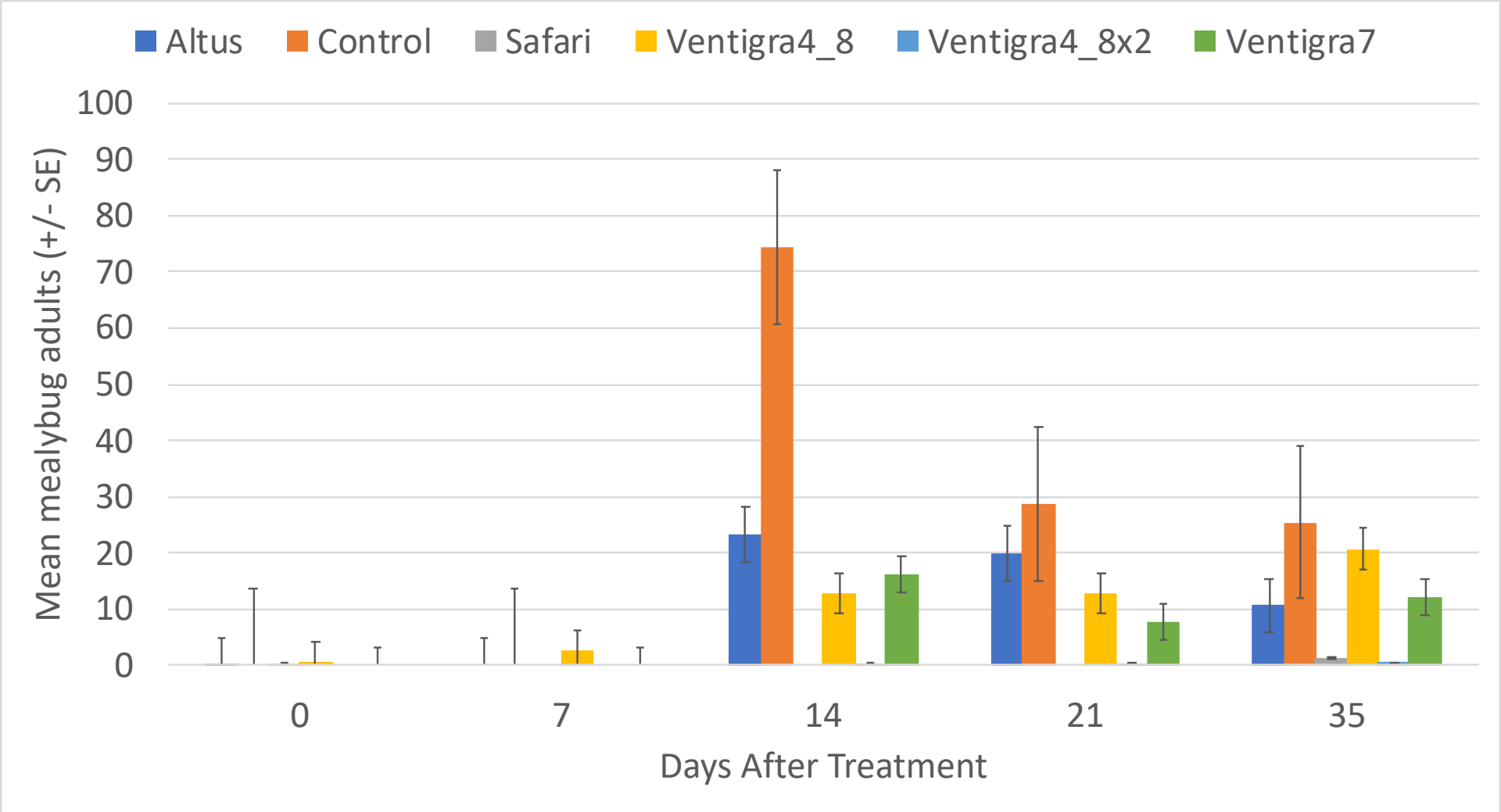
Mealybug Efficacy Trial



Mealybug Efficacy Trial



Mealybug Efficacy Trial



Crapemyrtle bark scale efficacy trial

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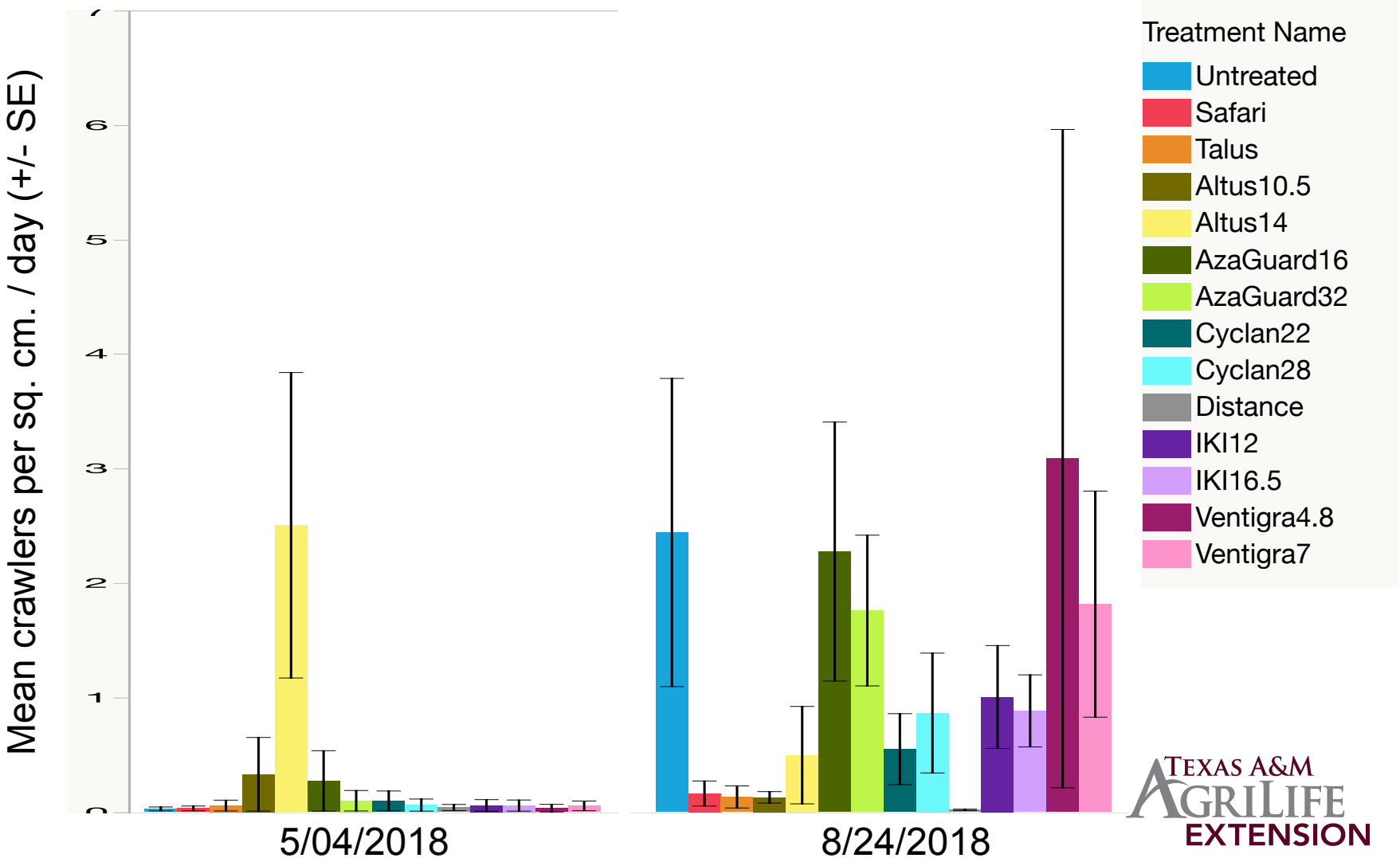
Crapemyrtle bark scale efficacy trial



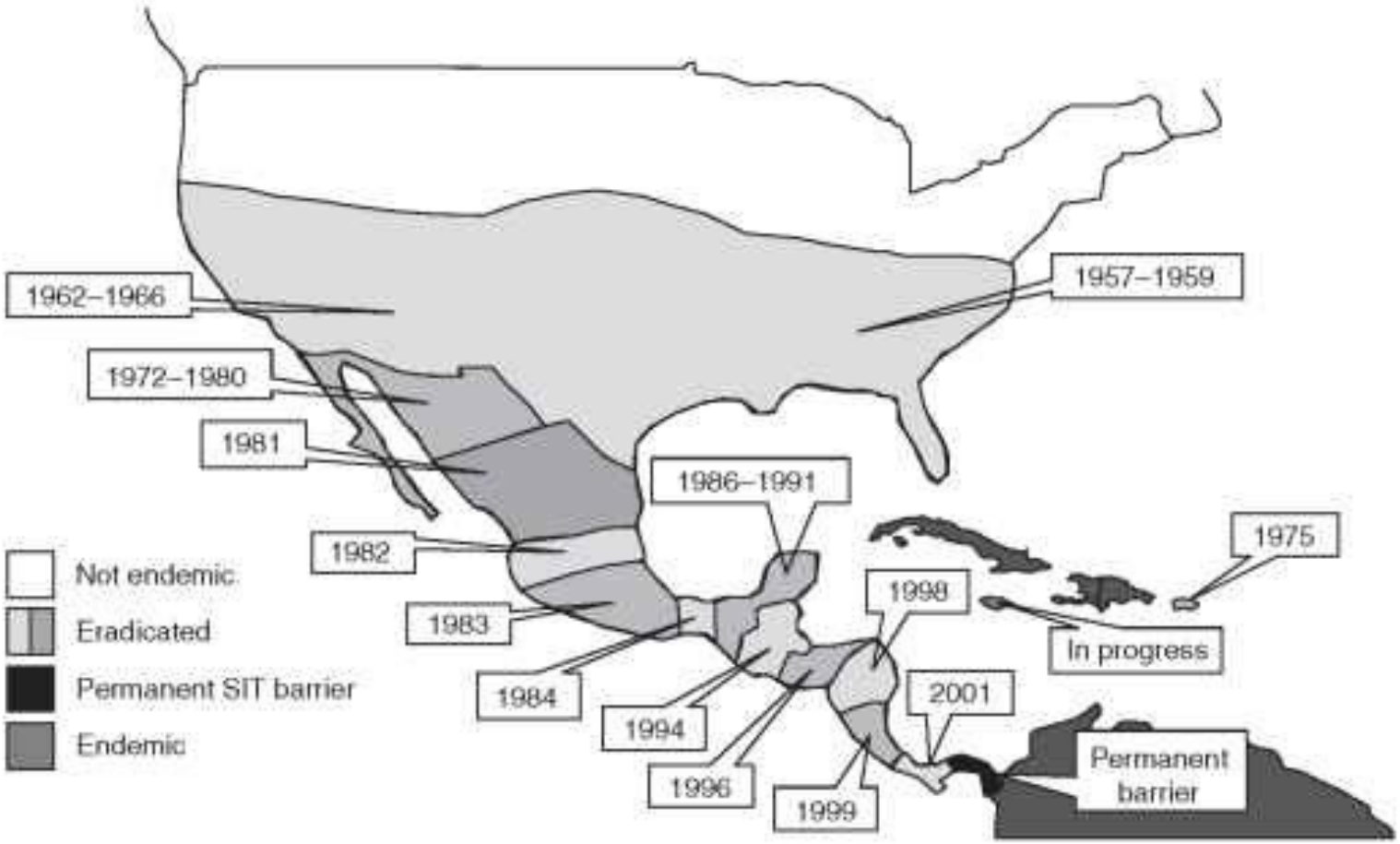
TEXAS A&M AGRILIFE EXTENSION

New Technologies

Sterile Insect Release

Texas A&M AgriLife Extension

Sterile Insect Release



TEXAS A&M AGRILIFE EXTENSION

Sterile Insect Release

Mosquitoes

Dengue Fever

- 50 - 100 million cases of dengue fever per year
- 500,000 dengue hemorrhagic fever per year
- 22,000 deaths per year (mostly among children)

Malaria

- 219 cases in 2010
- 660,000 deaths in 2010, mostly in African countries

WHO

Sterile Insect Release

OXITEC

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Home » News and Views » PRESS RELEASE: Oxitec report 96% suppression of the dengue mosquito in Brazilian trials

Categories

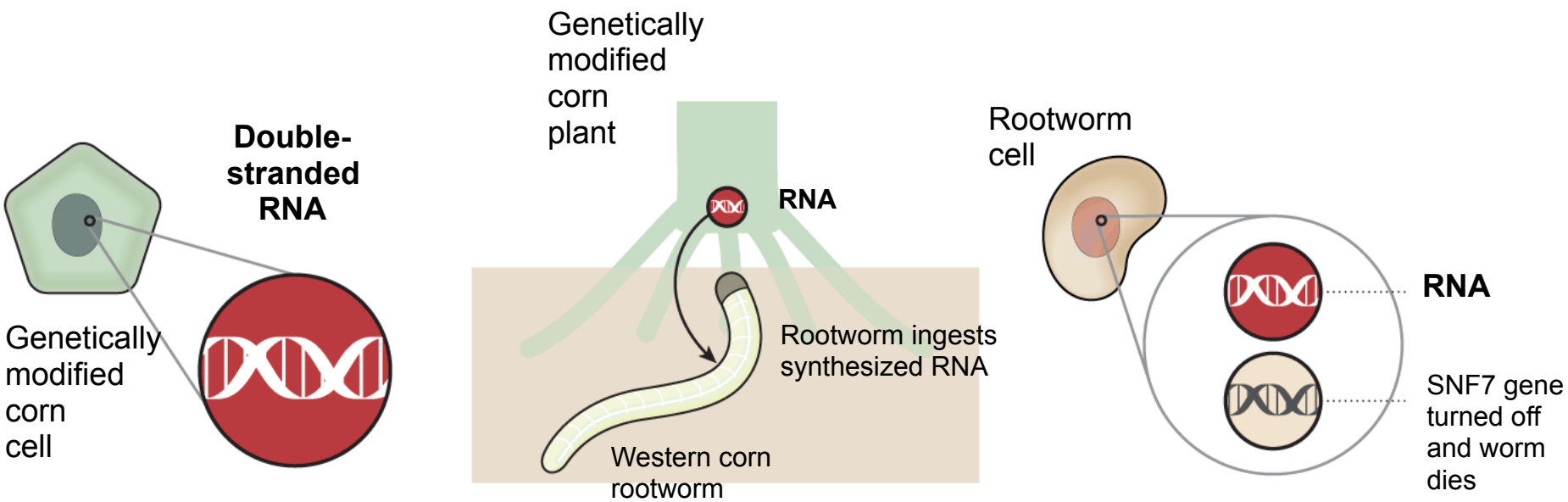
- News
- Newsletter
- Events
- Oxitec in the news
- Resources
  - Documents
  - Presentations

PRESS RELEASE: Oxitec report 96% suppression of the dengue mosquito in Brazilian trials

Tracy Thompson *21st May 2013* *News, Oxitec in the news*

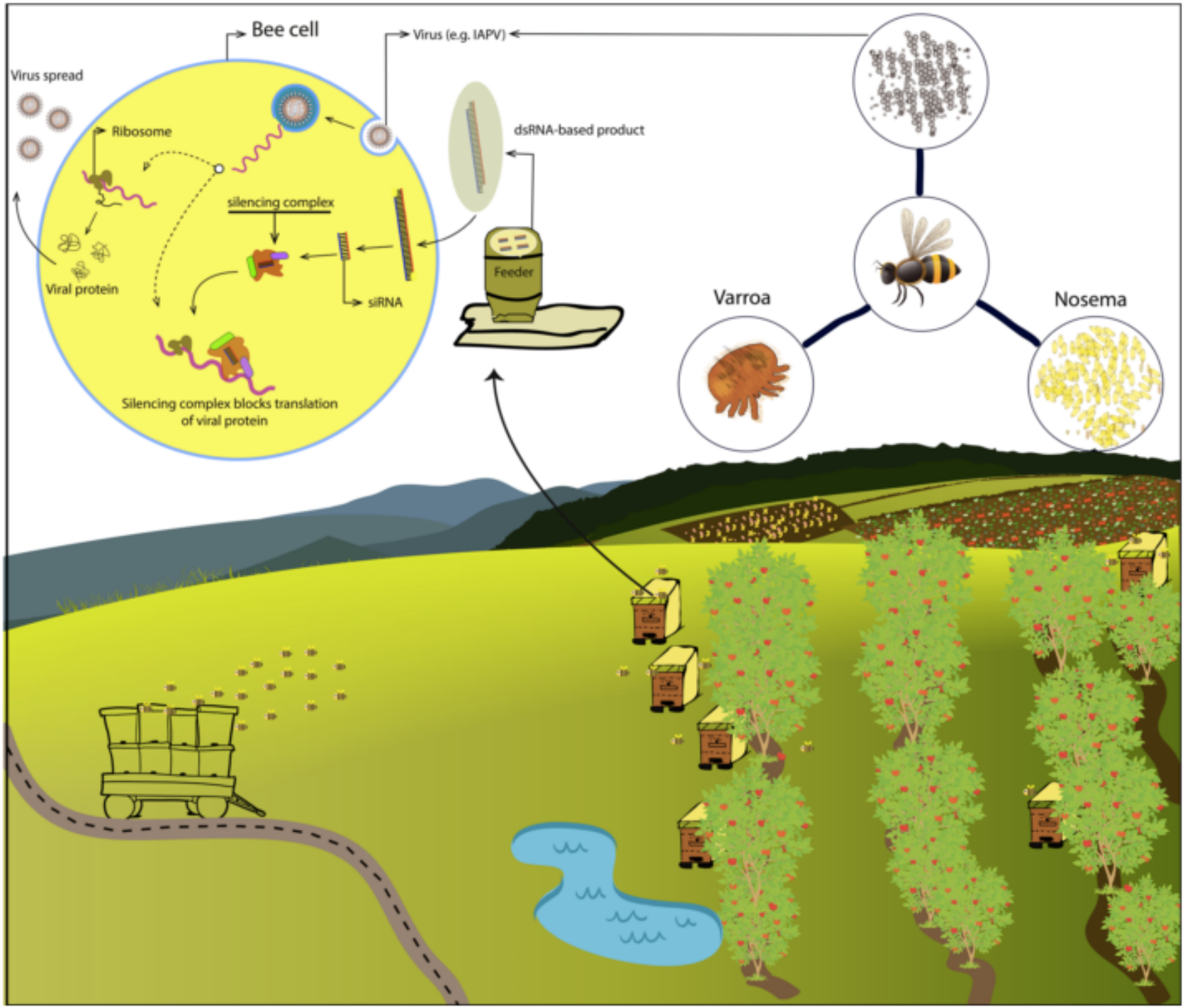
Mandacaru field trial report – press summary

RNAi



From: Using GMO Crops to Target a Pest

Texas A&M AgriLife Extension


Bee cell
Virus (e.g. IAPV)
Virus spread
Ribosome
dsRNA-based product
silencing complex
Viral protein
siRNA
Feeder
Silencing complex blocks translation of viral protein
Varroa
Nosema

Insect Allies

Dr. Blake Bextine

RESOURCES

DARPA Response to Science Opinion Piece

The Insect Allies program is pursuing scalable, readily deployable, and generalizable countermeasures against potential natural and engineered threats to the food supply with the goals of preserving the U.S. crop system. National security can be quickly jeopardized by naturally occurring threats to the crop system, including pathogens, drought, flooding, and frost, but especially by threats introduced by state or non-state actors. Insect Allies seeks to mitigate the impact of these incursions by applying targeted therapies to mature plants with effects that are expressed at relevant timescales—namely, within a single growing season. Such an unprecedented capability would provide an urgently needed alternative to pesticides, selective breeding, slash-and-burn clearing, and quarantine, which are often ineffective against rapidly emerging threats and are not suited to securing mature plants.

To develop such countermeasures, Insect Allies performer teams are leveraging a natural and efficient two-step delivery system to transfer modified genes to plants: insect vectors and the plant viruses they transmit. The program's three technical areas—viral manipulation, insect vector optimization, and selective gene therapy in mature plants—layer together to support the goal of

Recent Advances in Pest Management

Questions?

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