UMassAmherst

UMassAmherst

# Novel Strategies for Managing Insect Pests

**Dr. Jaime C. Piñero**

*Stockbridge School of Agriculture &*
*UMass Extension*

E-mail: jpinero@umass.edu

GROUP 28 INSECTICIDE

# VERDEPRYN® 100SL INSECTICIDE

With the active ingredient Cyclapryn®

| | |
|---|---|
| ACTIVE INGREDIENT: Cyclaniliprole* | 9.17% |
| OTHER INGREDIENTS: | 90.83% |
| Total | 100.0% |

$RT_{25}$ Phosmet: 51

$RT_{25}$ Permethrin: 72

$RT_{25}$ Cyclaniliprole: 3

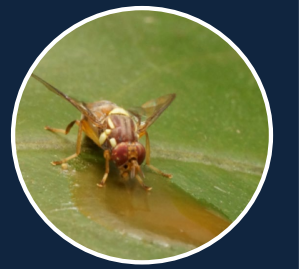
| Crop | Insects | Fl. Oz. Product Per Acre | Instructions |
|---|---|---|---|
| **Pome Fruit (Crop Group 11-10)*** | Codling moth<br>Obliquebanded leafroller<br>Green fruitworm<br>Redbanded Leafroller<br>Variegated leafroller<br>Tufted apple budmoth<br>Spotted tentiform leafminer<br>Western tentiform leafminer<br>White apple leafhopper<br>European apple sawfly<br>European corn borer<br>Oriental Fruit moth<br>Western flower thrips** | 5.5 to 11.0 fl oz<br><br>(0.036 to 0.072 lb. a.i. /A) | **Resistance Management:**<br>Do not apply VERDEPRYN 100SL INSECTICIDE or other Group 28 insecticide more than 3 times within a single generation of insect pest(s) on a crop.<br>**Restrictions:**<br>This product has been determined to have a short residual toxicity (RT25) time. Foliar application of this product is prohibited from onset of flowering until flowering is complete unless: The rate is limited to 0.036 to 0.054 lbs. a.i./A and the application is made in the time period between 2 hours prior to sunset and 8 hours prior to sunrise. [In California no more than one application may be made from the onset of flowering until flowering is complete. Applications must be made when bees are not foraging, adhering to the above restrictions.]<br>For dilute sprays, if higher spray volumes are desired for improved coverage, do not exceed the maximum rate of 0.072 lb ai/A/application.<br>Make no more than 3 applications per year.<br>Do not exceed 11 fl. oz. (0.072 lb a.i./A) per application |

UMASS

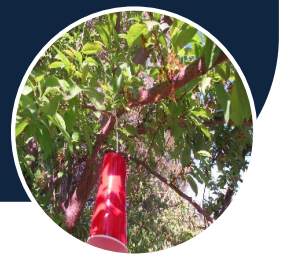
# Attract-and-kill systems

BAIT STATIONS → Fruit flies

MASS TRAPPING → Japanese beetles



BAIT SPRAYS → Fruit flies



TRAP TREES / TRAP CROPS → Plum curculio

**KEY COMPONENT: STRONG ATTRACTANTS (e.g., pheromones, plant volatiles)**

UMASS

# Effective commercial lures are available for some pests

| Pest | Semiochemical | Uses | Level of adoption |
|---|---|---|---|
| Plum curculio | Benzaldehyde + grandisoic acid | Monitoring (trap tree) | None |
| | | Control (bomb tree) | None |
| Apple maggot fly | 5-component blend | Monitoring | Low |
| | | Control (perimeter trapping) | None |
| European apple sawfly | None | ----- | ----- |
| Tarnished plant bug | None | ----- | ----- |

UMASS

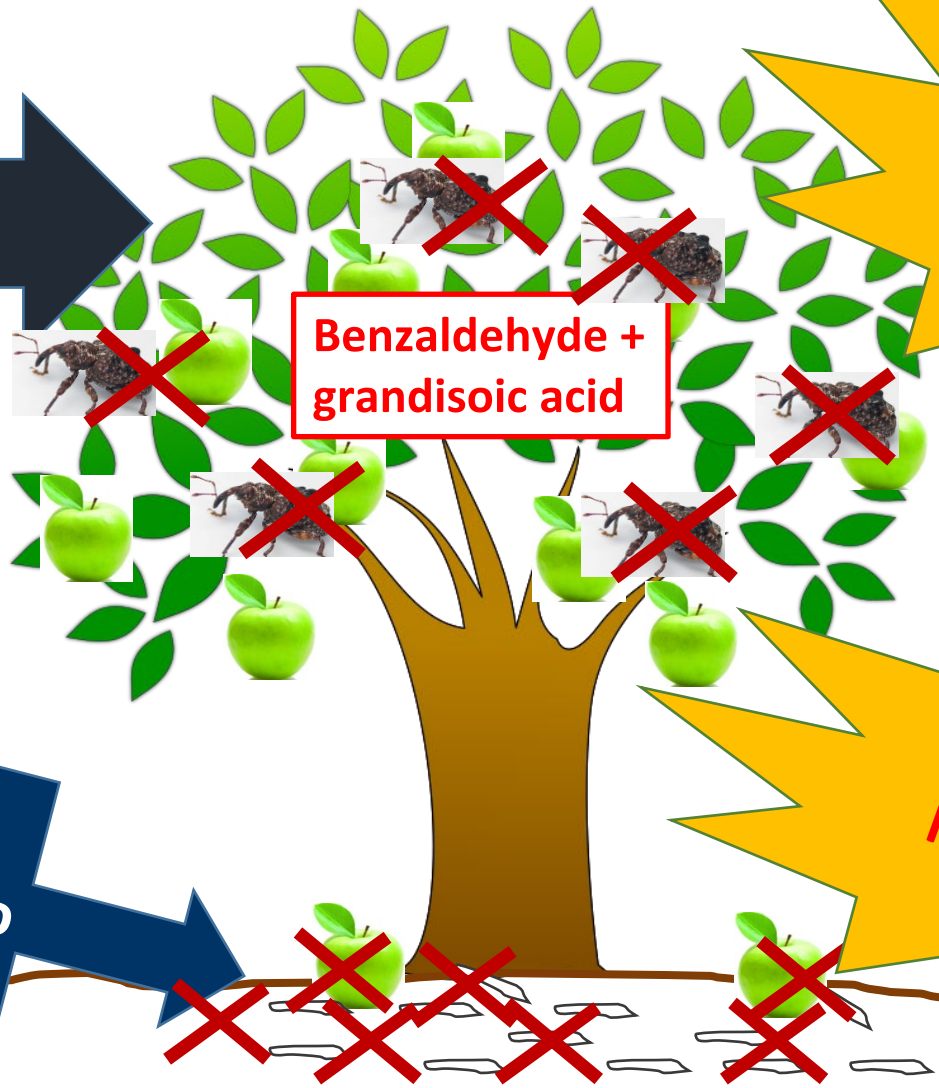
# Novel IPM strategy 1:

## Developing a permanent, low-cost, trap cropping system for multiple apple pests via *multi-cultivar grafting*

*Research in collaboration with Jeremy Delisle (UNH Extension)*

# Developing a multi-stage IPM system for plum curculio (PC)

Odor-baited trap trees attract plum curculios (PCs), leading to aggregations




Insecticides applied to trap trees kill adult PCs

PC-infested apples drop to the ground

Entomopathogenic nematodes (EPNs) kill PC larvae in soil

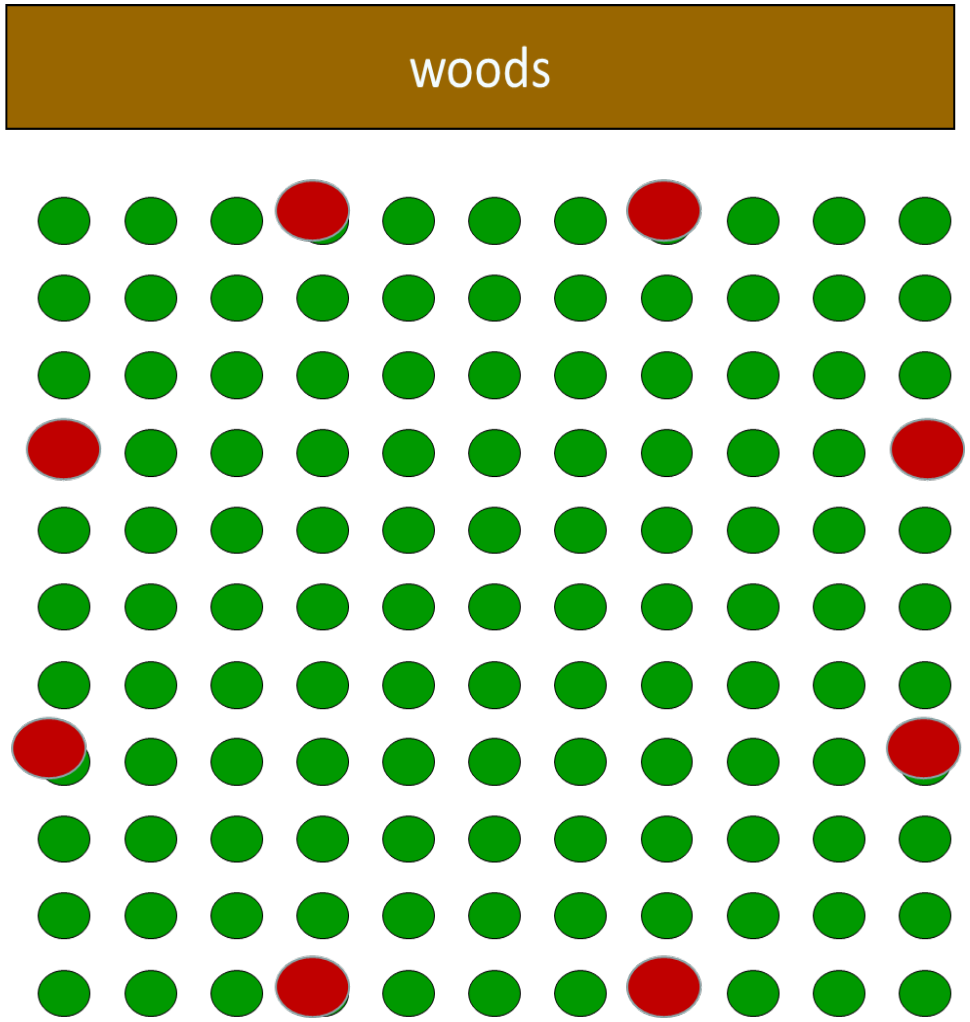
85-90% reduction in # of PC larvae in the soil

UMASS

Pinero et al. (2020) Insects

# Attract-and-kill (AK) strategy against adult PCs

- **The odor-baited trap tree approach is <u>effective</u>** (2004-2005 in 2 orchards, 2013-2019 in 6 orchards).
- 70% reduction of insecticide compared with perimeter-row sprays.
- 93% reduction of insecticide compared with standard full-block sprays.
- This AK strategy has not been adopted by any grower.




Leskey et al. (2008)

insects

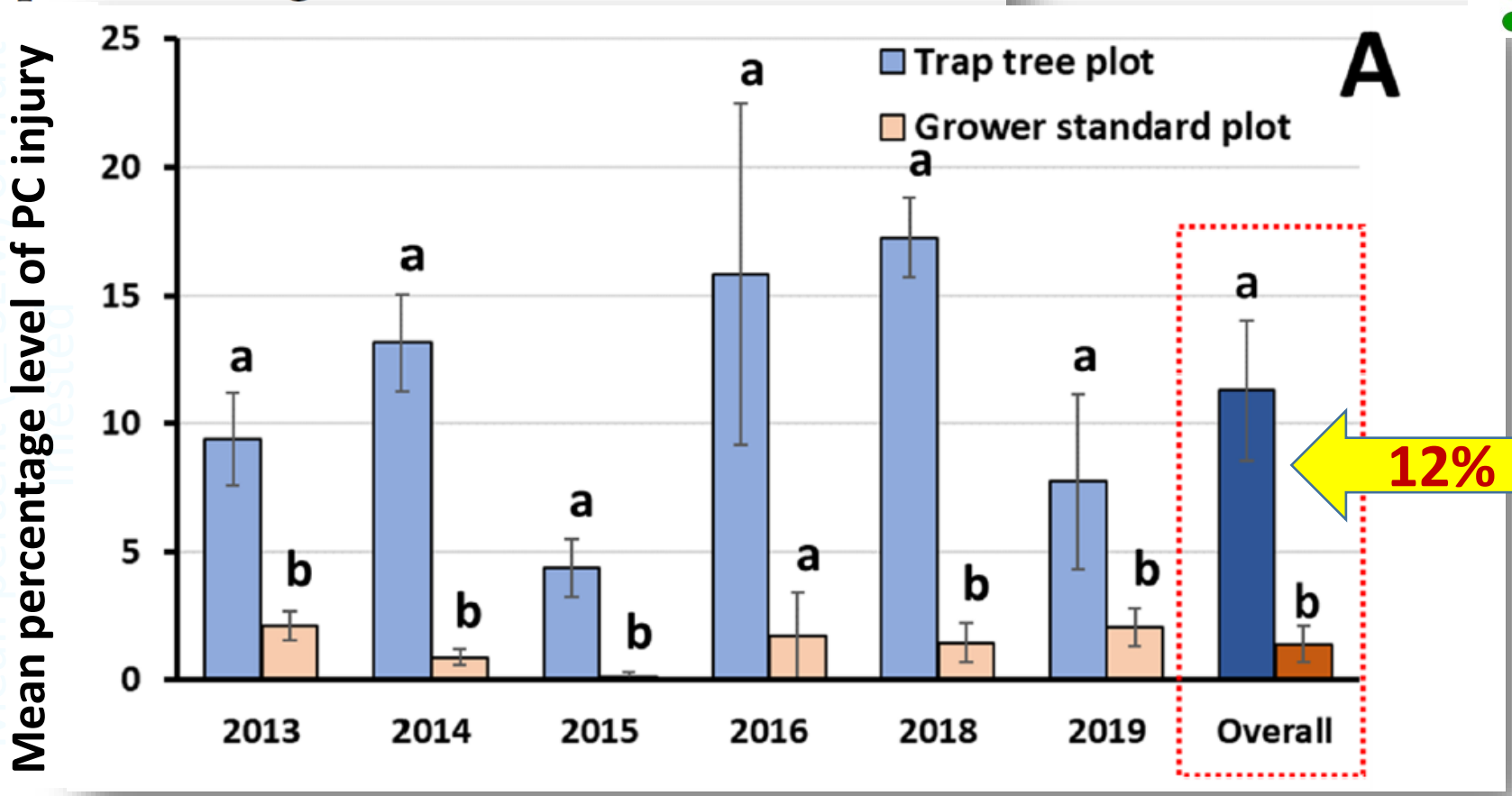
MDPI

Article

# Toward the Integration of an Attract-and-Kill Approach with Entomopathogenic Nematodes to Control Multiple Life Stages of Plum Curculio (Coleopter

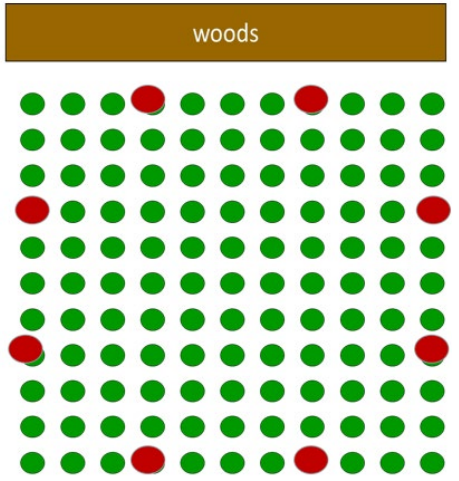
Jaime C. Piñero [1,*]

**Trap trees are baited with BEN+GA**




12%

**We are targeting this level of fruit infestation by PC.**



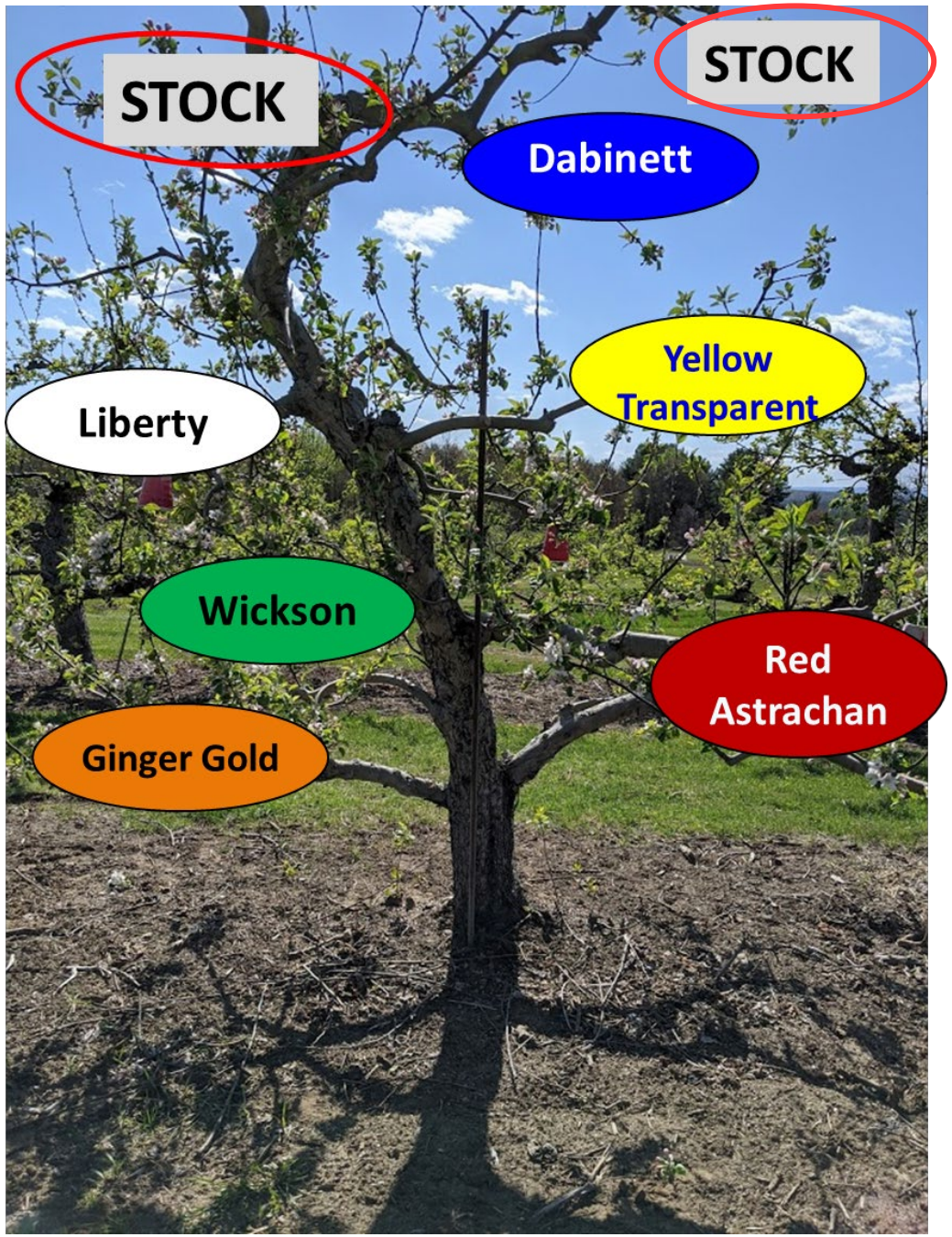

UMASS

# Long-term project: Idea developed in 2018 WITH growers

**Can we exploit natural sources of apple odor to develop a low-cost, permanent trap cropping system for multiple apple pests?**

- Each trap tree is grafted with **6 cultivars that are very attractive to PC and apple maggot fly (AMF)**.
- **Research focuses on PC and AMF** and includes European apple sawfly, Tarnished plant bug, and other pests.
- The concept is simple, affordable, and grower-friendly.

**Is it effective?**



# 20+ blocks in MA, NH, and ME

| State | Orchard name | Area (in acres) with grafted trees | No. grafted trees | Year grafting done | Area of control block |
|---|---|---|---|---|---|
| NH | 1. Poverty Lane Orchards | 8.8 | 32 | 2018 | 2.8 |
| MA | 2. UMass CSO – X-block | 0.5 | 4 | 2018 | 0.8 |
| MA | 3. UMass CSO – Empire block | 0.2 | 4 | 2018 | 0.3 |
| MA | 4. UMass CSO – Rock Mountain | 1.7 | 6 | 2019 | 1.2 |
| MA | 5. Clarkdale | 2.1 | 6 | 2018 | 1.3 |
| MA | 6. Nicewicz farm | 1.1 | 4 | 2018 | 1.1 |
| ME | 7. Ricker Hill orchards – block 1 | ? | ? | 2018 | ? |
| ME | 8. Ricker Hill orchards – block 2 | ? | ? | 2019 | ? |
| NH | 9. Apple Hill farm | 4.8 | 7 | 2019 | 2.0 |
| MA | 10. Sholan Orchards | 7.3 | 11 | 2019 | 4.1 |
| MA | 11. Tougas farms | 0.6 | 4 | 2019 | 0.5 |
| MA | 12. Ragged Hill Orchard | 0.3 | 3 | 2019 | 0.3 |
| MA | 13. Red Apple Farm | 2.9 | 6 | 2019 | 3.1 |
| MA | 14. UMass campus (Ag. Learning Center) | 0.2 | 3 | 2019 | ---- |
| | **TOTAL** | **30.5** | **90** | | **17.5** |

**2020**: No grafting.

**2021**: One more block grafted (MA)

**2022**: 5 more blocks (NH and ME)

# Plum curculio (PC) results

# Results: PC captures in traps and fruit injury in GRAFTED vs. NON-GRAFTED TREES

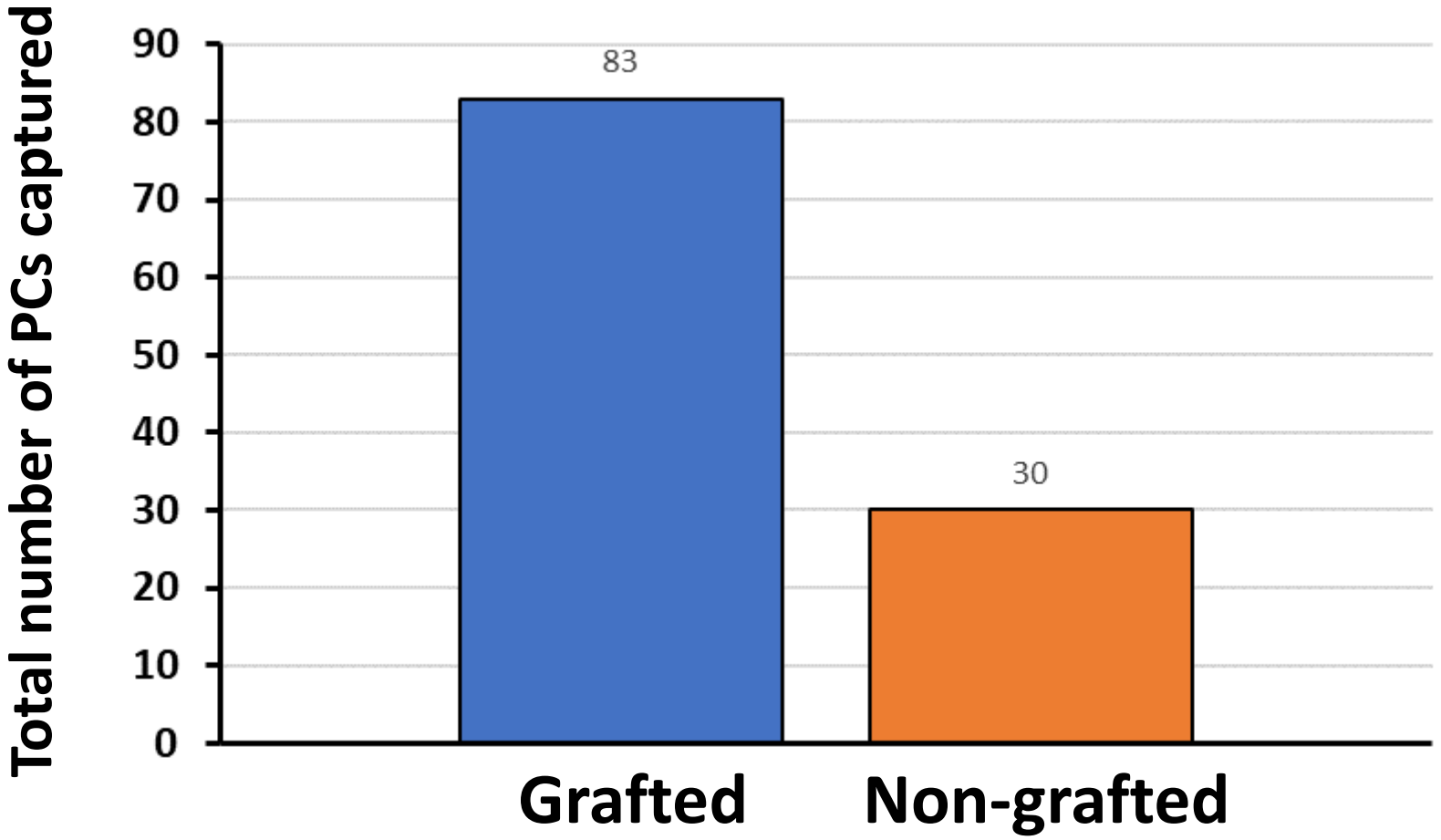
**Distance between grafted trees:**

30 meters

# PC captures in traps across all 12 blocks (10 MA, 2 NH)

## (early May to early June 2022)

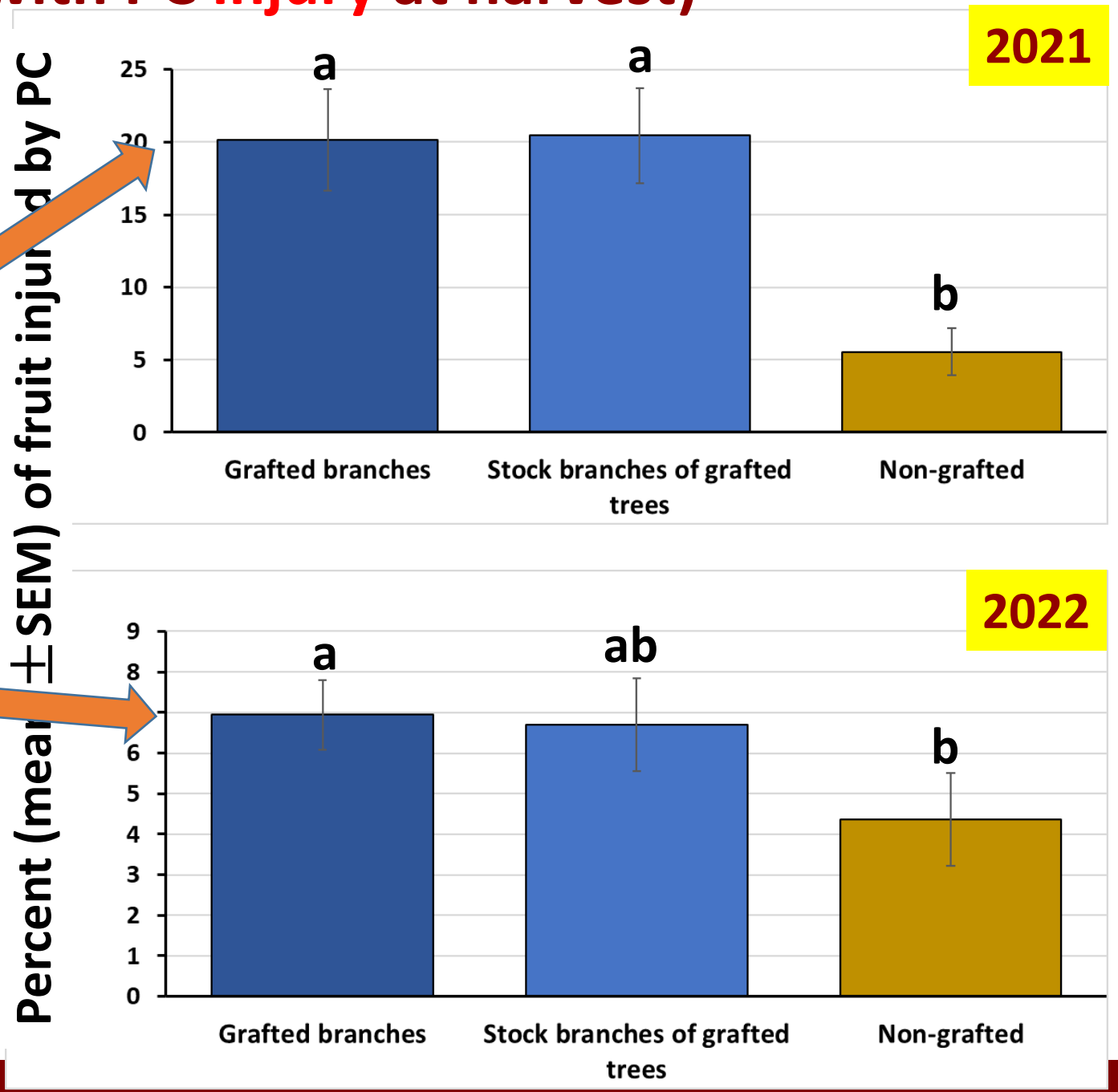
Black pyramid traps



# Results (% of fruit with PC injury at harvest)

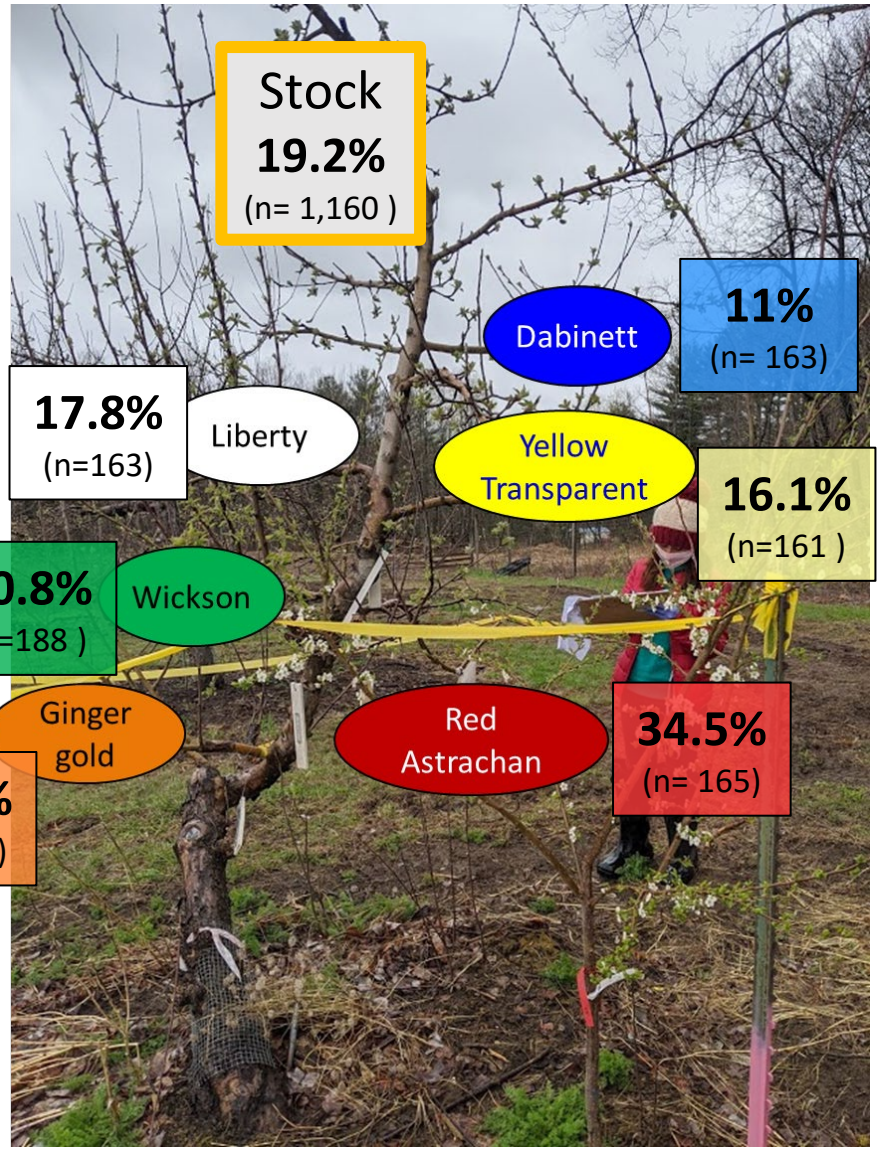
Average level of PC injury on grafted trees combining both years:

**13.5%**

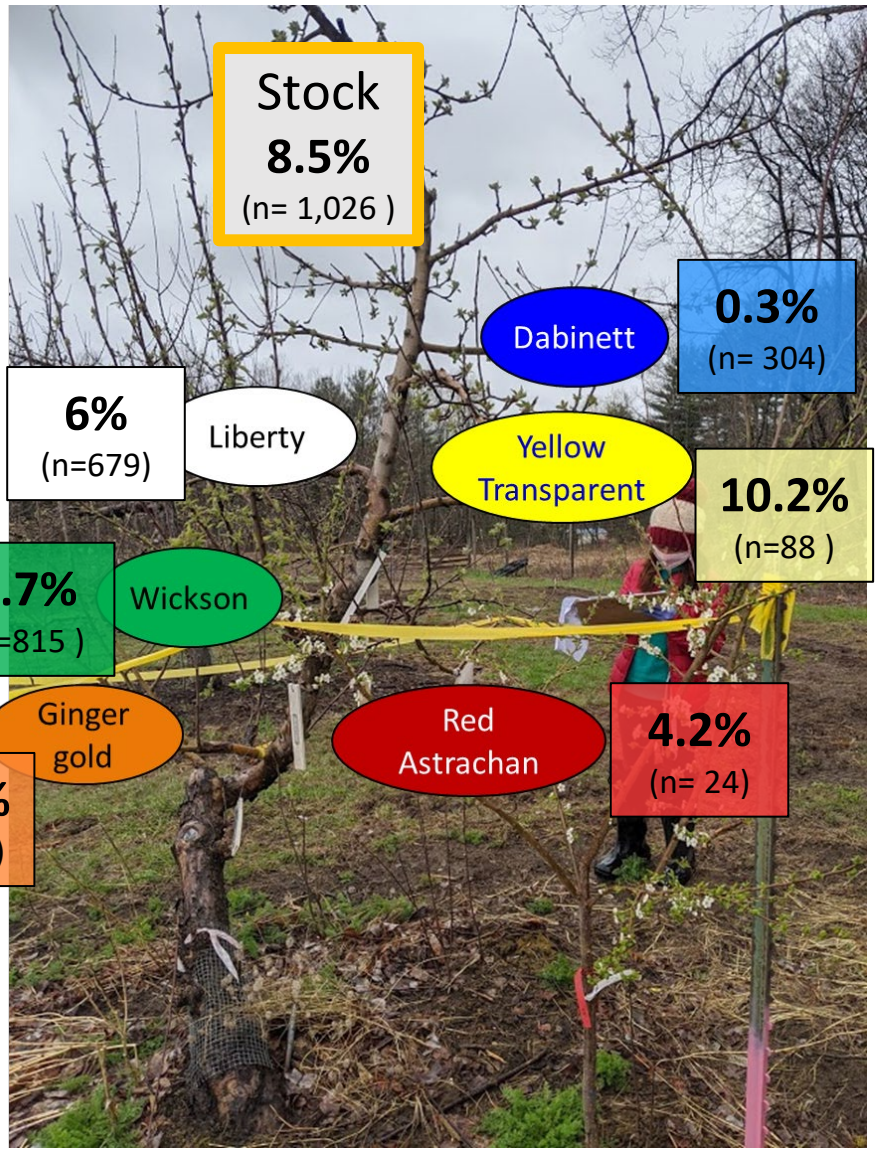


# PC INJURY BY CULTIVAR - ALL ORCHARDS COMBINED

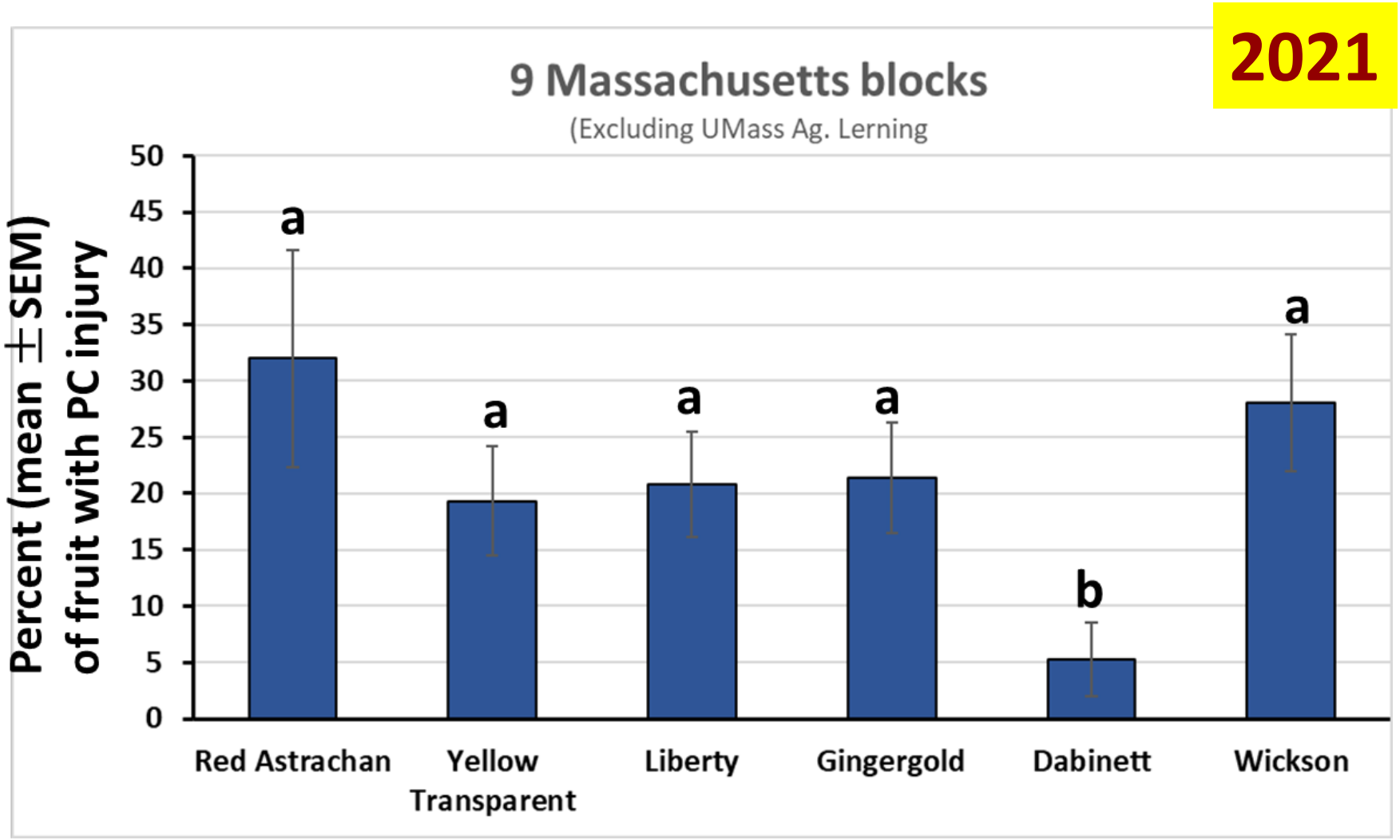
## 2021



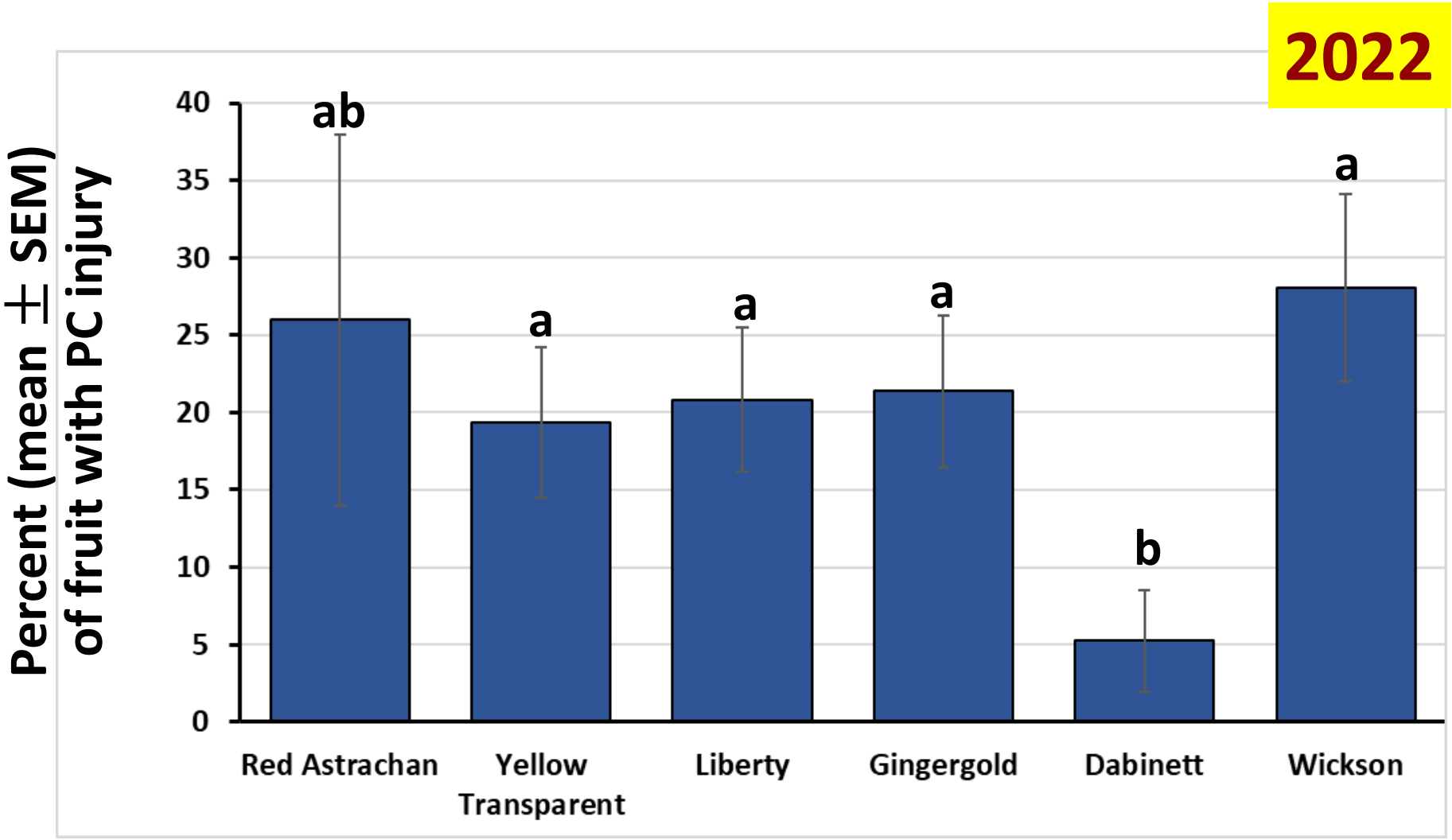

## 2022



# Comparison across cultivars (PC injury at harvest)



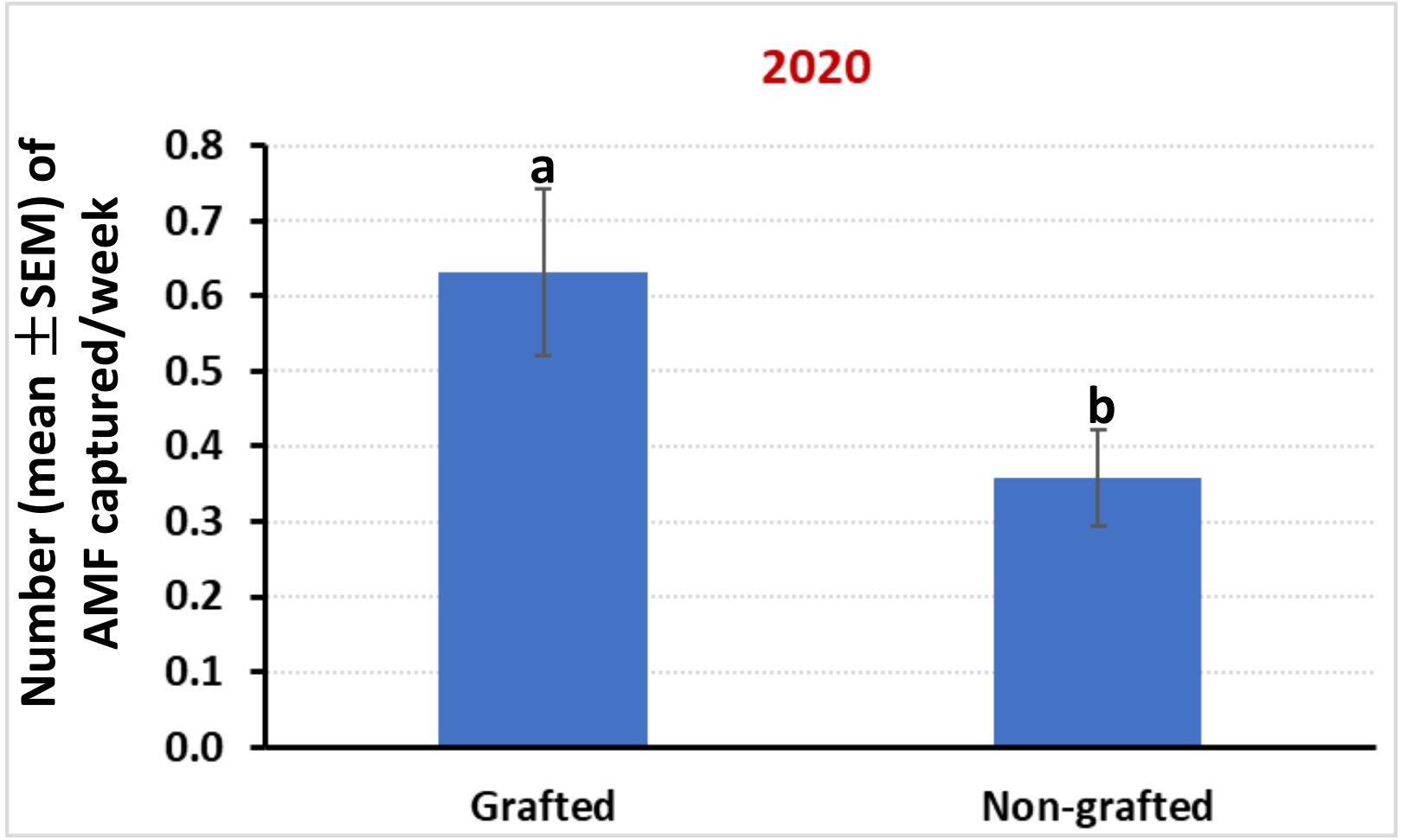
# Comparison across cultivars (PC injury at harvest)



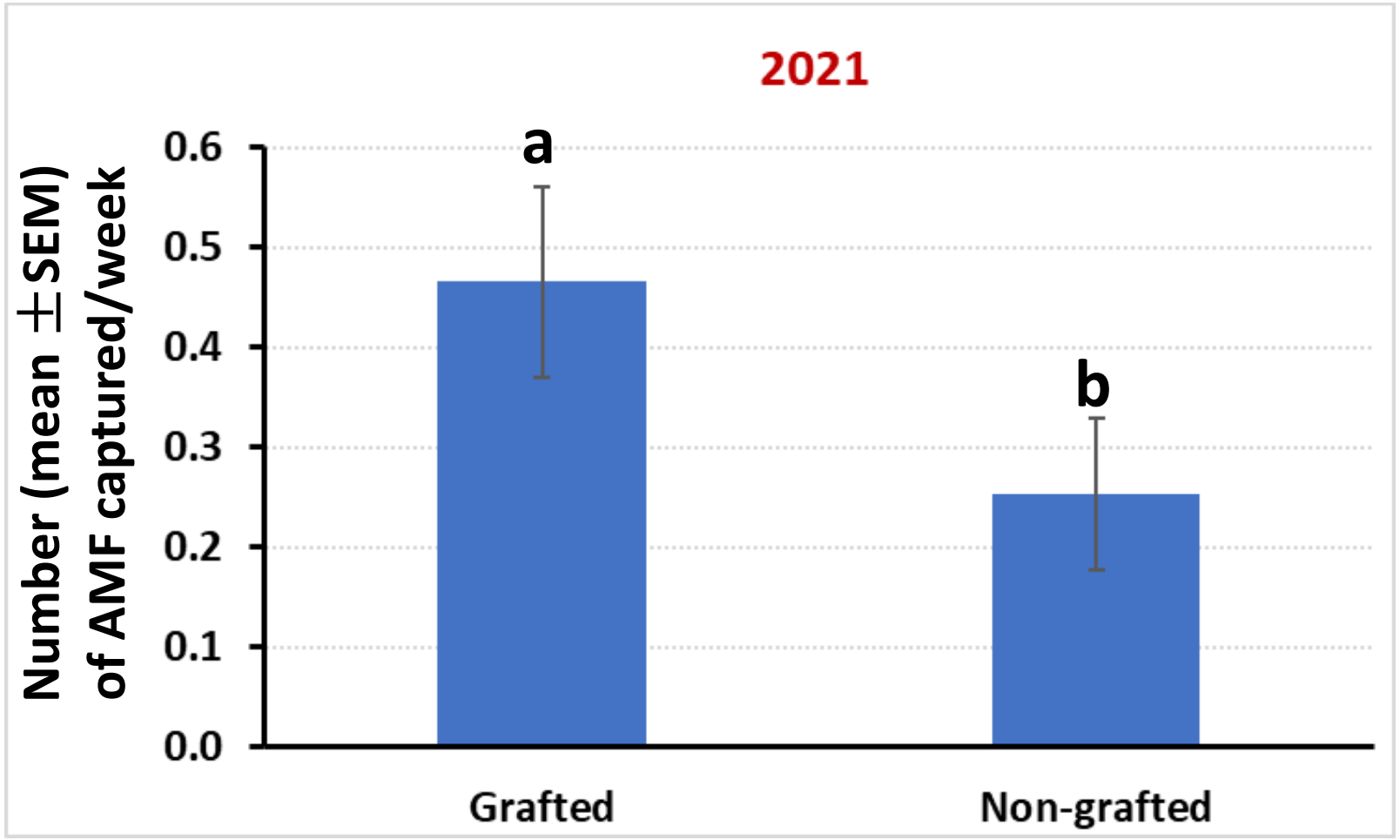
# Apple maggot fly (AMF) results

# 2020 results across 10 MA orchards (trap captures)

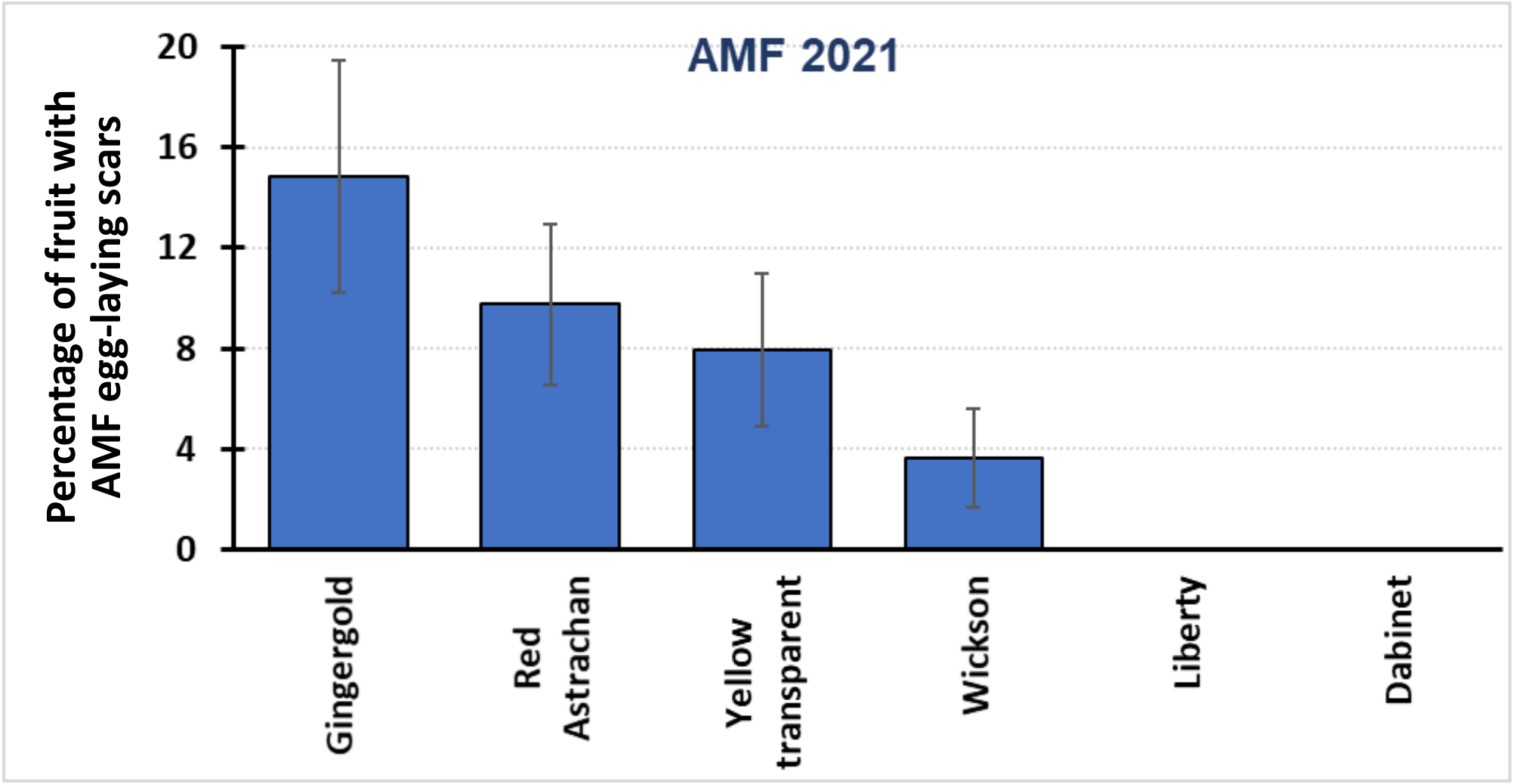
Comparison of AMF captures in unbaited sticky spheres in grafted vs. non-grafted trees



# 2021 results across 10 MA orchards (grafted branches with more fruit)

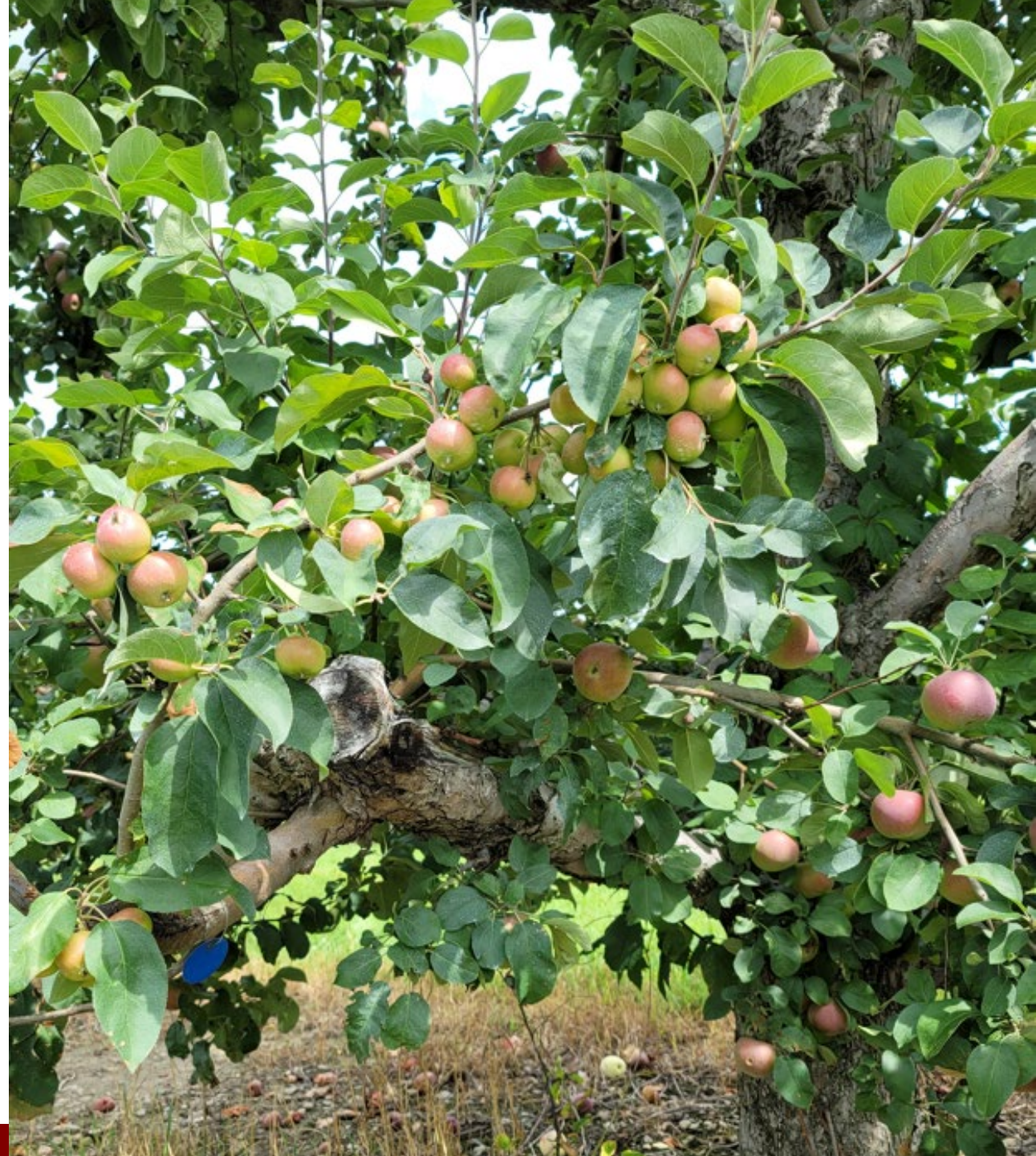


# 2021 Levels of fruit injury according to cultivar



# Wickson at Sholan Farms

Fruits with numerous AMF oviposition marks



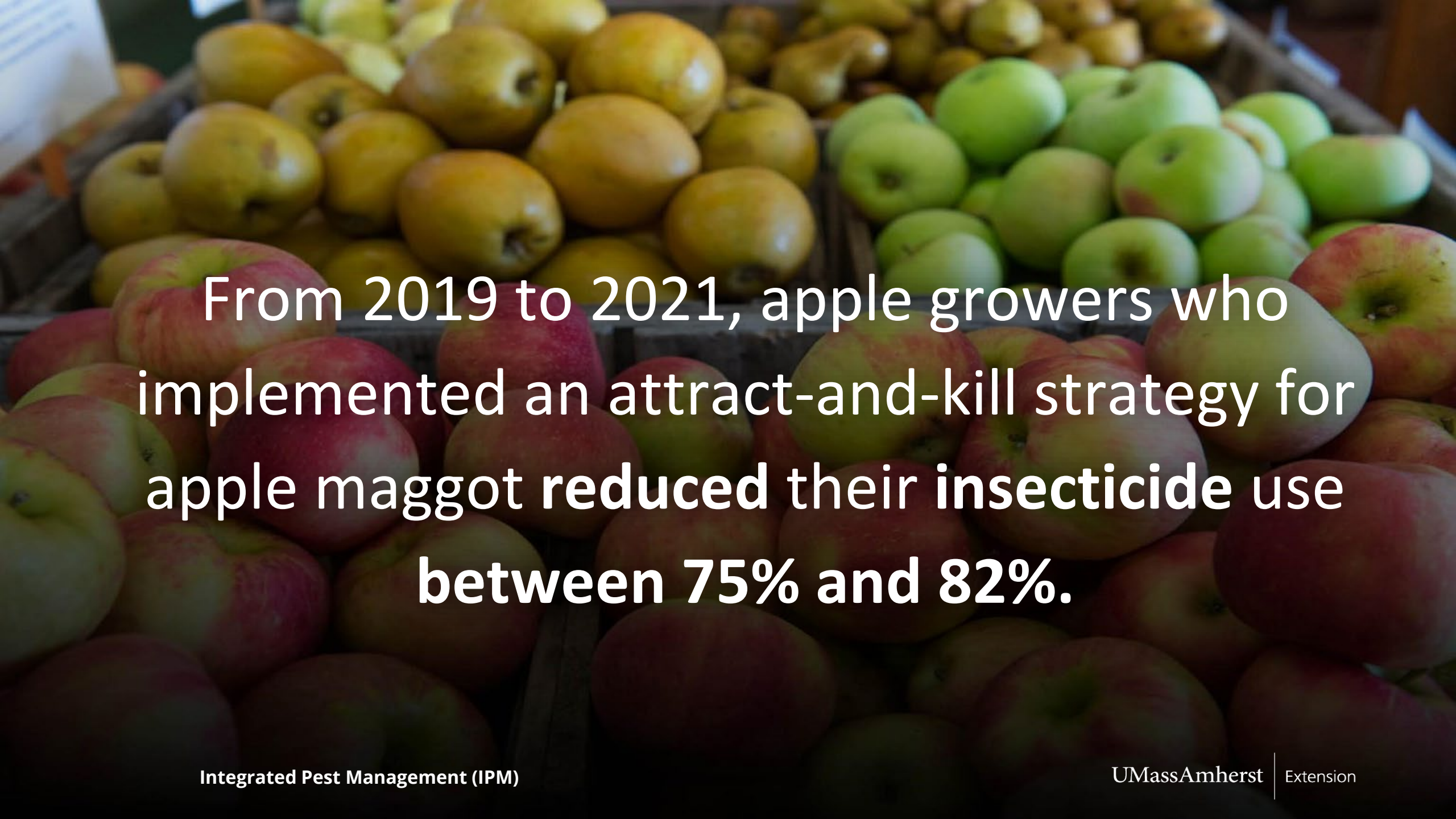
# Conclusion

Grafted trees seem to be effective at attracting PC and AMF relative to non-grafted trees in Massachusetts

# Novel IPM strategy 2:

## Grower-friendly attract-and-kill approach for AMF management

*Research in collaboration with Jeremy Delisle (UNH Extension) and Glen Koehler (UME Extension)*



From 2019 to 2021, apple growers who implemented an attract-and-kill strategy for apple maggot **reduced** their **insecticide** use **between 75% and 82%.**

Can we successfully manage AMF using lures and perimeter-row insecticide sprays with **sugar added**?

# Objective

To quantify the level of AMF control achieved in commercial orchards using an attract-and-kill strategy involving use of **synthetic lures** deployed in **perimeter-row** trees in combination with **insecticide sprays with 3% sugar**

# Approach

- **Commercial orchards (MA,NH, ME)**: **6** (2019), **11** (2020), and **10** (2021).
- **2 treatments per block**: 'Attract-and-Kill' (A&K) vs. grower standard (GS).

  **'Attract'**: 5-component lures deployed every ~30 meters along entire perimeter.

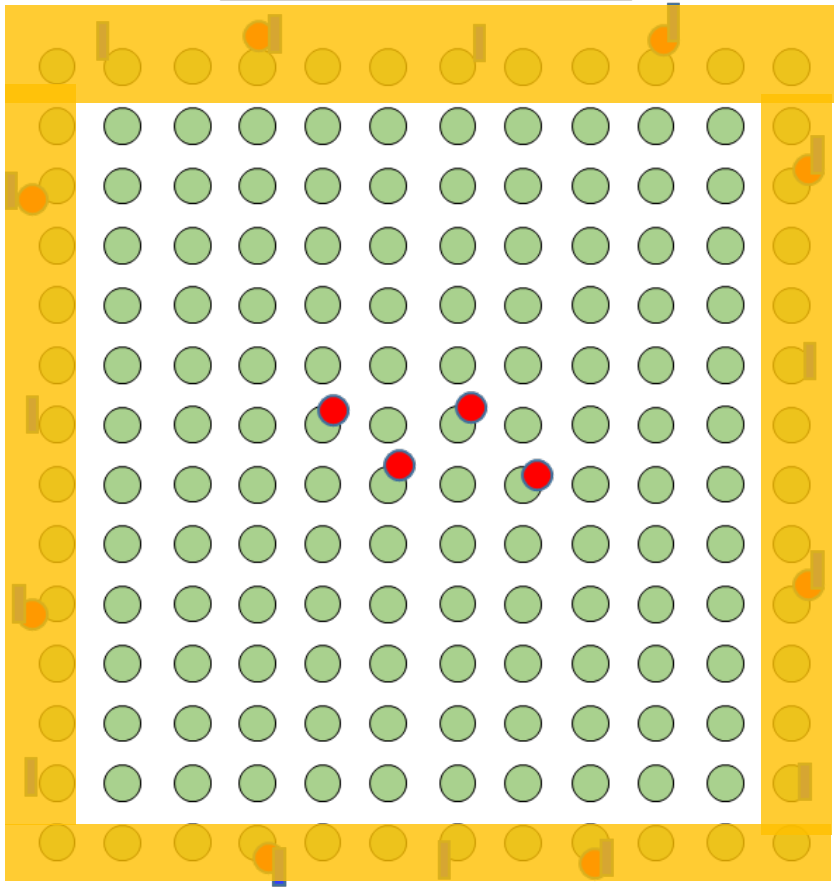
  **'Kill'**: Insecticide sprays with **sugar added** (to induce feeding)

| Orchard (2019) | Area (A&K / GS) | No. AMF lures (A&K block) |
|---|---|---|
| Clarkdale (MA) | 1.7 ac / 1.7 ac | 11 lures (6.4/ac) |
| Red Apple (MA) | 3.0 / 2.8 ac | 13 lures (4.3/ac) |
| UMass Cold Spring Orchard | 1.8 ac / 2 ac | 10 lures (5.5/ac) |
| Poverty Lane (NH) | 3.5 ac / 2.7 ac | 13 lures (3.7/ac) |
| Apple Hill (NH) | 4 ac / 3.8 ac | 17 lures (4.3/ac) |
| Ricker Hill (ME) | 5 ac / 5 ac | 25 lures (5.0/ac) |

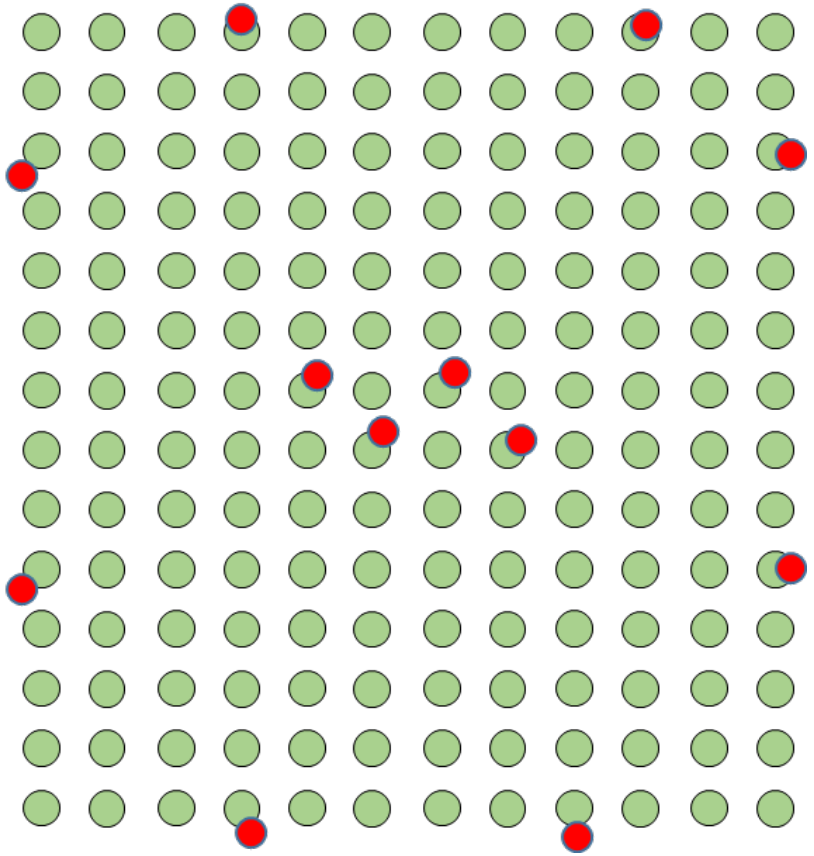
UMASS

= AMF lures
= Monitoring sticky sphere

**Attract-and-kill**

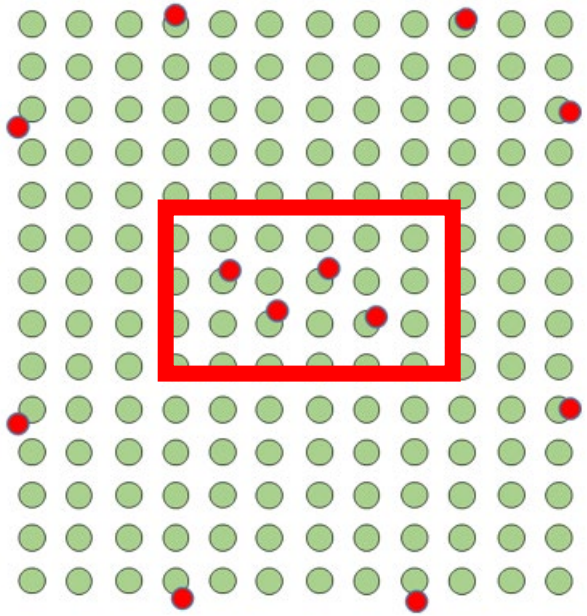


**Grower standard**



# Two methods of assessing treatment performance

**(1) Trap-capture data (interior spheres):**
Indicator of relative numbers of AMF adults that had penetrated into the interiors of blocks.



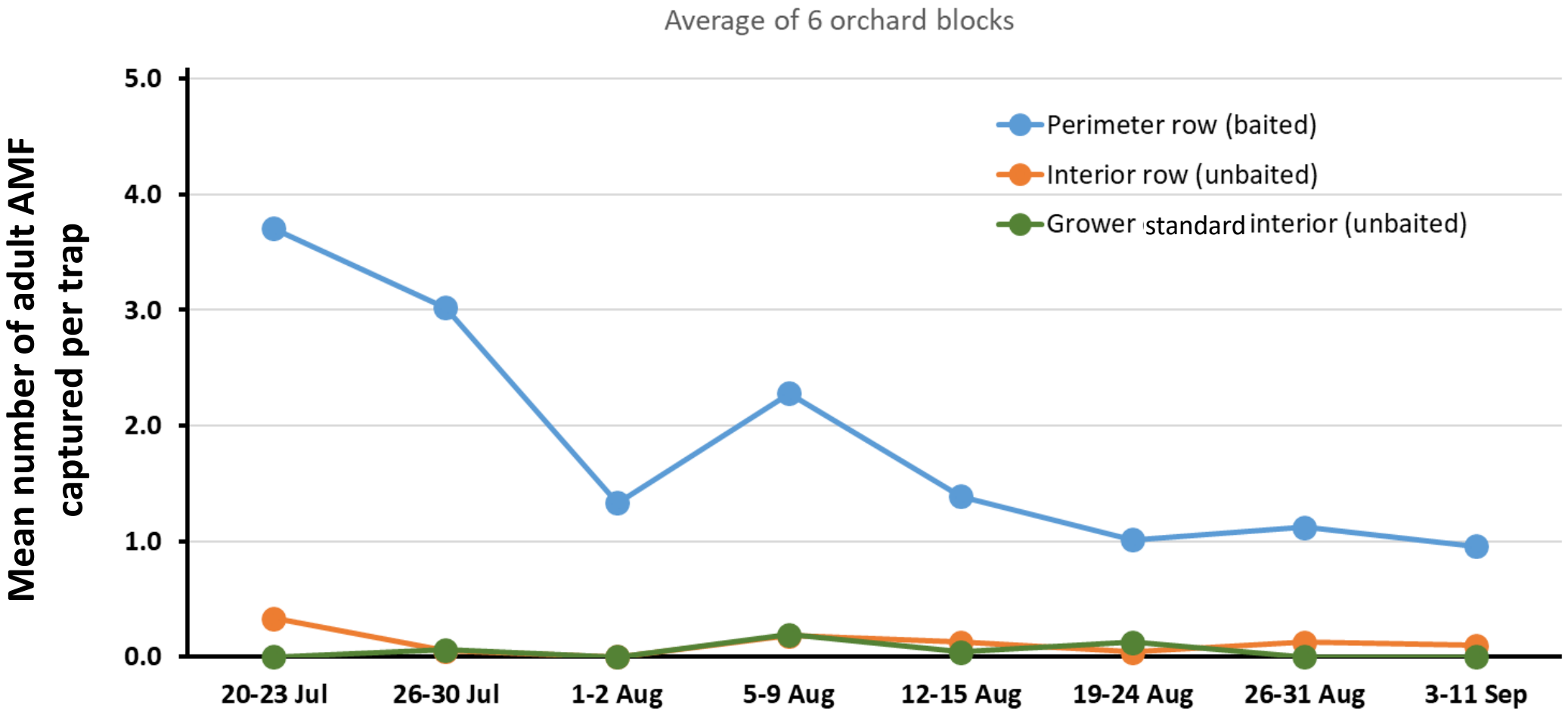
**(2) Fruit infestation data:** At harvest, we visually inspected:

- 20 apples on each of four trees on each of the four perimeter sides of each AK and each GS block.
- 20 apples on each of eight interior trees of each block.

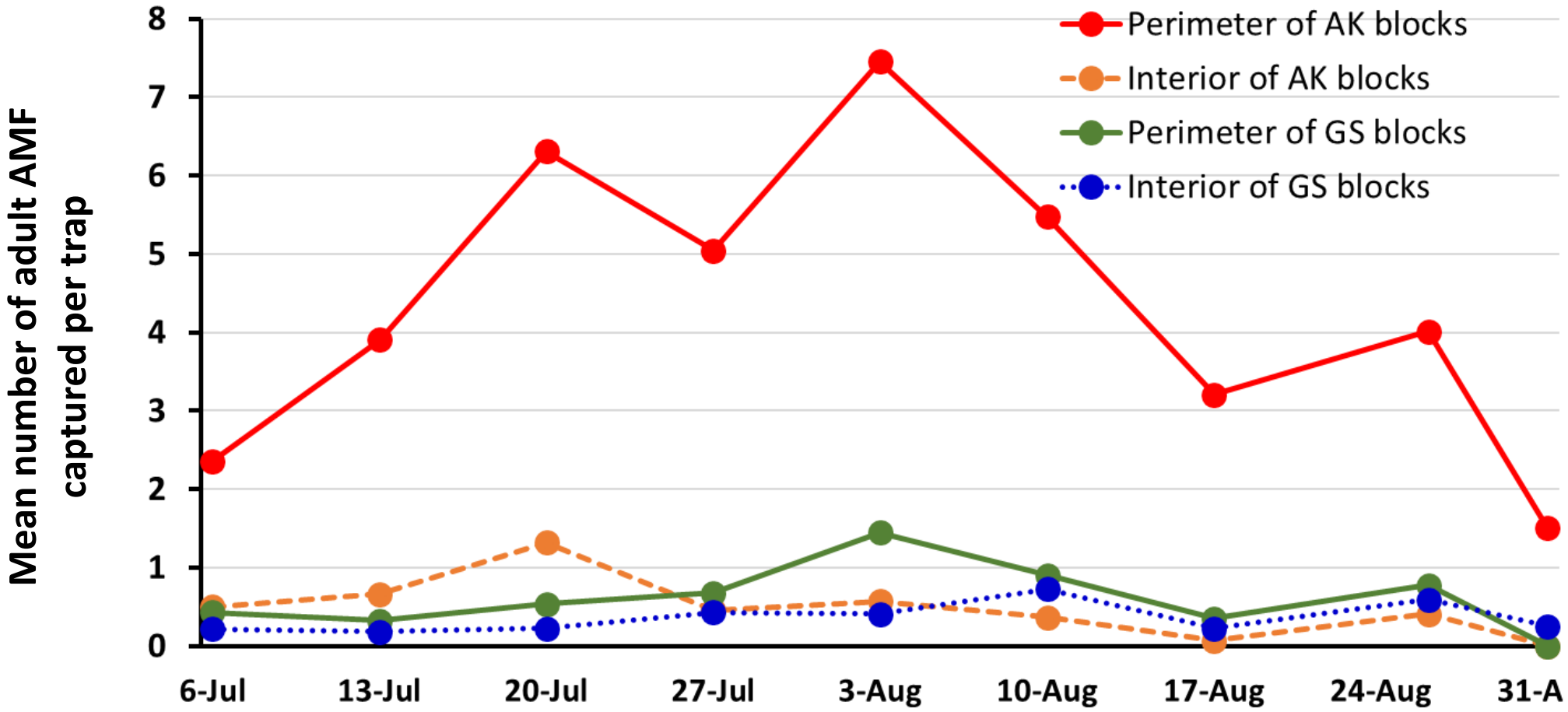
- **2019:** 2,880
- **2020:** 5,280
- **2022:** 4,800

**3 years:** 12,960

# 2019 results: trap captures



# 2020 results: trap captures



# **Fruit infestation results** (mean % infestation)

| | Attract-and-Kill (AK) | | Grower Standard (GS) | | % reduction in insecticide use (AK relative to GS) |
|---|---|---|---|---|---|
| | Perimeter-row | Interior-row | Perimeter-row | Interior-row | |
| 2019 | | | | | 75% |
| 2020 | | | | | 65% |
| 2021 | | | | | 82% |

# Conclusion

Over a 3-year period and across 6-11 orchards, the new AK system attracted to AMF to the perimeter of AK blocks, and no significant differences in levels of fruit infestation were detected

# What insect do you care more about?

Japanese beetle

Brown Marmorated Stink Bug

# Novel IPM strategy 3:

## Controlling Japanese beetles with no insecticides using a mass trapping system

**MASS TRAPPING:** Behaviorally-based method of reducing pest numbers by luring insect pests in large numbers to a trap or device that contains an attractant (usually a food component or a pheromone).

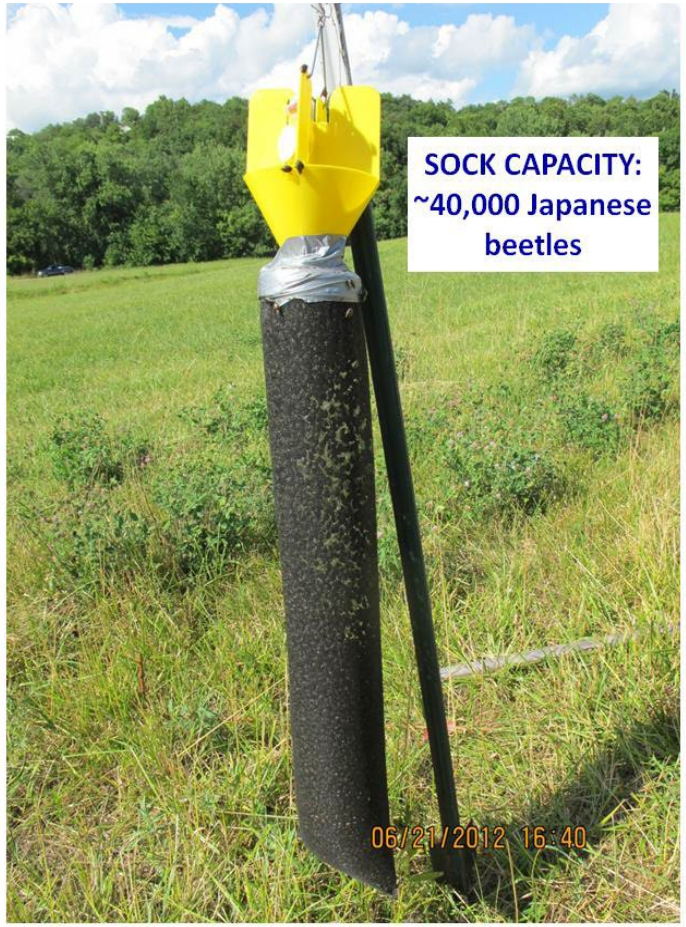
Floral lure

Sex pheromone

For agricultural use, available at:

**Great Lakes IPM**
http://www.greatlakesipm.com

**The mass trapping system**




Research Article

Received: 29 September 2017 Revised: 8 December 2017 Accepted article published: 16 January 2018 Published online in Wiley Online Library:

(wileyonlinelibrary.com) DOI 10.1002/ps.4862

# Mass trapping designs for organic control of the Japanese beetle, *Popillia japonica* (Coleoptera: Scarabaeidae)

**Jaime C Piñero*** and **Austen P Dudenhoeffer**

## Abstract

**BACKGROUND: In some regions of North America, damage caused by the Japanese beetle, *Popillia japonica*, has been increasing as beetle populations continue to become established and expand. This poses a pest management challenge for crop farmers, in particular organic producers. From 2014 to 2016 we evaluated the ability of novel mass trapping systems to capture *P. japonica* in elderberry and blueberry orchards in Missouri, USA.**

**RESULTS: Across a 3-year period in two locations, the mass trapping systems collected 10.3 million *P. japonica* adults while season-long adult densities on crop plants were comparatively low (elderberry: 0.5–3.7 per plant; blueberry: 0.01–0.07 per plant). Damage by *P. japonica* averaged 6.8% per plant in elderberry and 0.12% in blueberry. In 2015 and 2016, large-capacity bins with increased ventilation captured similar beetle numbers as did 1.2-m-long mesh socks (single design used in 2014), and these two trap designs outperformed non-ventilated bins.**

**CONCLUSION: The mass trapping designs captured high numbers of adult *P. japonica*, while comparatively few adults and little damage to the foliage were recorded on plants. Mass trapping may provide effective alternative management options for *P. japonica* with less or no insecticides applied to the crop.**

# “The Japanese Beetle Terminator 3000”


**Austen Dudenhoeffer**

# New low-maintenance (grower-friendly) design

Ventilation is important!

# 2017: The highest Japanese beetle populations ever recorded in Missouri

# Summary of captures (2012-2017)

| FARM | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | TOTAL |
|---|---|---|---|---|---|---|---|
| LU Carver farm | 801,000 | 92,300 | 848,710 | 1’602,089 | 2’649,294 | 2’895,000 | 8’888,393 |
| LU Busby farm | 710,800 | 100,400 | 792,466 | 1’641,995 | 2’800,591 | 672,000 | 6’718,252 |
| **TOTAL** | **1’511,800** | **192,700** | **1’641,176** | **3’244,084** | **5’449,885** | **3’567,000** | **15’606,645** |

LINCOLN UNIVERSITY MISSOURI

Integrated Pest Management
Lincoln University Cooperative Extension

UMASS

# Novel IPM strategy 4:

## Developing an attract-and-kill strategy for the brown marmorated stink bug

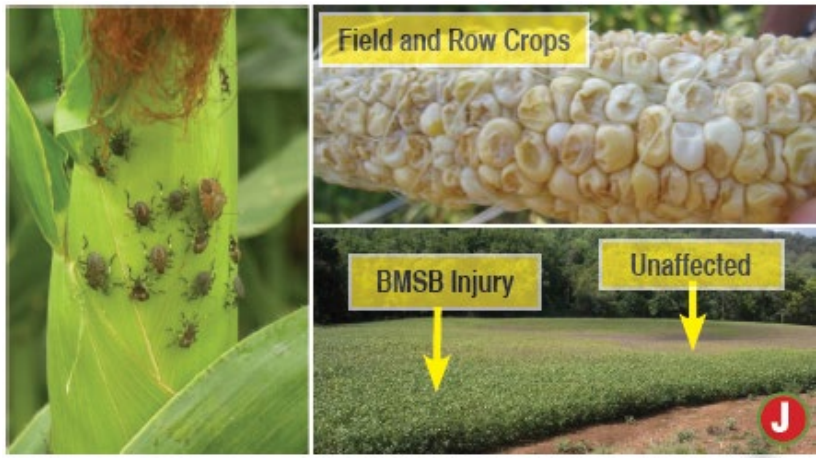
# Trap cropping ought to exploit a pest's dispersal and host selection behavior in order to protect a desired crop.

**Stink bugs and leaf-footed bugs show a preference for:**

- Sorghum
- Millet
- Sunflower
- Buckwheat

UMASS






Adult and nymphal feeding on corn and soybean in mid-August 2010.

The brown marmorated stink bug (BMSB) is an invasive insect that is a serious pest of fruits, vegetables, and other crops.

UMASS

PEST MANAGEMENT

# Sunflower as a Potential Trap Crop of *Halyomorpha halys* (Hemiptera: Pentatomidae) in Pepper Fields

D. C. SOERGEL,[1] N. OSTIGUY, S. J. FLEISCHER, R. R. TROYER, E. G. RAJOTTE, AND G. KRAWCZYK

Department of Entomology, Fruit Research and Extension Center, The Pennsylvania State University, P.O. Box 330, Biglerville, PA 17307-0330.

Environ. Entomol. 44(6): 1581–1589 (2015); DOI: 10.1093/ee/nvv136

- Study conducted in PA in 2012 and 2013.
- Sunflowers used as a trap crop to protect bell pepper.
- Significantly more BMSB were observed in sunflowers than in peppers.

UMASS

*Environmental Entomology*, 45(2), 2016, 472–478
doi: 10.1093/ee/nvw006
Advance Access Publication Date: 25 February 2016
Research article

OXFORD

Pest Management

# Identifying a Potential Trap Crop for a Novel Insect Pest, *Halyomorpha halys* (Hemiptera: Pentatomidae), in Organic Farms

**Anne L. Nielsen,[1,2] Galen Dively,[3] John M. Pote,[1] Gladis Zinati,[4] and Clarissa Mathews[5]**

[1]Department of Entomology, Rutgers University, 121 Northville Rd., Bridgeton, NJ 08302 (nielsen@aesop.rutgers.edu; jmp497@scarletmail.rutgers.edu), [2]Corresponding author, e-mail: nielsen@aesop.rutgers.edu, [3]Department of Entomology, University of Maryland, College Park, MD (galen@umd.edu), [4]The Rodale Institute, Kutztown, PA (Gladis.zinati@rodaleinstitute.org), and [5]Redbud Farm, LLC, Inwood, WV and Shepherd University, Shepherdstown, WV (CMathews@shepherd.edu)

Received 2 September 2015; Accepted 15 January 2016

- **Sorghum** was the most effective trap crop, followed by **sunflower**.

UMASS

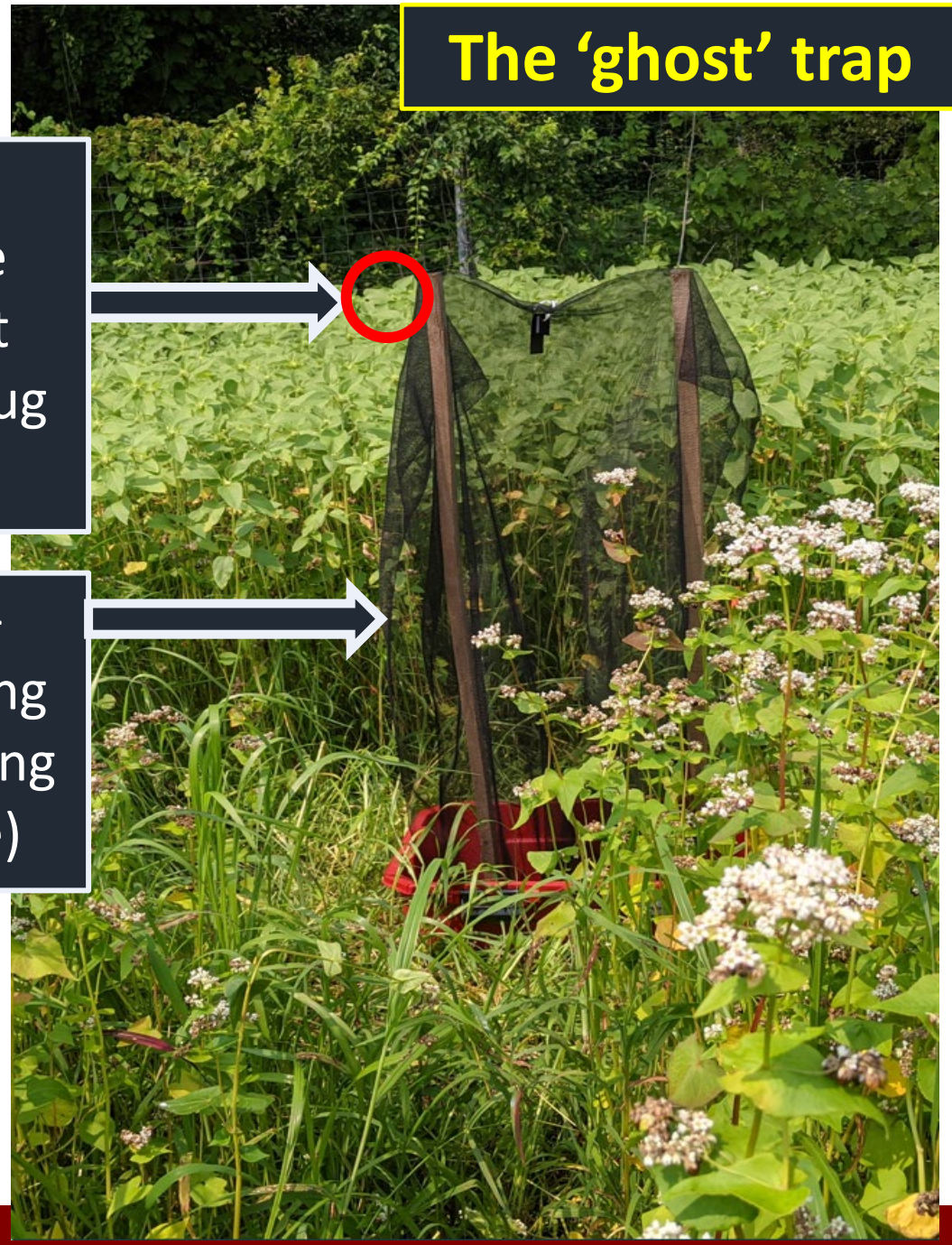
# Evaluation of a grower-friendly attract-and-kill IPM system for the Brown Marmorated Stink Bug

Northeastern IPM Center

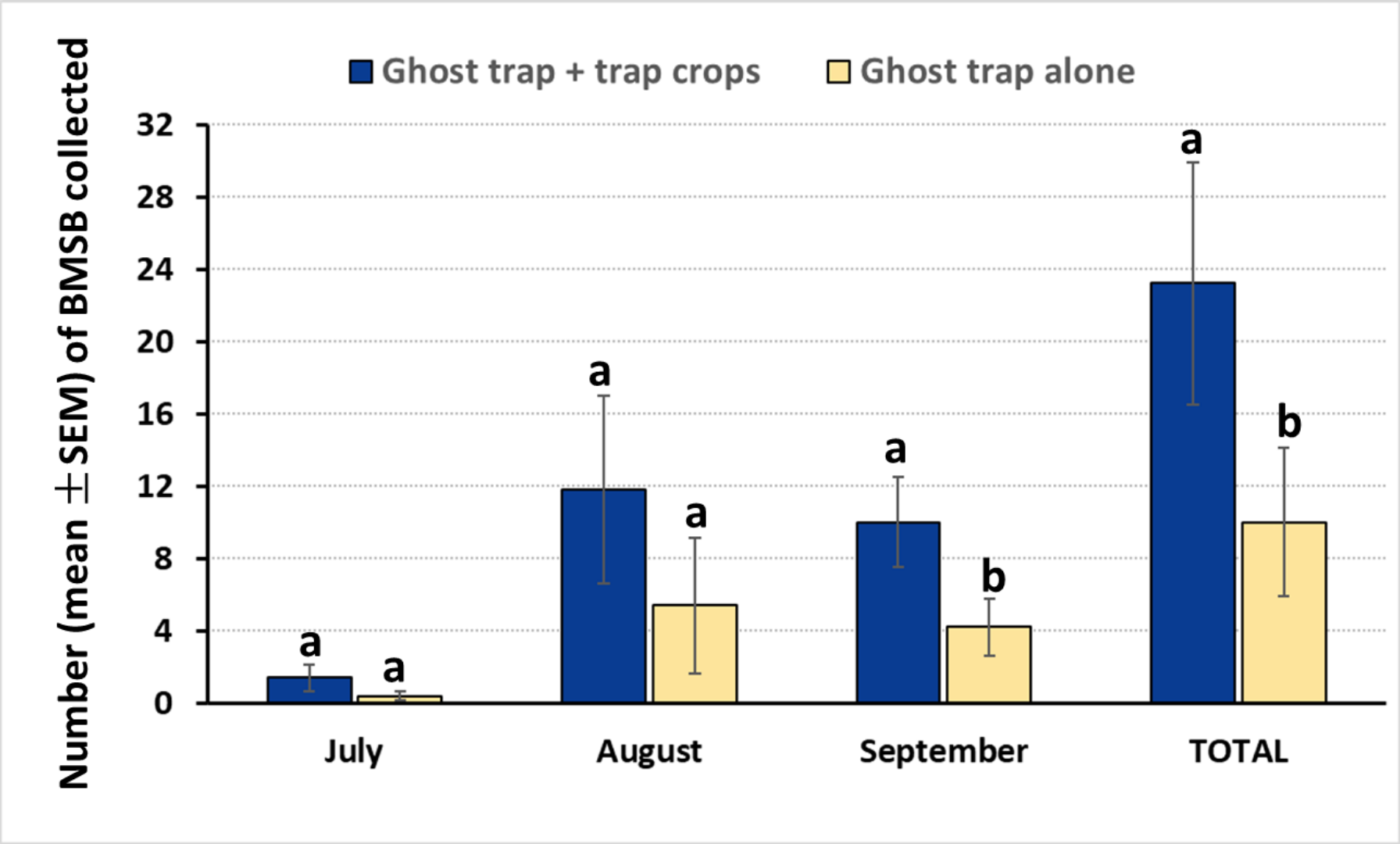



UMASS

# Killing pest stink bugs in trap crop plants without impacting beneficials (pollinators, predatory, and parasitic insects)



# 2021 results (Massachusetts only, n= 5)



# Sunflower and buckwheat may play an additional role in BMSB IPM

**Mateo Rull-Garza (graduate student):**

Investigating the complex of stink bug egg parasitoids present in Massachusetts

MDAR
MASSACHUSETTS DEPARTMENT OF AGRICULTURAL RESOURCES

UMASS

# Sunflowers provide multiple benefits to growers

# Sunflower pollen has medicinal, protective effects on bees


- Sunflower pollen can help bumblebees fight off two common pathogens.
- Defense chemicals in **pollen** can be 10 to 10,000 times more concentrated than they are in **nectar**.

# Sunflowers attract beneficial insects

- **Florida**: Predatory insects and spiders, parasitic wasps, and important pollinators insects observed on sunflowers than on crop vegetation.

- **Missouri**: Sunflower was as good as sweet alyssum and buckwheat at attracting ladybeetles.

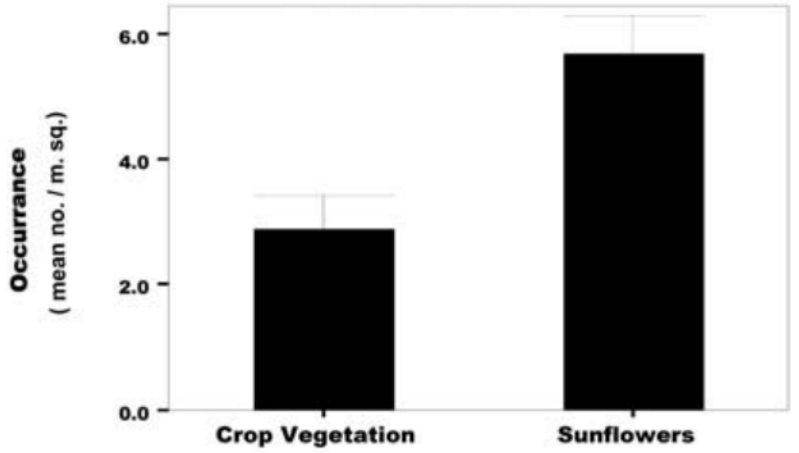
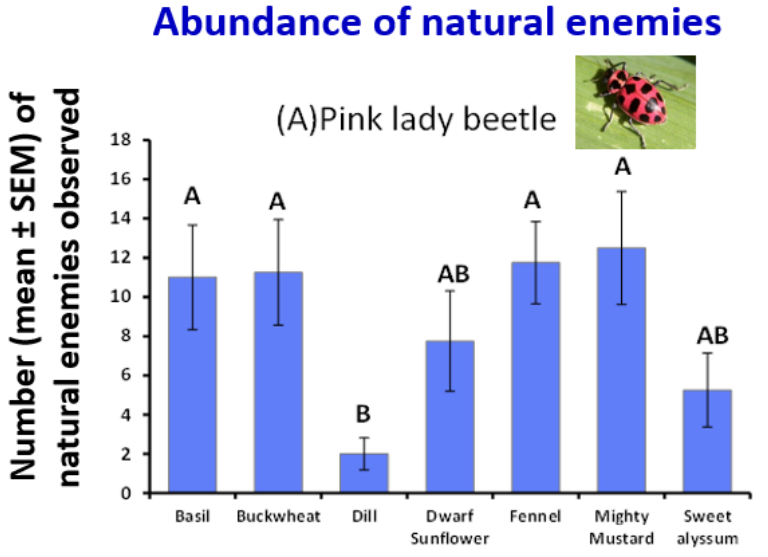



Fig. 2. Occurrence of beneficial insects was greater on sunflower vegetation than on crop vegetation during the 2002 growing season ($F_{1,16} = 11.78, P = 0.003$). Error



# Sunflowers can provide supplemental income

# Acknowledgements


## Growers:

- Massachusetts: Tom and Ben Clark, Keith Arsenault, Al Rose, Joanne DiNardo, Dana Clark, Shawn Mcintire.
- New Hampshire: Steve Wood, Chuck Souther, and Giff Burnap
- Maine: Harry and Sam Ricker

## Collaborators and assistants:

- Anna Wallingford, Jeremy Delisle (University of New Hampshire), Glenn Koehler (University of Maine).
- Sadie McCracken, Heather Bryant (Univ. New Hampshire), Dorna Saadat, Heriberto Godoy-Hernandez, Prabina Regmi, and Ajay Giri (UMass).

## Funding:


United States Department of Agriculture
National Institute of Food and Agriculture

- New England Tree Fruit Growers Research Committee


UMASS

*"We can't solve problems by using the same kind of thinking we used when we created them"*

*-Albert Einstein*