

# Mechanical Weed Management for Diversified Vegetable Farms: *Research Update*

**Peyton Ginakes**

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Dan Brainard

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Johnny Sanchez

Ruthie Sexton

Daniel Priddy



# Weed Ecology Team



Ruthie

Rebecca

Johnny

Sam

Jordan

Brad

Peyton

# The Problem



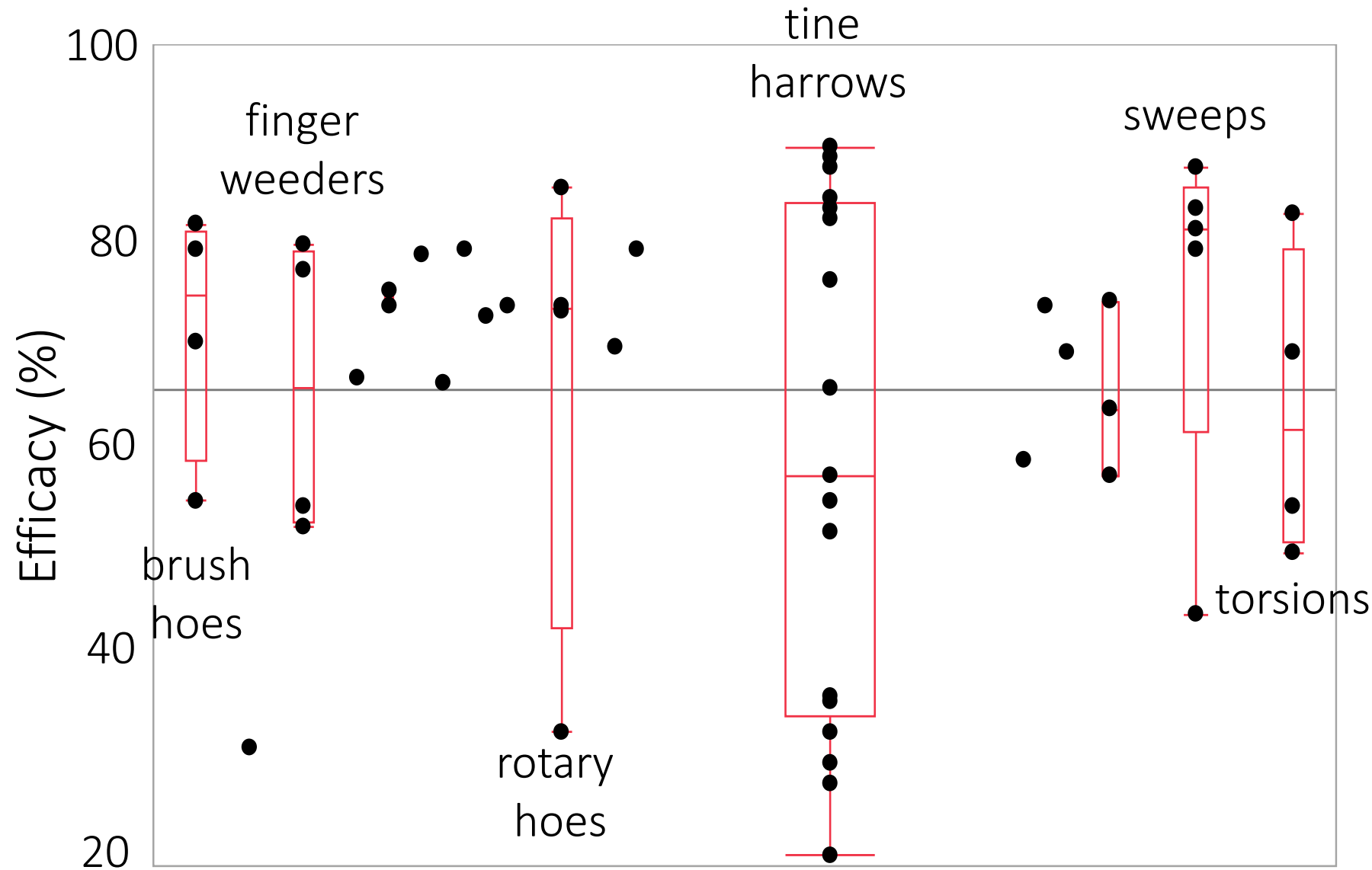
# The Problem



# The Problem



# The Problem: Low and Variable Efficacy!



55 experiments,  
1990 - 2015

Avg. Efficacy =  
66%

*Gallandt, Brainard,  
& Brown, 2018*

# Outline

## → Physical weed control

### Tools

Stacking tools

KULT Kress Duo units

Terrateck Double Wheel Hoe

Tine harrows

Robotic weeders

### Site

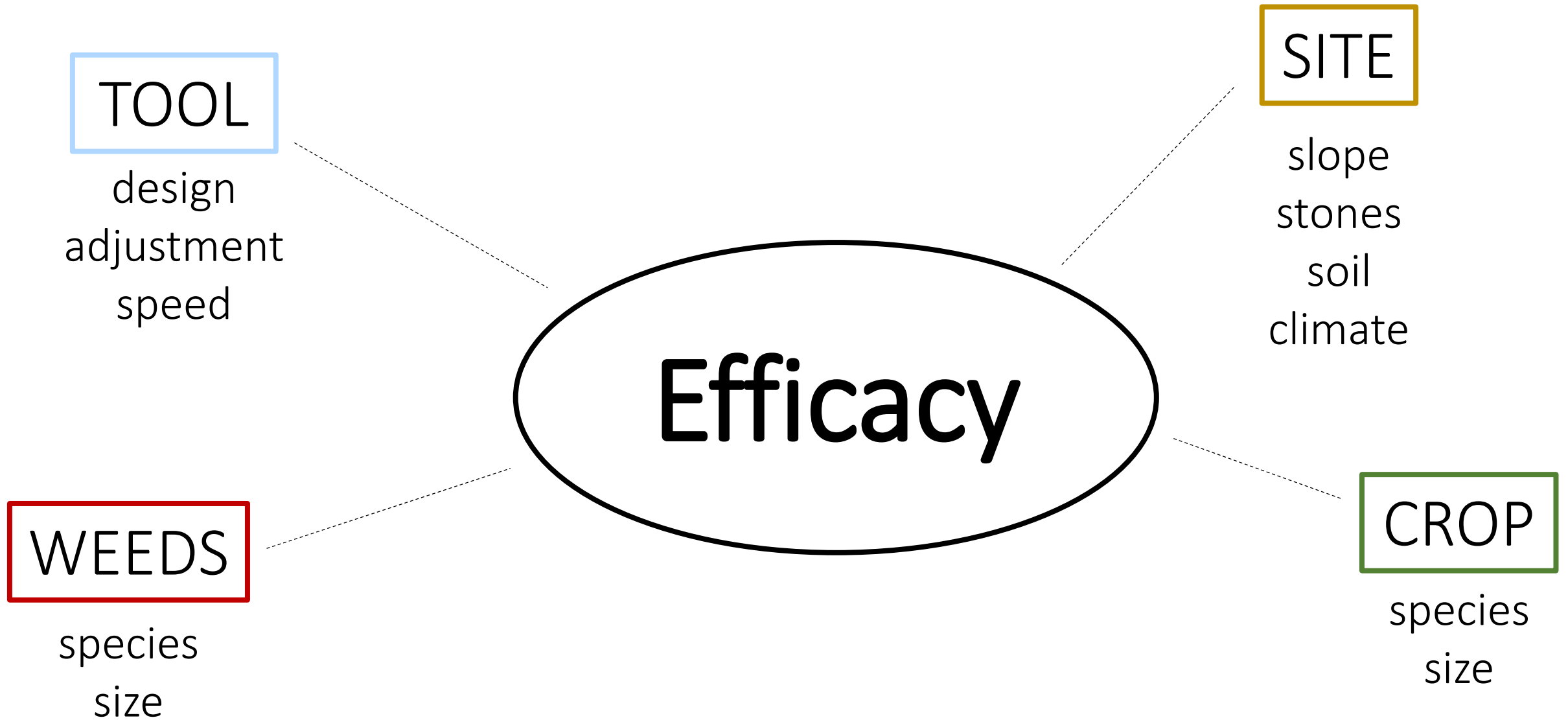
On-farm research

### Crop

Carrots

Beets

# Physical Weed Control





# Outline

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On-farm research

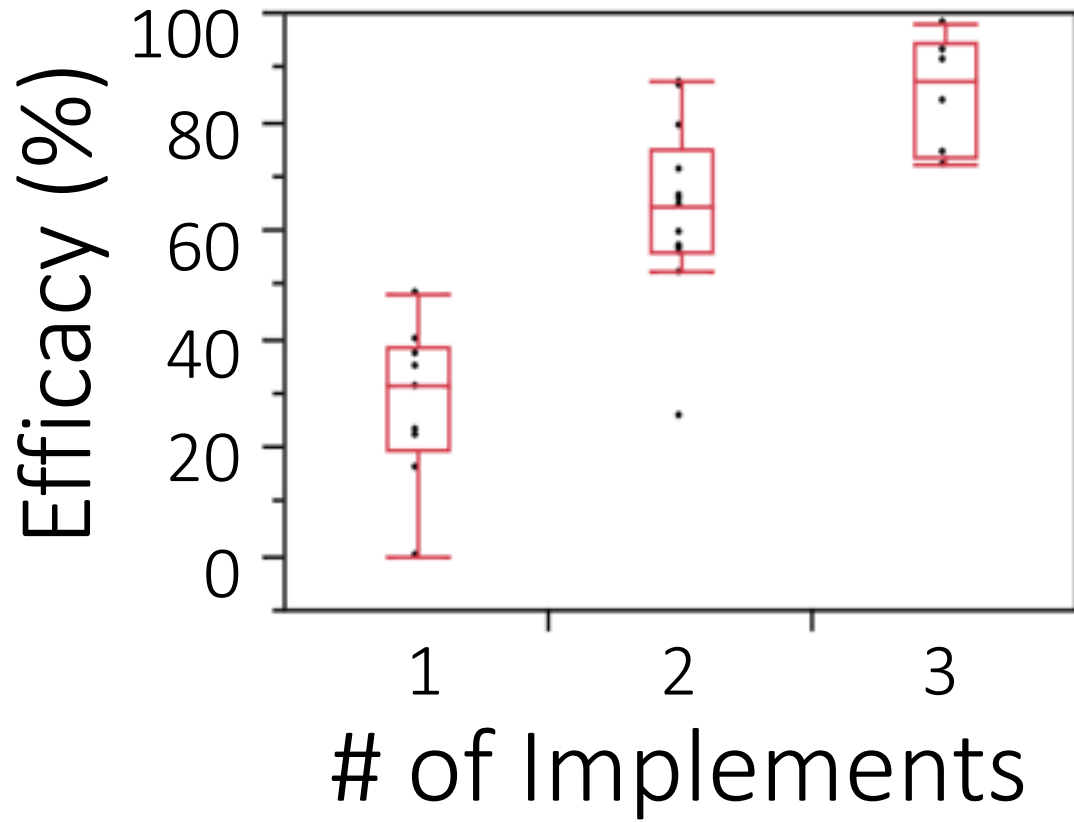
### Crop

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# Stacking Tools

TOOL



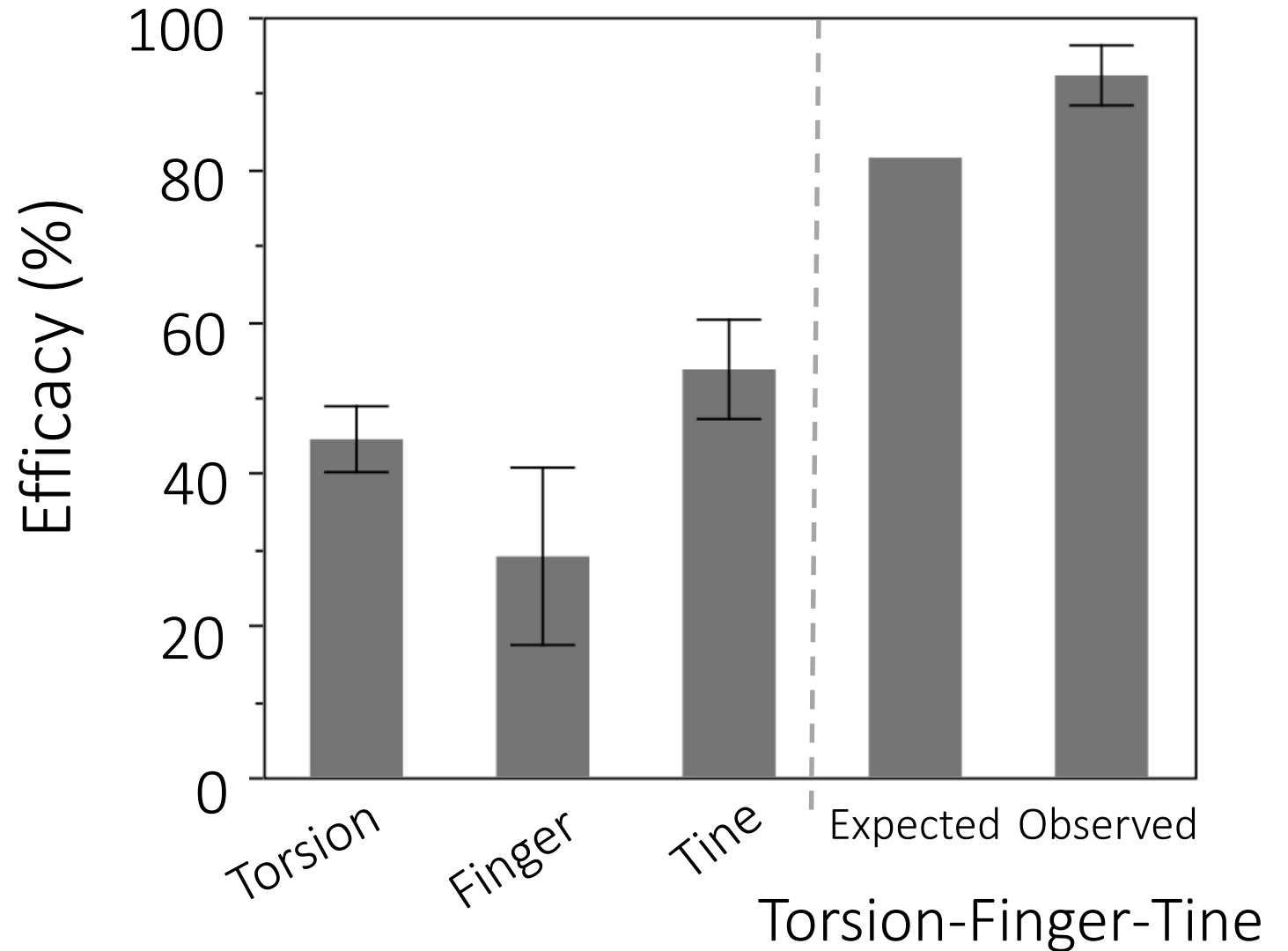
*Bryan  
Brown*

# Stacking Tools

TOOL

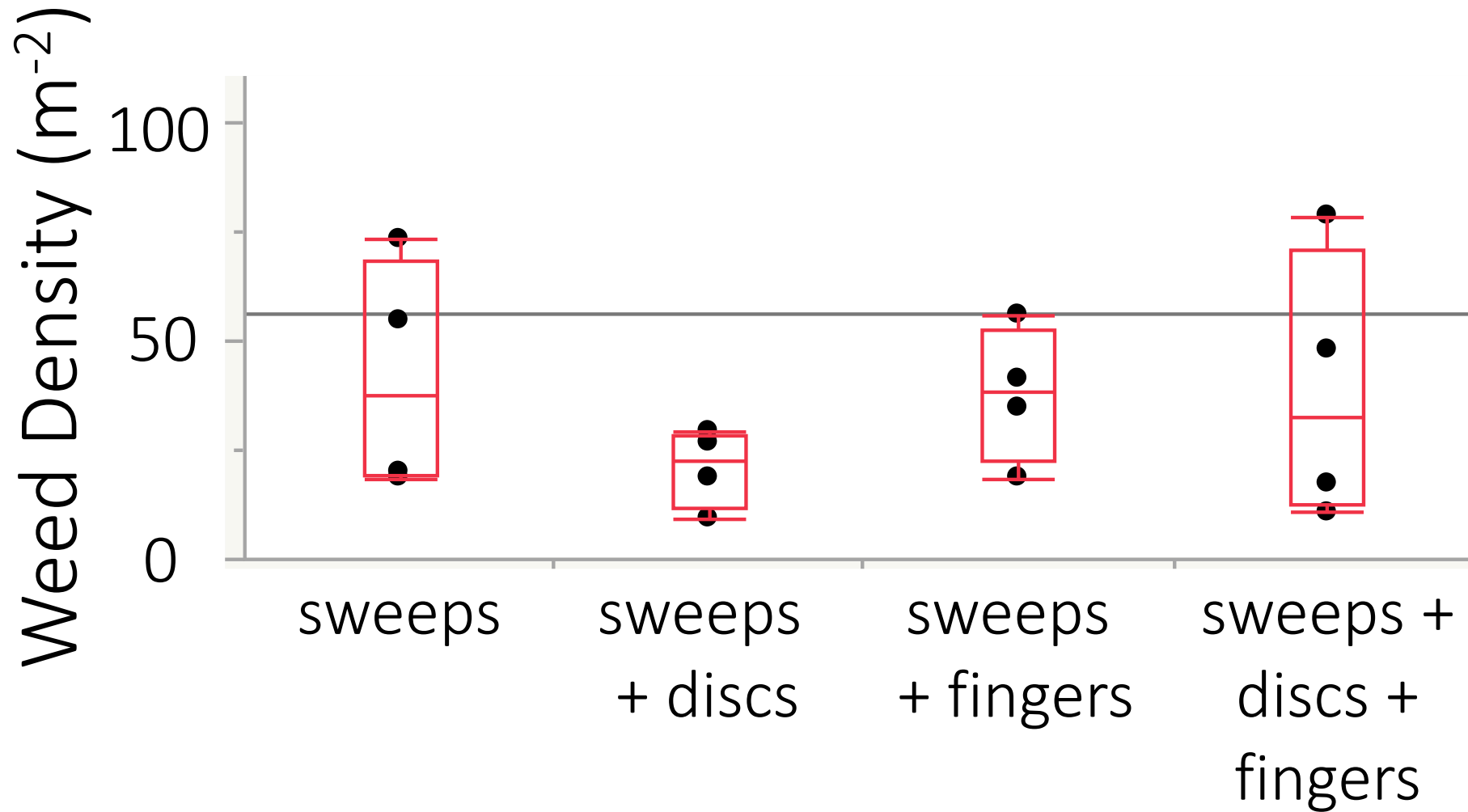
Evidence of synergy  
with 'stacked' intra-  
row cultivation tools

Bryan Brown & Eric Gallandt



# KULT Kress Duo Units

TOOL



Ruthie  
Sexton

# Terrateck® Double Wheel Hoe

TOOL

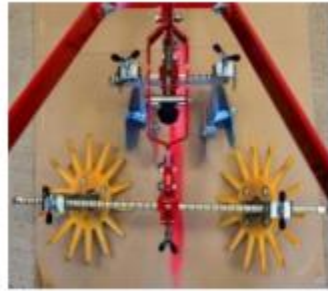


*Rebecca  
Champagne*

# Terrateck® Double Wheel Hoe

TOOL

2-TOOL  
STACKING



*Bio-Discs + Finger*



*Preci-Discs + Finger*



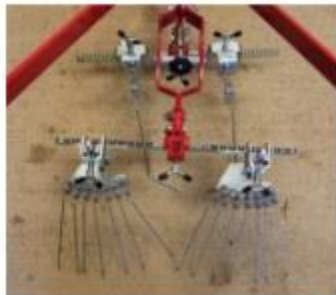
*L-Sweeps + Harrow*



*Finger + Torsion*



*L-Sweeps + Finger*



*Torsion + Harrow*



*L-Sweeps + Torsion*



*Harrow and Torsion*



*Preci-Discs + Harrow*



*Bio-Discs + Harrow*

3-TOOL  
STACKING



*Preci-Discs + Finger + Harrow*



*Preci-Discs + Harrow + Torsion*

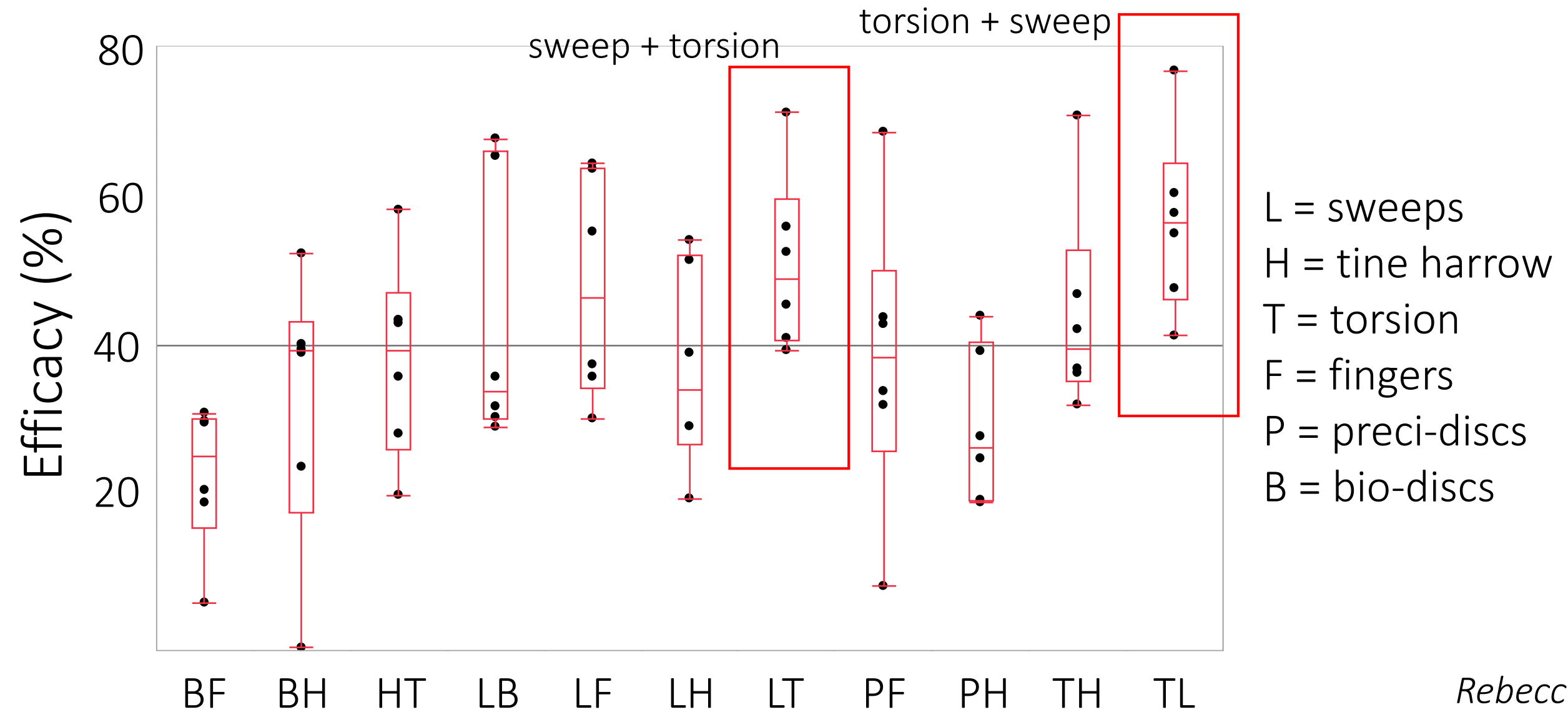


*L-Sweeps + Harrow + Torsion*

Rebecca  
Champagne

# Terrateck<sup>®</sup> Double Wheel Hoe

TOOL



Rebecca  
Champagne

# Terrateck® Double Wheel Hoe

TOOL

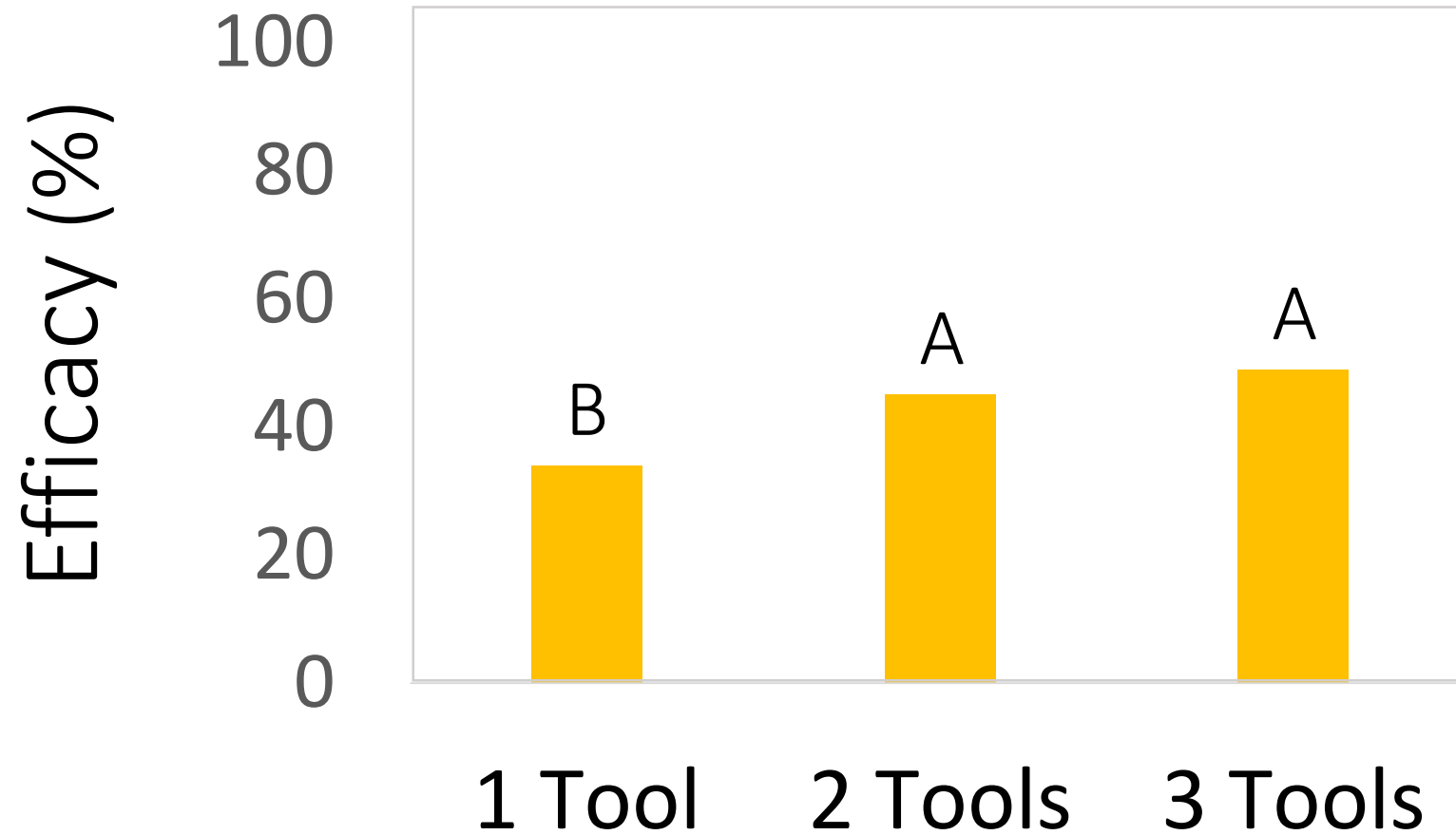


Rebecca  
Champagne



# Terrateck<sup>®</sup> Double Wheel Hoe

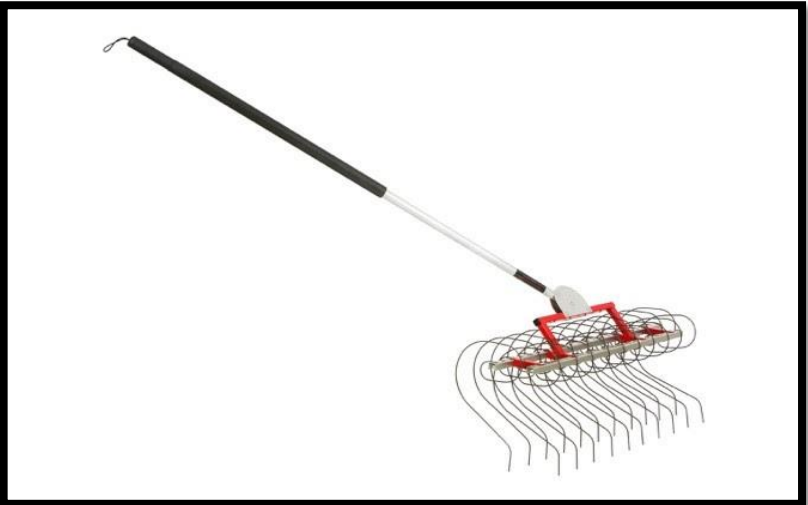
TOOL



*Rebecca  
Champagne*

# Tine Harrows

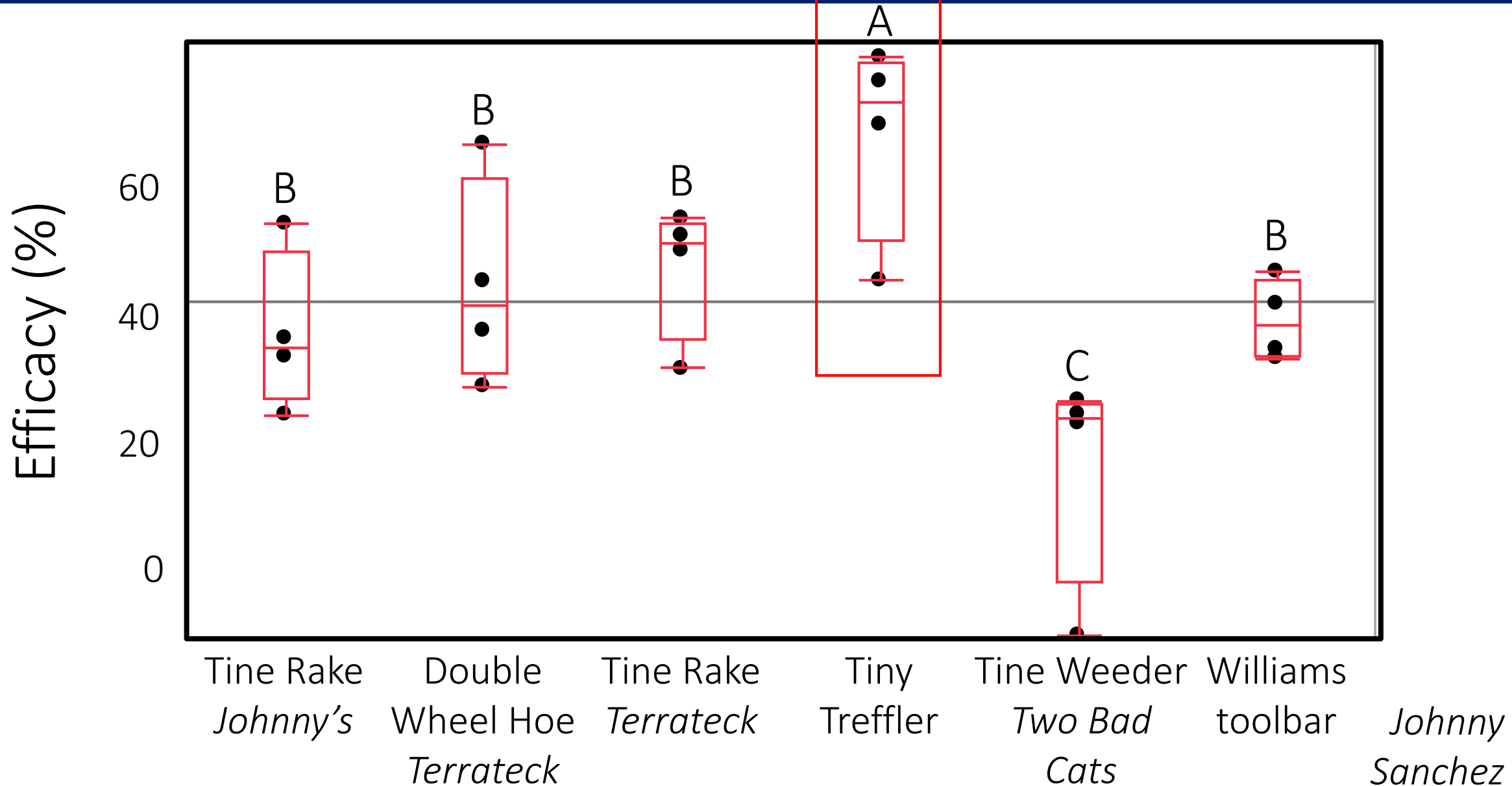
TOOL



Johnny Sanchez

# Tine Harrows

TOOL

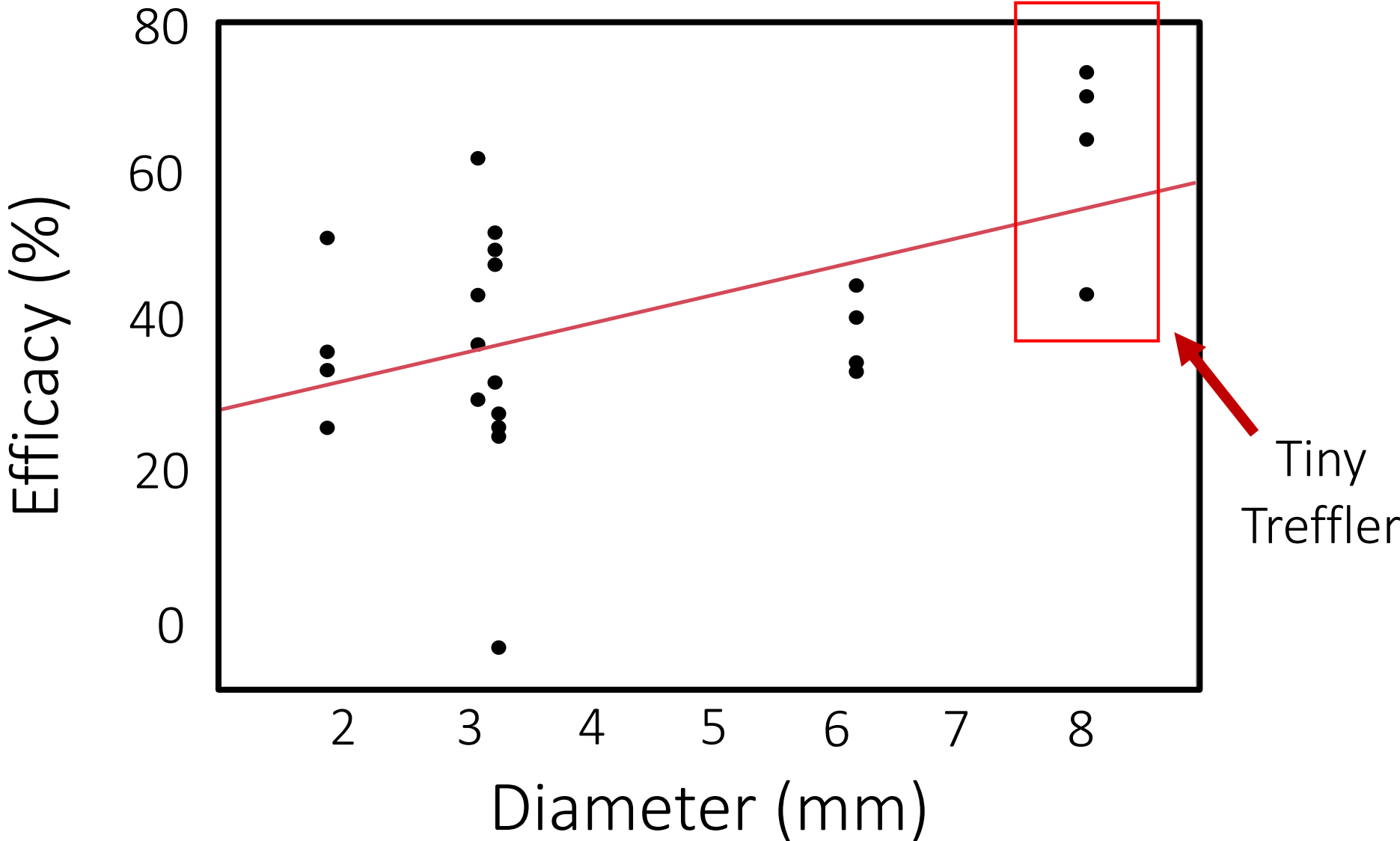


# Tine Harrows

TOOL

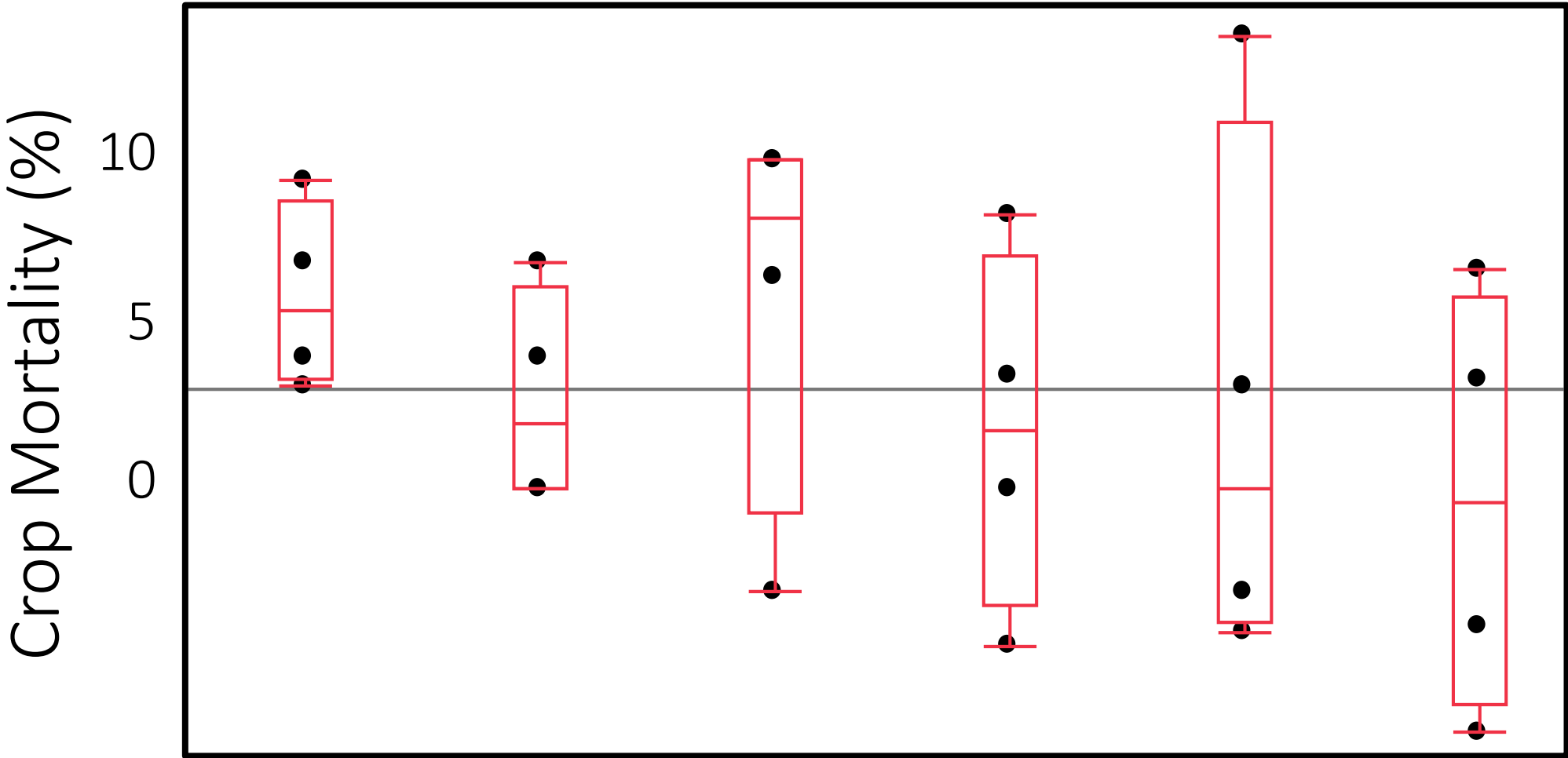
*Johnny  
Sanchez*

# Tine Harrows



# Tine Harrows

TOOL



Tine Rake  
*Johnny's*

Double  
Wheel Hoe  
*Terrateck*

Tine Rake  
*Terrateck*

Tiny  
Treffler

Tine Weeder  
*Two Bad  
Cats*

Williams  
toolbar

*Johnny  
Sanchez*



## Tertill™

### Bloomberg Businessweek

January 24, 2018, 9:00 AM EST

#### This \$300 Robot Can Weed Your Garden

- The pie-size Tertill is waterproof and solar-powered.

By Michael Belfiore



SOURCE: FRANKLIN ROBOTICS

# Robotic Weeders

TOOL



Johnny  
Sanchez



# Robotic Weeders

TOOL

## Agricultural Robot Competitors \$19,000 to \$250,000



BoniRob, Bosch



Oz, Naio



Hortibot, Aarhus University



Rippa, Sydney University



Anatis, Carre



Agtecher, EcoRobotix

*slide:  
Franklin Robotics*

# 2019 NE Mechanical Weed Control Expo



# Outline

## Physical weed control

### Tools

Stacking tools

KULT Kress Duo units

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Tine harrows

Robotic weeders



### Site

On-farm research

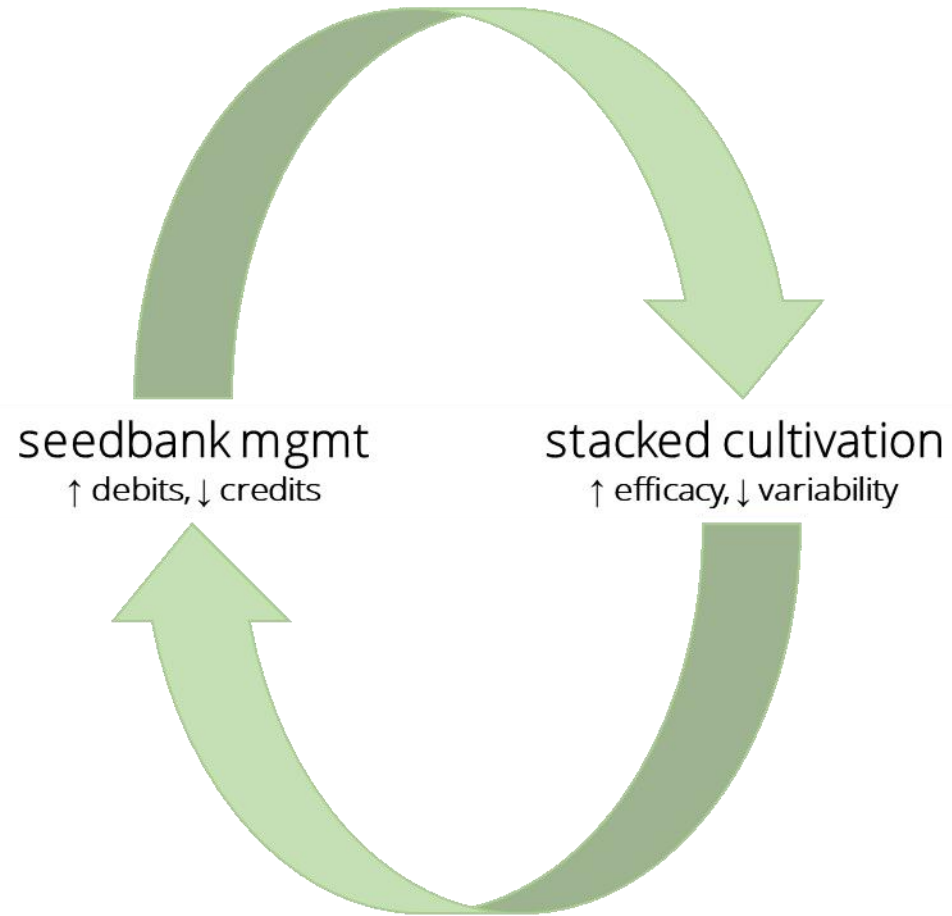
### Crop

Carrots

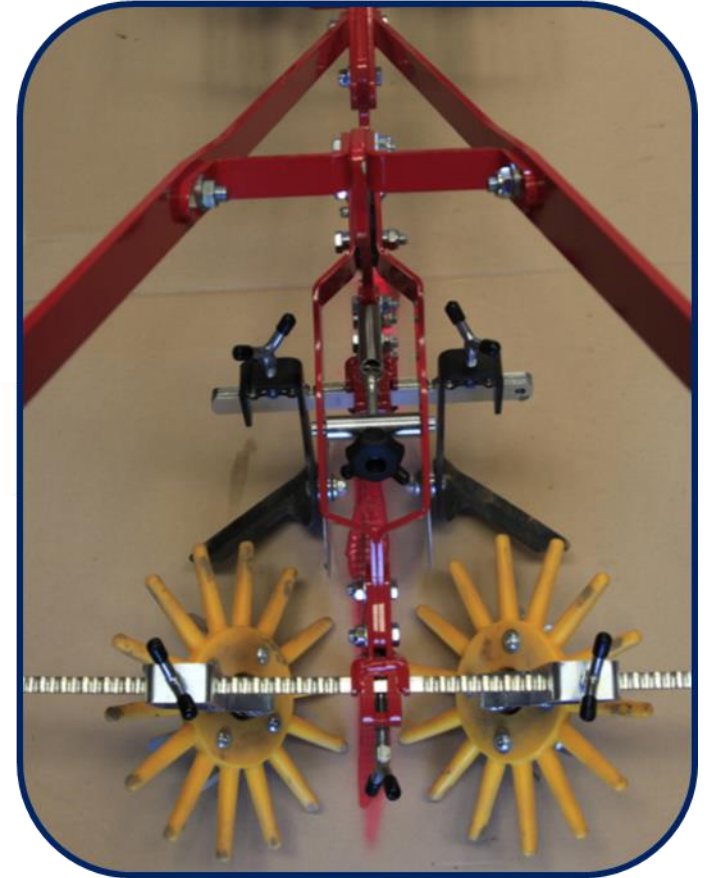
Beets

## a positive feedback loop

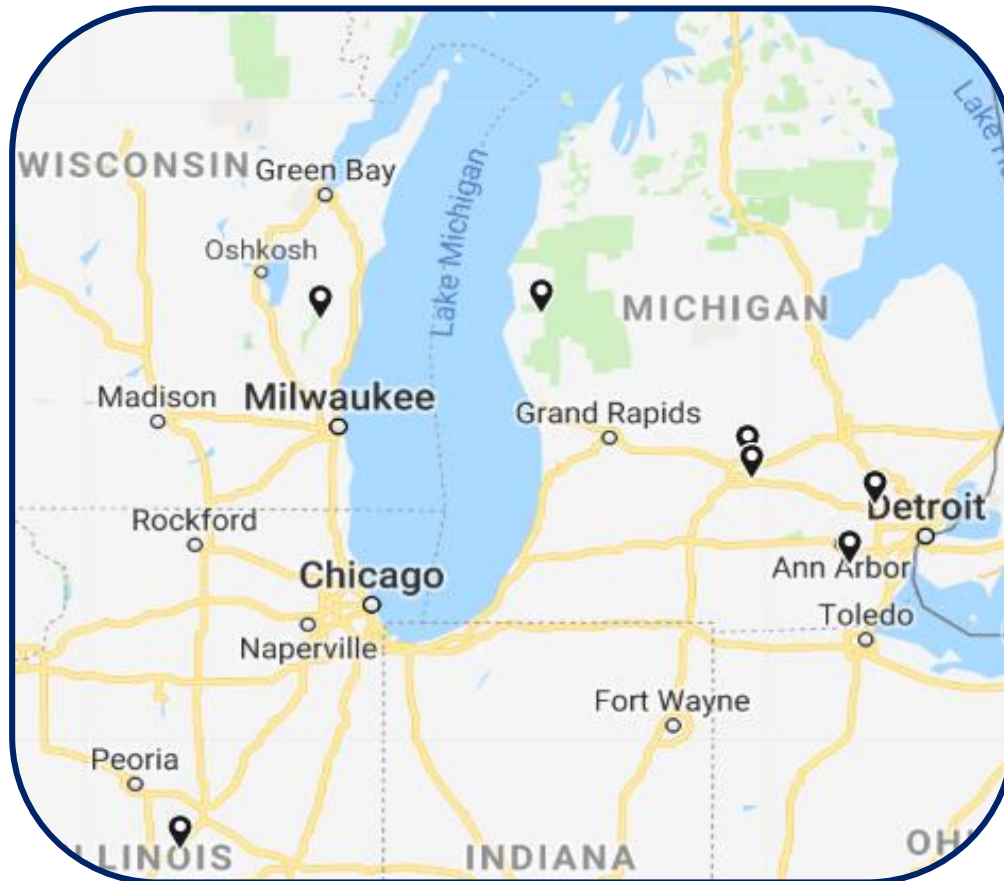
↓ seedbank = ↓ emergence



↓ survival = ↓ seed rain



## Midwest



## Northeast



































## Tools:

- Reference (**R**): tool normally used
- Stacked (**S**): implement with 2+ tools

## Weed Seedbank Mgmt:

- With (+): use of WSB mgmt strategy (tarping, flaming, stale seedbed...)
- Without (-): no WSB mgmt

## physical weed control

reference	stacked	reference	stacked
 	 	 	 
 	 	 	 
 	 	 	 
 	 	 	 
(+) WSB mgmt		(-) WSB mgmt	

## ecological management

































## Tools:

- Reference (**R**): tool normally used
- Stacked (**S**): implement with 2+ tools

## Weed Seedbank Mgmt:

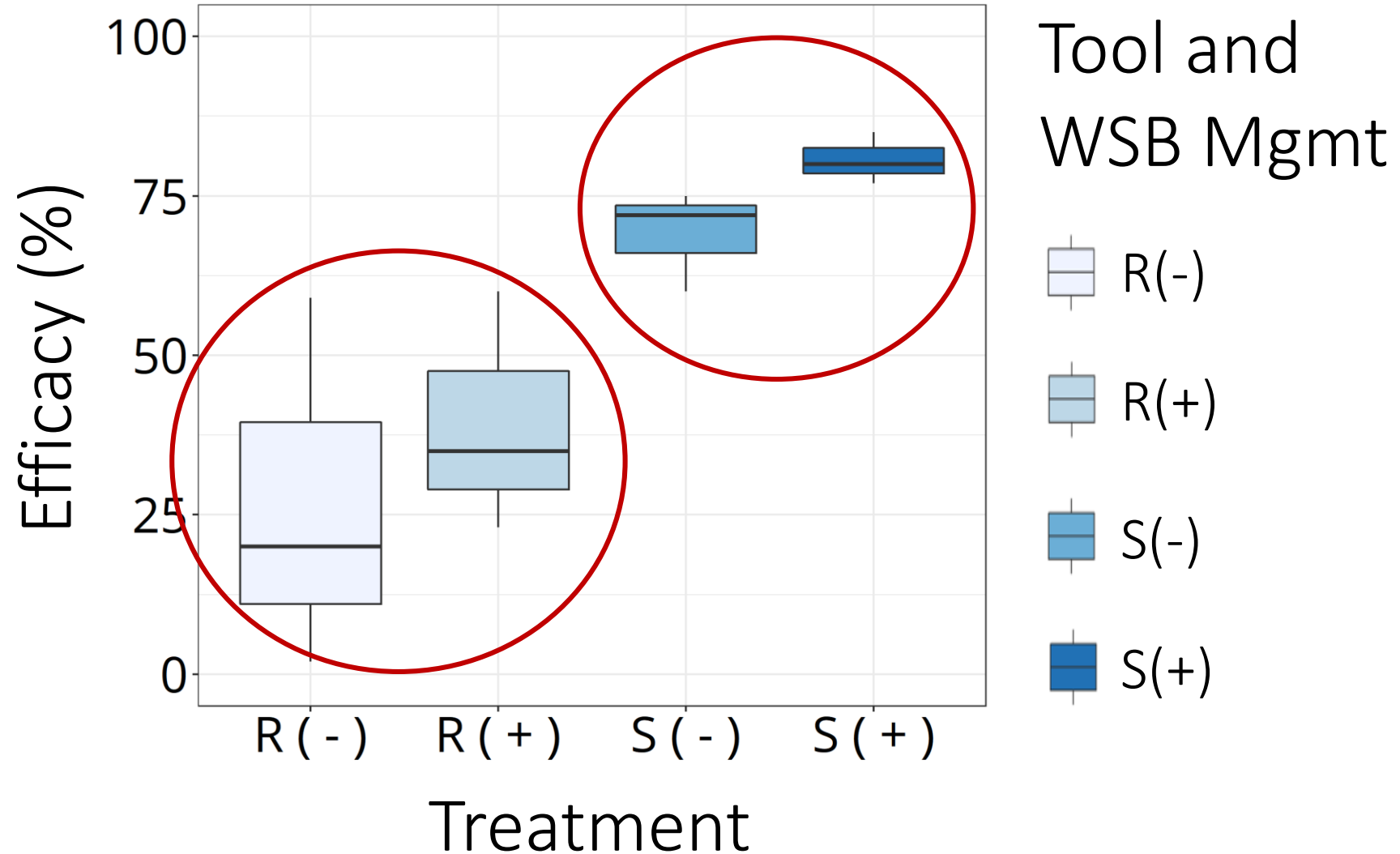
- With (+): use of WSB mgmt strategy (tarping, flaming, stale seedbed...)
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## physical weed control

reference	stacked	reference	stacked
 	 	 	 
 	 	 	 
 	 	 	 
 	 	 	 
(+) WSB mgmt		(-) WSB mgmt	

## ecological management

## Expected Results



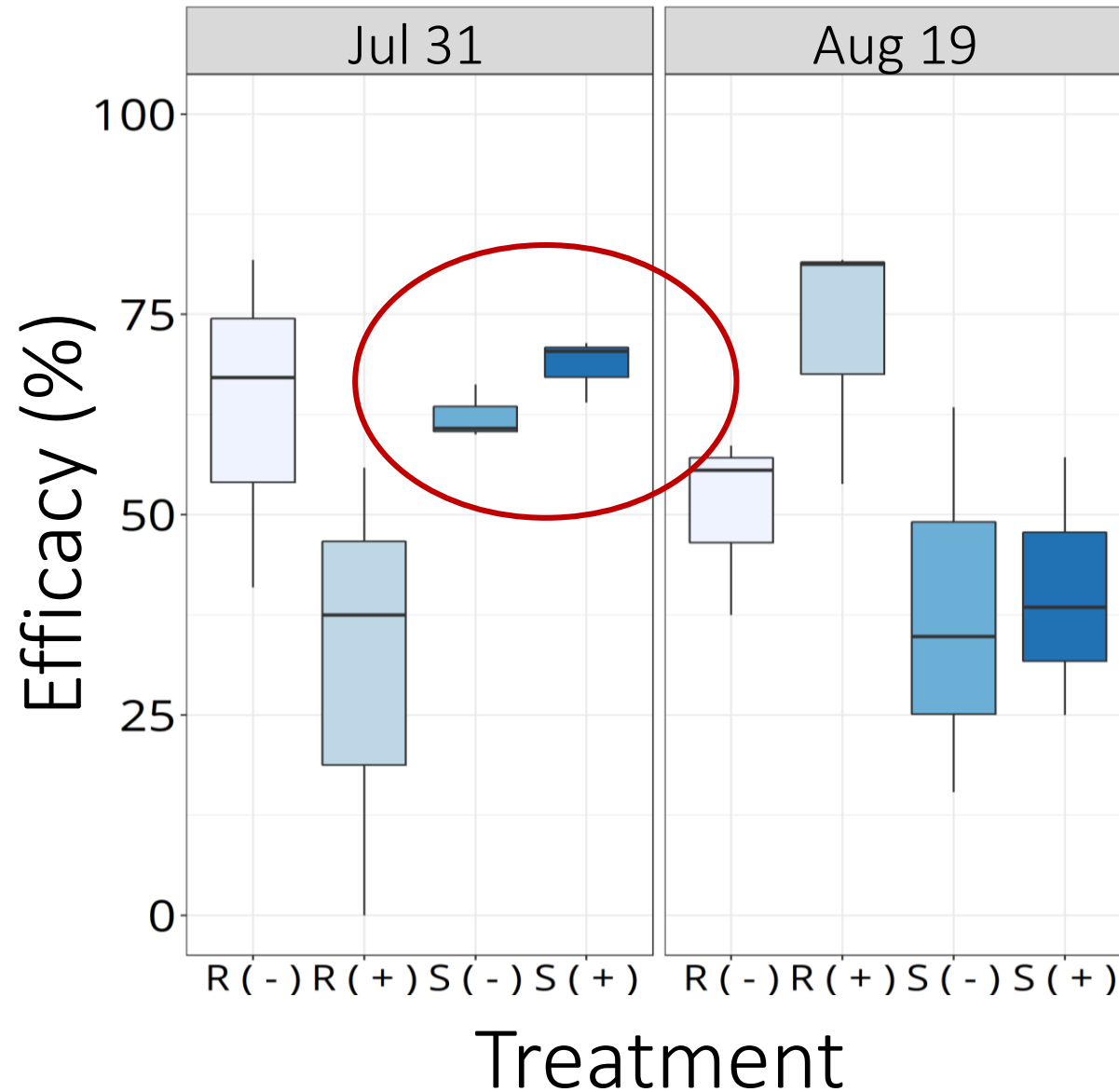


# On-Farm Research

SITE

reference	stacked	reference	stacked
hoe + hand weed, tarped	Terrateck double wheel hoe, tarped	hoe + hand weed	Terrateck double wheel hoe
(+) WSB mgmt		(-) WSB mgmt	

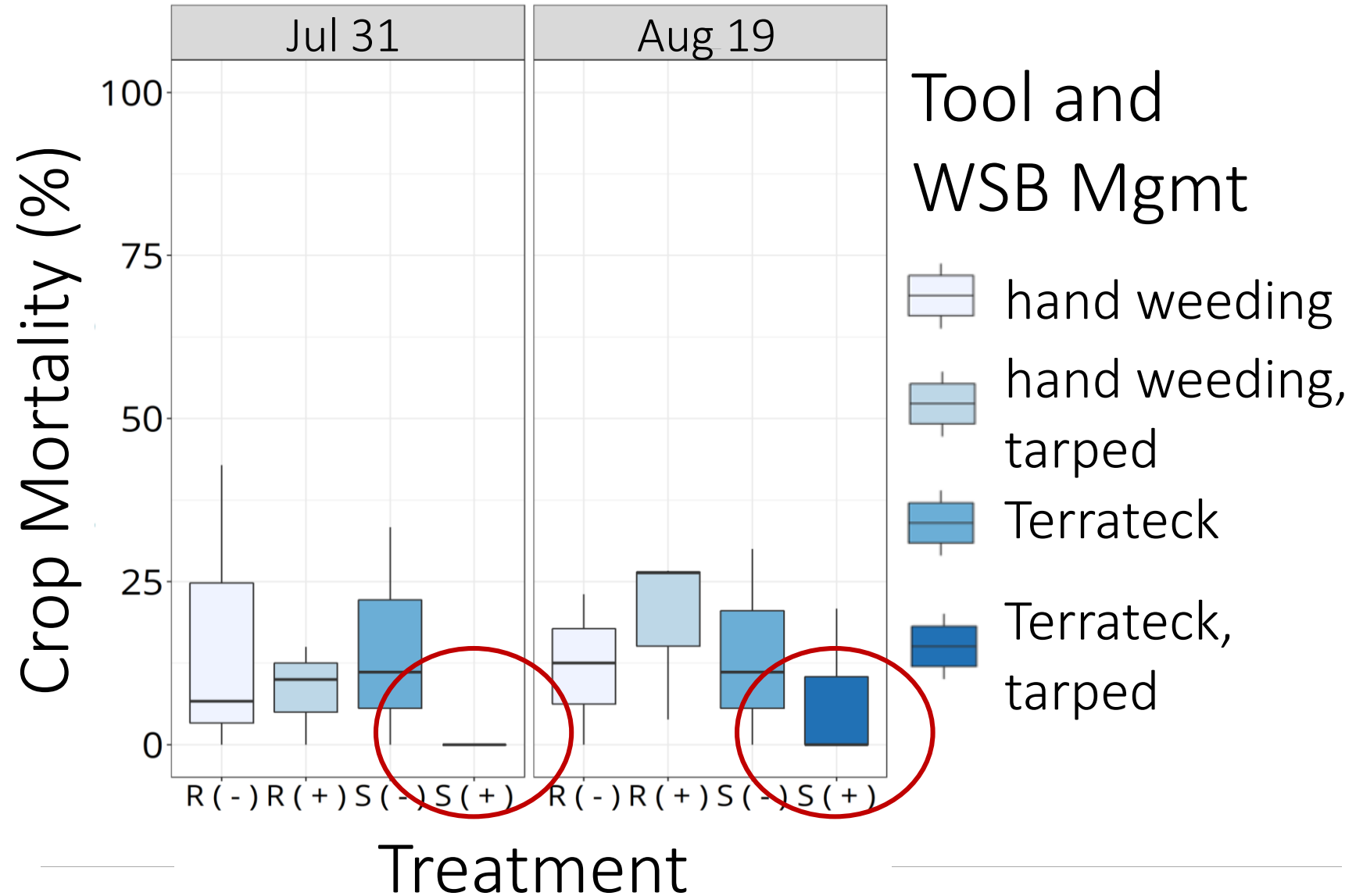
- Less variability with stacked tools at first cultivation
- Otherwise inconsistent



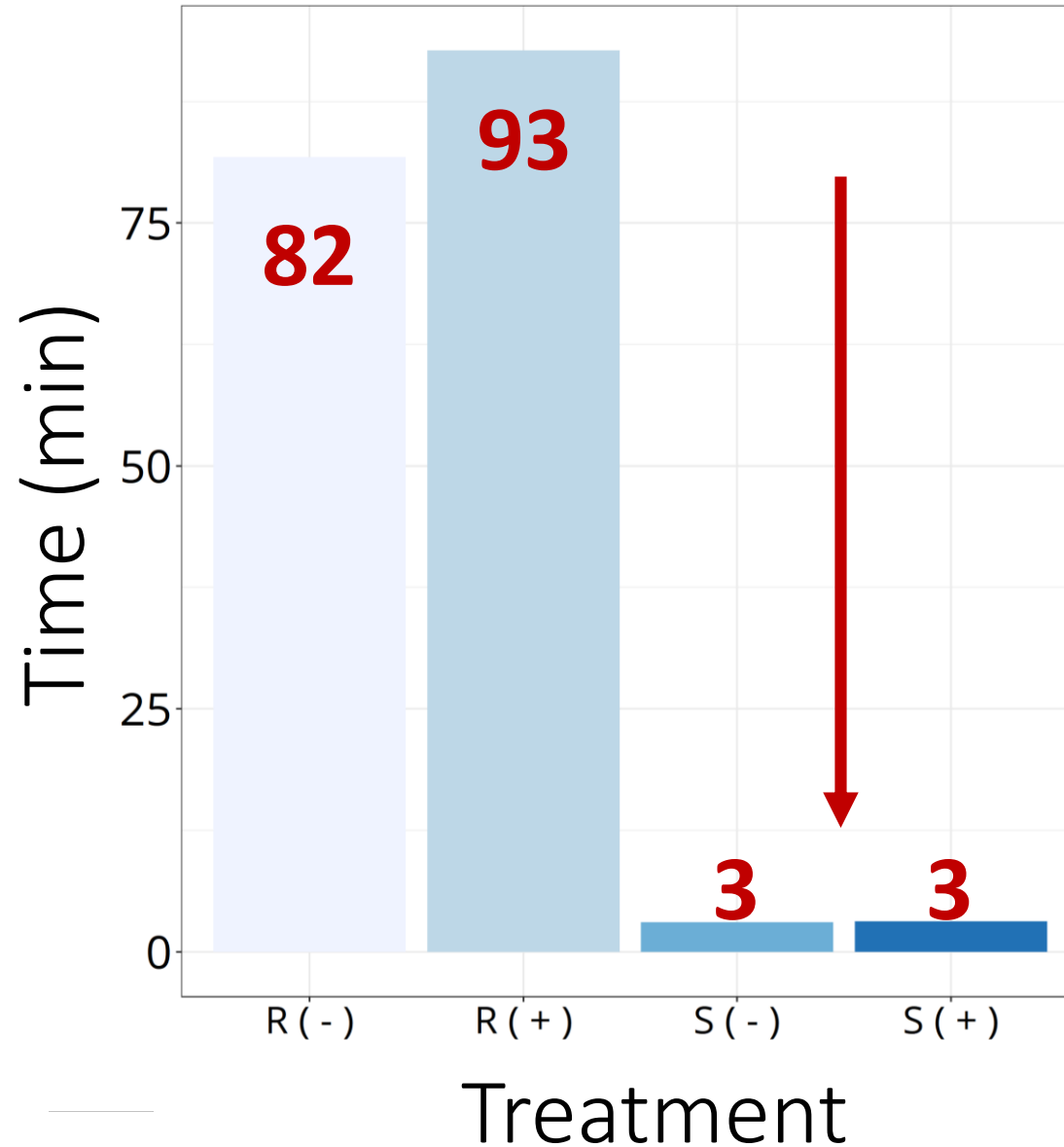
Tool and WSB Mgmt

- hand weeding
- hand weeding, tarped
- Terrateck
- Terrateck, tarped

Terrateck DWH  
may incur less  
crop mortality



Major reduction  
in weeding time  
when using  
Terrateck DWH



Tool and  
WSB Mgmt

- hand weeding
- hand weeding, tarped
- Terrateck
- Terrateck, tarped



## Organic Weed Management

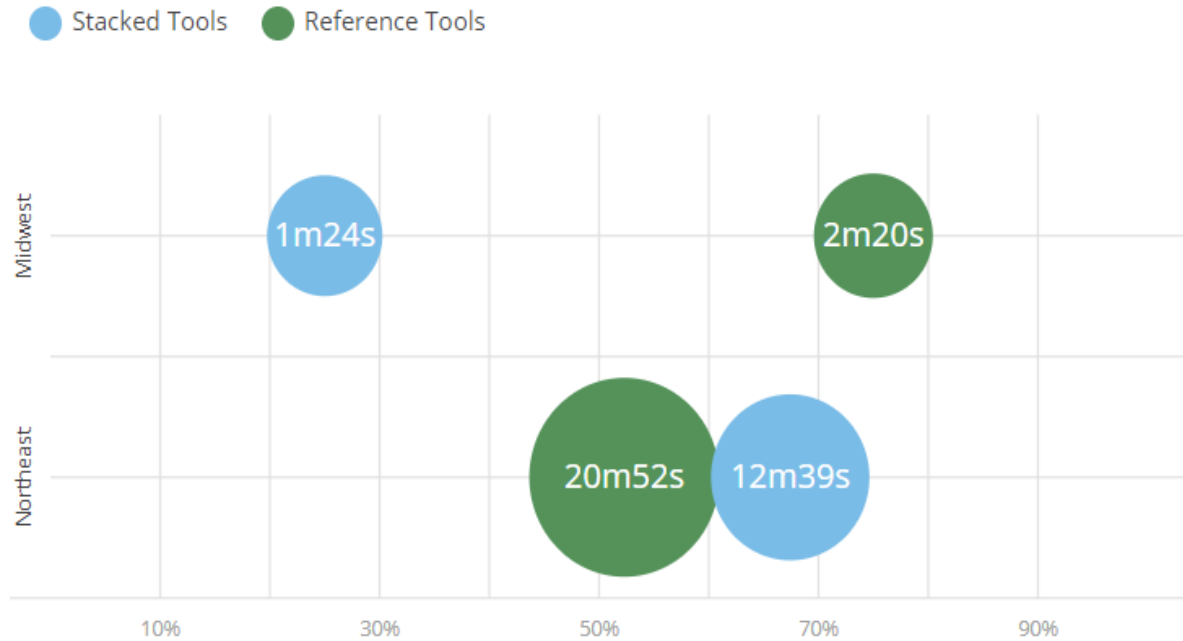
A collaborative project of the University of Maine and Michigan State University featuring advanced physical and ecological weed management practices to serve farmers in Northern New England and the Midwest.

[How to fight weeds?](#)

[weedmanagement.umaine.edu](http://weedmanagement.umaine.edu)

## Real-Time Data

Weed vs Crop Mortality ?



Cultivation Time

### Tool

Hand Tool

Walk Behind Tractor

Tractor Mounted

### Crops



Small-seeded



Large-seeded



Transplanted

### Weed seedbank ?

Not managed

Managed

Both

Weeds Grass



# Outline

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Tine harrows

Robotic weeders

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On-farm research



### Crop

Carrots

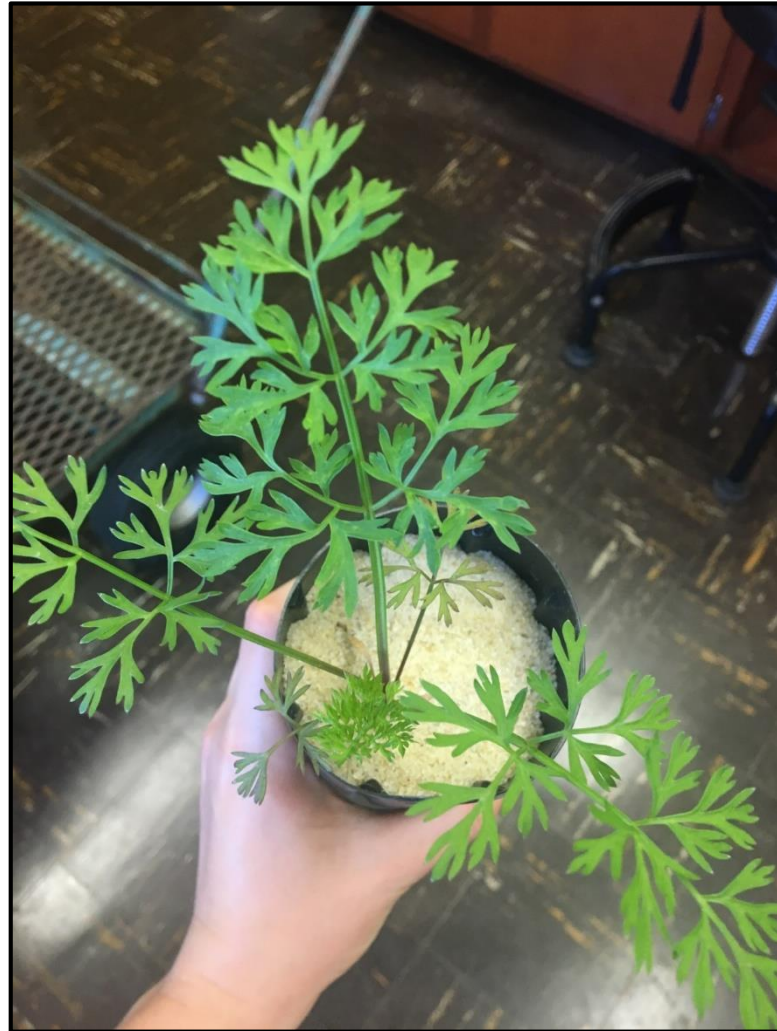
Beets

# Carrots

CROP

## Cultivars:

Dragon  
Danvers  
Bolero  
Napoli  
Mokum  
Cupar  
Negovia

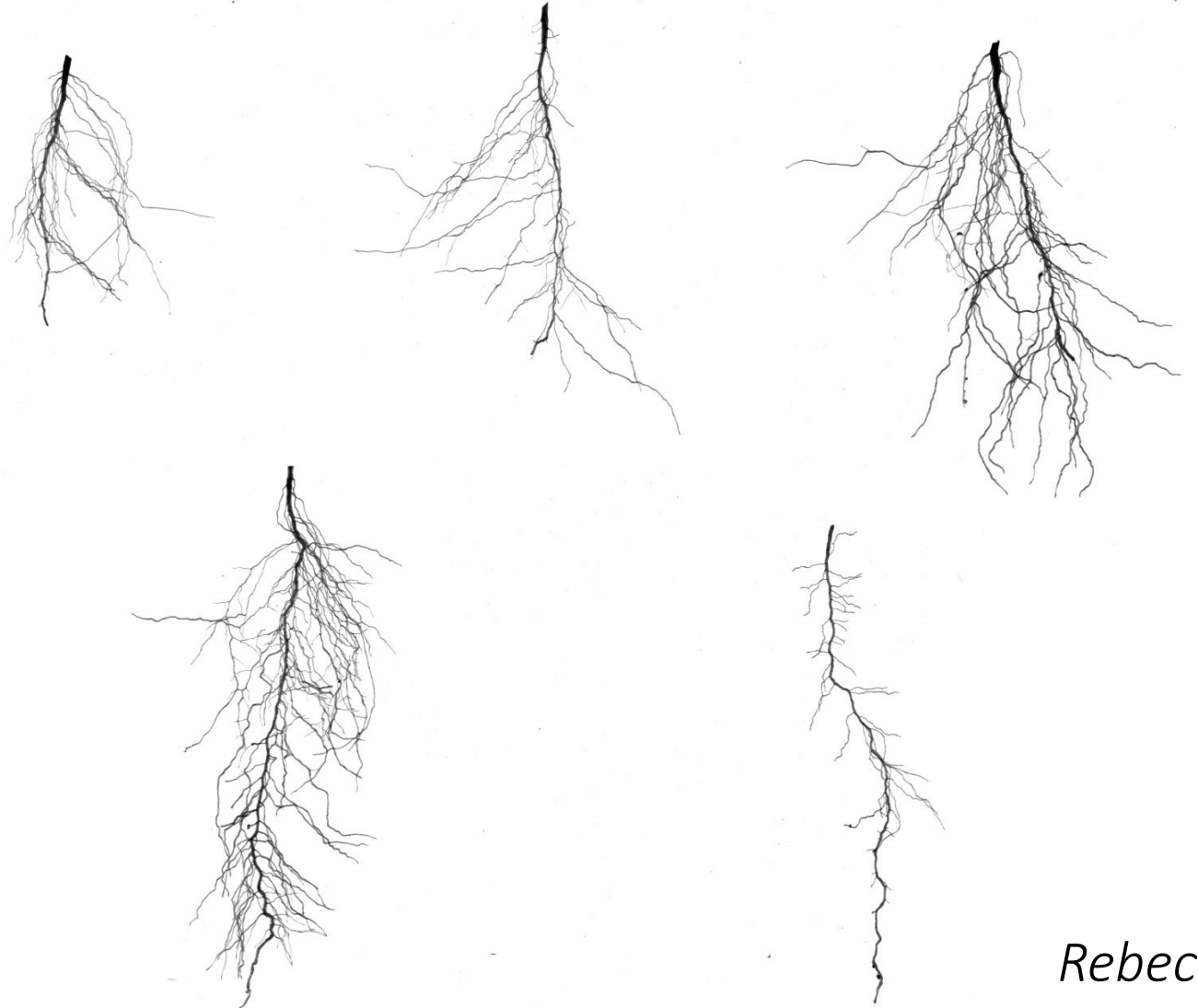


*Rebecca  
Champagne*



# Carrots

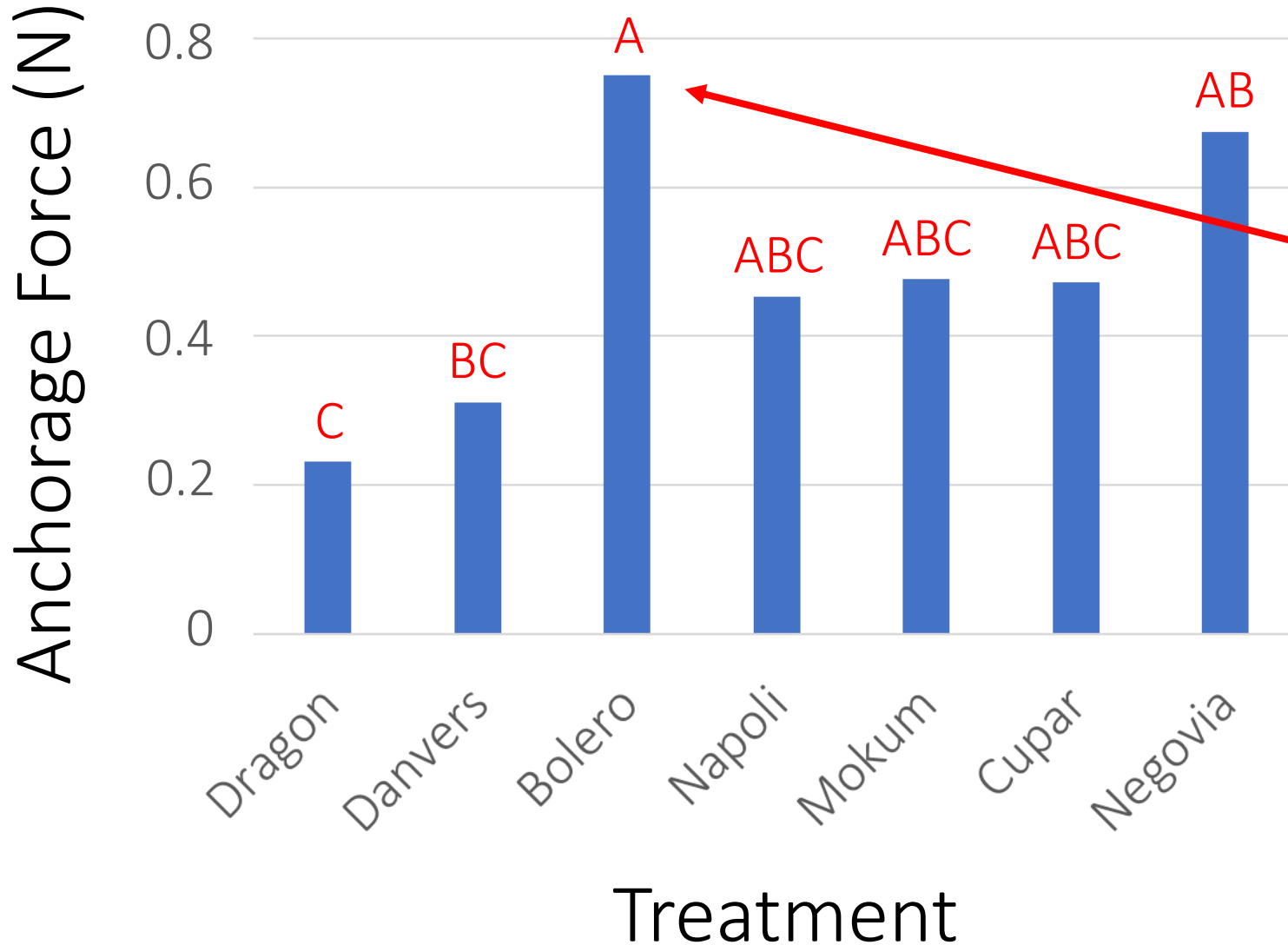
CROP



*Rebecca  
Champagne*

# Carrots

CROP



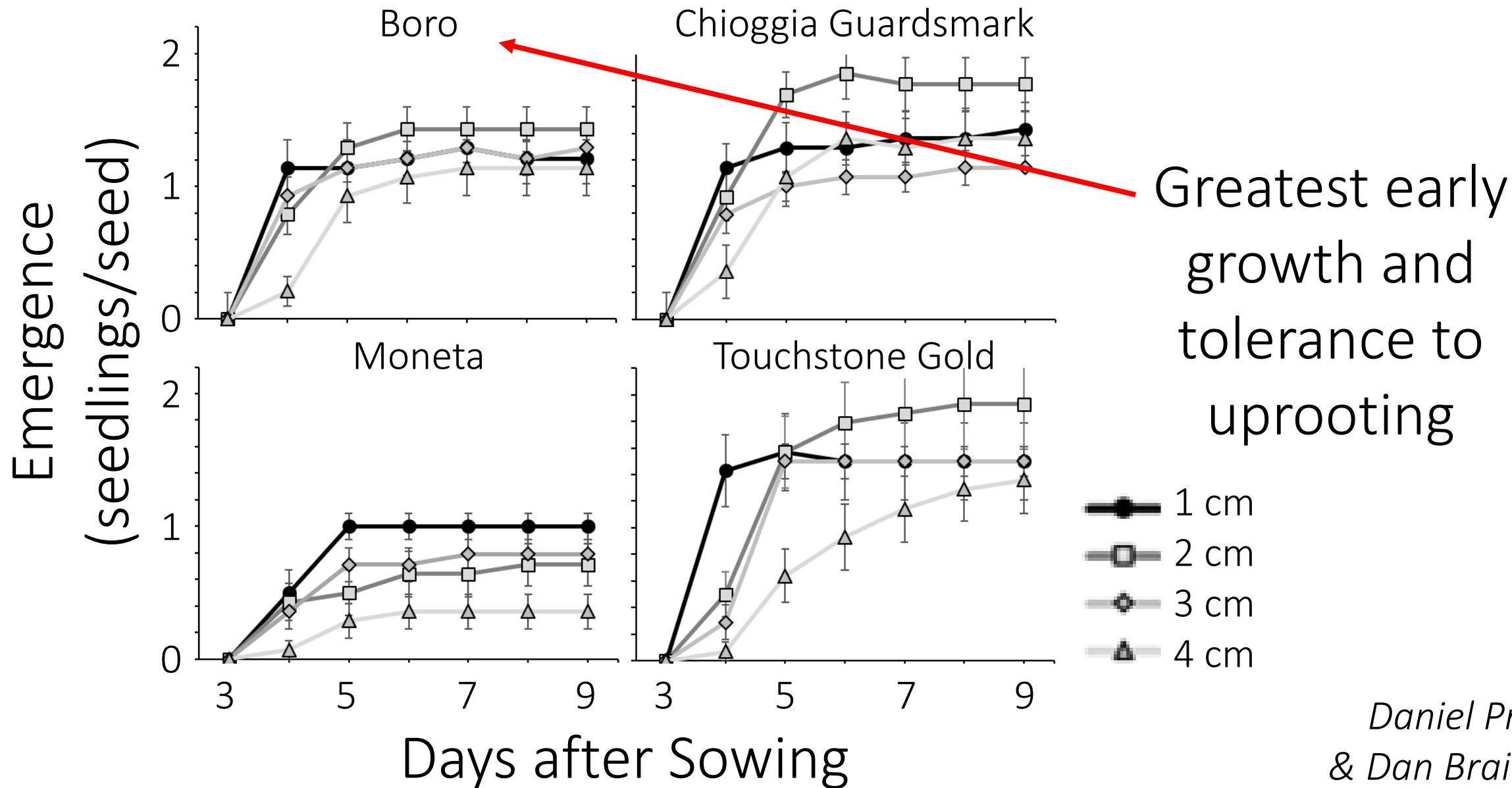
At 4 true leaves,  
Bolero required  
more force to  
uproot than Danvers  
and Dragon



'Boro' and 'Touchstone Gold' cultivars two weeks after planting

# Beets

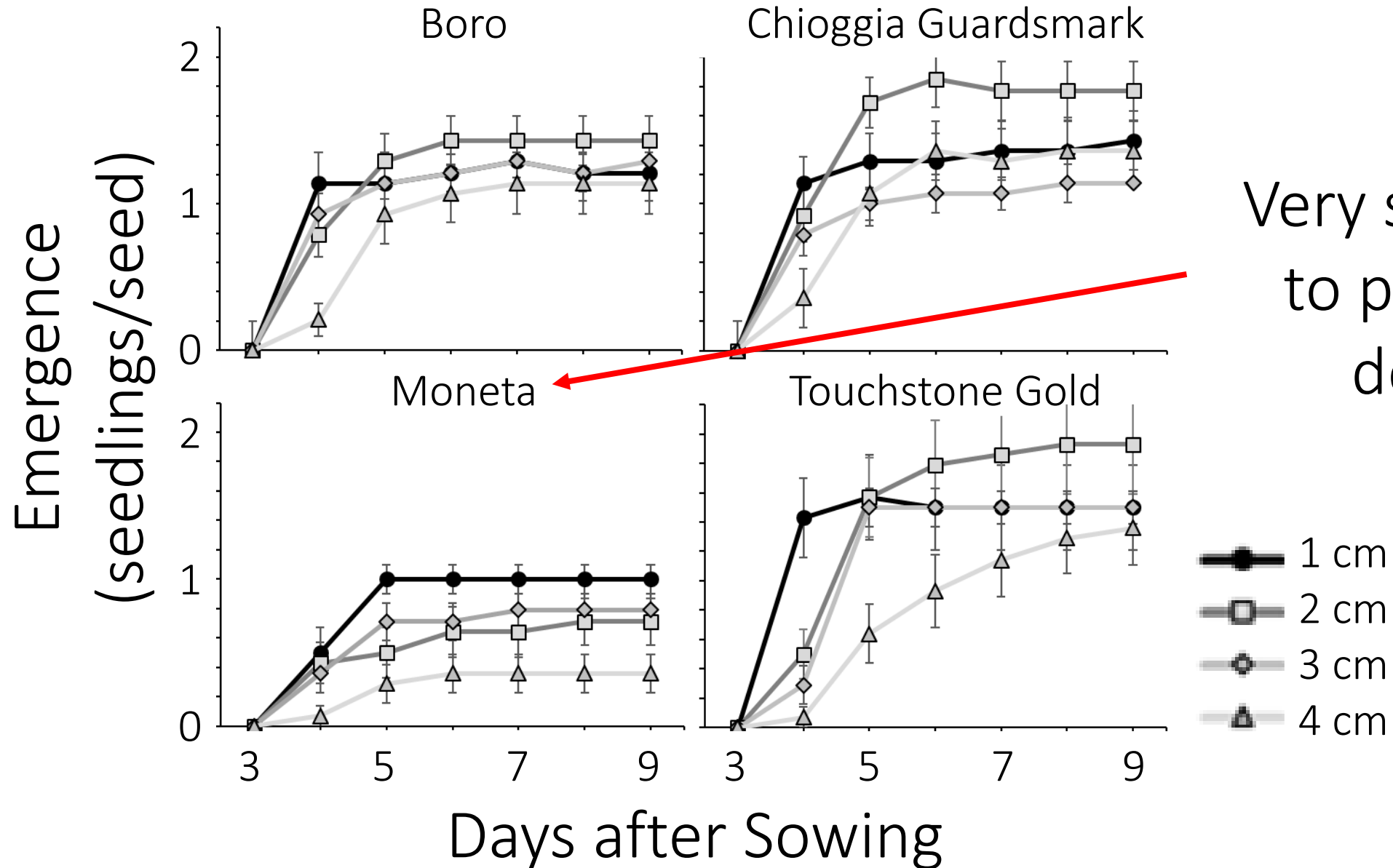
CROP



Daniel Priddy  
& Dan Brainard

# Beets

CROP

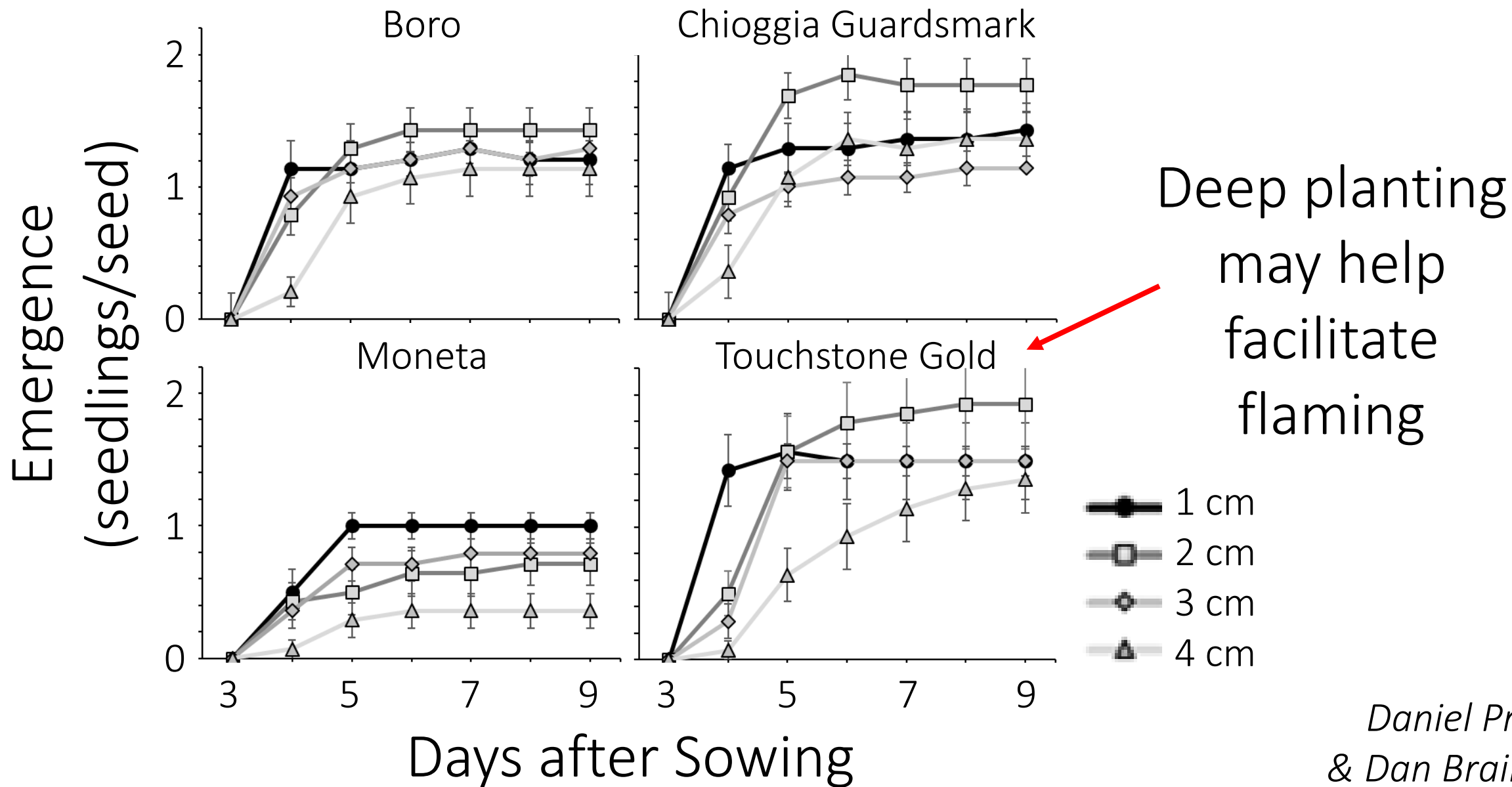


Very sensitive to planting depth

Daniel Priddy  
& Dan Brainard

# Beets

CROP



Daniel Priddy  
& Dan Brainard

# Funding

## Integrating Advanced Cultural and Mechanical Strategies for Improved Weed Management in Organic Vegetables

funded by USDA-NIFA Organic Agriculture Research & Extension Initiative program for 2018-2022

Eric Gallandt (UMaine) and Dan Brainard (MSU)



# Check us out online! Questions?



[umaine.edu/weedecology](http://umaine.edu/weedecology)



[zeroseedrain](https://www.youtube.com/channel/UCz0seedrains)



[weedmanagement.umaine.edu](http://weedmanagement.umaine.edu)



[UMaineWeedEcology](https://www.instagram.com/UMaineWeedEcology)



[peyton.ginakes@maine.edu](mailto:peyton.ginakes@maine.edu)