Reducing synthetic chemical use to optimize pest management and crop production: A case study of onion thrips in onion

Brian Nault

Professor and Program Leader, Department of Entomology

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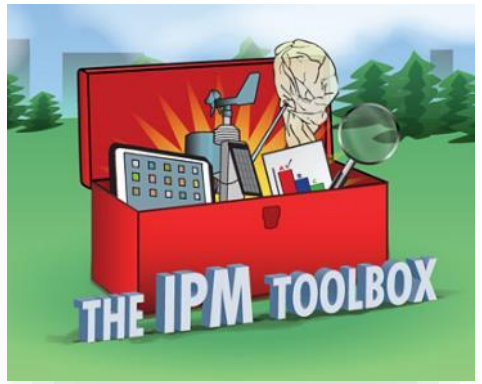

Northeastern IPM Center

April 11, 2024

USDA United States Department of Agriculture National Institute of Food and Agriculture

Cornell AgriTech
New York State Agricultural Experiment Station

Webinar Details

Live Transcription

A recording of this webinar will be available within a week at

http://www.neipmc.org/go/ipmtoolbox

Northeastern IPM Center

We Welcome Your Questions

Please submit a question **at any time** using the Q&A feature to your right at any time

If you'd like to ask a question anonymously, please indicate that at the beginning of your query.

Northeastern IPM Center

Webinar Presenter

Brian Nault

Professor and Program Leader

Department of Entomology

Cornell University AgriTech

Cornell AgriTech

New York State Agricultural Experiment Station

Northeastern IPM Center

Some Questions for You

Northeastern IPM Center

Reducing synthetic chemical use to optimize pest management and crop production: A case study of onion thrips in onion

Northeastern IPM Toolbox Webinar
April 11, 2024

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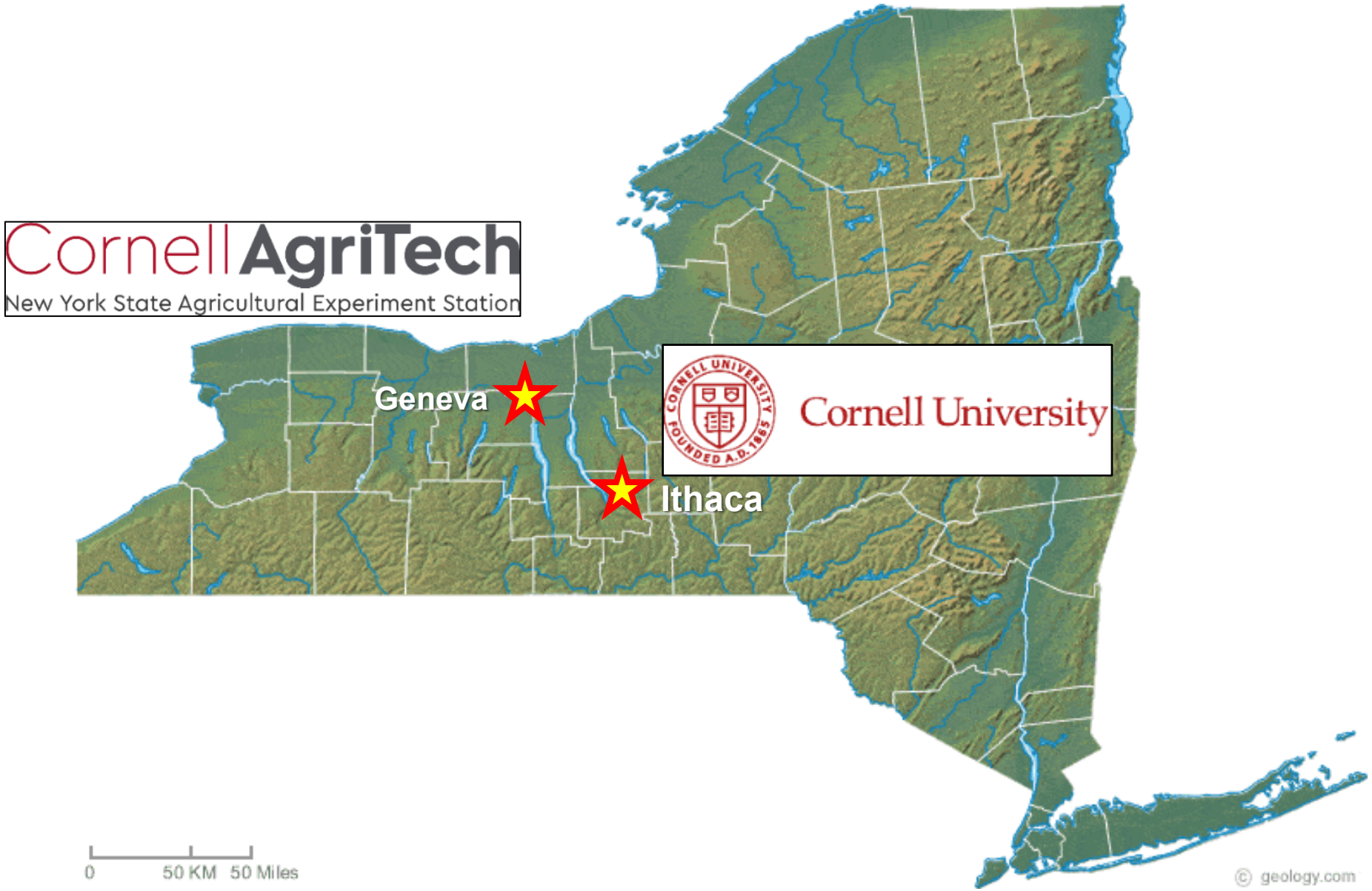
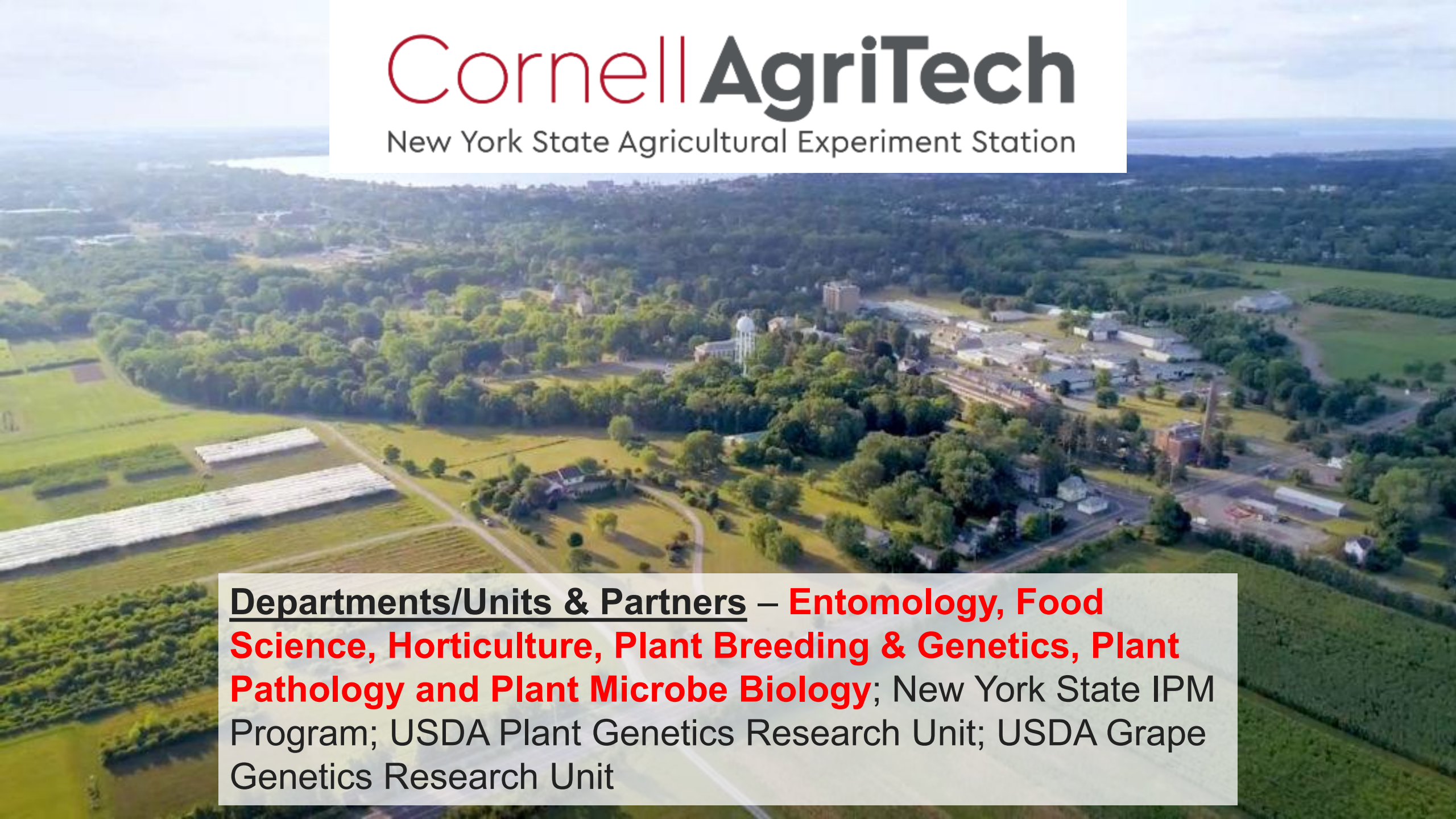
Cornell AgriTech
New York State Agricultural Experiment Station

Where is Cornell AgriTech?





Departments/Units & Partners – **Entomology, Food Science, Horticulture, Plant Breeding & Genetics, Plant Pathology and Plant Microbe Biology**; New York State IPM Program; USDA Plant Genetics Research Unit; USDA Grape Genetics Research Unit

Cornell AgriTech

New York State Agricultural Experiment Station

- Our **mission** is to create future food and agriculture systems by working across disciplines to explore questions from all sides and translate our discoveries into practical solutions that help growers and businesses thrive

- Our **focus** is on specialty crops – tree fruit, small fruit, grapes, vegetables, hops, hemp, shrub willow, turf

Cornell Vegetable Entomology

Goal

- Solve insect pest problems faced by the vegetable crop industry

Objectives

- Study biology and ecology of insect pests
- Develop management programs for the pests
- Implement management programs for the pests

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Case study: Onion thrips management in onion using fewer chemical inputs

Onion thrips
(*Thrips tabaci* Lindeman)

Onion
(*Allium cepa* L.)

Synthetic
chemicals

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Onion thrips and pathogens it transmits are major threats to the onion industry

- Annual losses from thrips damage in U.S. ~ $90 million
- Insecticide use for thrips control in U.S. adds ~ $12.5 million/yr

Thrips Damage

Damage by *Iris yellow spot virus*

Gent et al. (2006) *Plant Dis.*

OUTLINE

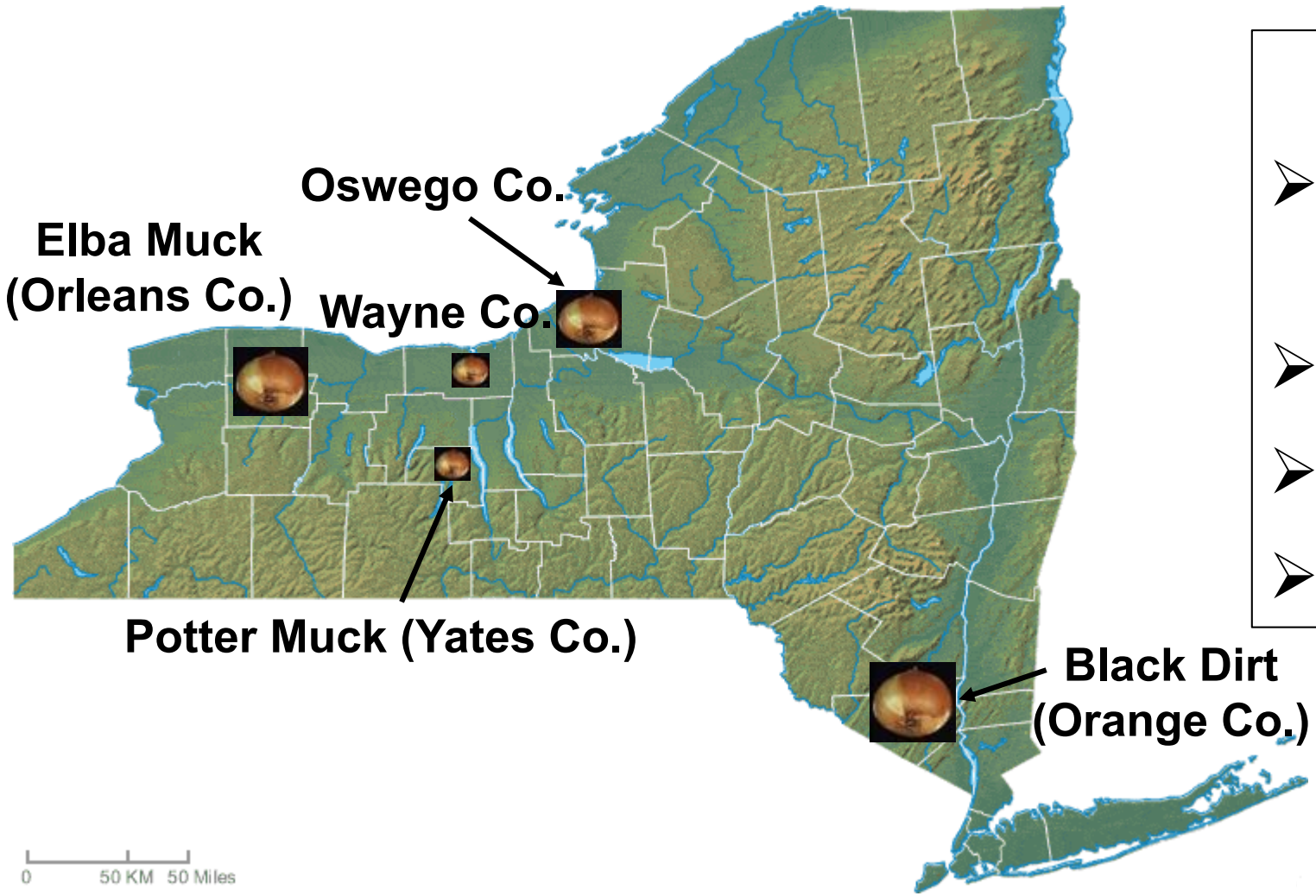
I. Overview of onion production, onion thrips biology and its damage

II. Onion thrips management – chemical control

III. Onion thrips management – cultural control

IV. Conclusions

Onion production in New York



Five-year average

- ~60% acreage in central/ west; ~40% acreage east
- 7,240 acres
- Ranked 8th in acreage US
- Value $47.9 million/ yr

USDA NASS New York Ag Stats Bulletin 2021-2022

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Onion production in New York

Elba Muck

Area = 5,979 acres

Photo: Erik Smith

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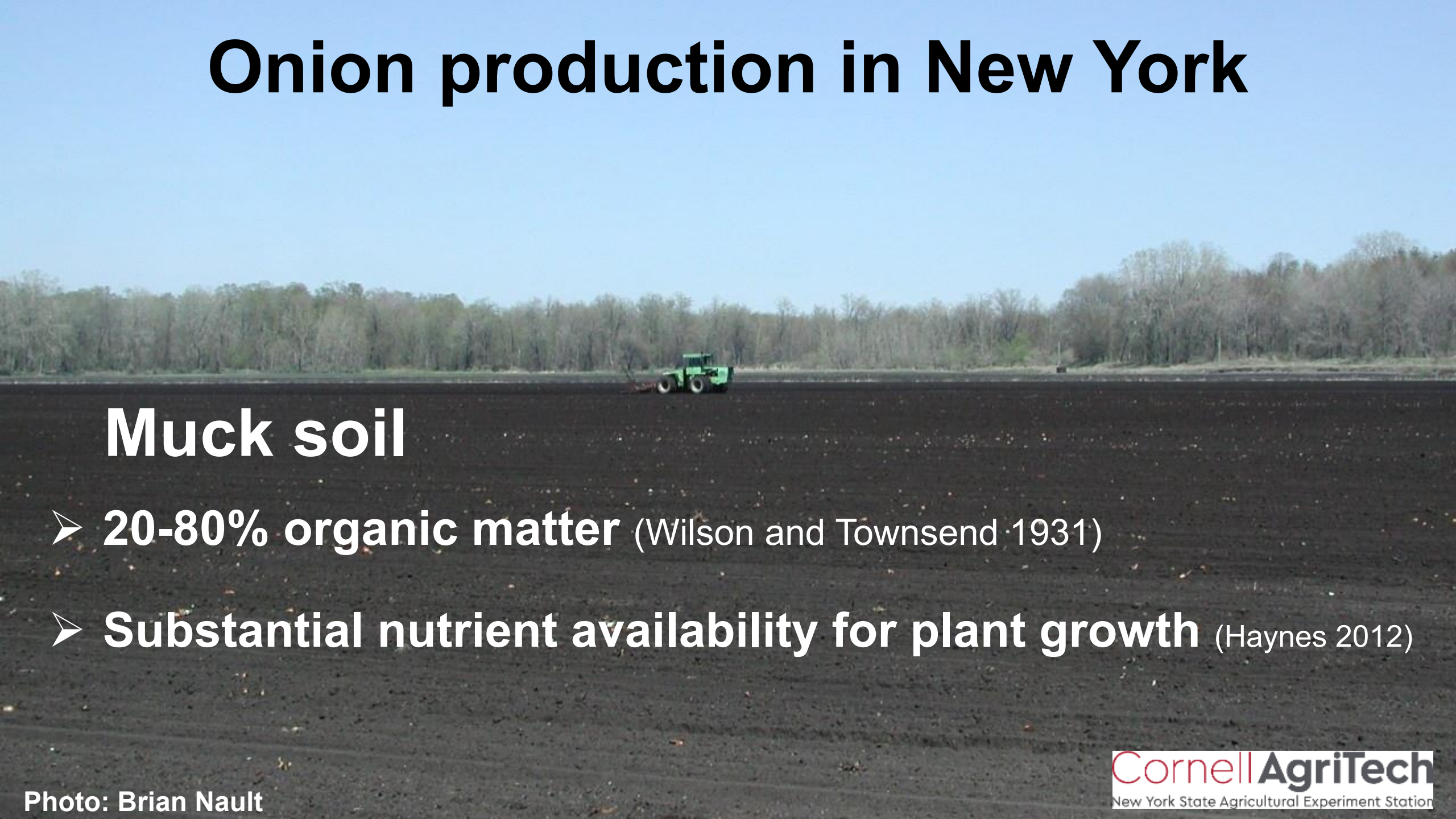
Onion production in New York



Muck soil

- **20-80% organic matter** (Wilson and Townsend 1931)
- **Substantial nutrient availability for plant growth** (Haynes 2012)

Photo: Brian Nault

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Onion production in New York

- Challenges of growing onions in drained swamps

Photo: Brian Nault

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Onion production in New York

- Challenges of growing onions in droughts

Photo: Brian Nault

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Onion production in New York

Onion production

APRIL MAY JUNE JULY AUG SEPT

Planting/ Transplanting

Harvest

Onion thrips, *Thrips tabaci* Lindeman

Photo: Isabella Yannuzzi

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Onion thrips distribution

- Polyphagous pest with a host range that includes hundreds of plant species
- Major pest of onion worldwide

https://www.cabi.org/isc/datasheet/53746

Onion thrips is a major pest of onion

- Onion thrips adults and larvae on onion plants


Photo: Brian Nault


Photo: Joe Ogrodnick

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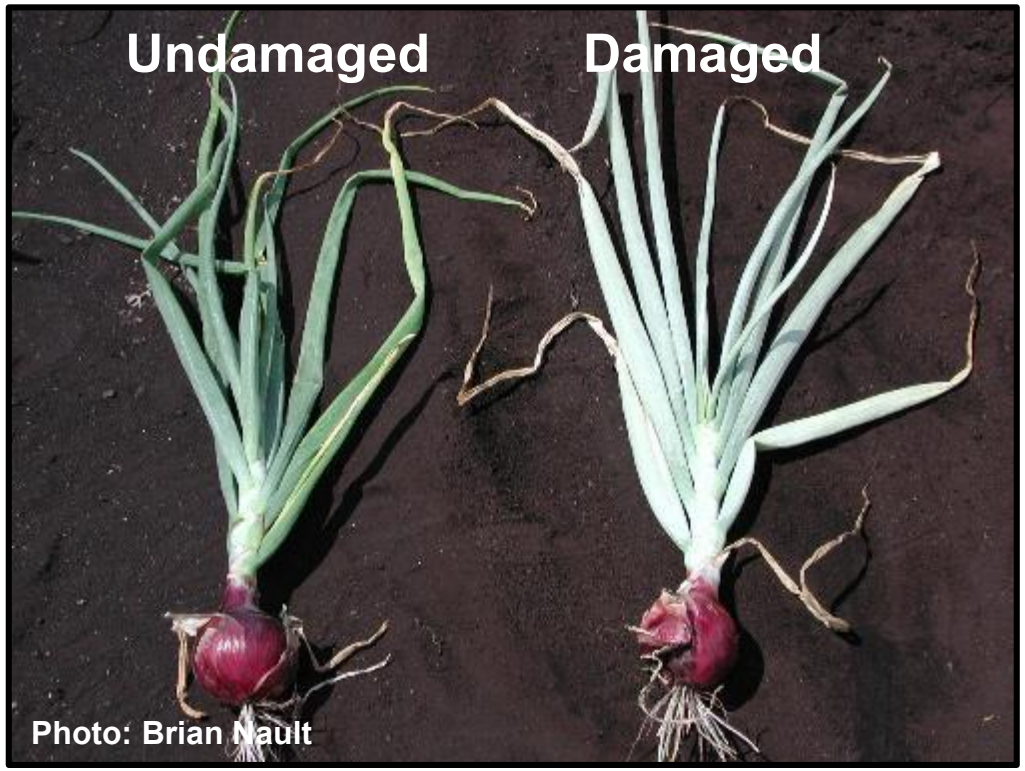
Onion thrips is a major pest of onion

- **Feeding on foliage can reduce bulb weights 30-60%**

  Nault and Huseth (2016) *J. Econ. Entomol*.
  Leach et al. (2017) *Agric. Ecosys. Environ*.



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Onion thrips is a major pest of onion

- **Spread viral, bacterial and fungal pathogens**

  Gent et al. (2006) *Plant Dis*.
  Dutta et al. (2014) *Phytopathology*
  Leach et al. (2020) *Ann Appl Biol*.


Photo: Brian Nault


Iris yellow spot


Center rot


Leaf blight

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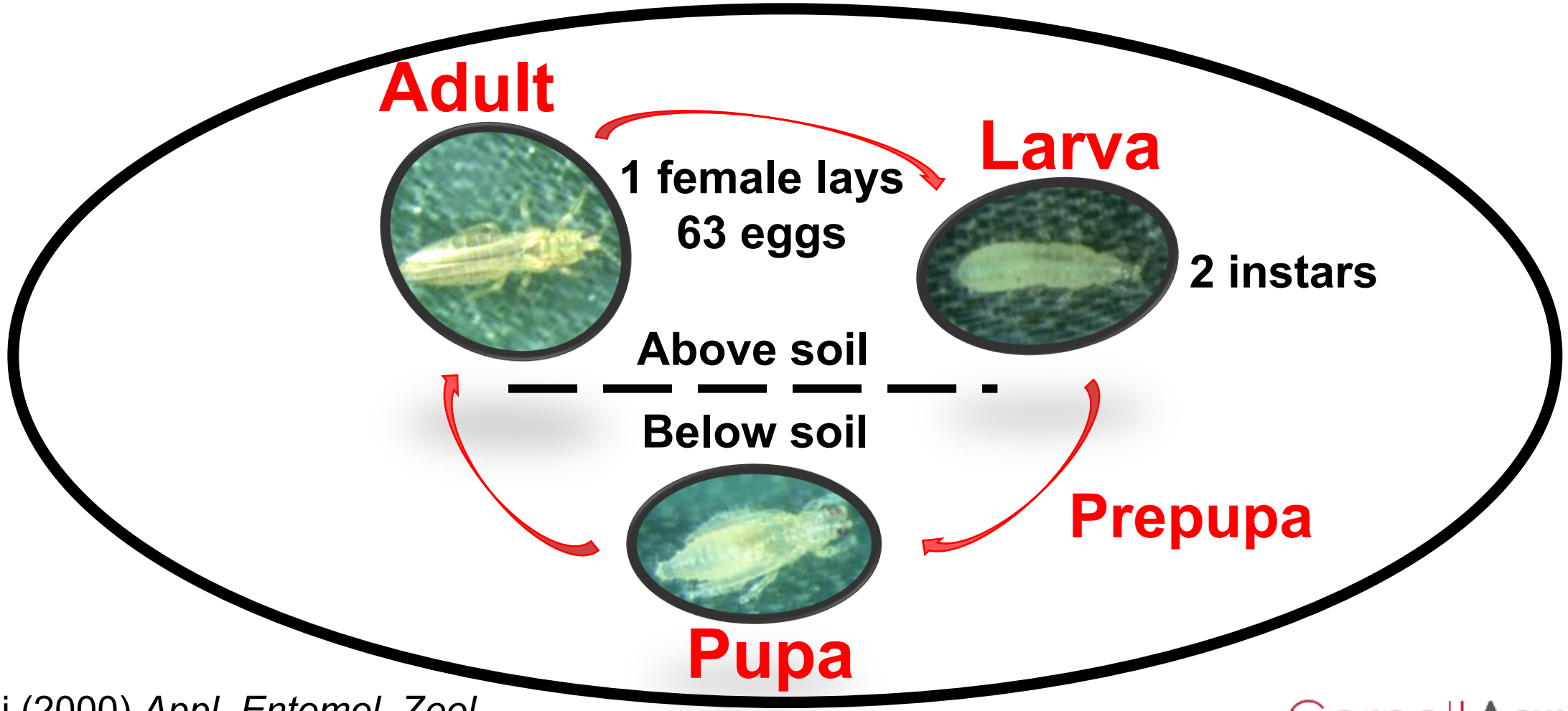
Onion thrips life cycle

✓Onion thrips can complete a generation in ~ 2 weeks



Murai (2000) *Appl. Entomol. Zool.*
Nault et al. (2006) *Environ. Entomol.*

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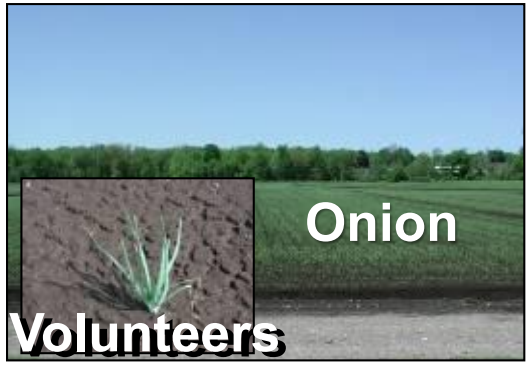
Onion thrips populations

- Thrips adults overwinter in soil
- Emerge in late April and May
- Colonize onion fields via other hosts



Larentzaki et al. (2007) *J. Econ. Entomol.*; Hsu et al. (2011) *Plant Dis.*

Onion thrips populations


Photo: I. Yannuzzi

Onion thrips infestation

Onion production

APRIL MAY JUNE JULY AUG SEPT

Planting/ Transplanting

Harvest

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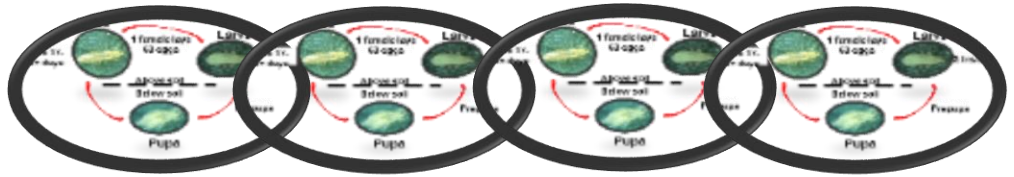
Onion thrips populations

Generations

1 2 3 4



Onion thrips infestation

Onion production

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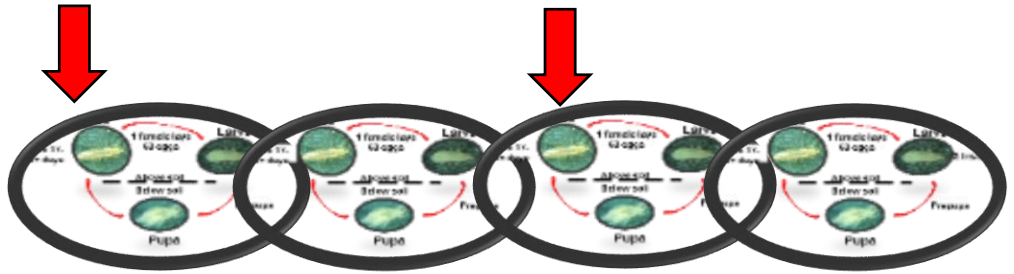
Planting/ Transplanting

Harvest

Foliar-applied insecticides used for control

Late 1980s

Lambda-cyhalothrin (Warrior T)



Onion thrips infestation

Onion production

APRIL MAY JUNE JULY AUG SEPT

Planting/ Transplanting

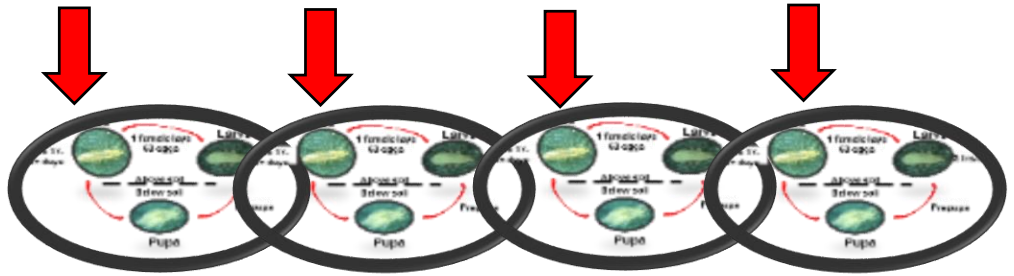
Harvest

Foliar-applied insecticides used for control

Late 1990s


Photo: I. Yannuzzi

Lambda-cyhalothrin (Warrior T)



Onion thrips infestation

Onion production

APRIL MAY JUNE JULY AUG SEPT

Planting/ Transplanting

Harvest

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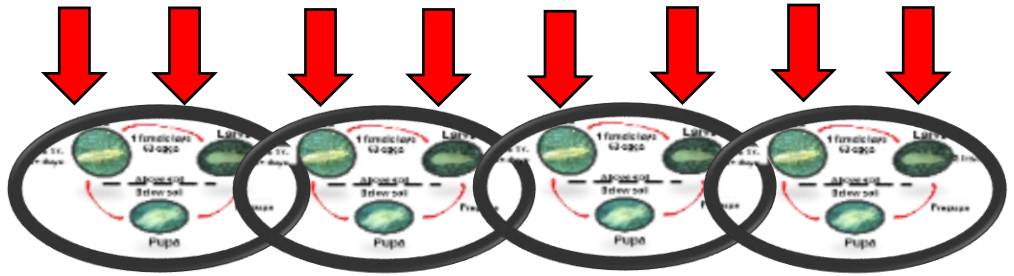
Foliar-applied insecticides used for control

Early 2000s


Photo: I. Yannuzzi

Lambda-cyhalothrin (Warrior T)



Onion thrips infestation

Onion production

APRIL MAY JUNE JULY AUG SEPT

Planting/ Transplanting

Harvest

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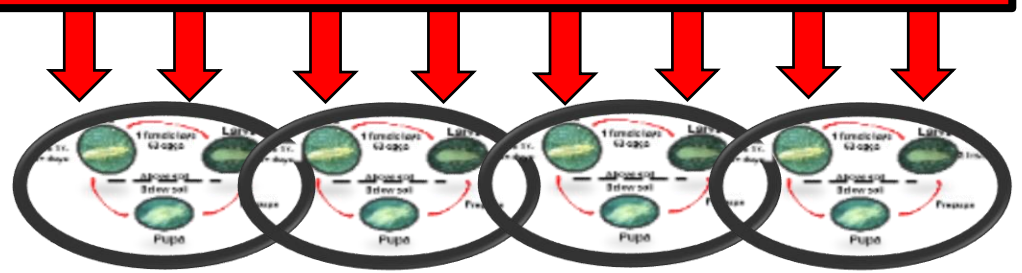
Foliar-applied insecticides used for control

CRISIS!

Early 2000s


Photo: I. Yannuzzi



Onion thrips infestation

Onion production

APRIL MAY JUNE JULY AUG SEPT

Planting/ Transplanting

Harvest

***Insecticide resistance was confirmed in early 2000s**

Shelton et al. (2003) *J. Econ. Entomol*.; Shelton et al. (2006) *J. Econ. Entomol*.

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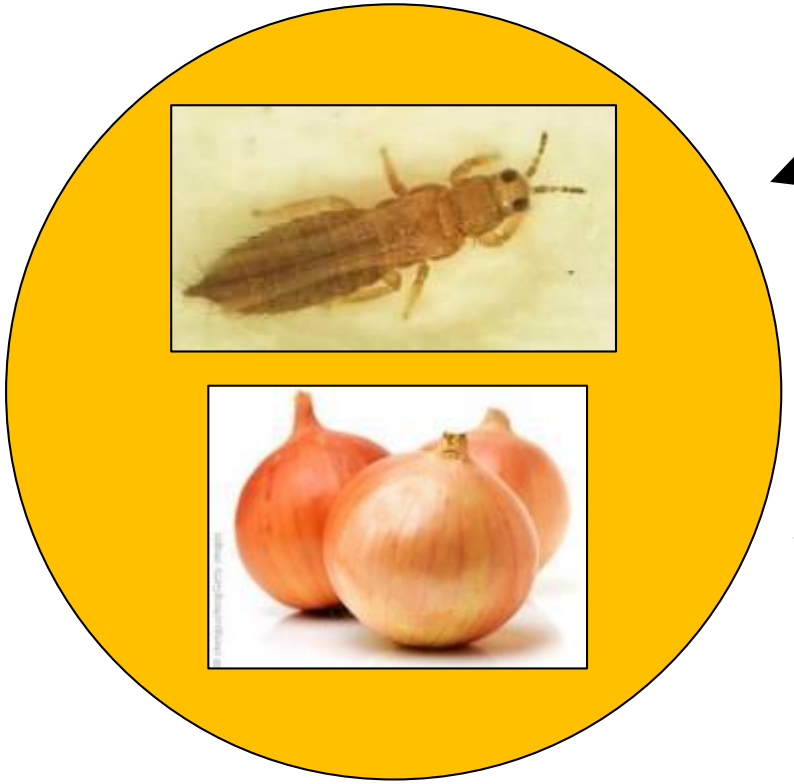
Integrated Pest Management

Chemical Control

Plant Resistance



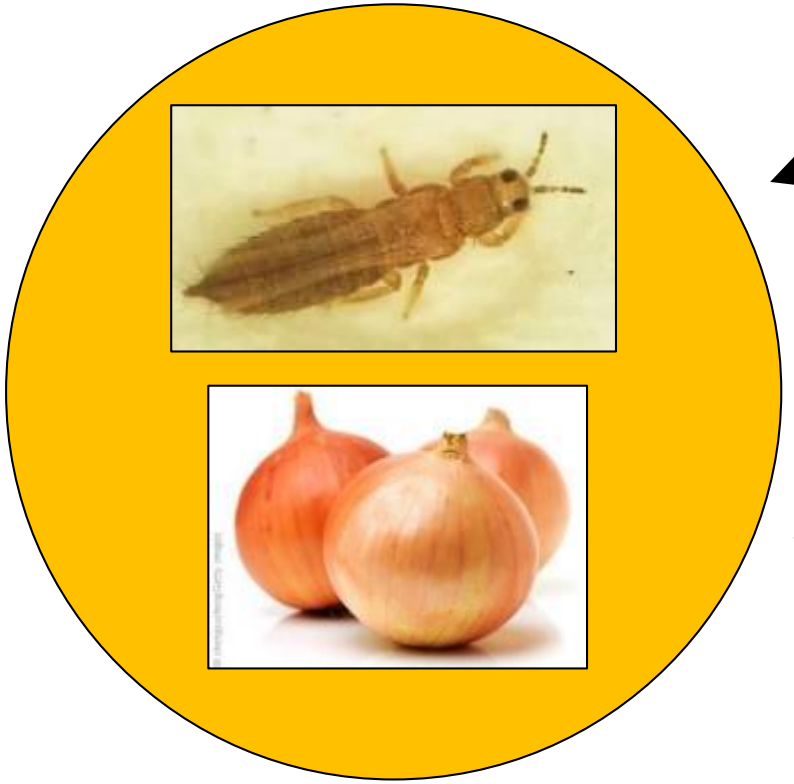
Cultural Control

Biological Control

Integrated Pest Management

Chemical Control

Plant Resistance



Cultural Control

Biological Control

OUTLINE

I. Onion production, onion thrips biology and its damage

II. Onion thrips management – chemical control

III. Onion thrips management – cultural control

IV. Conclusions

Reducing insecticide use to manage thrips

Approach:

- Identify effective insecticides and assist in registration
- Develop an insecticide-based program that optimizes insecticide use and mitigates resistance
- Implement insecticide-based program and measure success

Reducing insecticide use to manage thrips

- Effective insecticides identified in 2005 and then registered

Agri-Mek SC (abamectin)

Carzol SP INSECTICIDE (formetanate hydrochloride)

Spintor 480SC (spinosad)

The IR-4 Project

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Reducing insecticide use to manage thrips

Product Name	Chemical Name	IRAC class	Restrictions for thrips
Agri-Mek SC	abamectin	6	2 sequential applications then rotate to another class
EXIREL INSECT CONTROL	cyantraniliprole	28	2 sequential applications then rotate to another class
Lannate™ INSECTICIDE	methomyl	1A	Do not make more than 8 applications
Minecto Pro	abamectin + cyantraniliprole	6 + 28	2 sequential applications only
MOVENTO	spirotetramat	23	2 sequential applications only
Senstar INSECTICIDE	spirotetramat + pyriproxyfen	23 + 7C	2 applications only
Radiant SC INSECTICIDE	spinetoram	5	2 sequential applications then rotate to another class
Warrior II with Zeon Technology	lambda-cyhalothrin	3	Do not make more than 8 applications

Reducing insecticide use to manage thrips

- Develop an onion thrips management plan based on IRM principles

Major Principles

IRAC
Insecticide Resistance Action Committee

1) Limit use of each insecticide class
2) Rotate insecticide classes (sequence)
3) Action thresholds
4) Combine with other management tactics

https://irac-online.org/documents/moa-classification/

Reducing insecticide use to manage thrips

- Sequence of effective insecticides

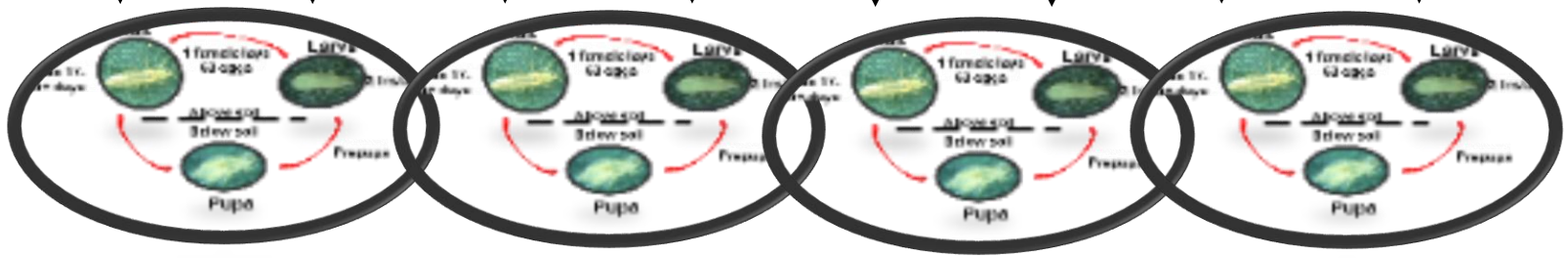

Photo: I. Yannuzzi

MOVENTO

Agri-Mek SC

Radiant SC
INSECTICIDE

EXIREL
INSECT CONTROL



Onion thrips infestation

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Reducing insecticide use to manage thrips

- **Economic Injury Level (EIL): season mean avg. 2.2 larvae/ leaf** Fournier et al. (1995) *J. Econ Entomol.*

- **Action thresholds developed for commonly used insecticides; 1 thrips/leaf most preferred** Nault & Shelton (2010) *J. Econ. Entomol.*


Photo: Brian Nault

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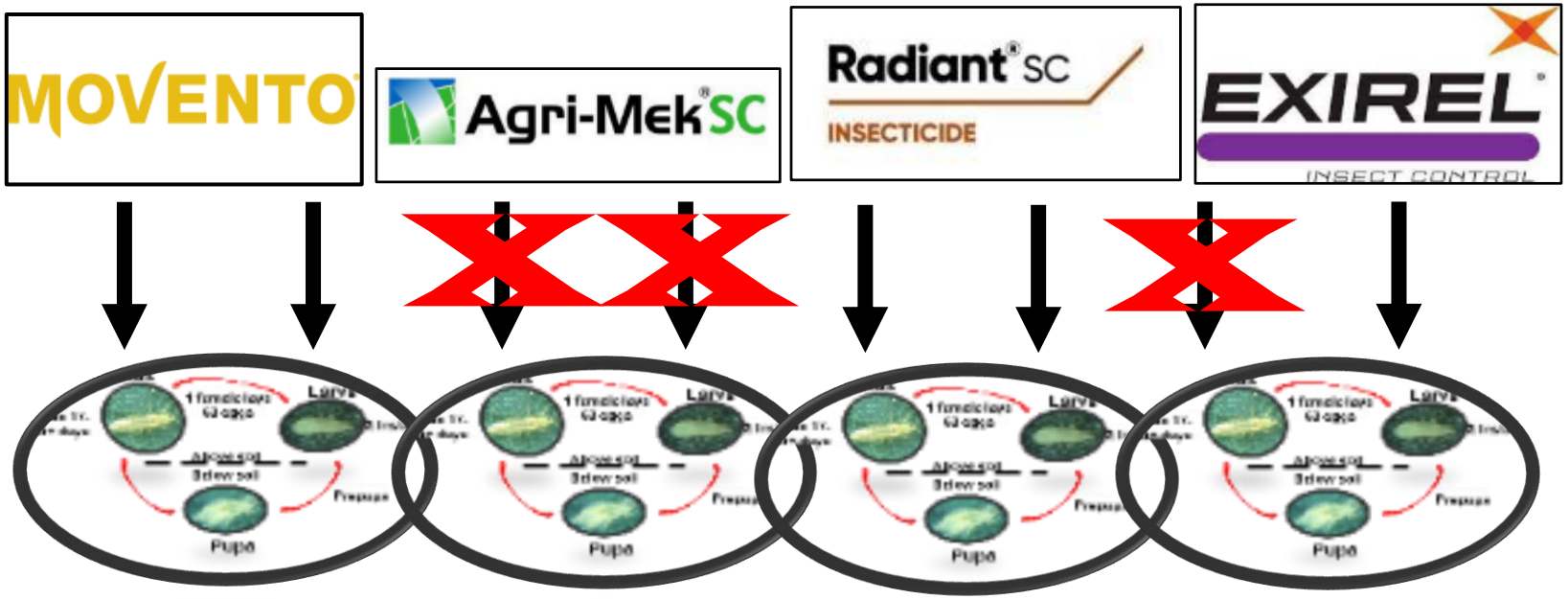
Reducing insecticide use to manage thrips

- Combined insecticide sequence & action thresholds


Photo: I. Yannuzzi



Onion thrips infestation

Reducing insecticide use to manage thrips

Photo: Karly Regan

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Objective

- **Compare thrips control and marketable bulb yield using an action-threshold based insecticide program vs. standard weekly insecticide program**

Objective

- Compare thrips control and marketable bulb yield using an action-threshold based insecticide program vs. standard weekly insecticide program

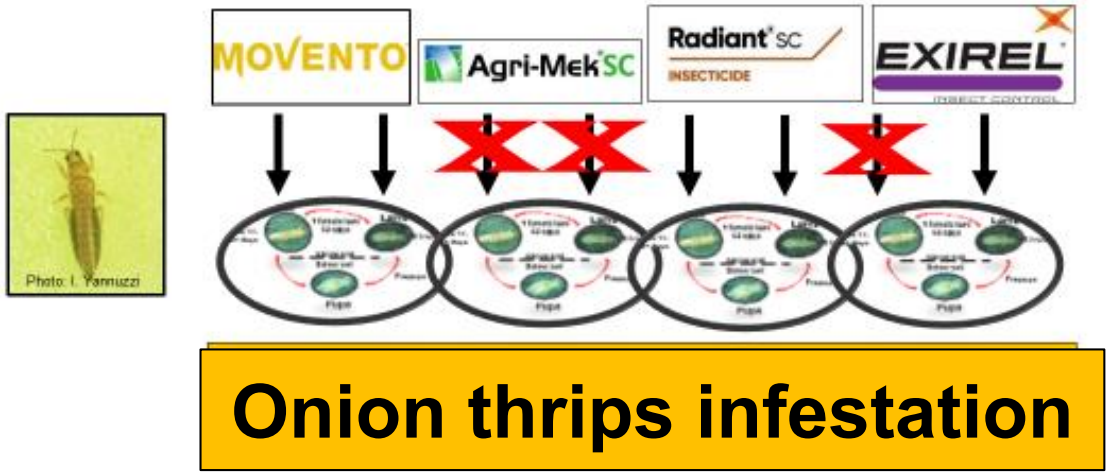
Hypothesis

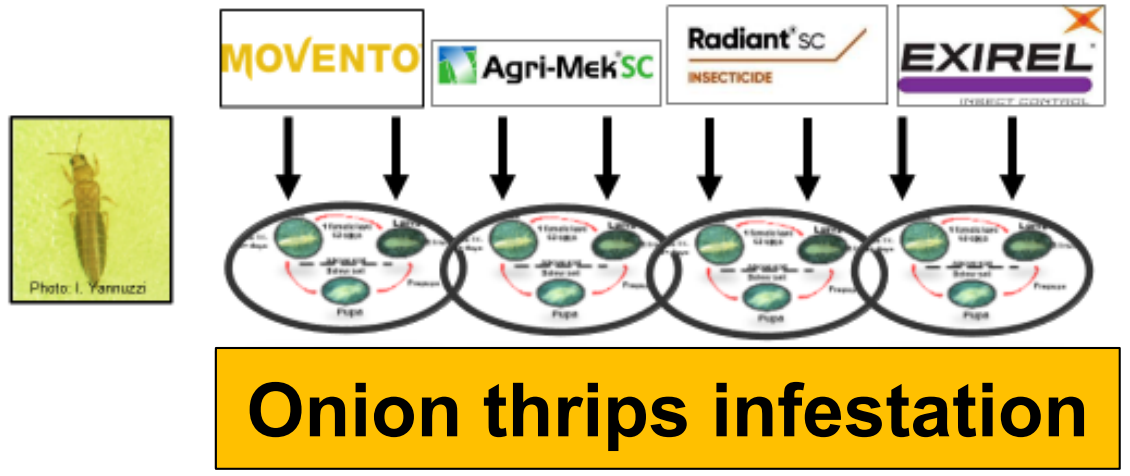
- Thrips control and marketable yield in onions treated following the action-threshold program will be the same as those following the standard insecticide program

Reducing insecticide use to manage thrips

Ashley Leach

Action-threshold based program vs. Standard weekly program





Leach et al. (2017) *Agric., Ecosys. & Environ.*

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Reducing insecticide use to manage thrips

- 3 cultivars (‘Avalon’, ‘Delgado’, ‘Bradley’)
- 2 years

Photo: Brian Nault

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Reducing insecticide use to manage thrips

Dependent Variable: Season mean # thrips larvae per leaf

Season mean larval density

Marketable bulb yield

Photo: Brian Nault

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Reducing insecticide use to manage thrips

Dependent Variable:
Bulb size and weight

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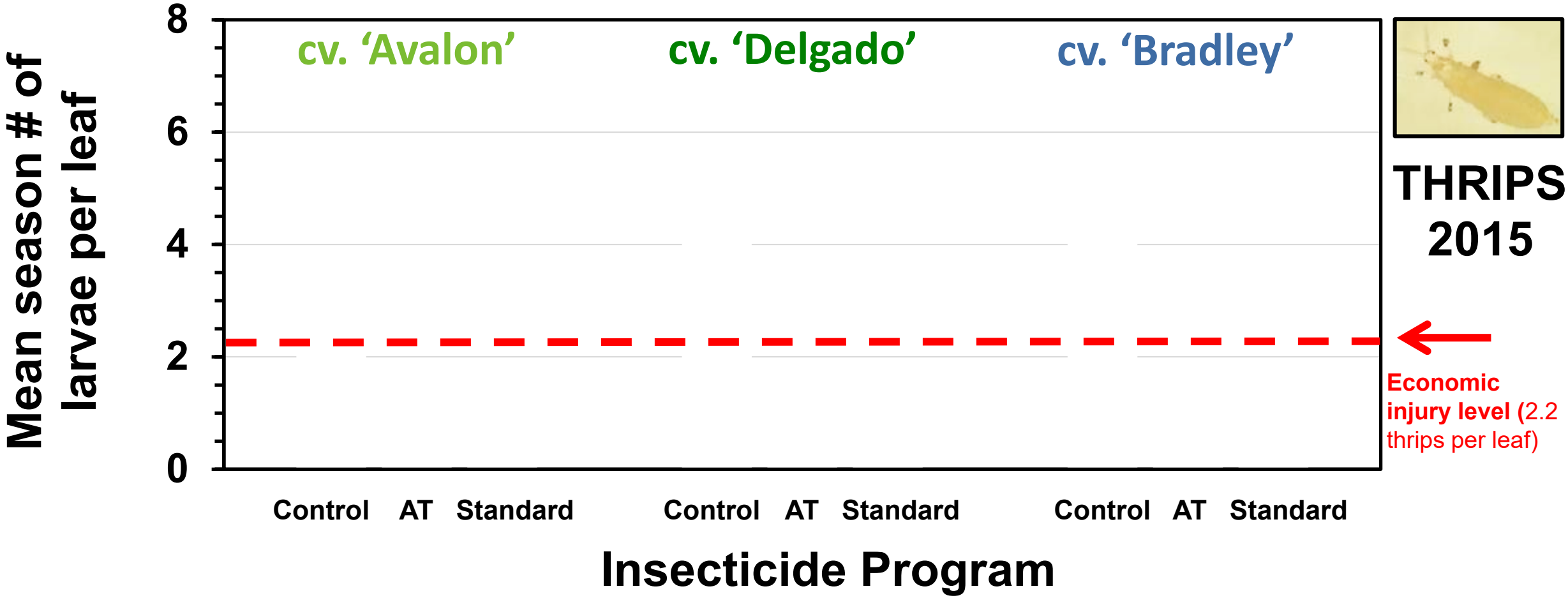
Reducing insecticide use to manage thrips

➢ Comparison between insecticide programs: Action threshold (AT) vs. Standard weekly



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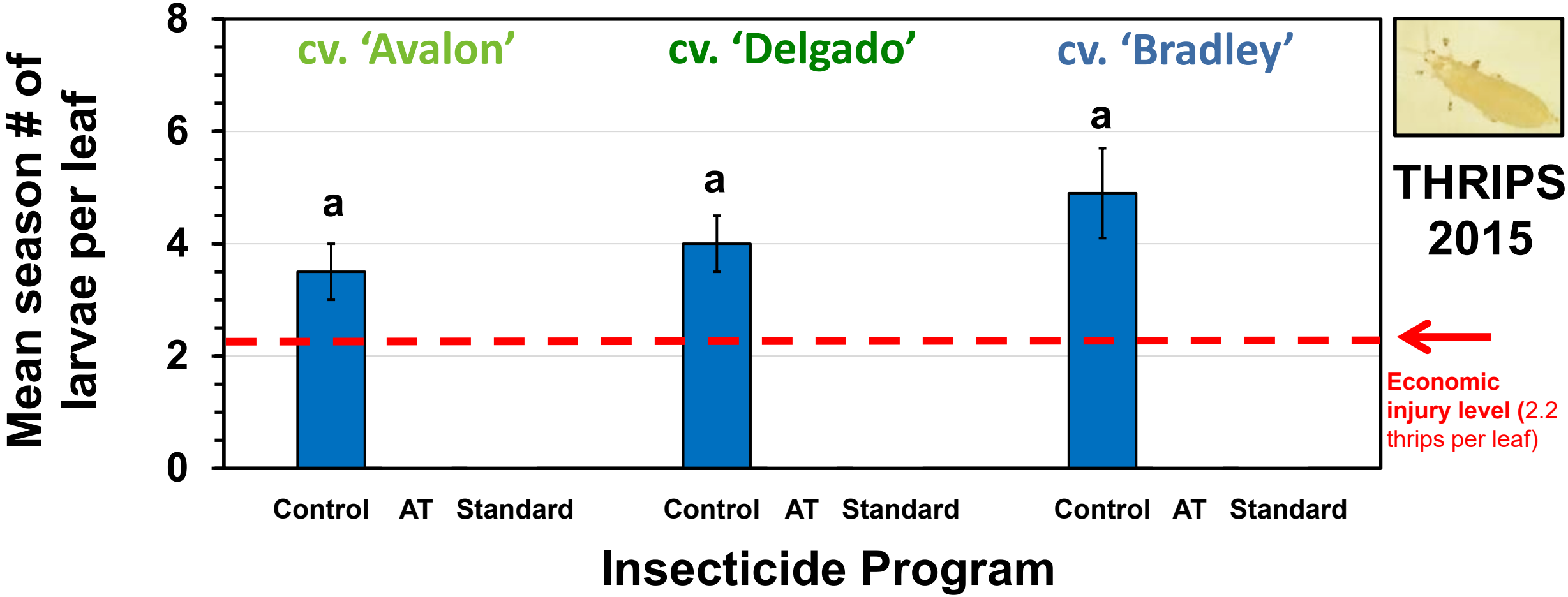

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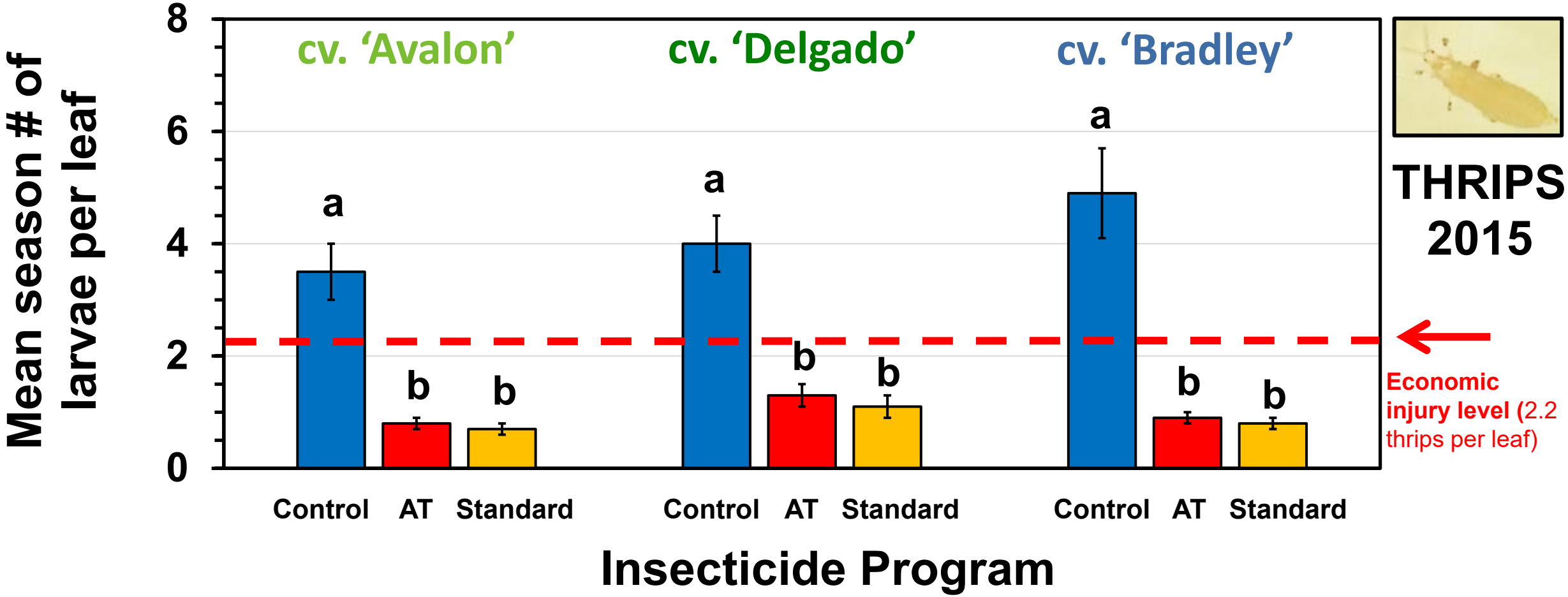

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Reducing insecticide use to manage thrips

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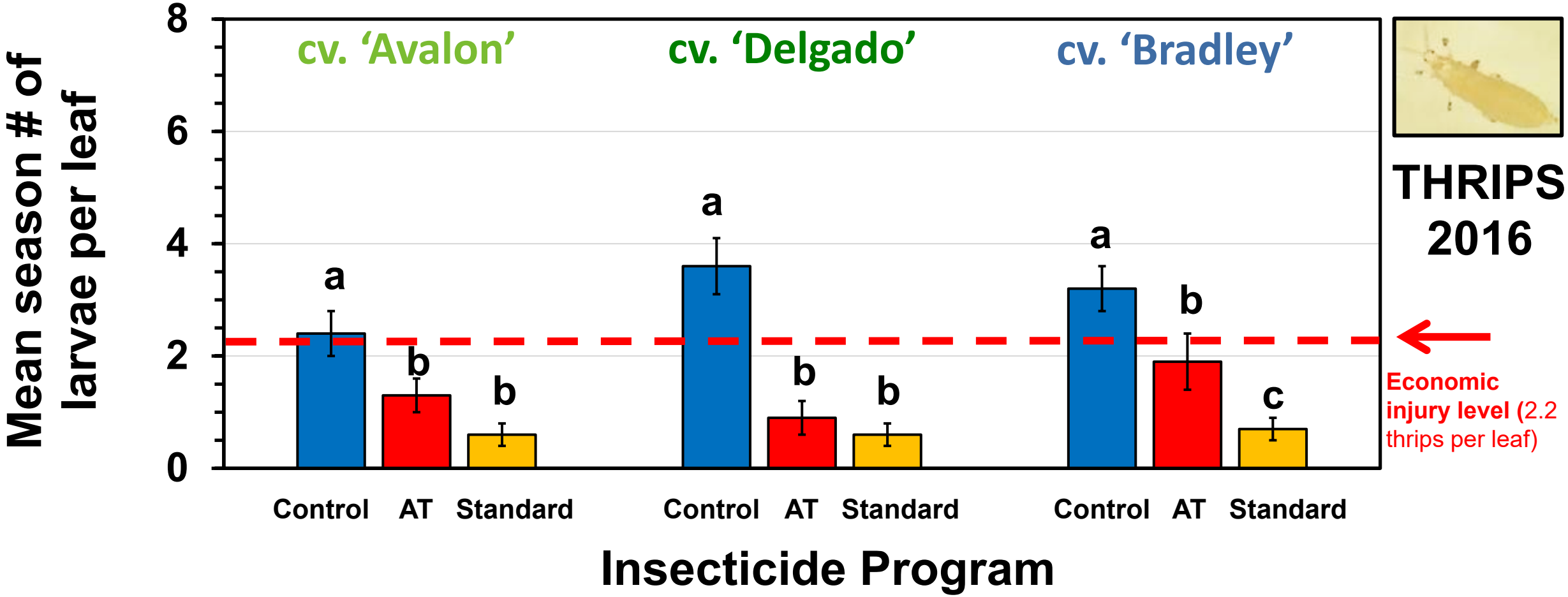

Leach et al. (2017) *Agric., Ecosys. & Environ.*

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Reducing insecticide use to manage thrips

- Comparison between insecticide programs: Action threshold (AT) vs. Standard weekly

Cultivar	Year	AT-based applications	Standard weekly applications	Reduction
Avalon	2015		7	
Delgado			7	
Bradley			7	
Avalon	2016		6	
Delgado			6	
Bradley			6	

SPRAYS

Leach et al. (2017) *Agric., Ecosys. & Environ*.

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Reducing insecticide use to manage thrips

- Comparison between insecticide programs: Action threshold (AT) vs. Standard weekly

Cultivar	Year	AT-based applications	Standard weekly applications	Reduction
Avalon	2015	3.7	7	48%
Delgado		4.7	7	33%
Bradley		3.7	7	48%
Avalon	2016	3	6	50%
Delgado		4	6	33%
Bradley		3.3	6	46%

SPRAYS

Leach et al. (2017) *Agric., Ecosys. & Environ.*

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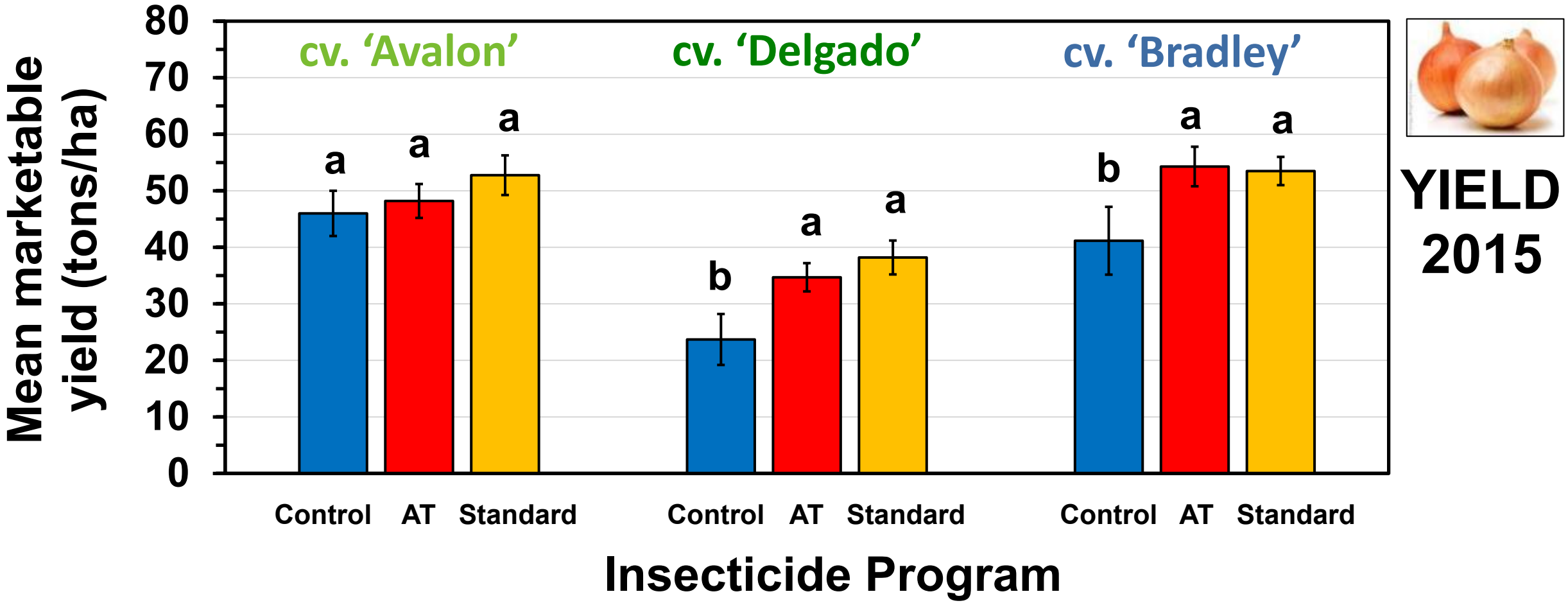
Reducing insecticide use to manage thrips

- Comparison between insecticide programs: Action threshold (AT) vs. Standard weekly



YIELD 2015

Leach et al. (2017) *Agric., Ecosys. & Environ.*

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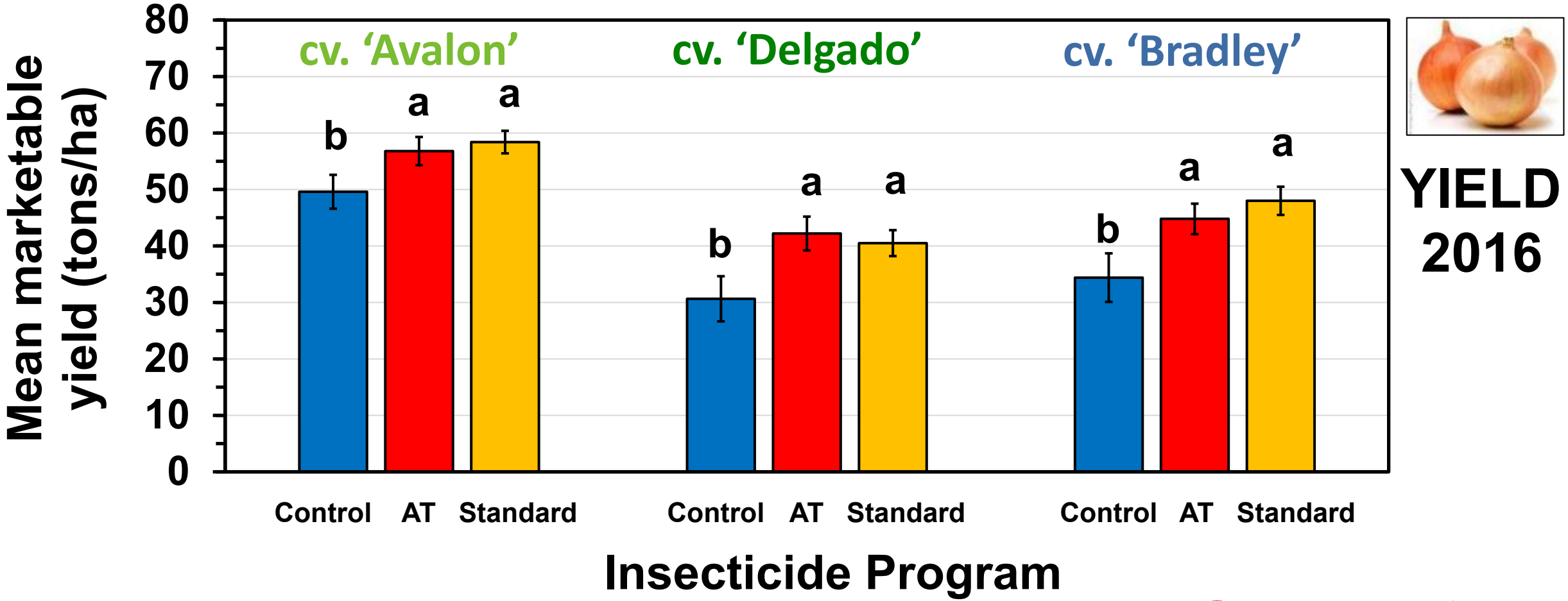
Reducing insecticide use to manage thrips

- Comparison between insecticide programs: Action threshold (AT) vs. Standard weekly



YIELD 2016

Leach et al. (2017) *Agric., Ecosys. & Environ.*

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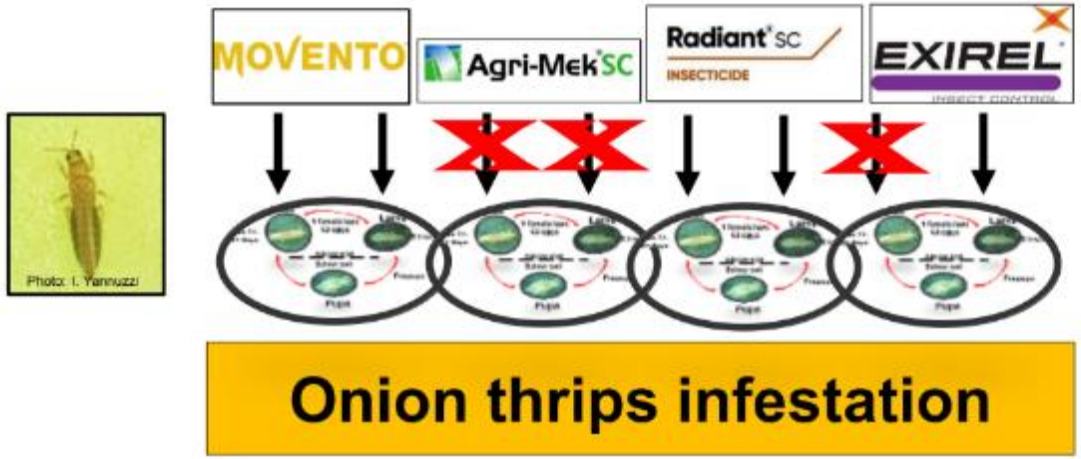
Reducing insecticide use to manage thrips

Hypothesis

- Thrips control and marketable yield in onions treated following the action-threshold program will be the same as those following the standard insecticide program



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Reducing insecticide use to manage thrips

oto: Brian Nault

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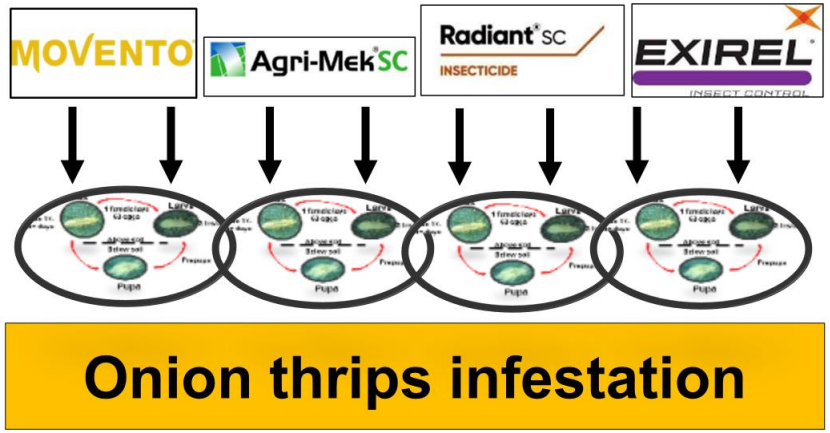
Onion thrips management guidelines for onion

Version 1.0

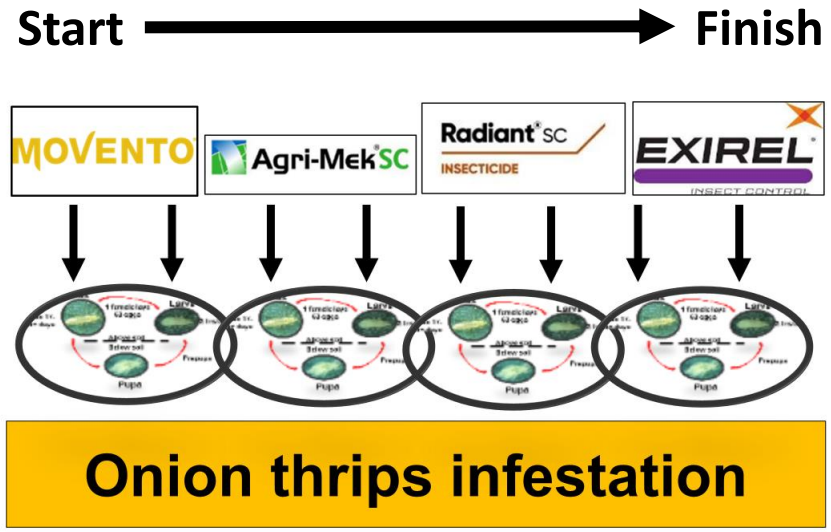
Start → Finish



Onion thrips infestation

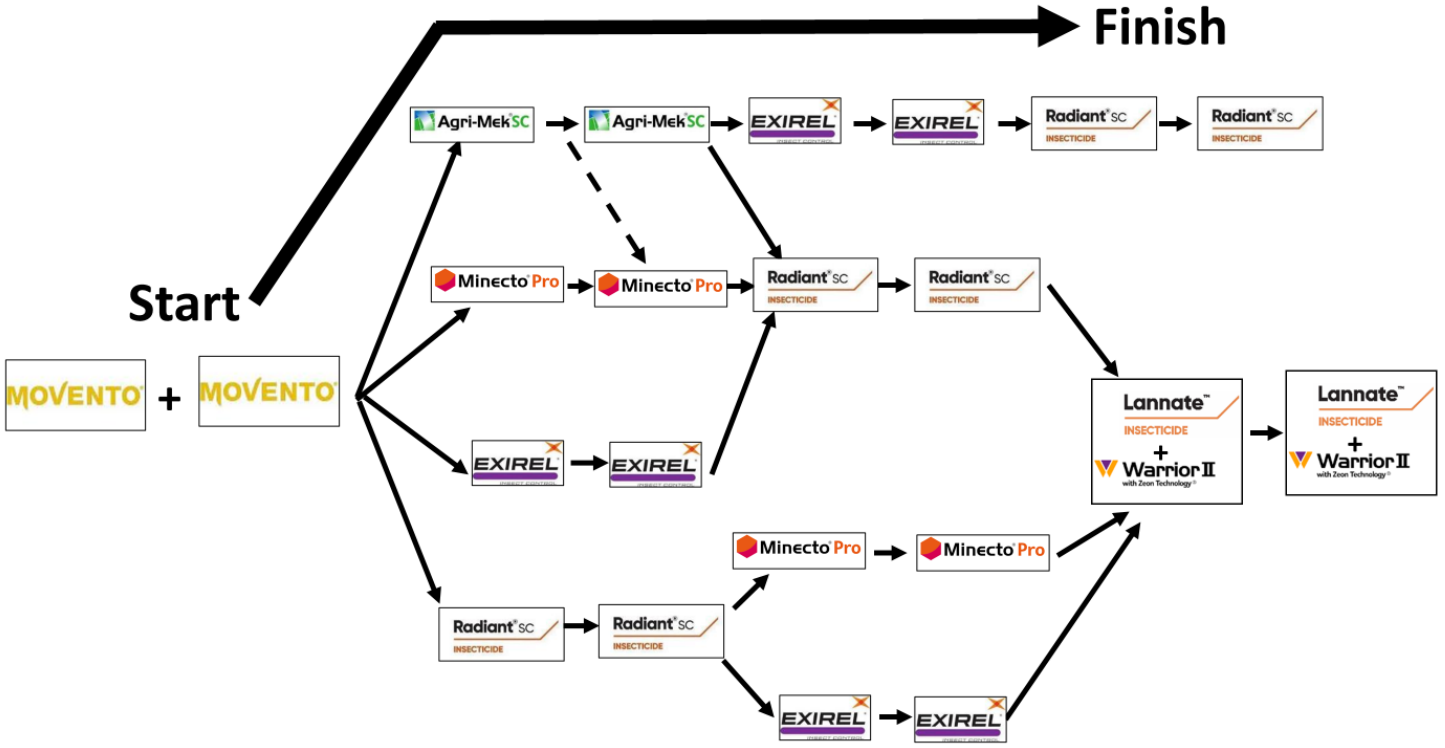
Onion thrips management guidelines for onion

Version 1.0



Onion thrips infestation

Version 10.0



Onion thrips infestation

Objective

- **Evaluate onion grower adoption of the Cornell Onion Thrips Management Guidelines for Onion (=insecticide rotation and action thresholds)**

Objective

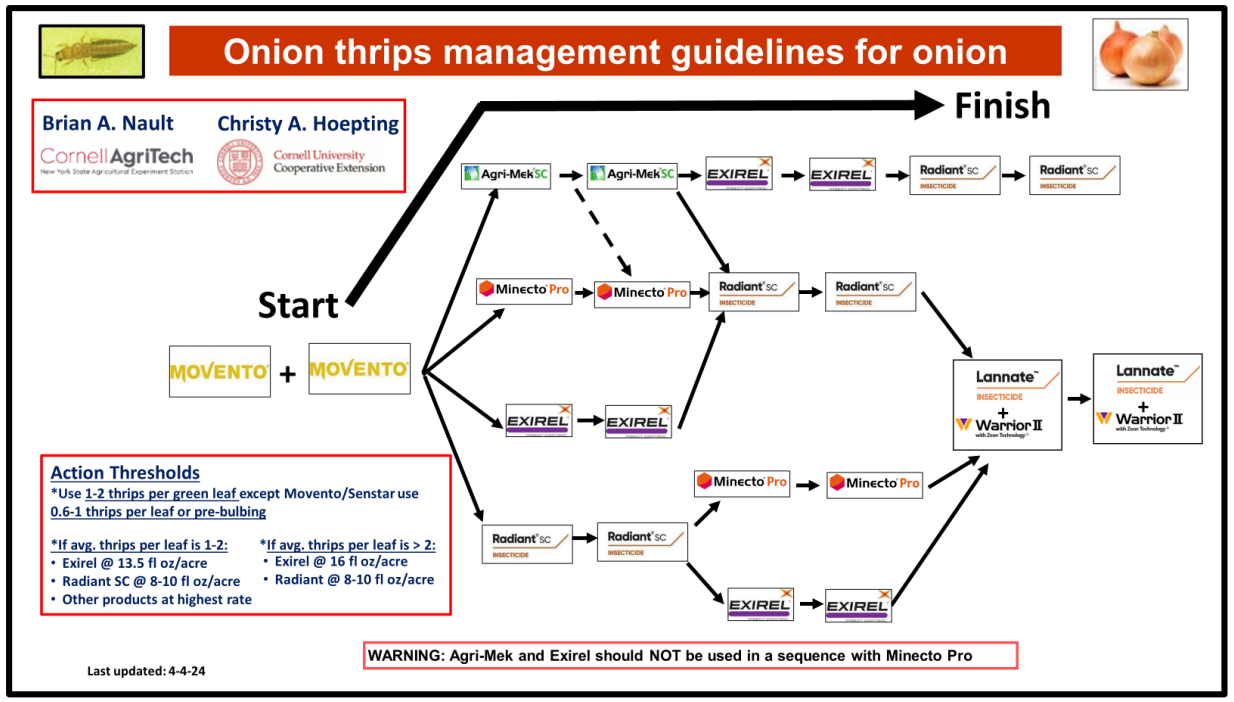
- **Evaluate onion grower adoption of the Cornell Onion Thrips Management Guidelines for Onion (=insecticide rotation and action thresholds)**

Hypothesis

- **Onion growers will increase their adoption of <u>rotating insecticide classes</u> and <u>using action thresholds</u>**

Reducing insecticide use to manage thrips

- Implement insecticide-based program and measure success



Christy Hoepting

Ashley Leach

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Reducing insecticide use to manage thrips

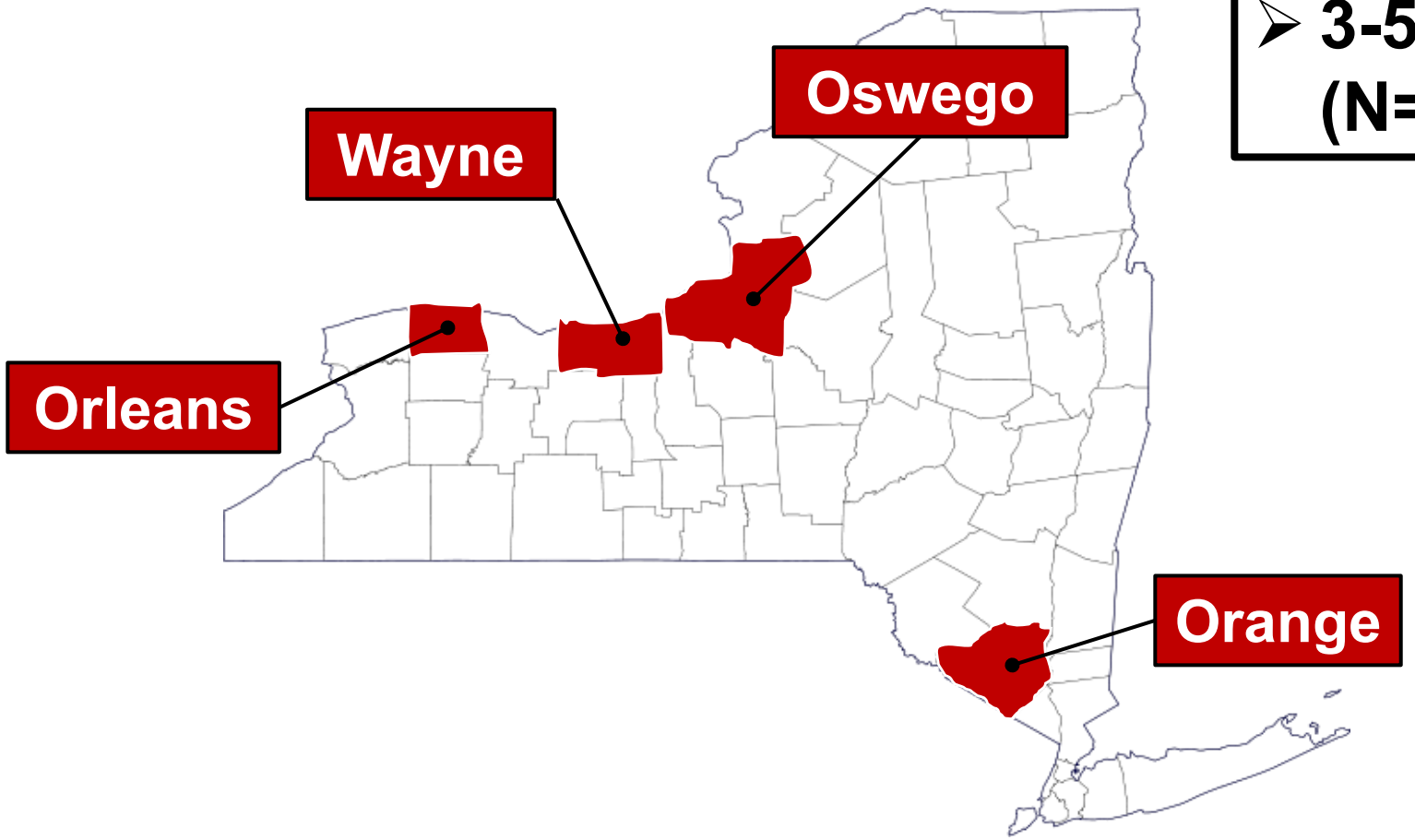
- **Baseline survey results for New York onion grower insecticide use and IRM practices**

Factor	2014 survey results (n=17)	
Insecticide applications made using proper class rotation	76%	
Insecticide applications made following action thresholds	57%	
Frequency of insecticide applications per field	1 per week	
Savings in insecticide costs per acre	-	

Leach, Hoepting & Nault (2019) *Pest Manag Sci.*

Reducing insecticide use to manage thrips

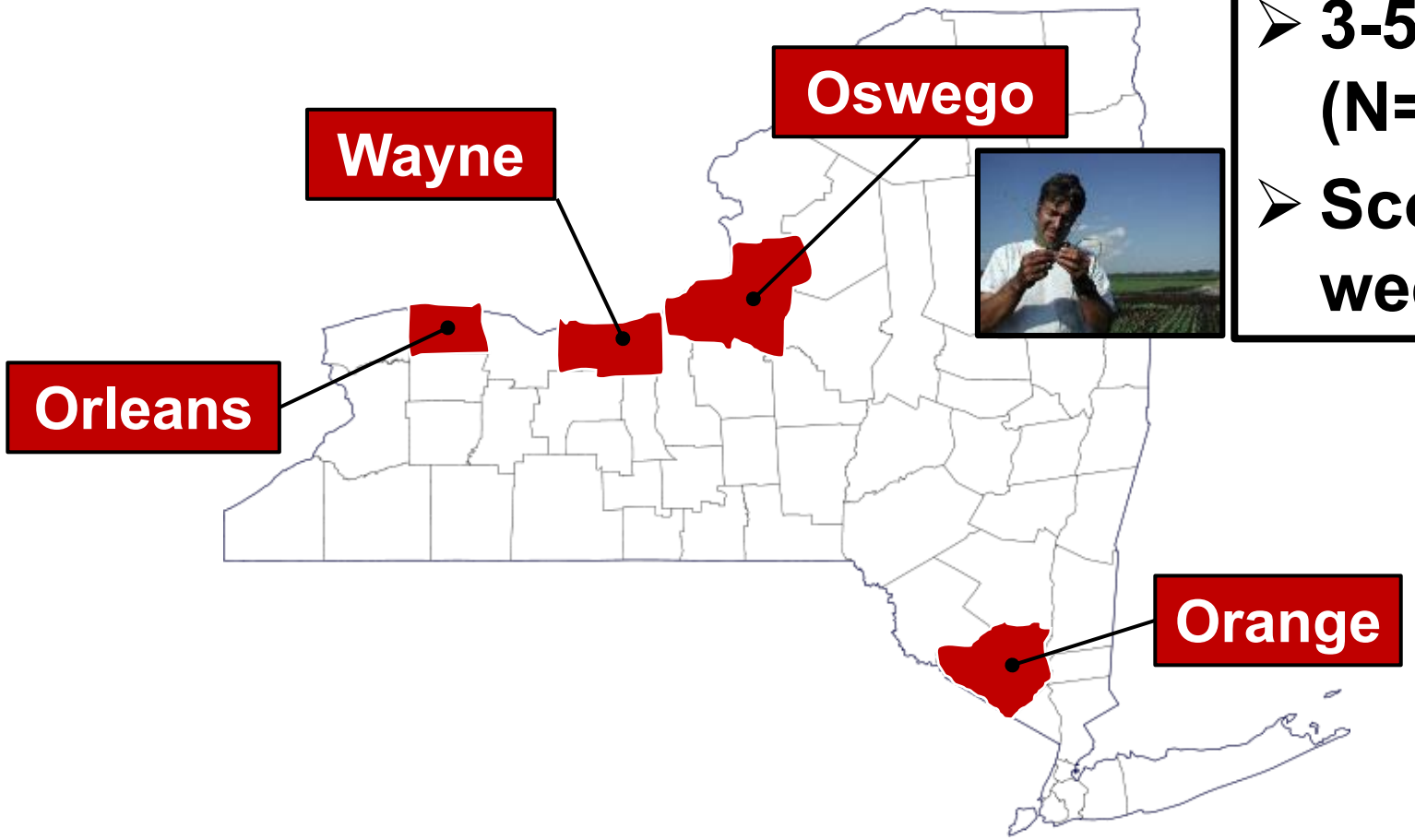
- Four major onion-producing counties targeted for onion thrips management plan adoption



- 3-5 growers per county (N= 17) over 3 yrs

Reducing insecticide use to manage thrips

- Four major onion-producing counties targeted for onion thrips management plan adoption



- 3-5 growers per county (N= 17) over 3 yrs
- Scouted onion fields weekly for *T. tabaci*

Spray **No Spray**

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Reducing insecticide use to manage thrips

- **Final results of New York onion growers adoption of the onion thrips management plan**

Factor	2014 survey results (n=17)	2017 post-project results (n= 17)
Insecticide applications made using proper class rotation	76%	100% ↑
Insecticide applications made following action thresholds	57%	82% ↑
Frequency of insecticide applications per field	1 per week	2-4 less/season ↓
Savings in insecticide costs per acre	-	$60

Leach, Hoepting & Nault (2019) *Pest Manag Sci.*

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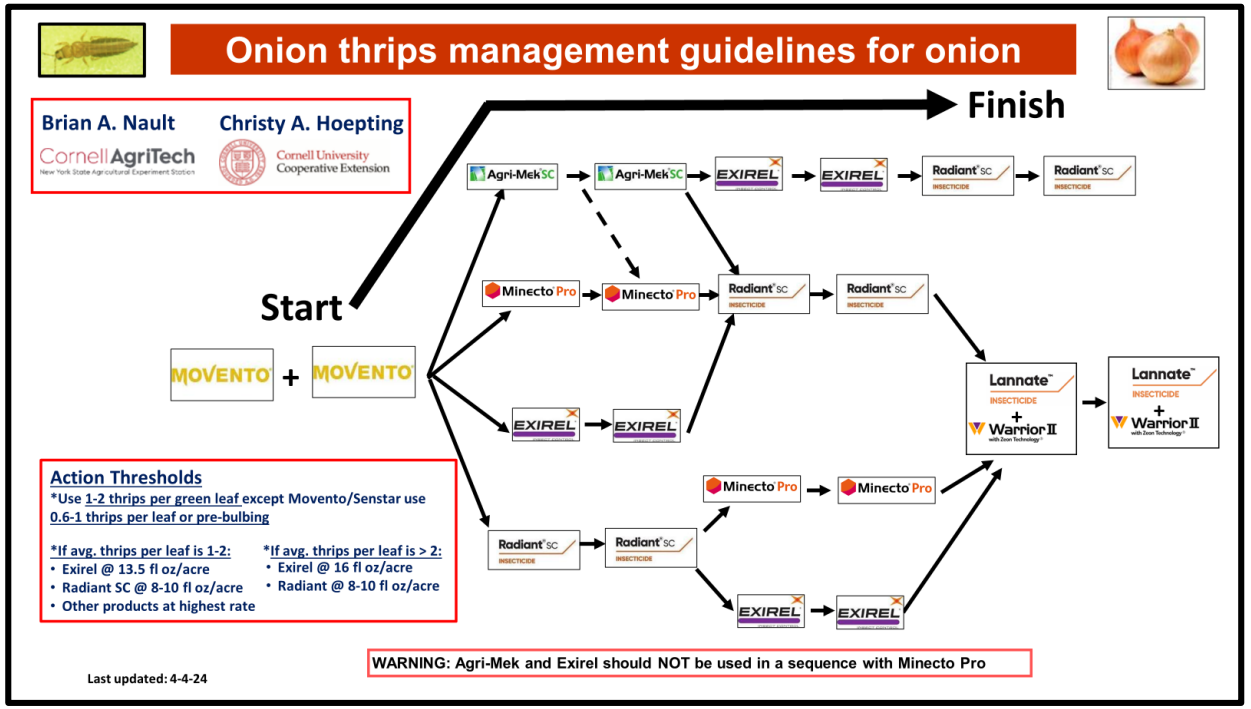
Reducing insecticide use to manage thrips

Hypothesis

- Onion growers will increase their adoption of rotating insecticide classes and using action thresholds



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Reducing insecticide use to manage thrips

- Onion growers from Elba Muck honored with 2019 NYS IPM Award primarily for adoption of the onion thrips management plan


Photo: Brian Nault

- Reasons for adoption
  - #1 - mitigate insecticide resistance, *not* to save money
  - #2 - regular interactive meetings with growers to build trust
- No insecticide resistance to newer products

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Questions

Northeastern IPM Center

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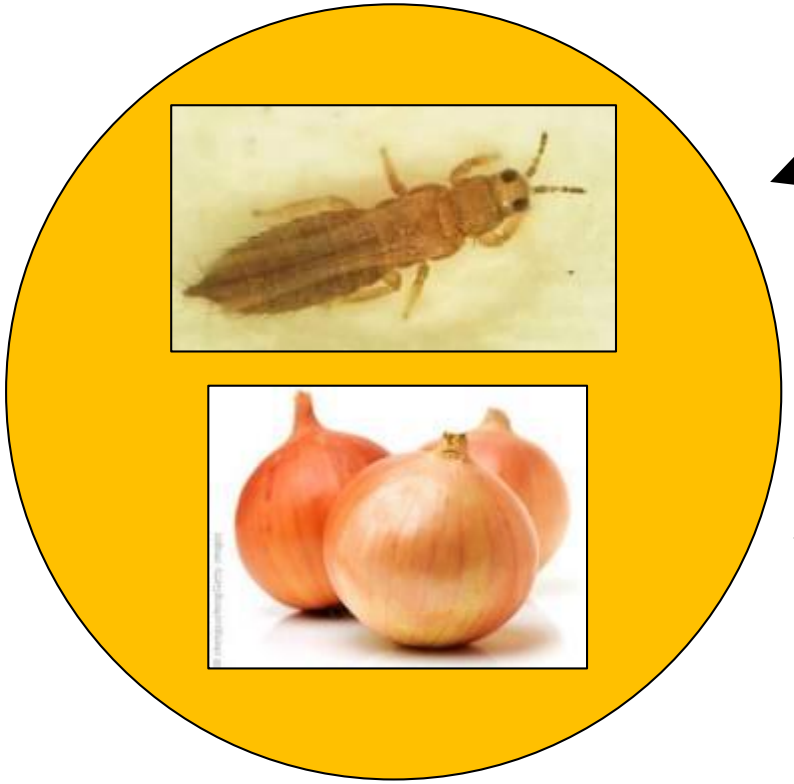
Reducing insecticide use to manage thrips

Chemical Control

…was a success, but…



Plant Resistance

Cultural Control

Biological Control

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New York State Agricultural Experiment Station

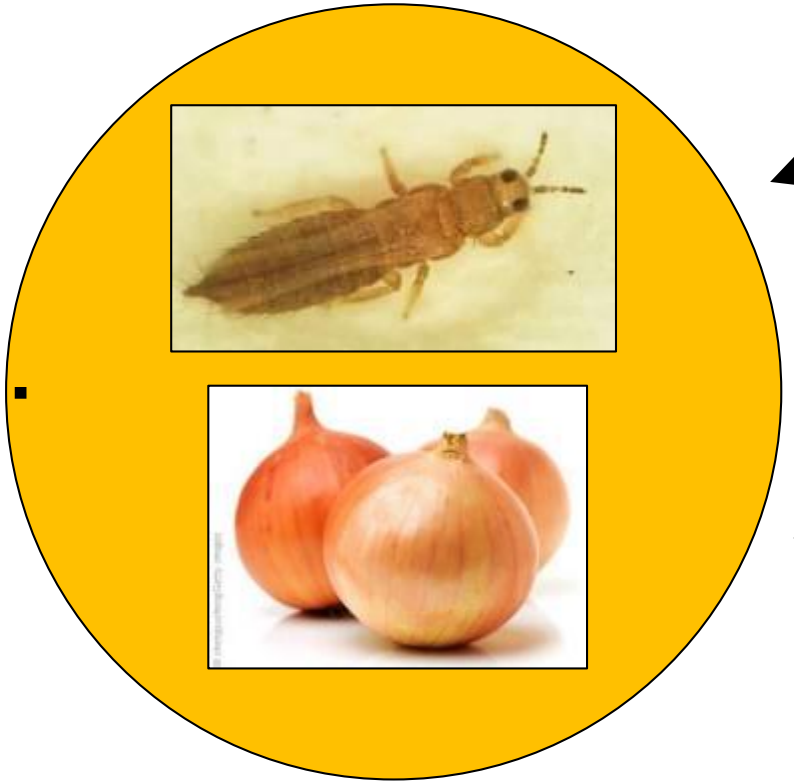
Reducing insecticide use to manage thrips

Chemical Control

…was a success, but…

Plant Resistance

…need other tactics…



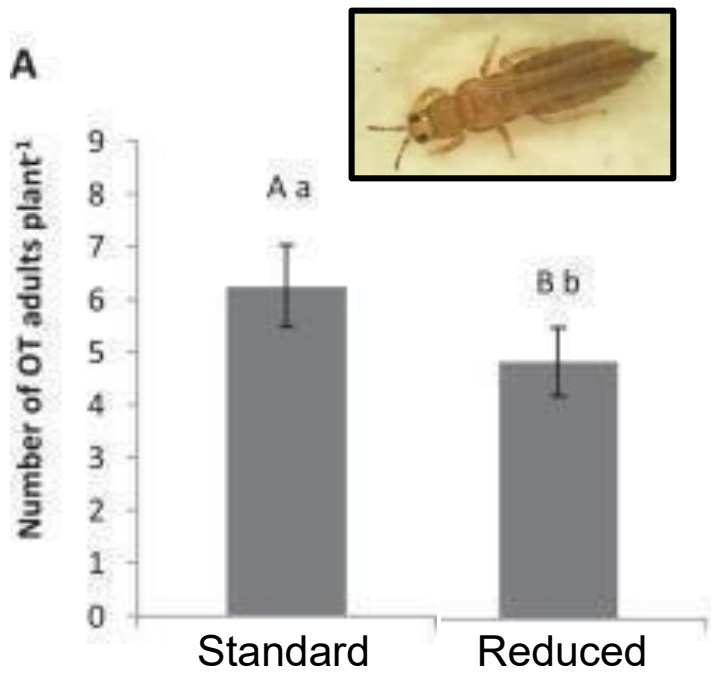
Cultural Control

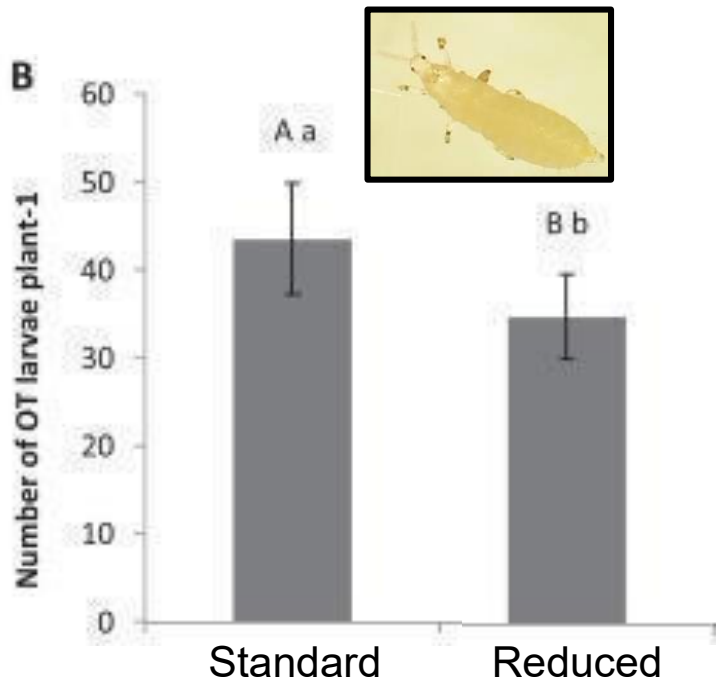
Biological Control

SAES-422 Multistate Research Project W-1008
"Biology and Management of IYSV and Thrips"

Impact of fertilizer on onion thrips

- Onion thrips populations in onion were significantly lower (~25%) when less fertilizer was applied





Modified from Buckland et al. (2013) *Agric. Ecosys. Environ*.

OUTLINE

I. Onion production, onion thrips biology and its damage

II. Onion thrips management – chemical control

III. Onion thrips management – cultural control

IV. Conclusions

Reducing fertilizer use to manage thrips

Approach:

- Identify impact of reducing fertilizer on onion thrips populations and bulb yield
- Determine optimal amount of fertilizer that will reduce onion thrips infestations, but not bulb yield
- Implement fertilizer reduction program and measure success

Cornell University
Cooperative Extension

Onion fertility guidelines

- **Nitrogen** (N) (100 to 125 lbs/acre) or (112 to 140 kg/ha)
- **Phosphorus** (P) (50 to 150 lbs/acre) or (56 to 168 kg/ha)
- **Potassium** (K) (50 to 150 lbs/acre) or (56 to 168 kg/ha)

- **Typical ingredients in custom-blended fertilizer mix**
  - Copper (0-0-0-12CU)
  - Manganese Oxy-Sulfate (0-0-0-18.5S-32Mn)
  - Ammonium Sulfate (12-0-0-24S)
  - K-Mag (0-0-22-22S)
  - Monoammonium Phosphate (11-52-0)
  - Potassium Chloride (0-0-60)
  - Urea (44-0-0)

https://cropandpestguides.cce.cornell.edu/Preview/2023/2023_Vegetables_Preview.pdf

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New York State Agricultural Experiment Station

Objective

- **Compare thrips densities and marketable bulb yield using reduced rates of fertilizer vs. the standard fertilizer program**

Objective

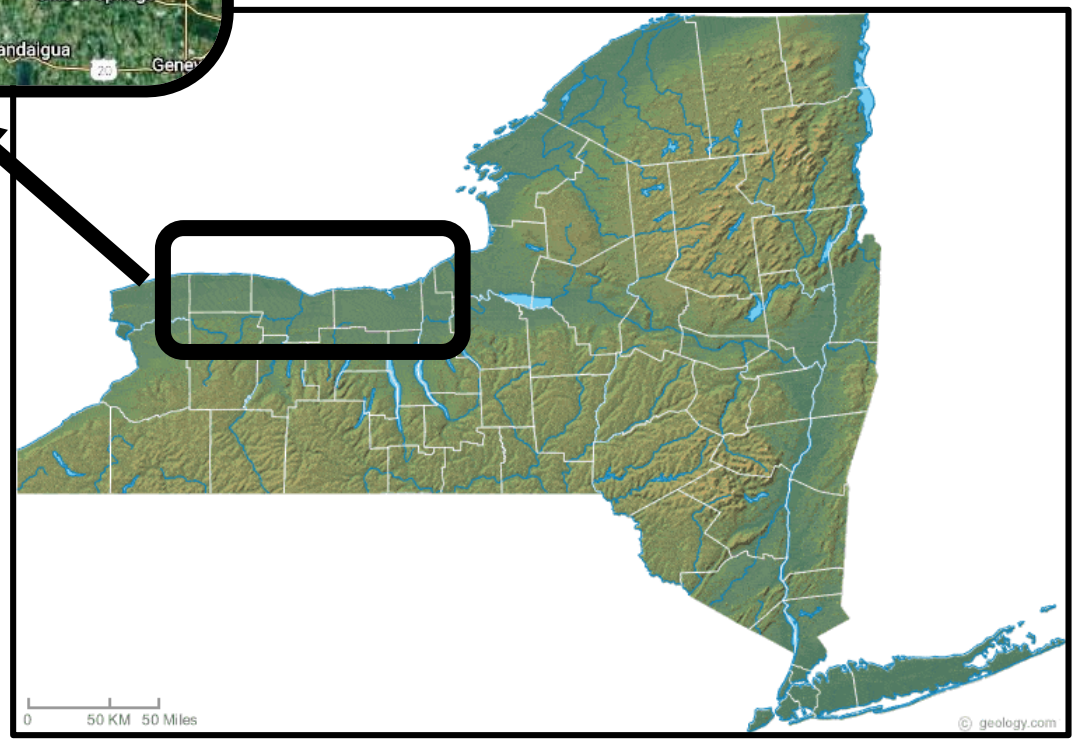
- Compare thrips densities and marketable bulb yield using reduced rates of fertilizer vs. the standard fertilizer program

Hypothesis

- Thrips densities in onions grown using reduced rates of fertilizer will be lower than those following the standard fertilizer program, but without a reduction in yield

Reducing fertilizer use to manage thrips

Karly Regan



➢20 Commercial onion fields across central and western New York from 2019 through 2021

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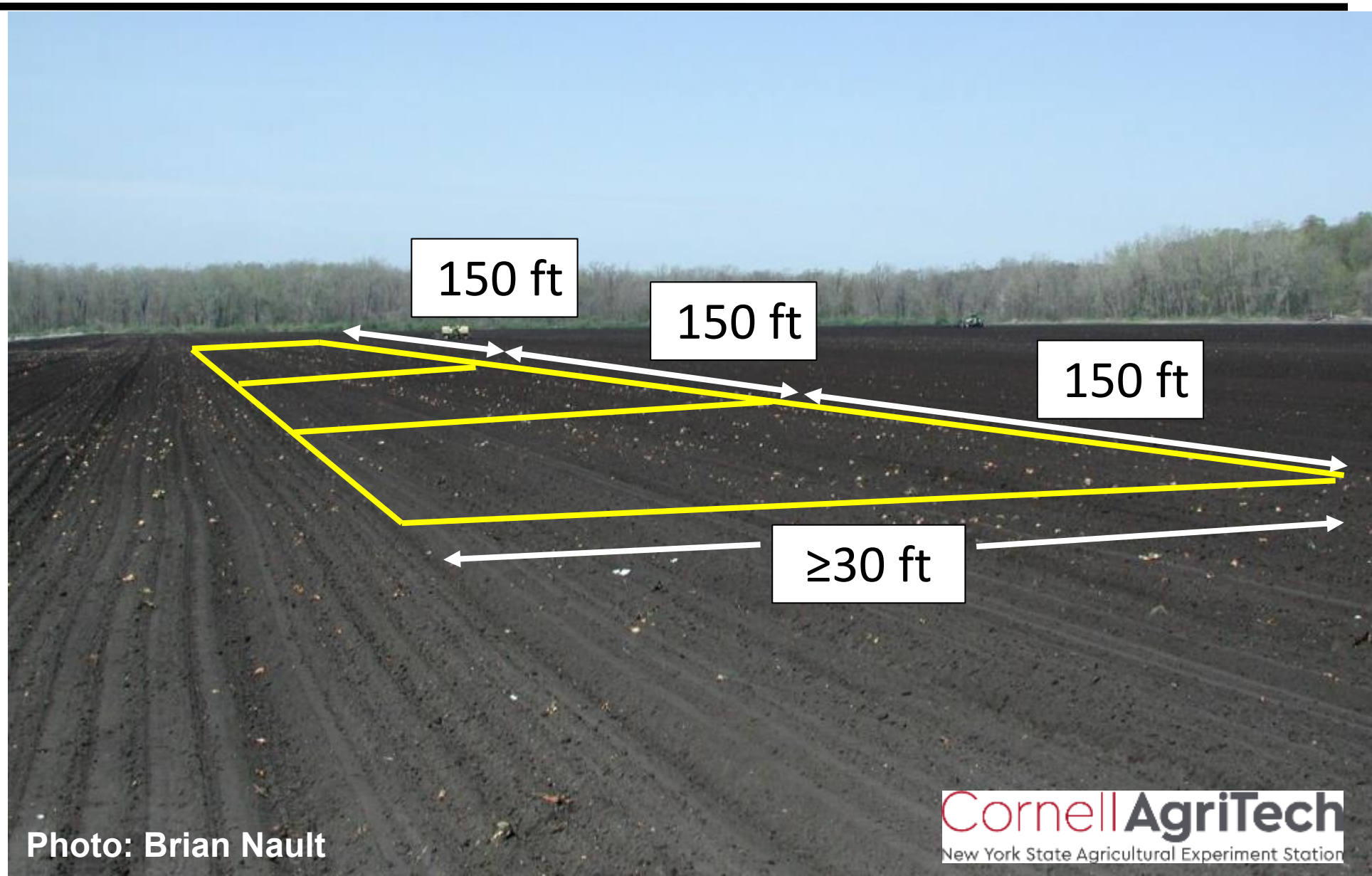
New York State Agricultural Experiment Station

Reducing fertilizer use to manage thrips



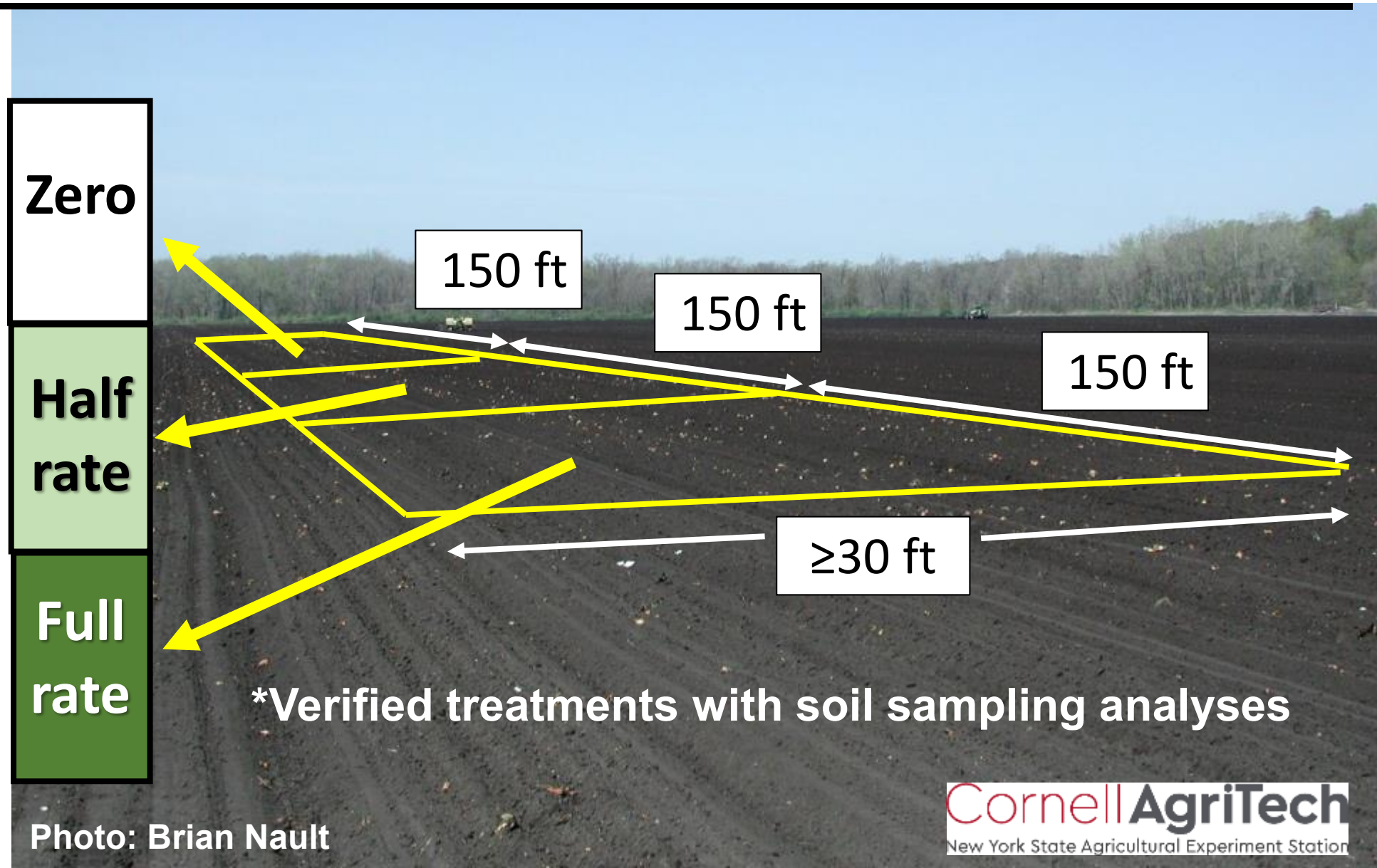
Reducing fertilizer use to manage thrips

Mean amounts

N: 0
P: 0
K: 0

N: 56 lb/acre
P: 55 lb/acre
K: 98 lb/acre

N: 112 lb/acre
P: 112 lb/acre
K: 196 lb/acre



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Reducing fertilizer use to manage thrips

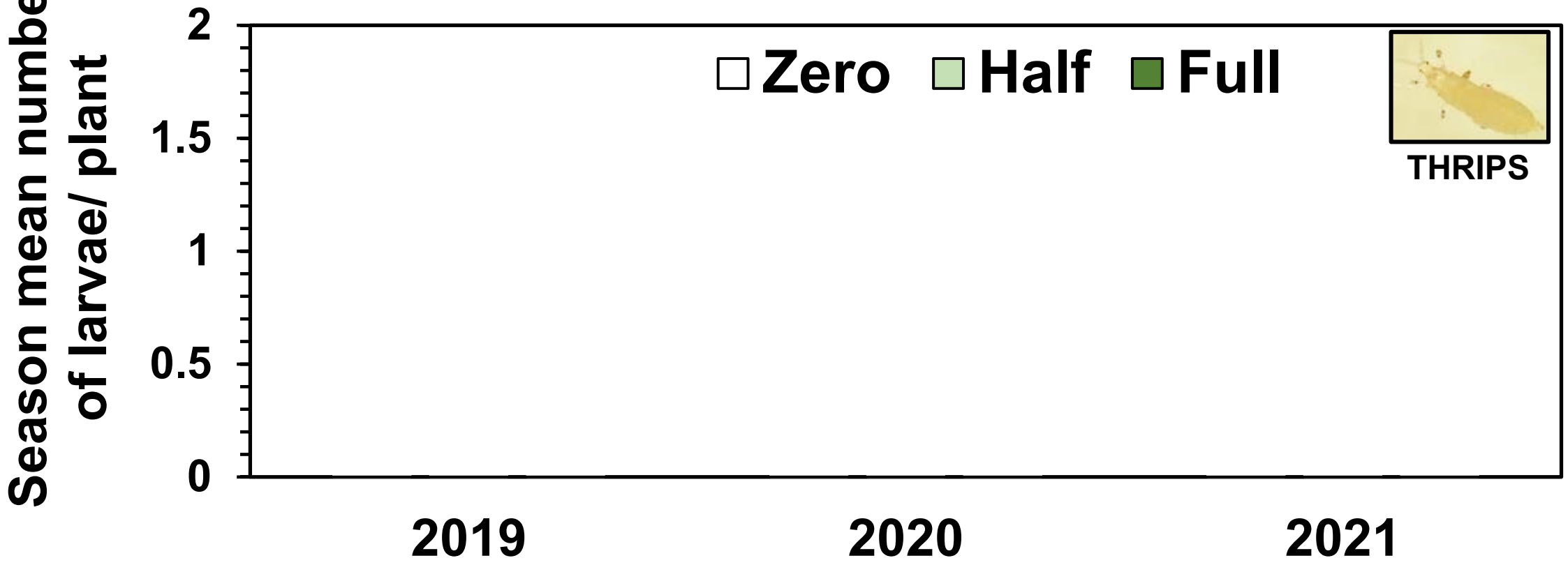
- Identify impact of reducing fertilizer on onion thrips populations and bulb yield

Weekly visual assessments of thrips densities on 4-8 farms over 3 years (n=20)

Assessed bulb yield at harvest

Reducing fertilizer use to manage thrips

➢ Fertilizer treatments impact on onion thrips densities



NS = not significant *P*>0.05

Regan & Nault (2022) *Agronomy*

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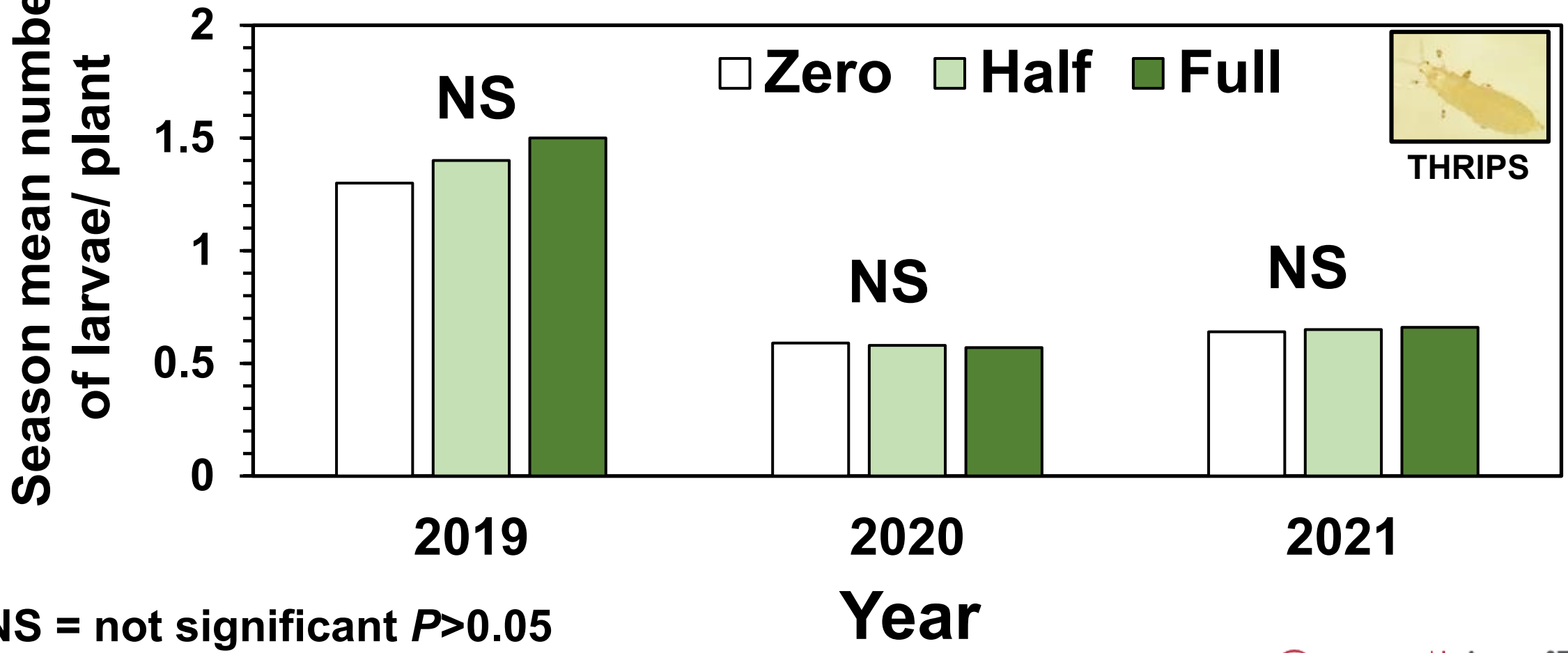
Reducing fertilizer use to manage thrips

➢ Fertilizer treatments did <u>not</u> impact onion thrips densities



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Regan & Nault (2022) *Agronomy*

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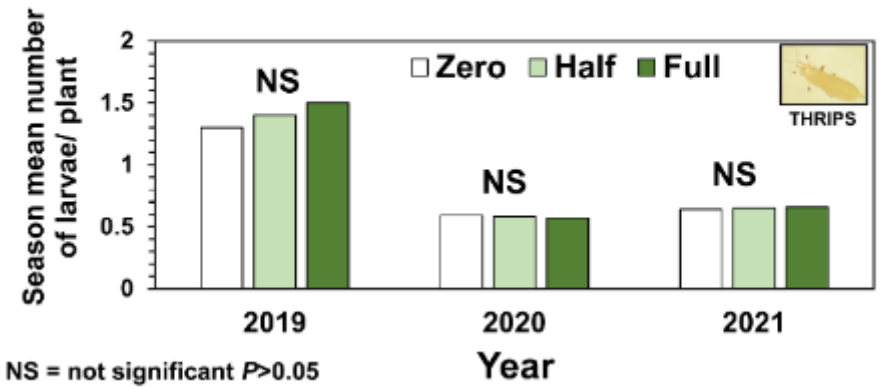
Reducing fertilizer use to manage thrips

Hypothesis

- Thrips densities in onions grown using reduced rates of fertilizer will be lower than those following the standard fertilizer program, but without a reduction in yield



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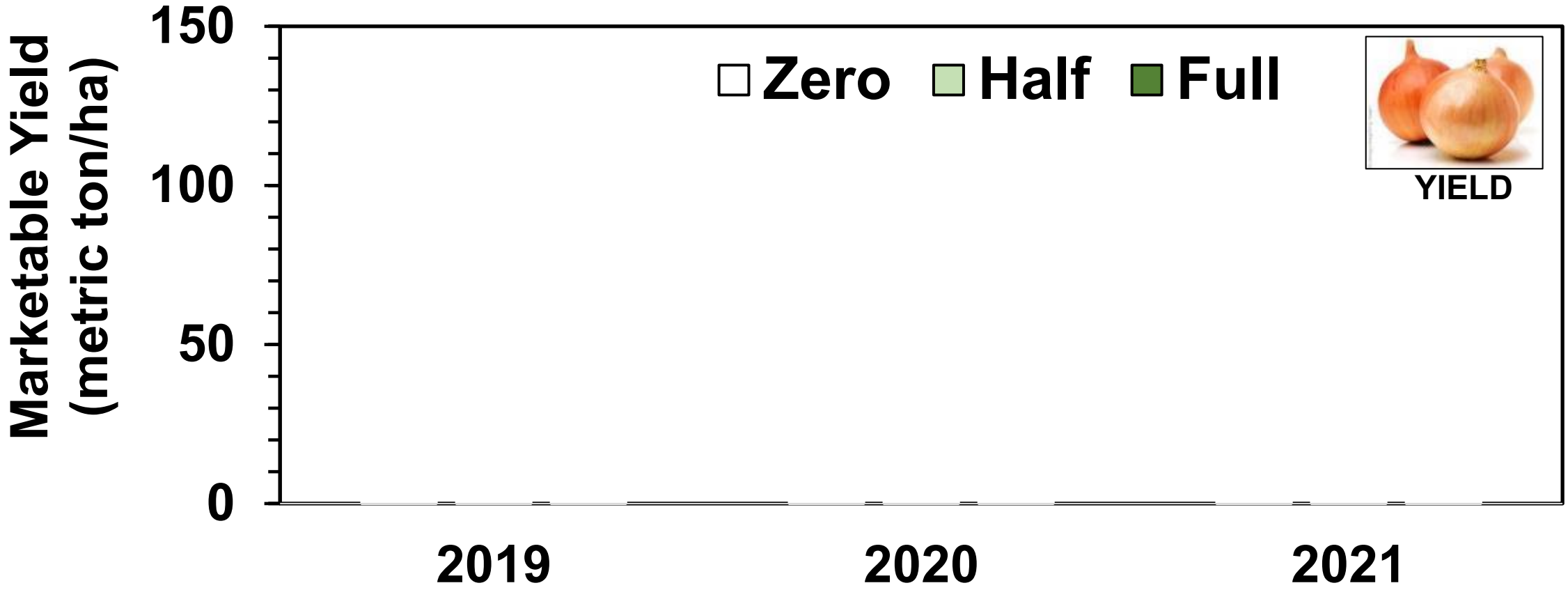
Reducing fertilizer use to manage thrips

- Fertilizer treatments impact on marketable yield!



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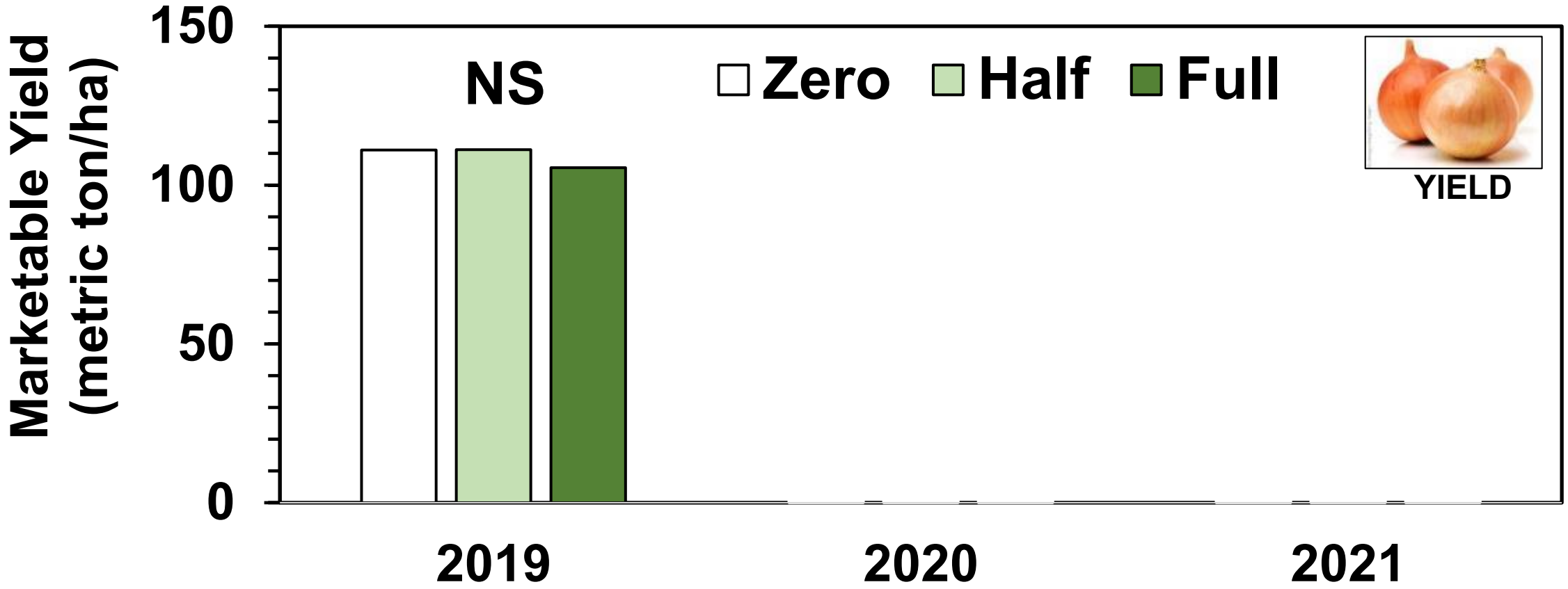
Reducing fertilizer use to manage thrips

- Fertilizer treatments did not impact marketable yield!



NS = not significant $P>0.05$

Regan & Nault (2022) *Agronomy*

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Reducing fertilizer use to manage thrips

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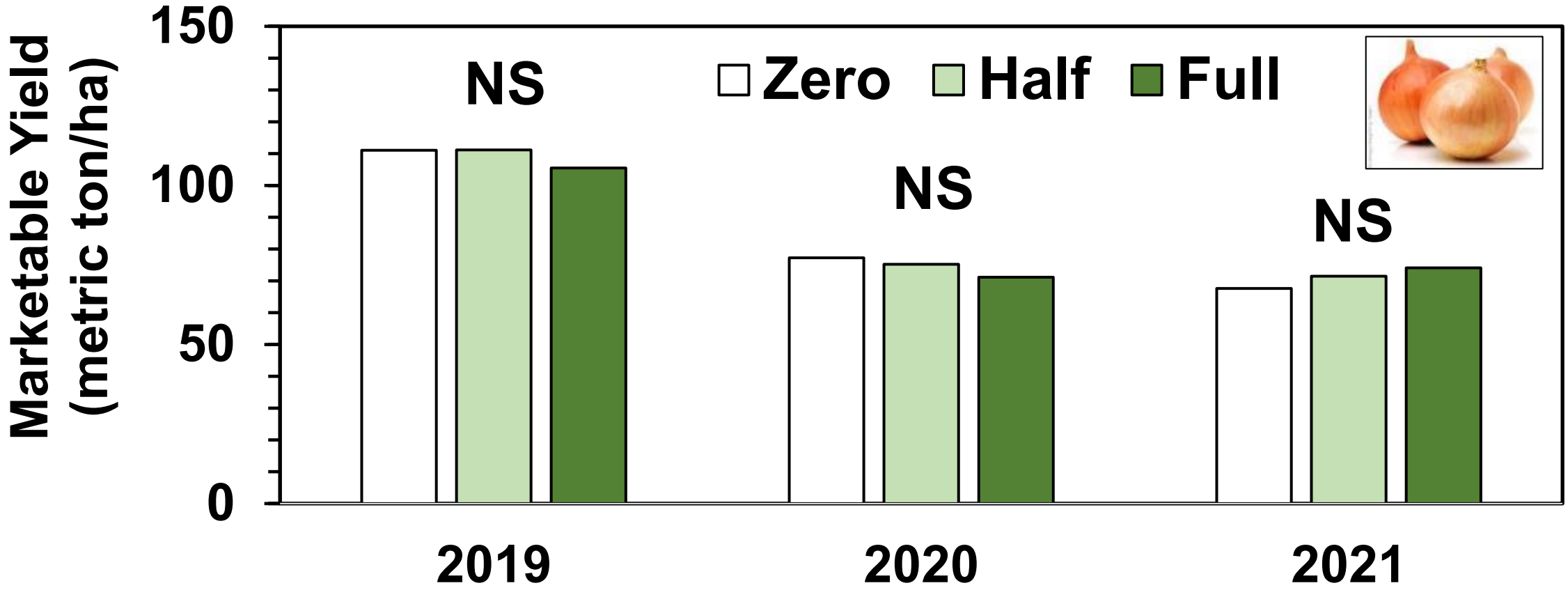

NS = not significant $P>0.05$

Regan & Nault (2022) *Agronomy*

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Reducing fertilizer use in onions

- Demonstration trial on commercial farm – onion growers could NOT distinguish between zero, half and full fertilizer

Karly Regan

Cornell AgriTech
New York State Agricultural Experiment Station

Reducing fertilizer use in onions

Muck soil

- **20-80% organic matter** (Wilson and Townsend 1931)
- **Substantial nutrient availability for plant growth** (Haynes 2012)

Photo: Brian Nault

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Reducing fertilizer use in onions

- Implement reduced fertilizer program and measure success; timing was perfect

Christy Hoepting

CCE VEGETABLE

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Photo: Brian Nault

Reducing fertilizer use in onions

Photo: CropLife

Reducing fertilizer use in onions

- **Amount of N fertilizer reduced based in part from our research**

Location (acres)	Before Project	After Project	Reduction
Elba (120 acres)	122 lbs/acre	86 lbs/acre	30%
Wayne Co. (75 acres)	115 lbs/acre	90 lbs/acre	22%
Oswego Co. (200 acres)	140 lbs/acre	60 lbs/acre	57%
Oswego Co. (230 acres)	100 lbs/acre	80 lbs/acre	20%

- **No perceived reductions in bulb yield or bulb size**

Hoepting (unpublished)

Reducing fertilizer use in onions

➢ **Onion grower testimonial (Big "O" Farms, Elba, NY) on 10/26/23**

Factor	Before Project	After Project
Onions grown on farms	2,150 acres[1]	2,150 acres[1]
Fertilizer (N-P-K) applied		
% reduction in fertilizer		
Total amount of fertilizer reduced on farm		
Total $US saved on fertilizer costs on farm		

[1]Total acres: 1,300 acres transplanted + 800 acres seeded;
29% of total onion acreage in New York State

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Reducing fertilizer use in onions

➢ **Onion grower testimonial (Big "O" Farms, Elba, NY) on 10/26/23**

Factor	Before Project	After Project
Onions grown on farms	2,150 acres[1]	2,150 acres[1]
Fertilizer (N-P-K) applied	1,000 lbs/acre	350-400 lbs/acre (transplants) 750-800 lbs/acre (seeded)
% reduction in fertilizer	-	44-49%
Total amount of fertilizer reduced on farm	-	950,000 to 1,057,000 lbs/yr
Total $US saved on fertilizer costs on farm	-	$420,000 to $470,000/yr

[1]Total acres: 1,300 acres transplanted + 800 acres seeded;
29% of total onion acreage in New York State

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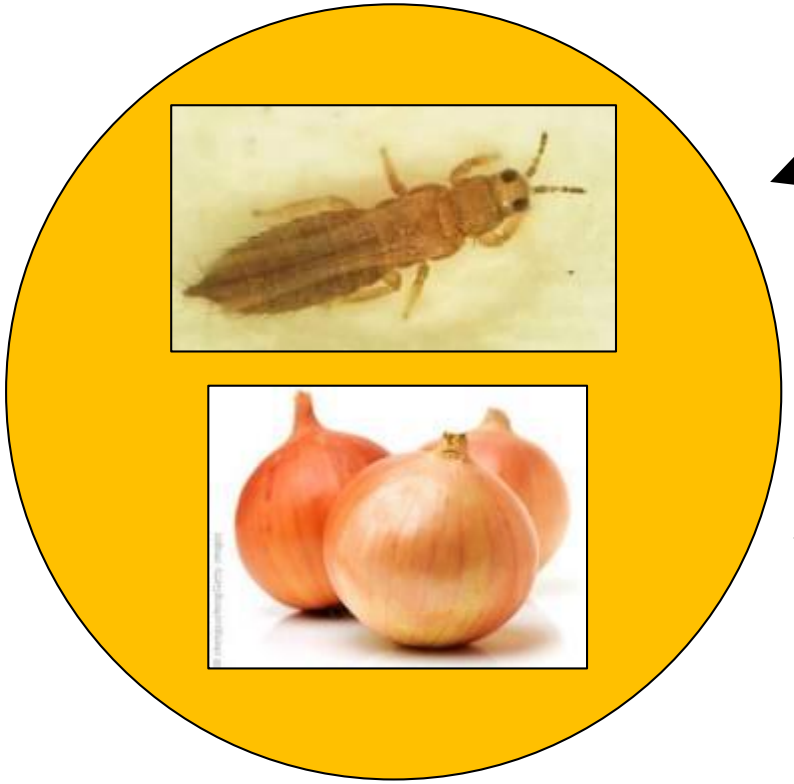
Reducing fertilizer use to manage thrips

Chemical Control

Plant Resistance



Cultural Control

Biological Control

…failed as a control tactic for thrips

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Reducing fertilizer use to manage thrips

Chemical Control

Plant Resistance

Cultural Control

- Reduced costs, increased profits
- Less pollution
- Decreased labor and carbon emissions

…failed as a control tactic for thrips,

…but successful for production…

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OUTLINE

I. Onion production, onion thrips biology and its damage

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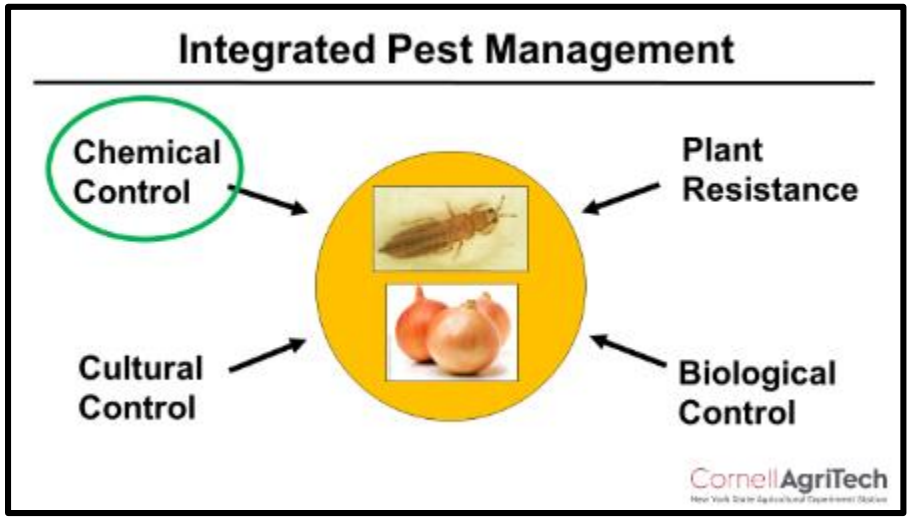
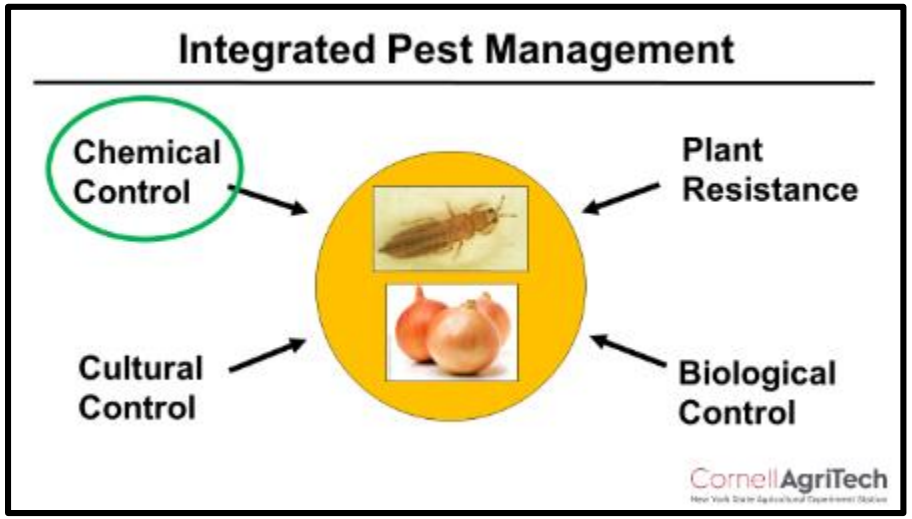
Conclusions

- Onion thrips management is still reliant on insecticide use…other tactics have not been promising



Conclusions

- Onion thrips management is still reliant on insecticide use…other tactics have not been promising



- Both insecticide and fertilizer inputs can be reduced substantially without negatively impacting onion yield!

Acknowledgements

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Tony Shelton, PhD
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- NY Ag and Markets Specialty Crops Block Grant
- New York Farm Viability Institute
- New York Onion Research & Development Program

USDA NIFA
United States Department of Agriculture
National Institute of Food and Agriculture

NY farm viability INSTITUTE

NY ORDP
NEW YORK STATE OF OPPORTUNITY. Agriculture and Markets

THE END

Photo: Brian Nault

Questions

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Some Questions for you

Northeastern IPM Center

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USDA United States Department of Agriculture National Institute of Food and Agriculture

Northeastern IPM Center

Land Acknowledgment

The Northeastern IPM Center is based at Cornell University in Ithaca, New York.

Cornell University is located on the traditional homelands of the Gayogo̱hó·nǫ' (the Cayuga Nation). The Gayogo̱hó·nǫ' are members of the Haudenosaunee Confederacy, an alliance of six sovereign Nations with a historic and contemporary presence on this land. The Confederacy precedes the establishment of Cornell University, New York state, and the United States of America. We acknowledge the painful history of Gayogo̱hó·nǫ' dispossession, and honor the ongoing connection of Gayogo̱hó·nǫ' people, past and present, to these lands and waters.

This land acknowledgment has been reviewed and approved by the traditional Gayogo̱hó·nǫ' leadership.

USDA United States Department of Agriculture National Institute of Food and Agriculture

Northeastern IPM Center

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