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Crop Wars: The Pigweed Strikes Back

USDA Agricultural Research Service

TakeACTION Herbicide-Resistance Management

ARKANSAS RICE CHECK-OFF

ARKANSAS SOYBEAN PROMOTION BOARD

USDA National Institute of Food and Agriculture
U.S. DEPARTMENT OF AGRICULTURE

AR WEED SCIENCE

2021 Indiana CCA Conference

Indianapolis, IN

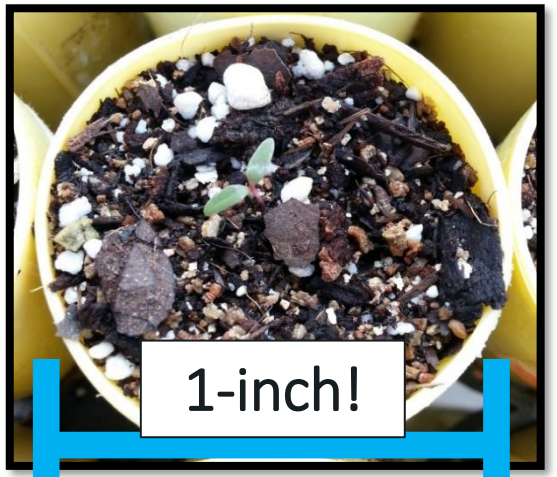
Dr. Thomas R. Butts

14 Dec. 2021

Pigweeds (*Amaranthus spp.*)

- Summer annuals
- Small seeded (black and shiny)
- Oval-diamond shaped, alternate leaves
- Mainly erect-bushy plants
- Dense inflorescences

What's the Big Deal with Pigweeds?



Prolific Growth Characteristics!

Horak and Loughlin (2000). Weed Sci 48:347–355; Sellers et al. (2003). Weed Sci 51:329–333.

Tricky Germination Timings

- Palmer amaranth and waterhemp emerge later than a lot of other weeds…
- They like temperatures to be at least 75°F during the day
  - In the Midwest, this is around the beginning to mid June
  - In the South, this is beginning to mid May
  - Control can be challenging as it is likely after the crop is planted

Will germinate throughout entire growing season as long as temperatures persist

When did these germinate?

Pigweed Herbicide Resistance (U.S.)

- **Palmer amaranth and waterhemp have been confirmed resistant to:**
  - ALS Inhibitors – Group 2 (Raptor, Pursuit, Scepter)
  - Photosystem II Inhibitors – Group 5,6,7 (Atrazine, metribuzin)
  - Microtubule Inhibitors – Group 3 (Prowl, Treflan)
  - EPSPS Inhibitors – Group 9 (glyphosate)
  - HPPD Inhibitors – Group 27 (Laudis, Callisto)
  - PPO Inhibitors – Group 14 (Flexstar, Ultra Blazer, Valor)
  - VLCFA Inhibitors – Group 15 (Dual Magnum, Zidua, Warrant, Outlook)
  - Synthetic Auxins – Group 4 (2,4-D, dicamba)
  - Glutamine Synthetase Inhibitor – Group 10 (Liberty)
- **Multiple resistance also identified:**
  - Arkansas and Kansas have identified 5-way resistant Palmer
  - Iowa, Nebraska, and Illinois have 4-, 4-, and 5-way resistant waterhemp, respectively

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Pigweed Herbicide Resistance (Neighbors)

- Indiana (waterhemp):
  - ALS Inhibitors (Raptor, Pursuit, Scepter)
  - EPSPS Inhibitors (glyphosate)
  - PPO Inhibitors (Flexstar, Ultra Blazer, Valor)
- Illinois (waterhemp):
  - ALS Inhibitors (Raptor, Pursuit, Scepter)
  - EPSPS Inhibitors (glyphosate)
  - PPO Inhibitors (Flexstar, Ultra Blazer, Valor)
  - PSII Inhibitors (atrazine)
  - HPPD Inhibitors (Laudis, Callisto)
  - Synthetic Auxin (2,4-D, dicamba)
  - VLCFA Inhibitors (Dual Magnum, Outlook, Warrant, Zidua)
- Ohio (waterhemp):
  - ALS Inhibitors (Raptor, Pursuit, Scepter)
  - EPSPS Inhibitors (glyphosate)
- Michigan (waterhemp):
  - ALS Inhibitors (Raptor, Pursuit, Scepter)
- Kentucky (waterhemp):
  - EPSPS Inhibitors (glyphosate)
- Indiana, Kentucky, Michigan, & Ohio (Palmer amaranth):
  - EPSPS Inhibitors (glyphosate)
- Illinois (Palmer amaranth):
  - EPSPS Inhibitors (glyphosate)
  - ALS Inhibitors (Raptor, Pursuit, Scepter)
  - PPO Inhibitors (Flexstar, Ultra Blazer, Valor)

Palmer amaranth Herbicide Resistance in Arkansas

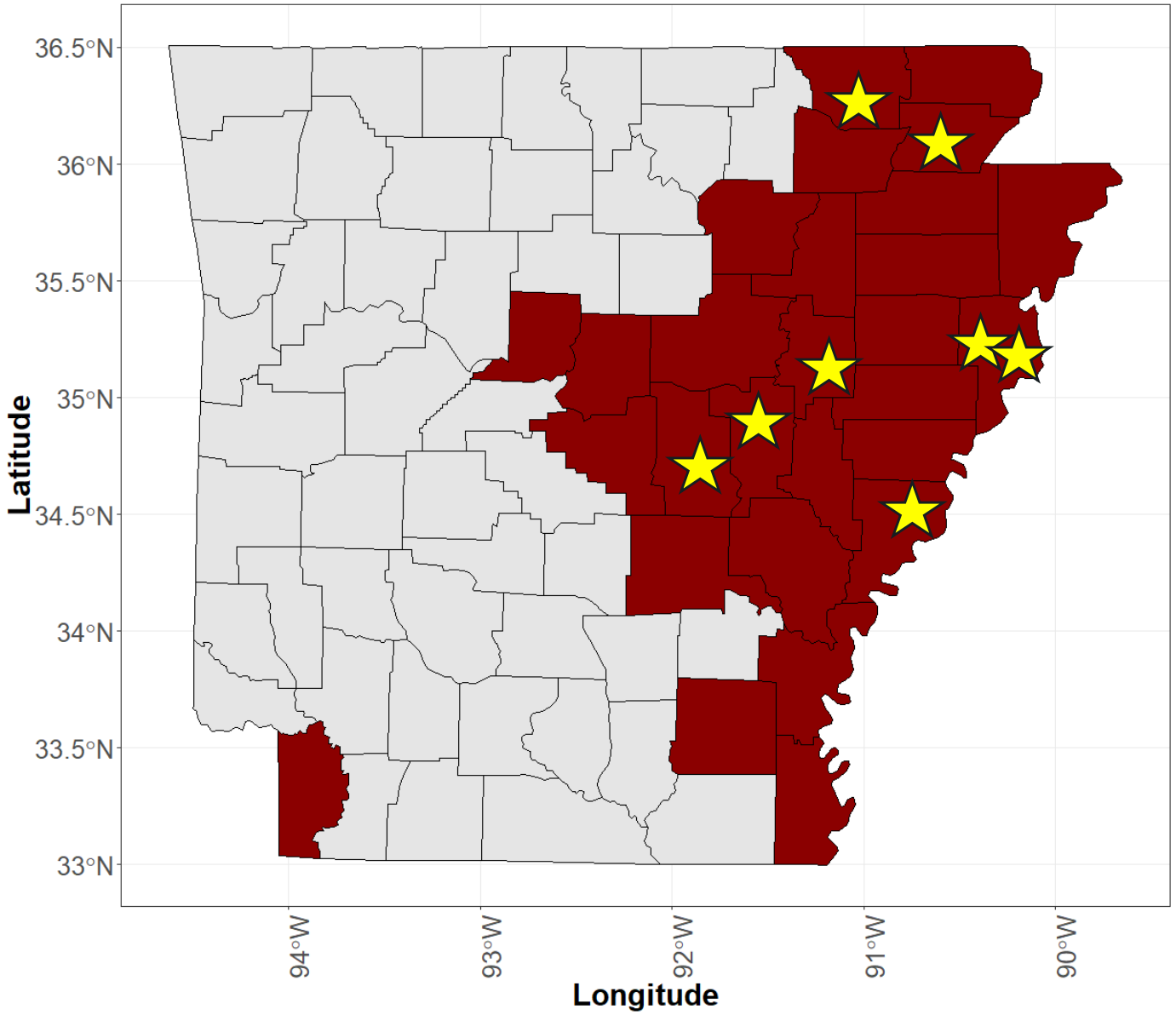
Palmer amaranth has been confirmed resistant to 7 sites-of-action in AR:

- EPSPS Inhibitors – Group 9 (glyphosate)
- Dinitroanilines – Group 3 (Prowl, Treflan)
- ALS-Inhibitors – Group 2 (Raptor, Pursuit)
- HPPD-Inhibitors – Group 27 (Laudis, Callisto)
- PPO-Inhibitors – Group 14 (Flexstar, Ultra Blazer, Valor)
- VLCFA-Inhibitors – Group 15 (Dual Magnum, Warrant)
- Glutamine Synthetase Inhibitor – Group 10 (Liberty)
- Synthetic Auxins – Group 4 (2,4-D, Dicamba) *Next on the list?*

Considered to be isolated areas at this time, not widespread.

These three resistances are typically assumed to be in 100% of the Palmer amaranth populations in the state.

Palmer amaranth Herbicide Resistance in Arkansas

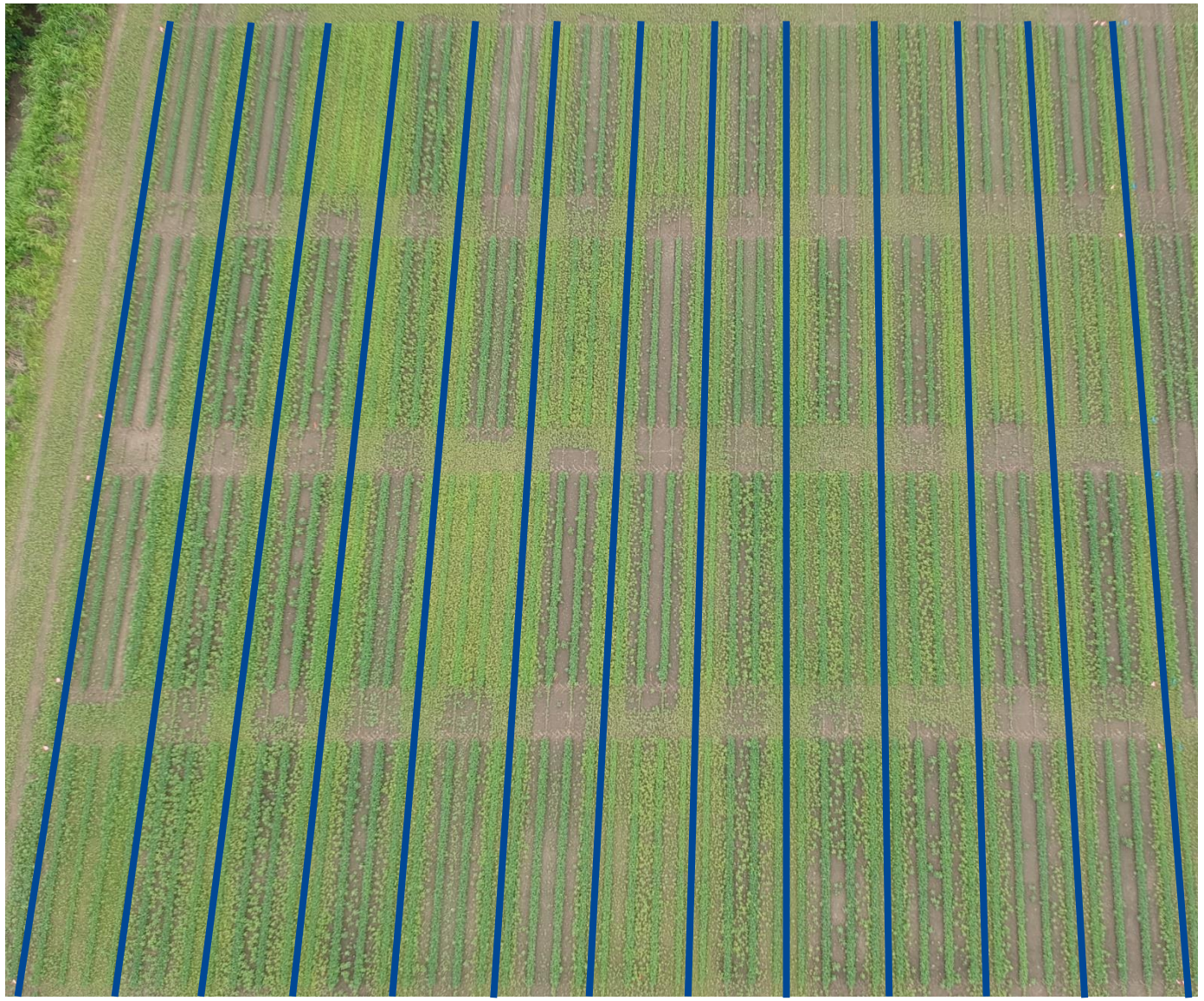


Confirmed PPO-Inhibitor Resistance
(Flexstar, Ultra Blazer, Valor)

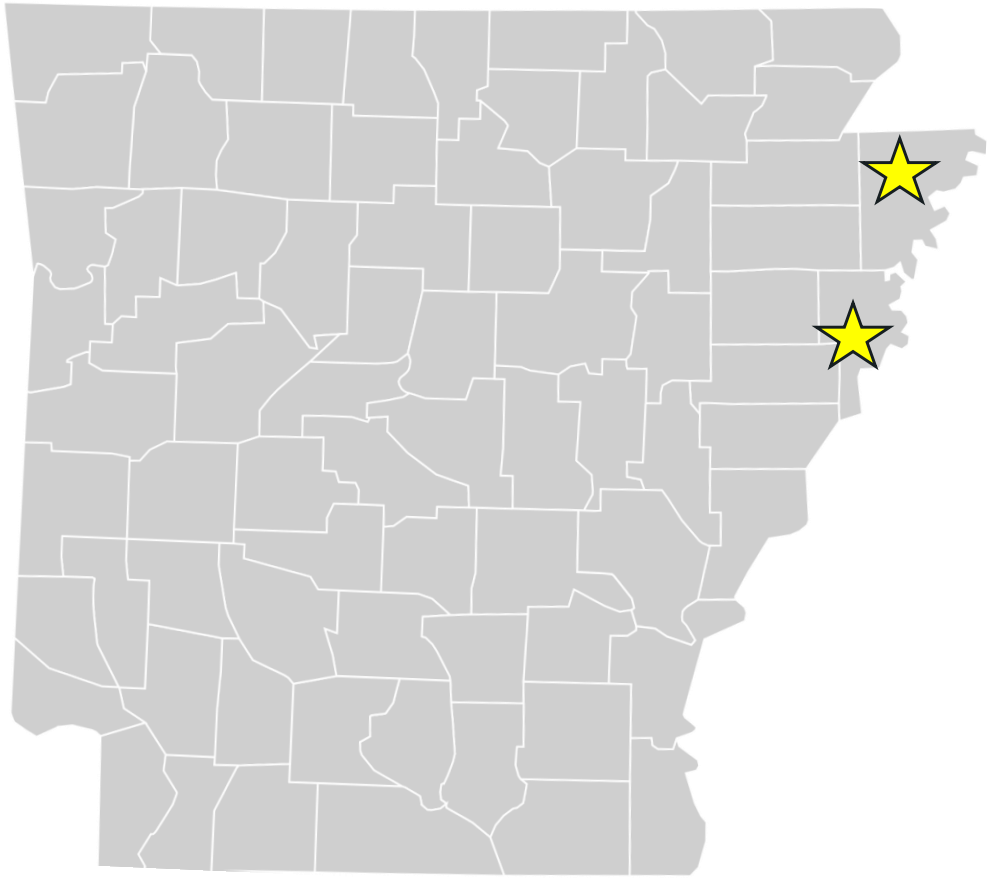
Confirmed VLCFA-Inhibitor Resistance
(Dual Magnum, Warrant)

Aerial View – 36 Days After Application

Marion, AR



Glufosinate Resistance



Confirmed Glufosinate Resistance
(Liberty)

Arkansas Palmer amaranth response to glufosinate

16 fl oz/A | 32 fl oz/A | 128 fl oz/A | 256 fl oz/A

Liberty rate

Accession 20-59 (Mississippi Co.)

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Glufosinate Resistance

Susceptible

Accession 20-59
(Mississippi County)

32 fl oz/A Liberty

Herbicide program for LibertyLink cotton in 2019

Preemergence: Fluometuron + Paraquat
Early postemergence: Glyphosate + Glufosinate
2 weeks later: Glufosinate + Acetochlor

2 weeks later: Glufosinate (XR nozzle)
10 days later: Glufosinate (XR nozzle)
13 days later: Glufosinate (XR nozzle)

Accession 19-62

Crawfordsville, Arkansas

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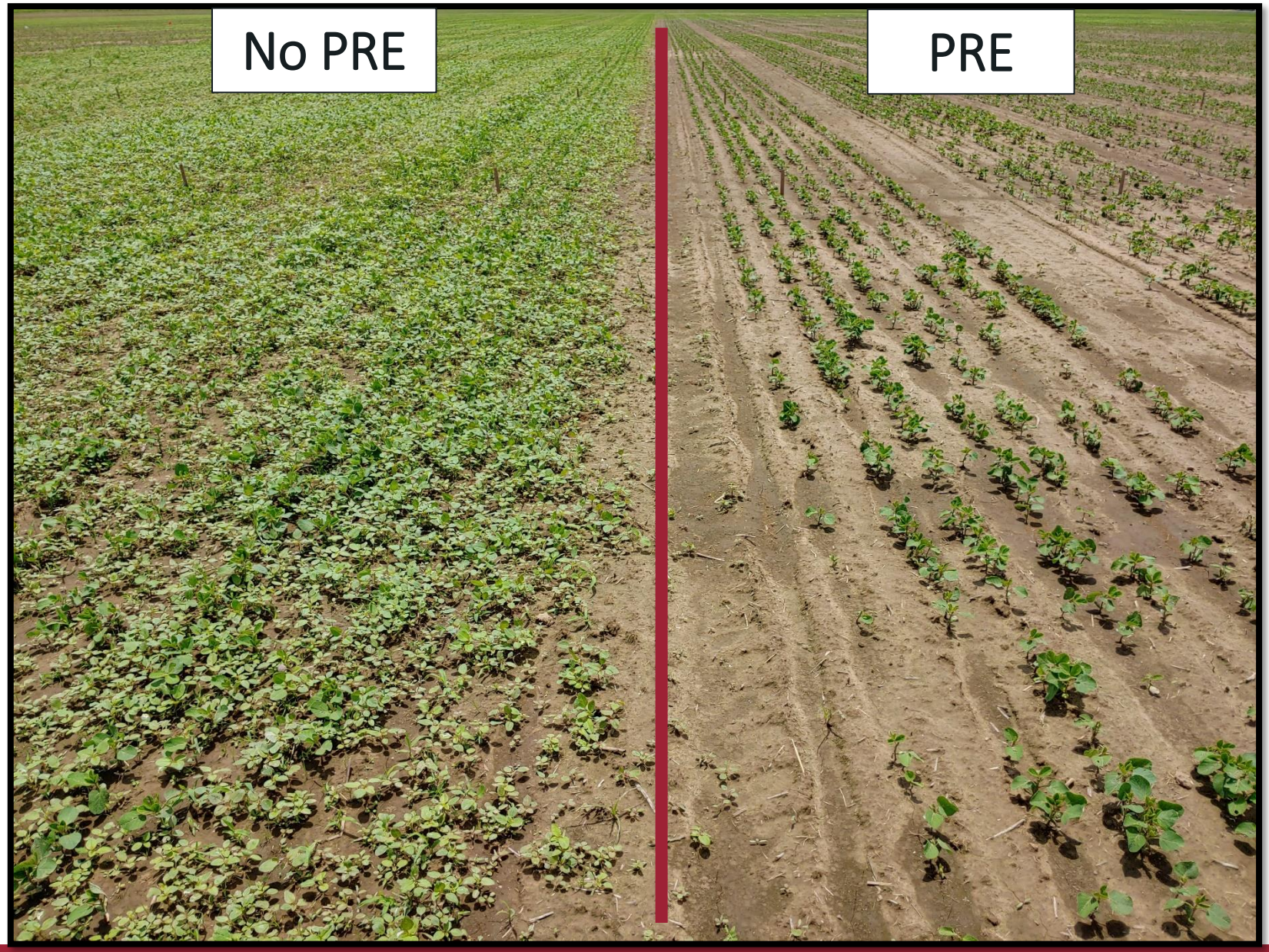
So pigweeds are a huge problem…
What can we do?

- **Multiple, diverse integrated weed management strategies**
  - Multiple, effective modes-of-action/tank-mixing
  - Optimize spray applications
  - Clean tillage/harvest equipment
  - Enhance crop competitiveness
  - Effectively implement and utilize new technologies
  - Weed seedbank management

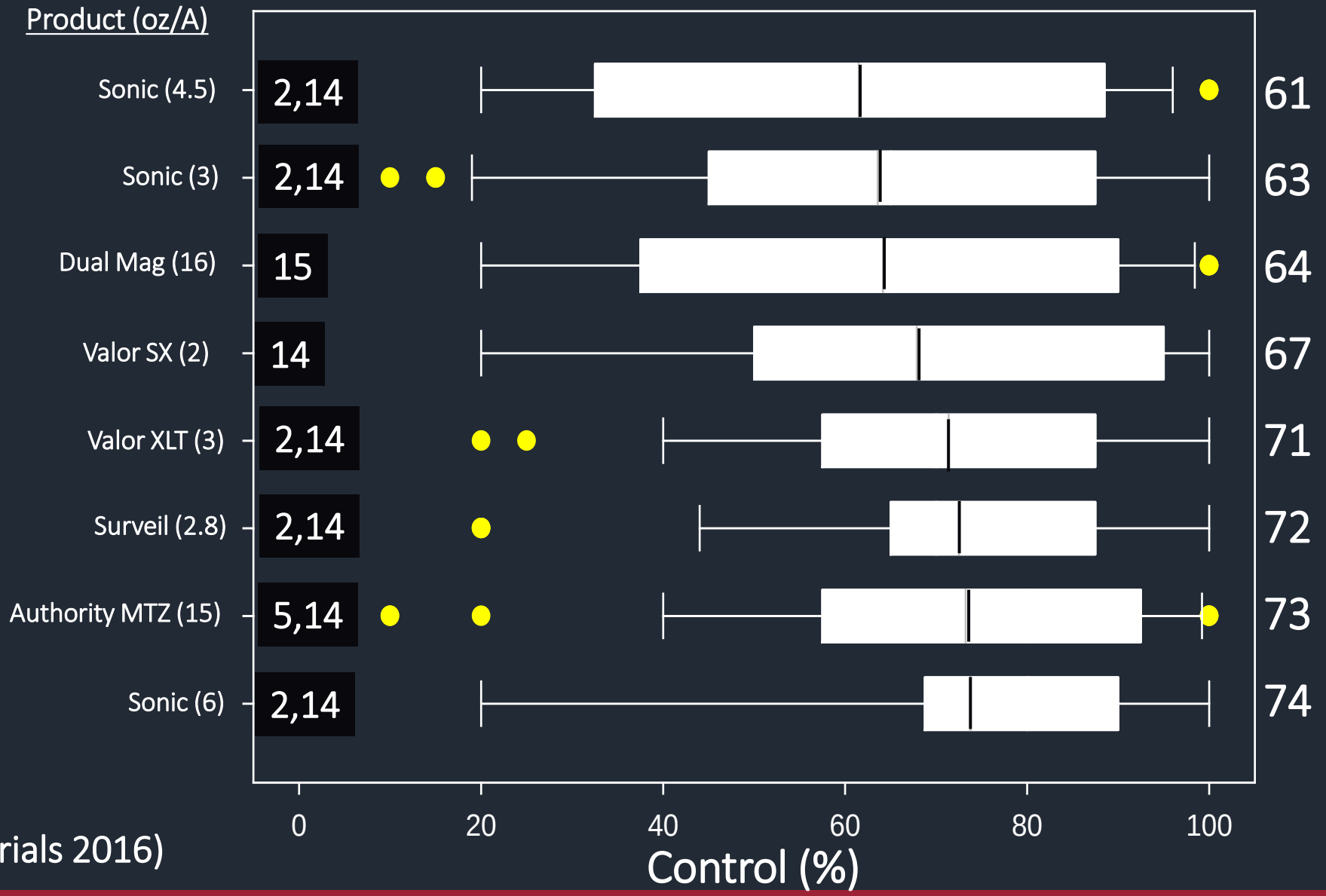
PRE Herbicide Use

- Alternate herbicide sites-of-action
  - Reduces selection pressure for evolution of herbicide resistance
- PRE residual herbicides
  - Reduce number of weeds exposed to postemergence (POST) herbicide
  - Reduce early-season weed competition
  - Provide flexibility

PRE Herbicide Use

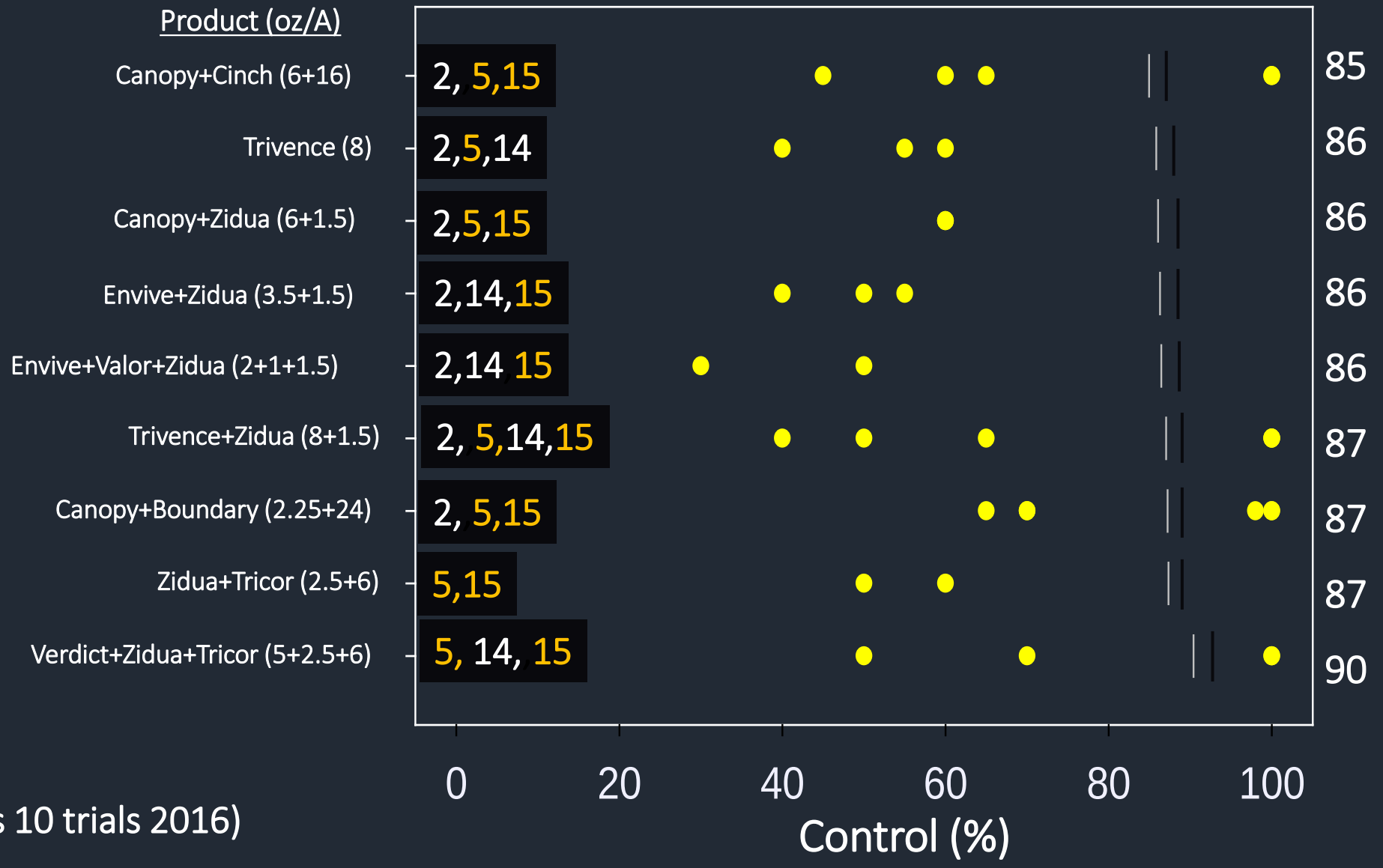


PRE Programs on PPO- & VLCFA-Resistant Palmer Amaranth (26 to 28 DAT)



(Across 10 trials 2016)

PRE Programs on PPO- & VLCFA-Resistant Palmer Amaranth (26 to 28 DAT)



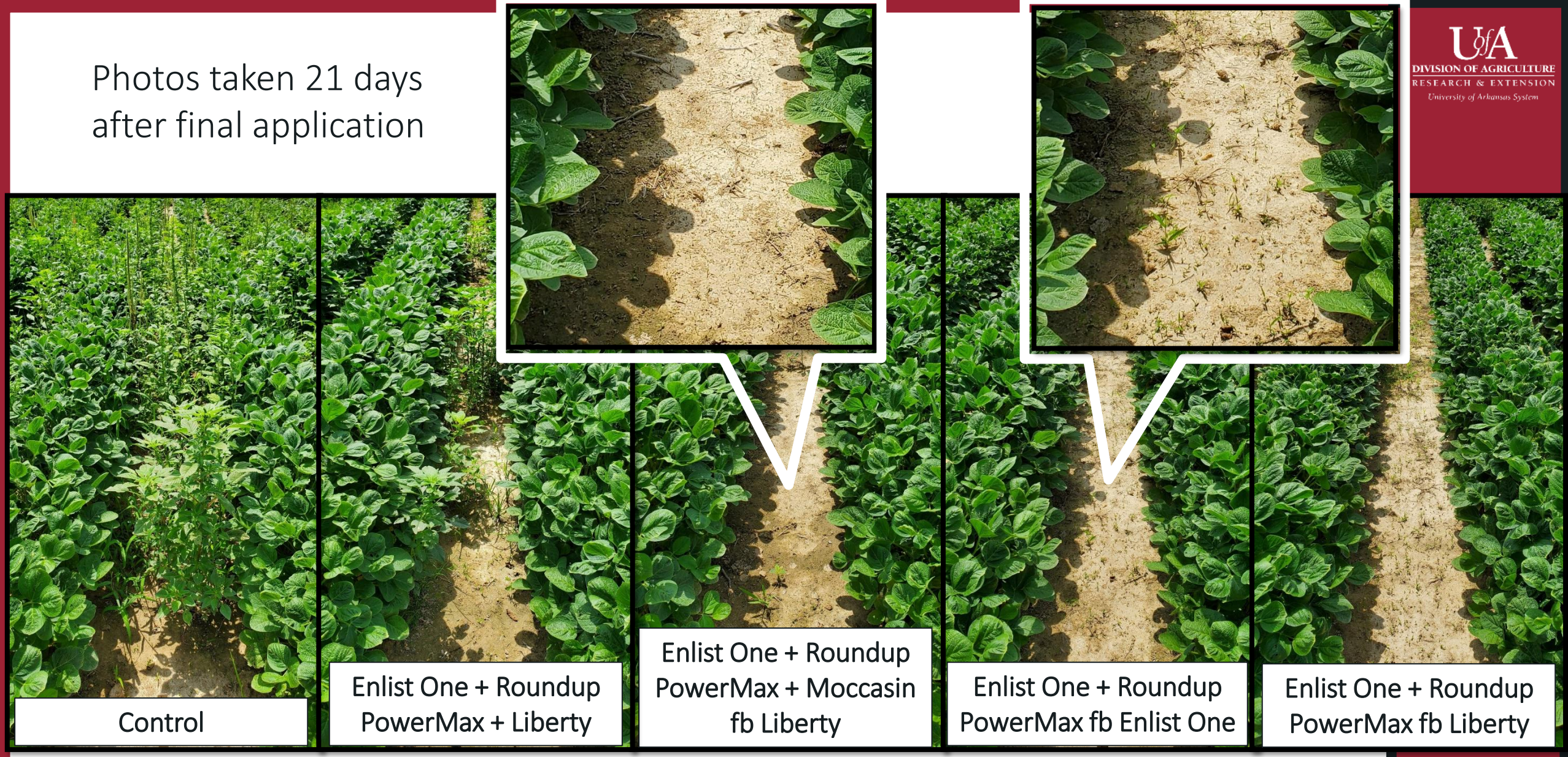
(Across 10 trials 2016)

Preemergence Residuals!

Photos taken 35 days after application

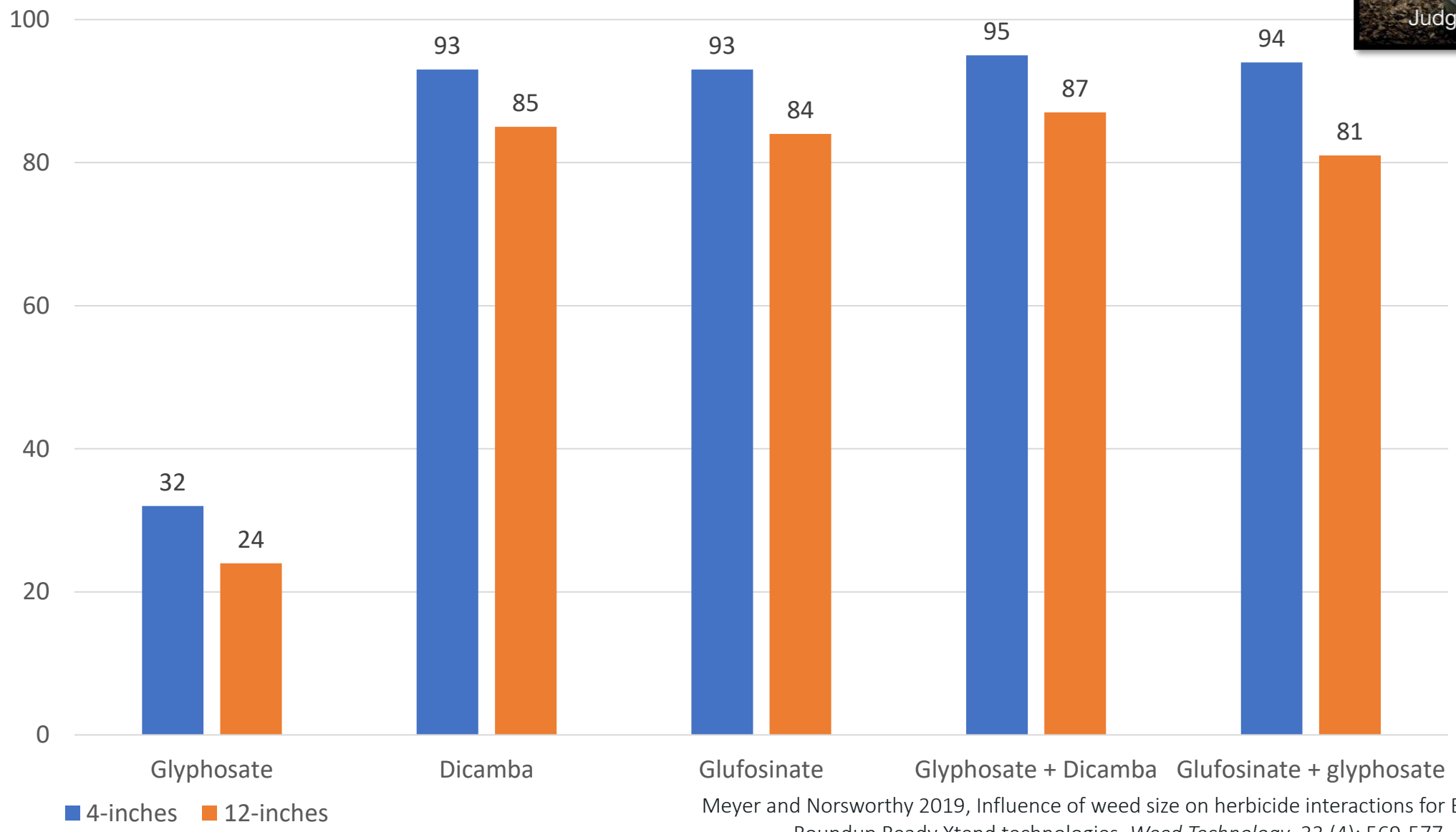
- Multiple, effective sites-of-action are needed
- Group 15's and metribuzin are extremely important for pigweed control

Photos taken 21 days after final application



Enlist E3 Recs & Overlapping Residuals

Weed Size Effect on Control



Meyer and Norsworthy 2019, Influence of weed size on herbicide interactions for Enlist and Roundup Ready Xtend technologies, *Weed Technology*, 33 (4): 569-577.

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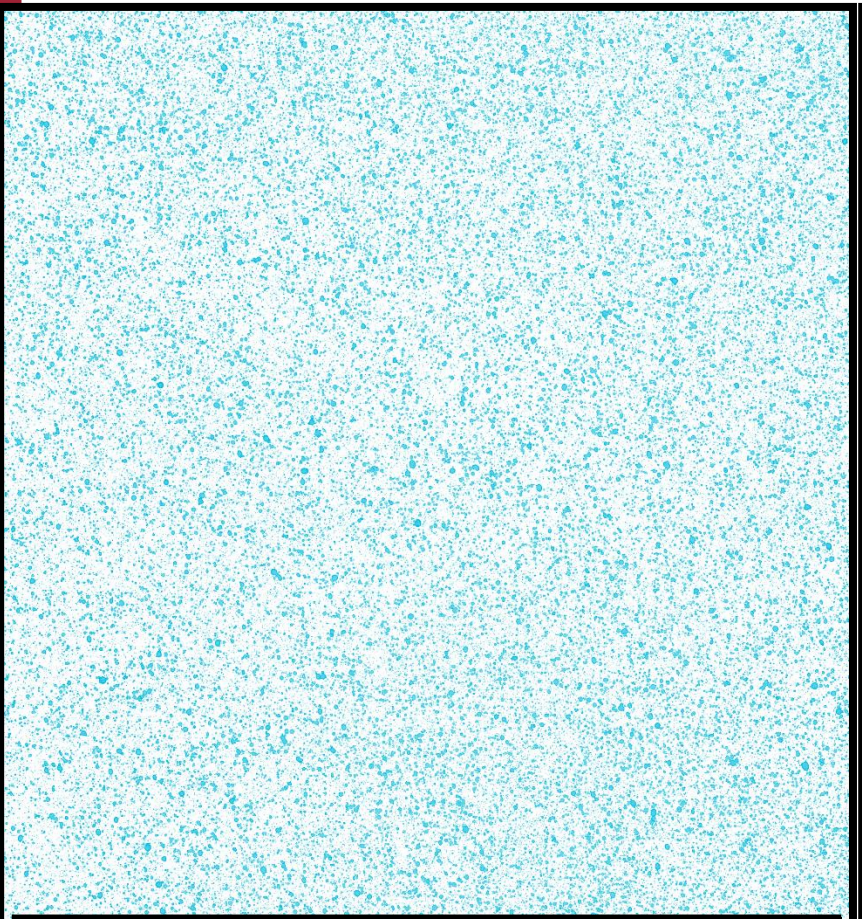
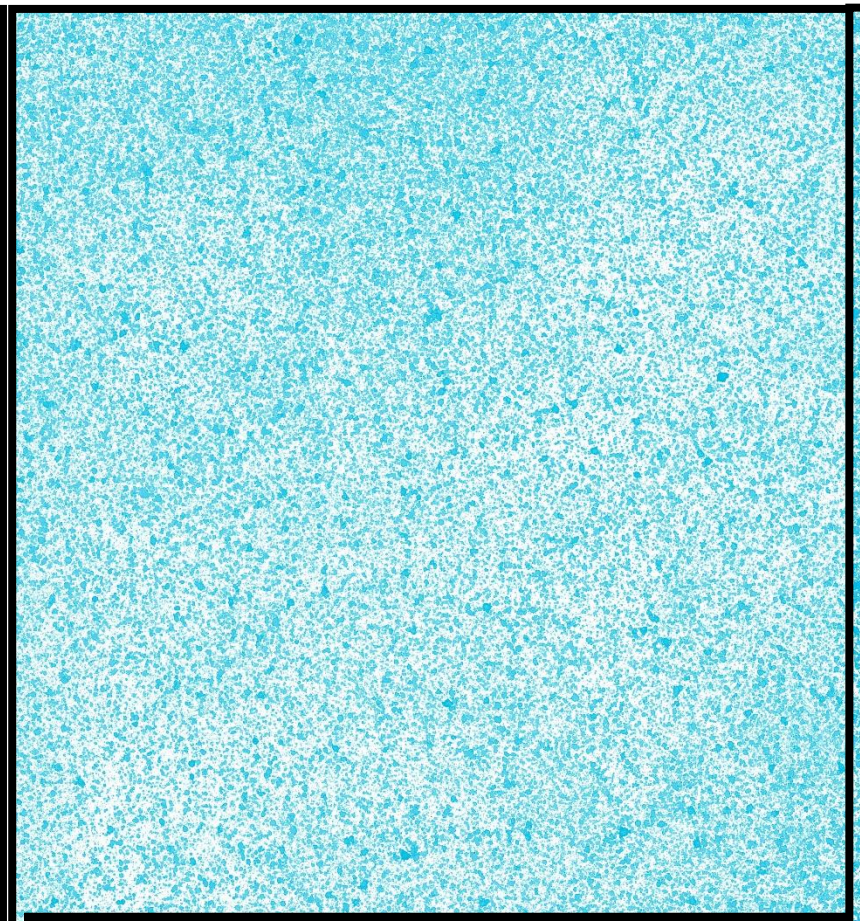
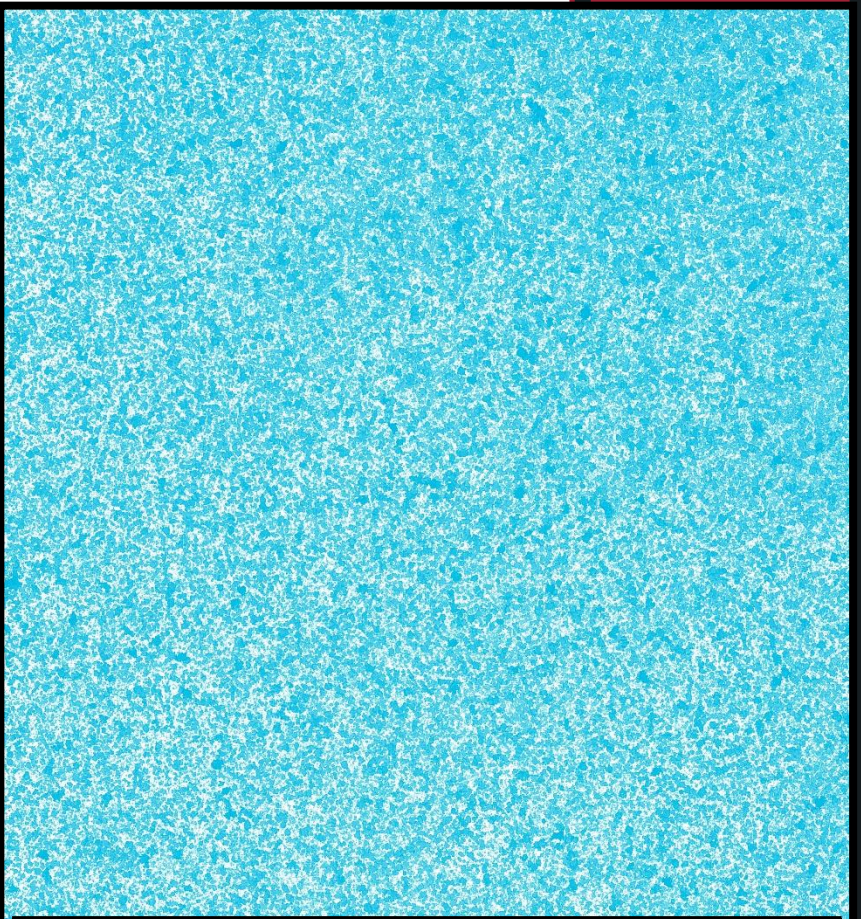
Spray Coverage (XR nozzle)



XR – 5 GPA		
Droplet size	Spray Classification	Coverage
280 µm	Medium	19.9 %

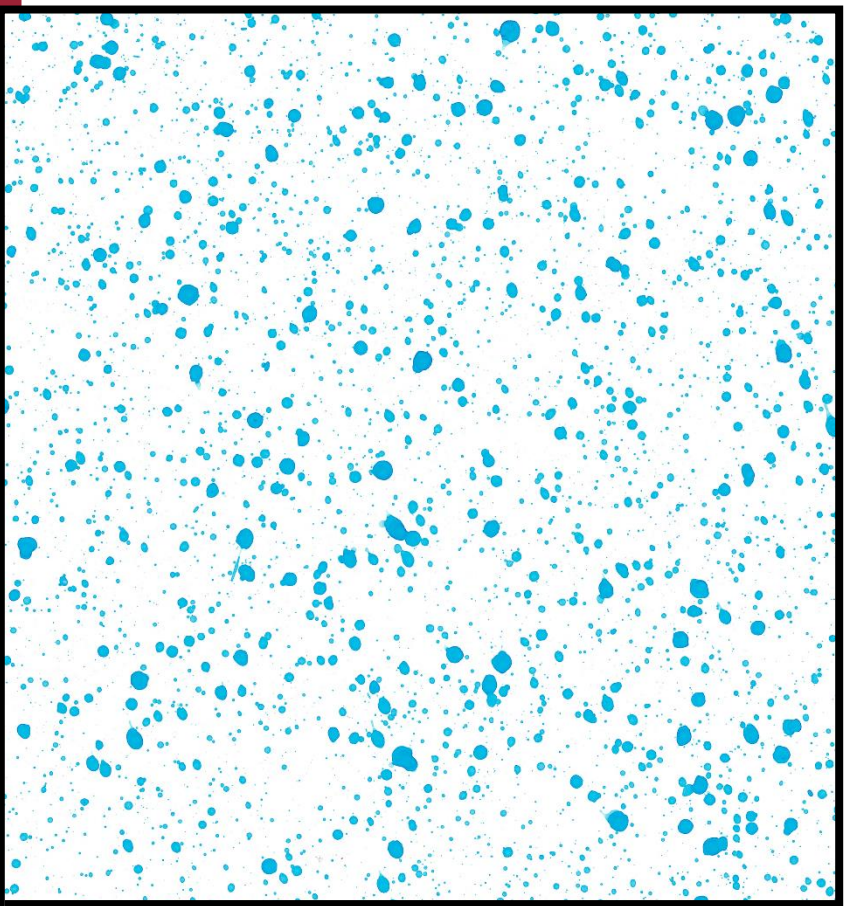


XR – 10 GPA		
Droplet size	Spray Classification	Coverage
280 µm	Medium	42.7 %



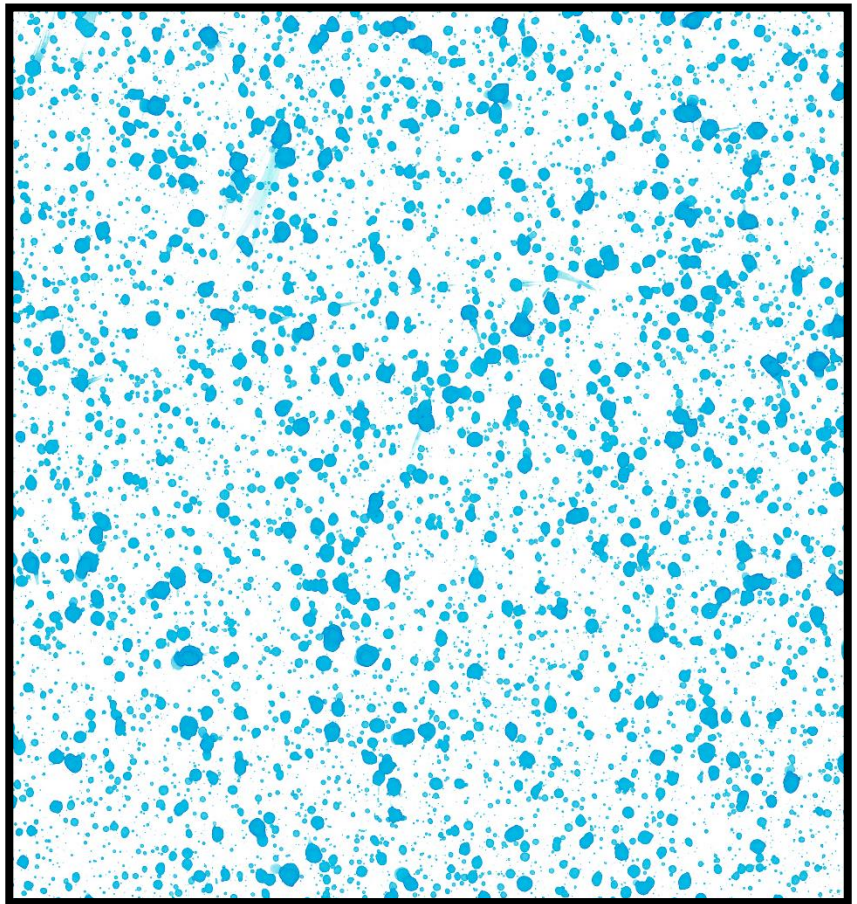
XR – 15 GPA		
Droplet size	Spray Classification	Coverage
280 µm	Medium	64.5 %

Spray Coverage (TTI nozzle)



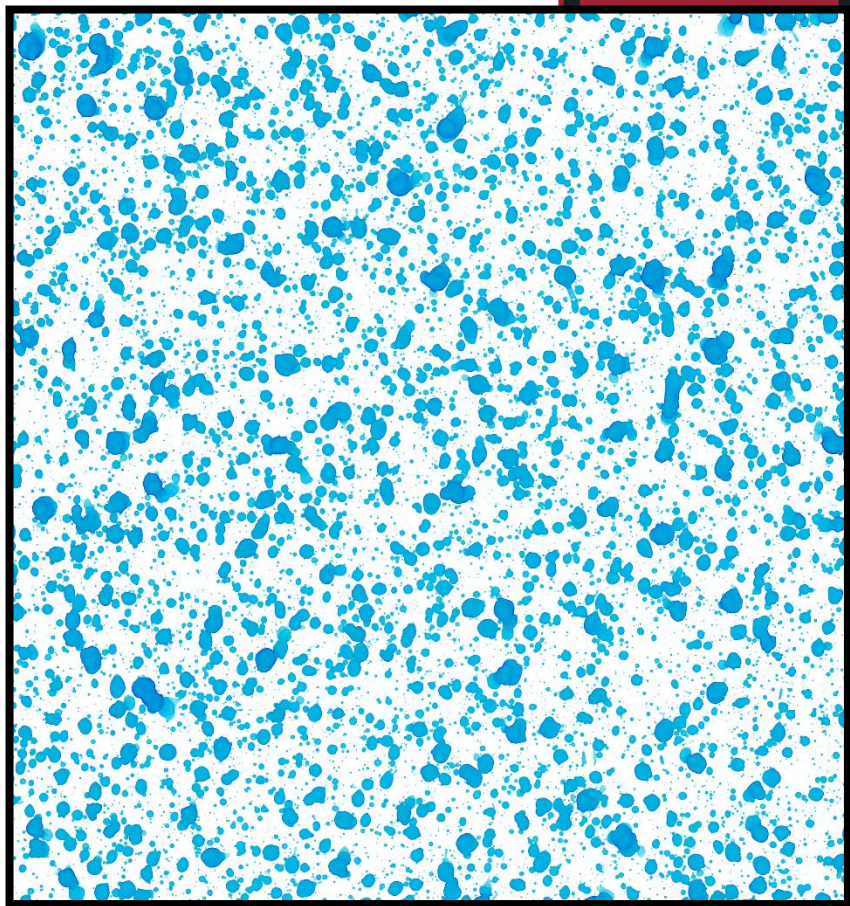
TTI – 5 GPA

Droplet size	Spray Classification	Coverage
800 µm	Ultra Coarse	9.7 %



TTI – 10 GPA

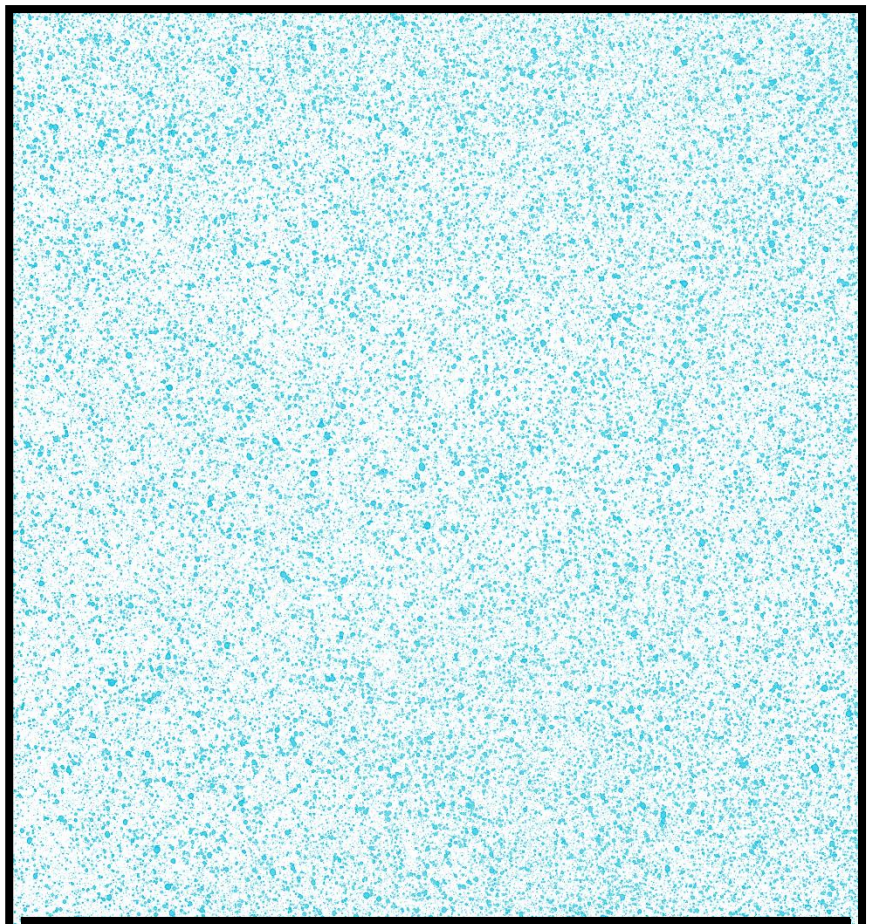
Droplet size	Spray Classification	Coverage
800 µm	Ultra Coarse	21.2 %



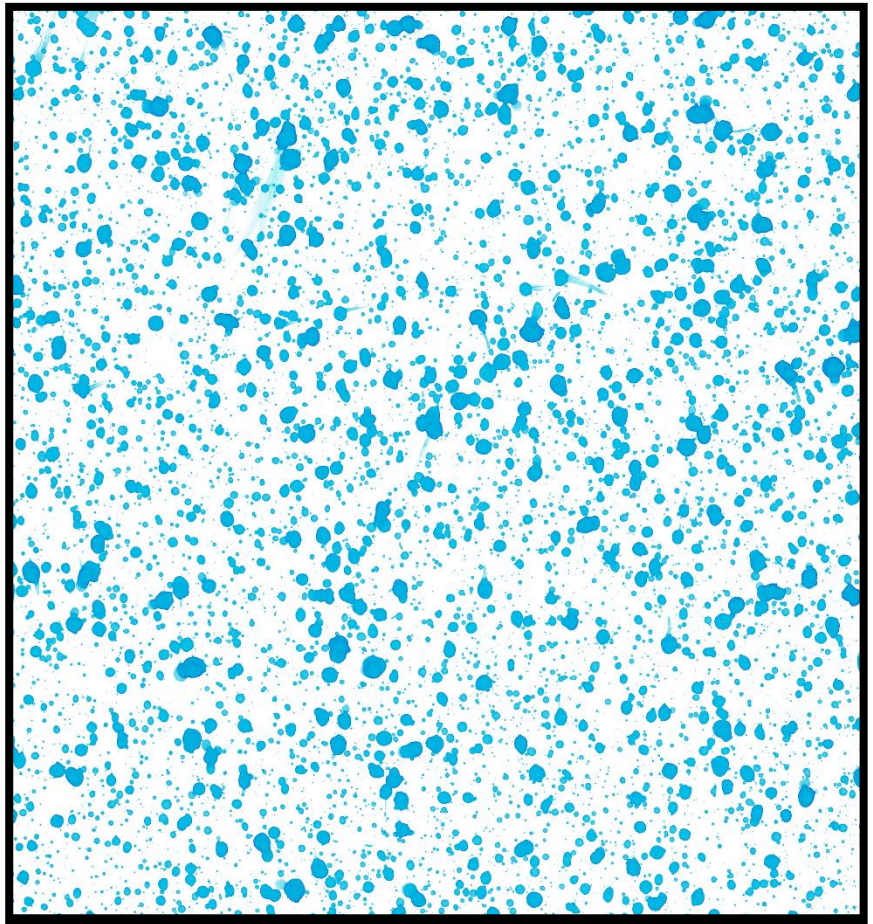
TTI – 15 GPA

Droplet size	Spray Classification	Coverage
800 µm	Ultra Coarse	30.6 %

Spray Coverage (Comparison)

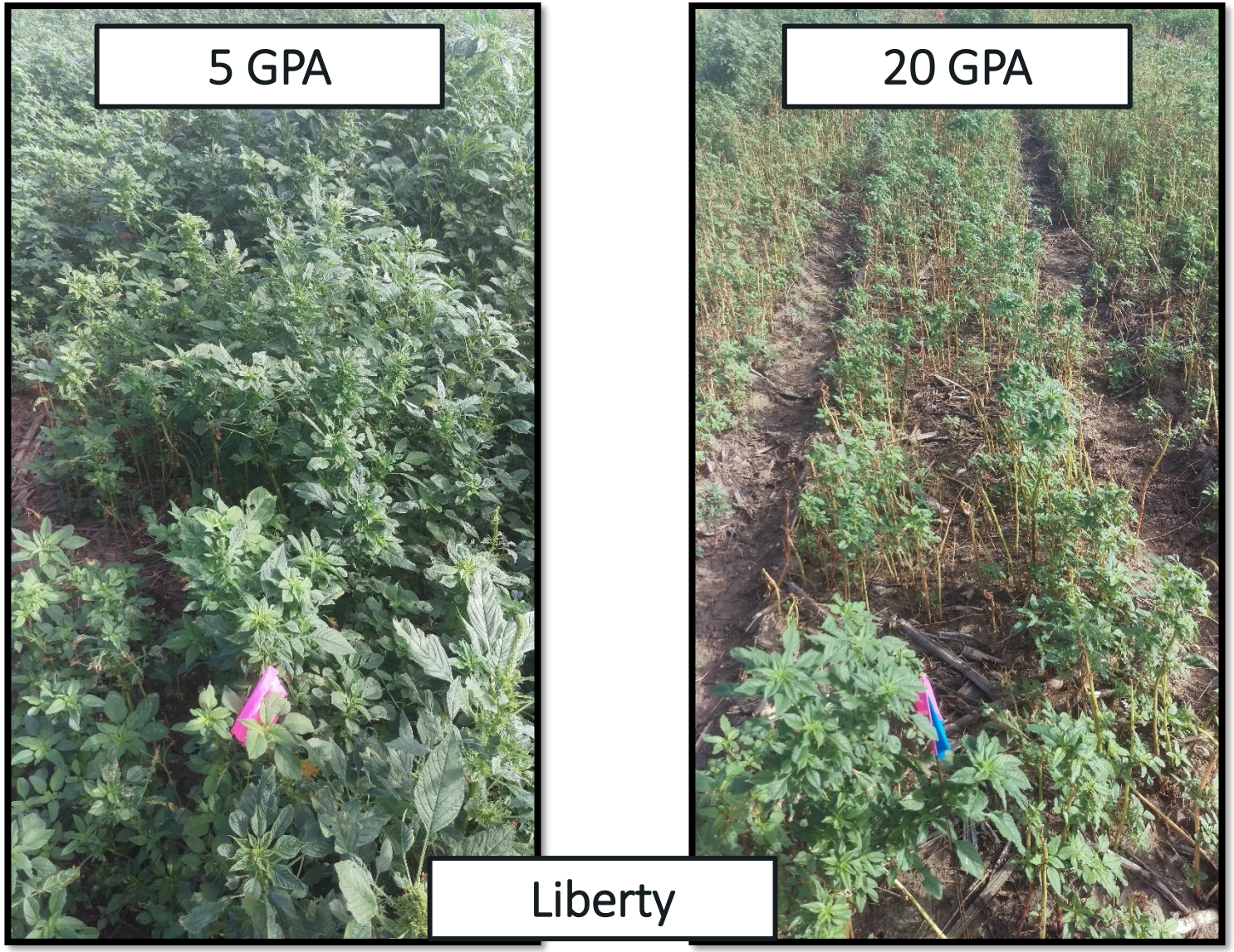


XR – 5 GPA		
Droplet size	Spray Classification	Coverage
280 µm	Medium	19.9 %



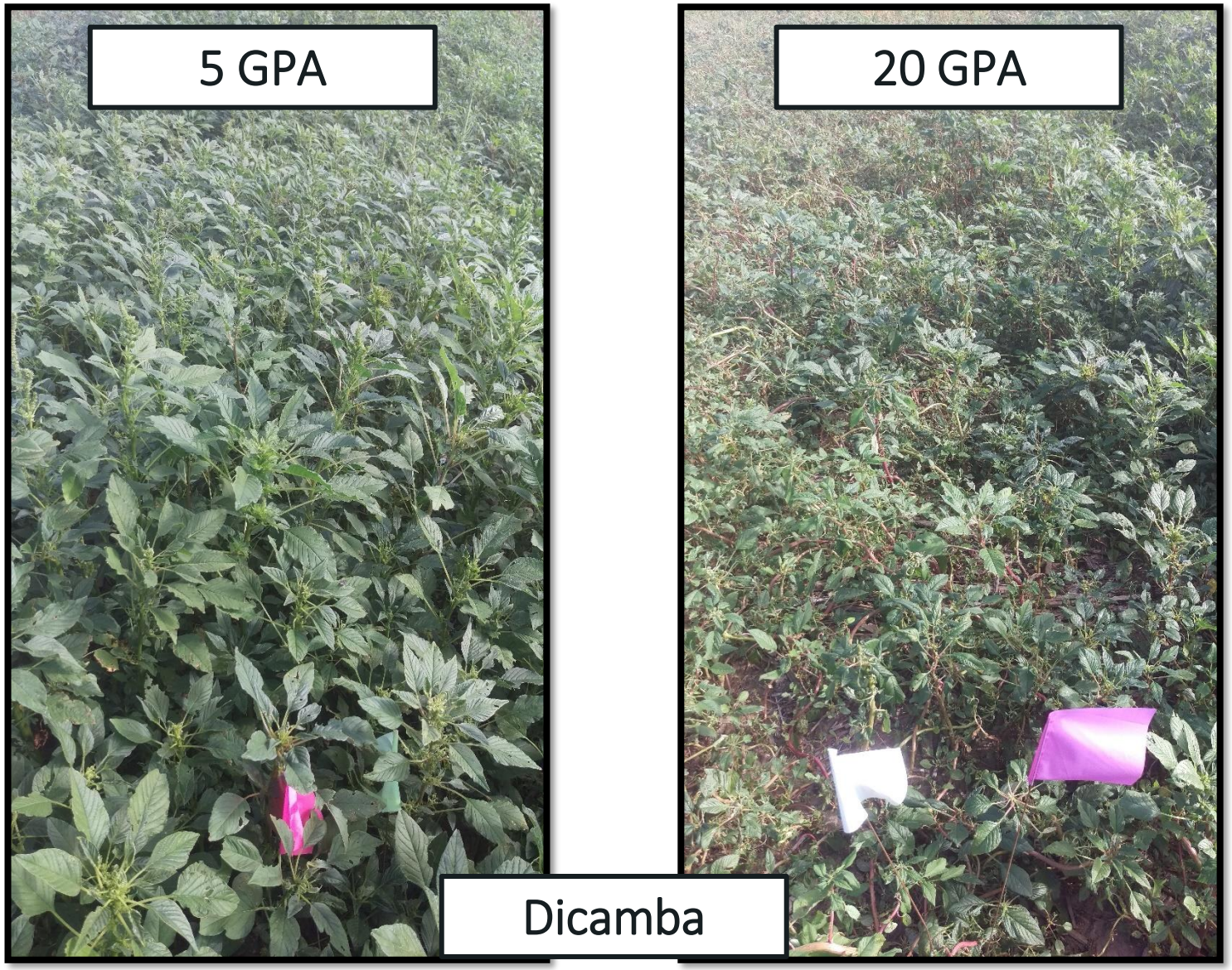
TTI – 10 GPA		
Droplet size	Spray Classification	Coverage
800 µm	Ultra Coarse	21.2 %

Spray Volume Effect on Weed Control



Butts et al. 2018, Spray droplet size and carrier volume effect on dicamba and glufosinate efficacy, *Pest Management Science*, 74 (9): 2020-2029.

Spray Volume Effect on Weed Control



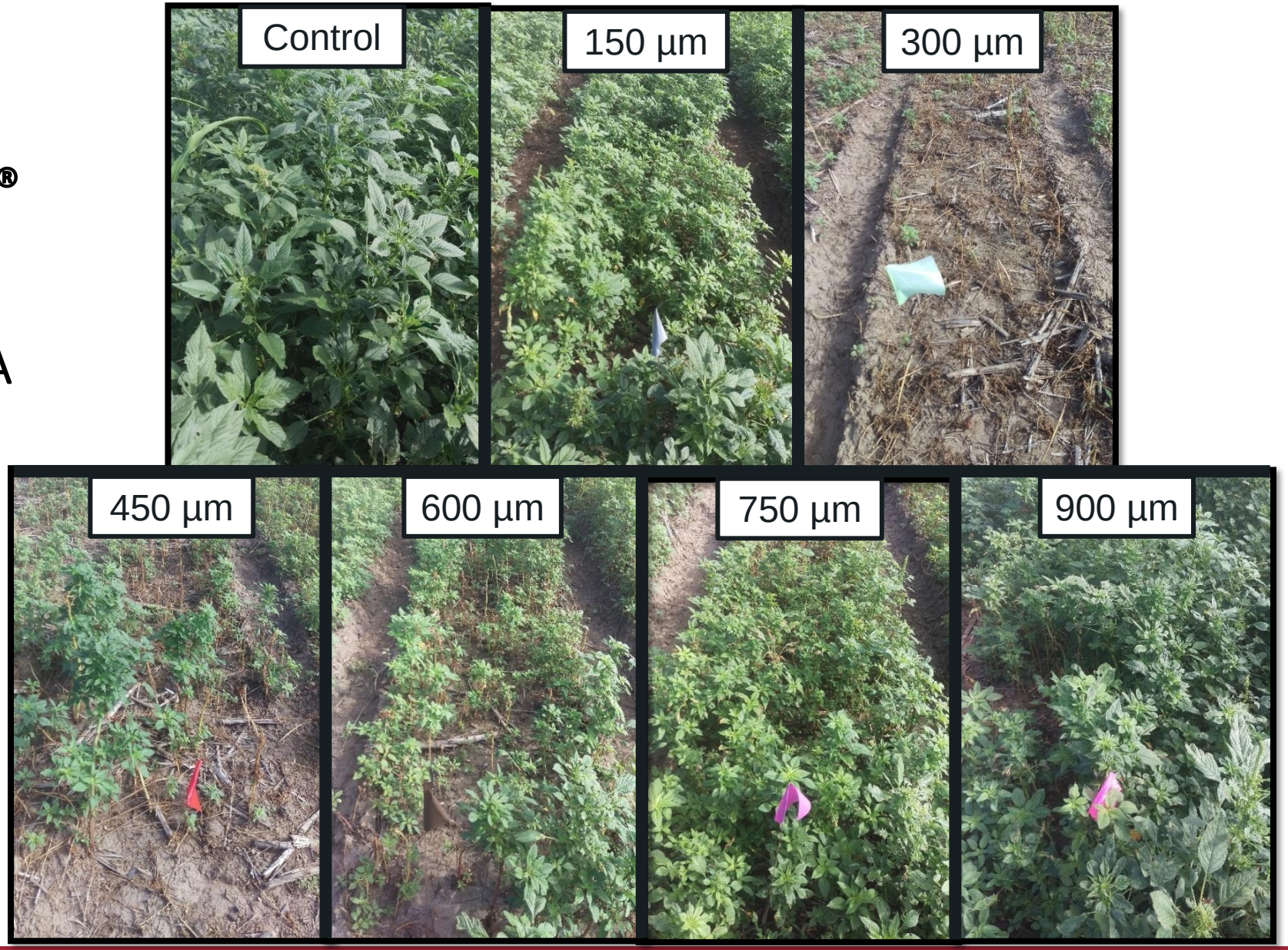
Butts et al. 2018, Spray droplet size and carrier volume effect on dicamba and glufosinate efficacy, *Pest Management Science*, 74 (9): 2020-2029.

Droplet Size Effect on Weed Control

Liberty®

5 GPA

14 DAA



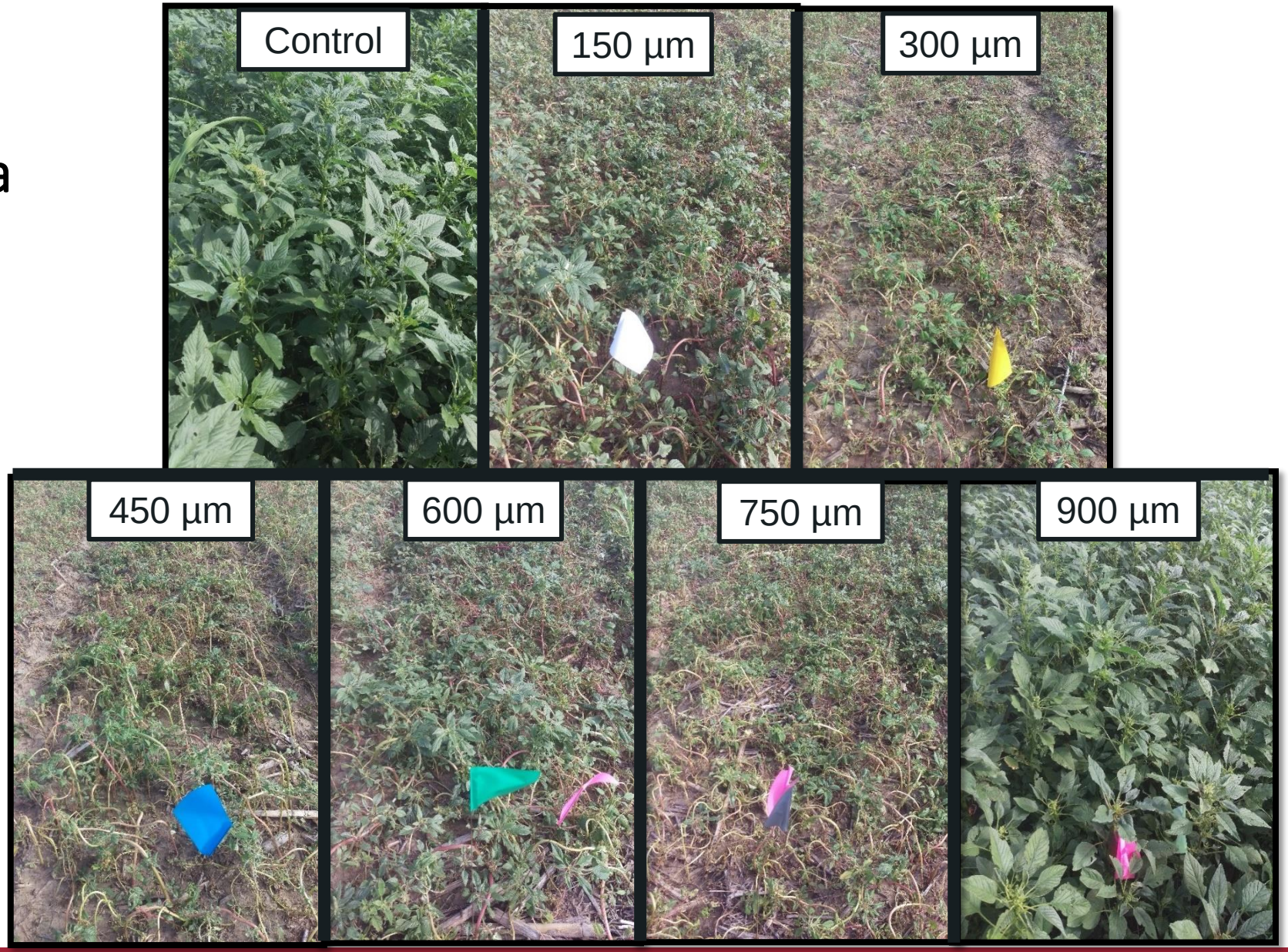
Butts et al. 2018, Spray droplet size and carrier volume effect on dicamba and glufosinate efficacy, *Pest Management Science*, 74 (9): 2020-2029.

Droplet Size Effect on Weed Control

Dicamba

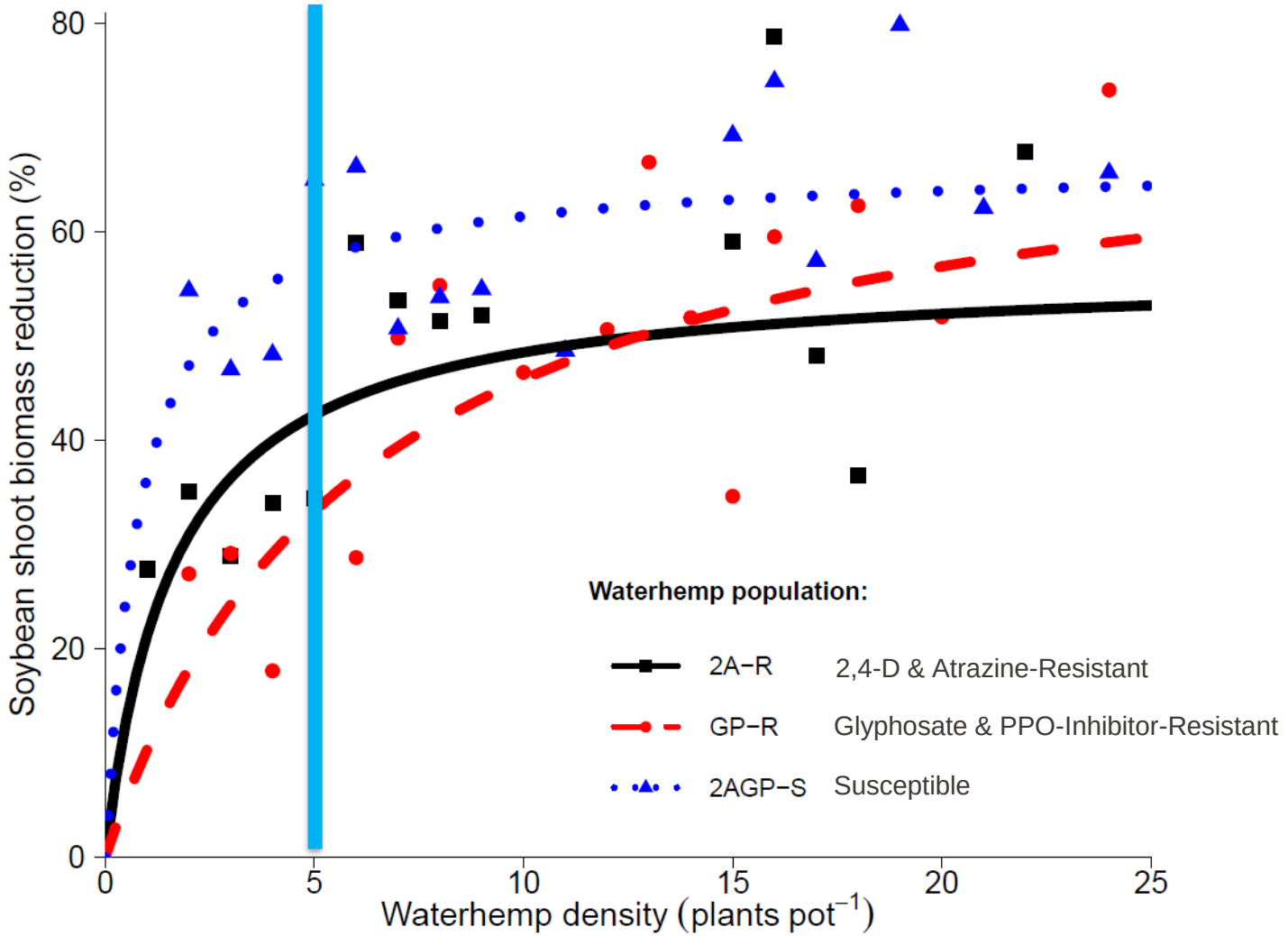
5 GPA

14 DAA



Butts et al. 2018, Spray droplet size and carrier volume effect on dicamba and glufosinate efficacy, *Pest Management Science*, 74 (9): 2020-2029.

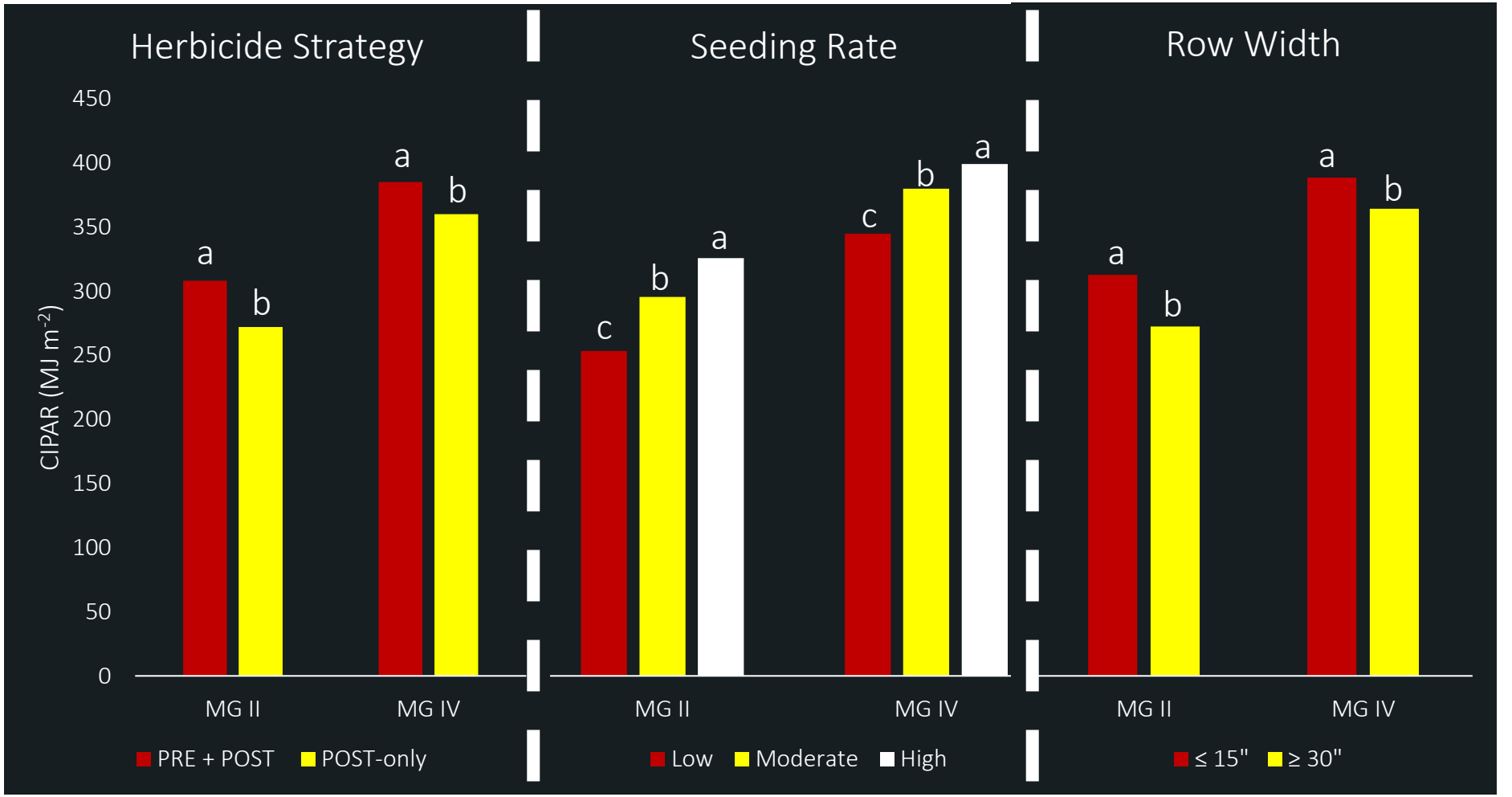
Enhancing Crop Competitiveness



Adapted from:
Butts et al., 2018. Competitiveness of herbicide-resistant waterhemp (*Amaranthus tuberculatus*) with soybean. Weed Sci 66(6):729-737. DOI: 10.1017/wsc.2018.45

Soybean CIPAR

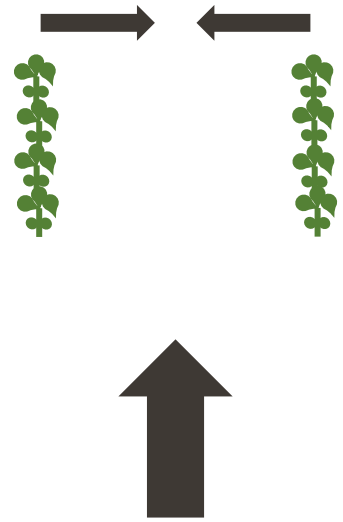
MG II and MG IV Regions



Adapted from:
Butts et al., 2016, Management of Pigweed in Glufosinate-Resistant Soybean in the Midwest and Mid-South, Weed Technology, 30 (2): 355-365.

Pigweed Seed Production

	MG II + III	MG IV
Factor	Seed	Seed
	seeds m^{-2}	seeds m^{-2}
Row width		
≤ 15”	10 a	22 a
≥ 30”	17 a	62 b
Seeding rate (seeds ac^{-1})		
70,000	--	57 b
130,000	--	51 b
190,000	--	17 a
Herbicide strategy		
PRE + POST	1 a	17 a
POST-only	123 b	78 b



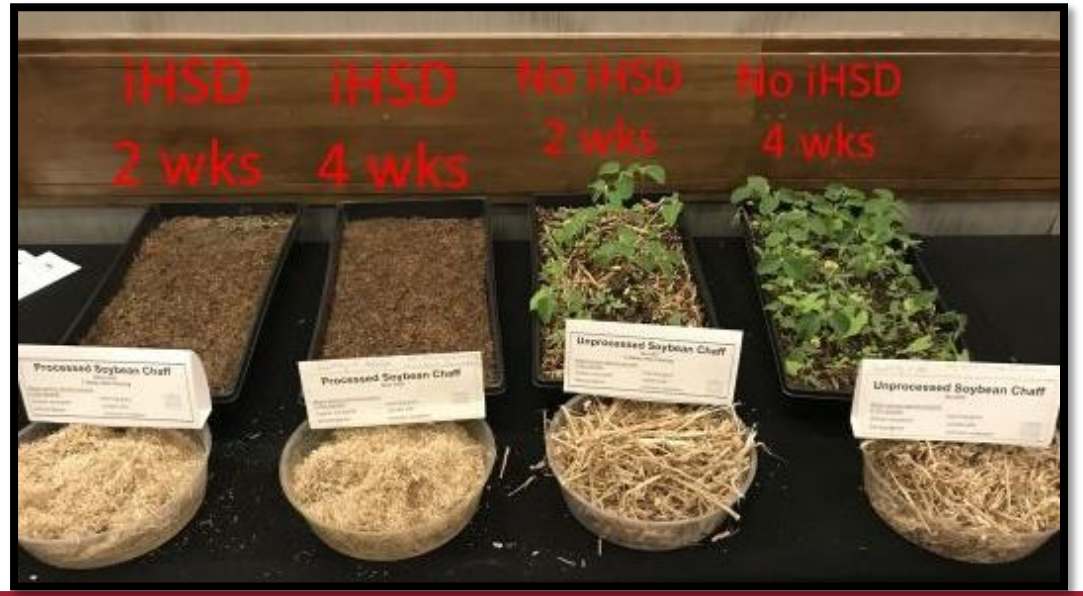
2 is better than 1!

Adapted from:
Butts et al., 2016, Management of Pigweed in Glufosinate-Resistant Soybean in the Midwest and Mid-South, Weed Technology, 30 (2): 355-365.

Equipment Cleanout & a Community Problem

1. Necessary to clean tillage and harvest equipment thoroughly to stop the spread.
2. We all need to work **together** as a community to combat weed problems…

Harvest Weed Seed Destruction



Twin Mill RedeKop™ Seed Destructor Installed on JD S680

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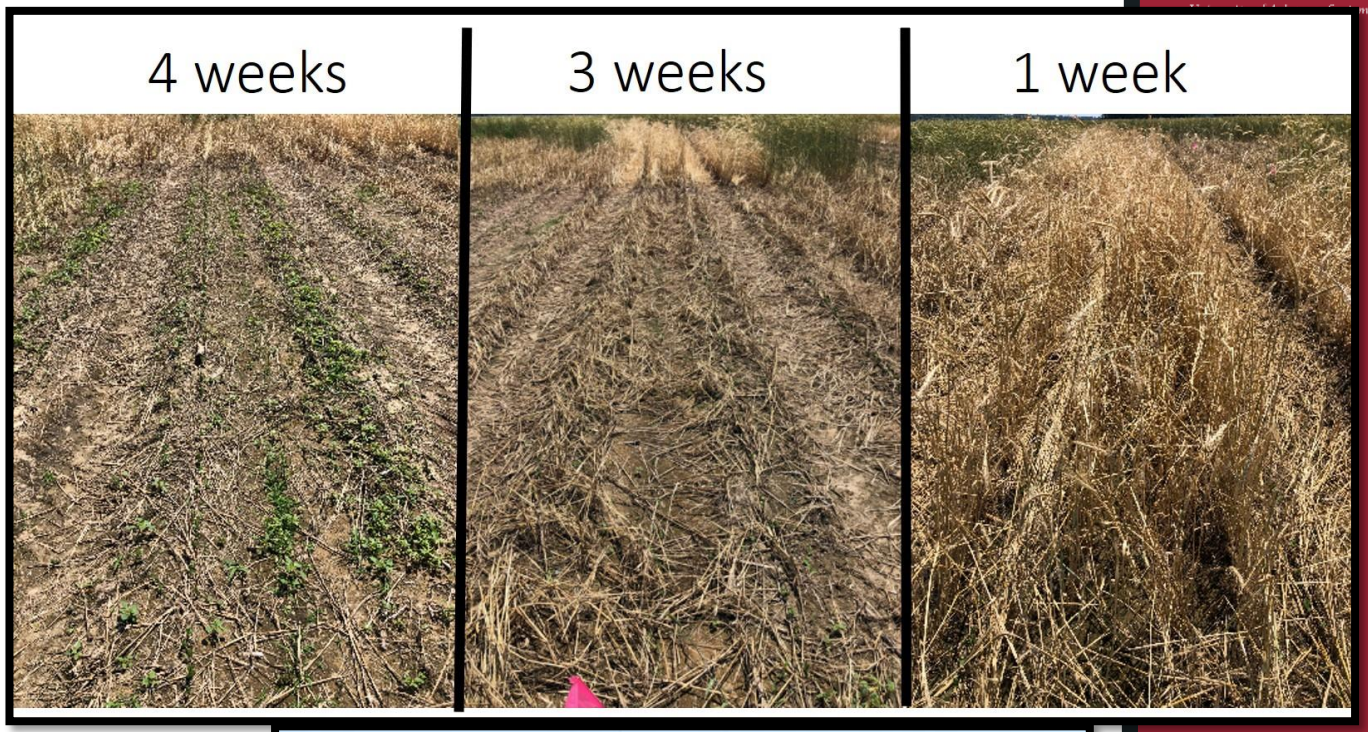
Other Integrated Weed Management Strategies

- Cover crops
- Tillage:
  - Deep tillage (>6 inches) can bury seeds
  - Buries seeds deeper in the soil profile than they can emerge from (typical emergence comes from top 2 inches)
  - Should only occur every 4-5 years (otherwise, weed seeds will still be viable)



SPORTS Weed Control Extension Campaign

Start clean

Preemergence herbicides

Overlap residuals

Required: IWM tactics [crop rotation, seed prevention, tillage, etc.]

Timely

Selection of multiple, effective site-of-action herbicides

SCAN ME

https://bit.ly/UAEX-SPORTS

Other Information

Visit our website -> https://www.uaex.uada.edu/weeds

http://bit.ly/HRTraitsGuide https://bit.ly/Palmer-Resistance-Management http://bit.ly/UAEX-MP44

Other Information

Visit our website -> https://www.uaex.uada.edu/weeds

SCAN ME

http://bit.ly/UAEXHerbSymptoms

Get weed control updates directly on your phone.

Opt-in to our UAEX Field Crop Extension Specialist Text Service!

Text "**weeds**" to (501) 300-8883.

Weeds AR Wild podcast series on Arkansas Row Crops Radio

- Weekly episode
- https://www.uaex.uada.edu/farm-ranch/crops-commercial-horticulture/RowCropsRadio.aspx

Acknowledgements

University of Arkansas Weed Science Group

Arkansas Rice Research and Promotion Board

Arkansas Soybean Promotion Board

United Soybean Board, Take Action

USDA-NIFA CPPM Grant Award No. 2020-70006-32981

USDA-ARS, Aerial Application Technology Unit

Wilger, Inc.

Capstan Ag

Industry Collaborators

Thank you! Questions?

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