What We've Learned About Spray Drone Performance with Herbicides in Missouri Cropping Systems
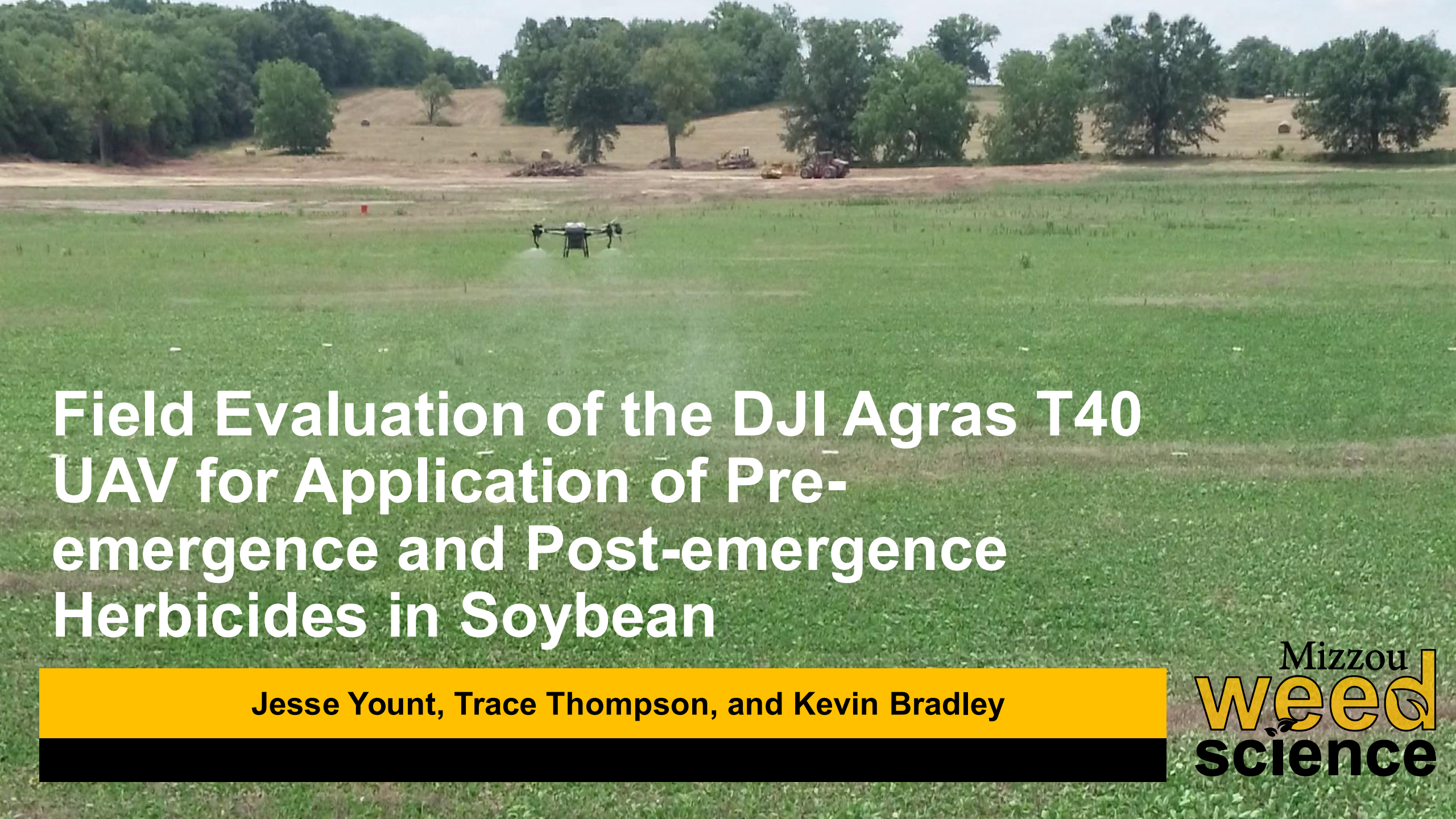
Jesse Yount and Kevin Bradley
University of Missouri

Field Evaluation of the DJI Agras T40 UAV for Application of Pre-emergence and Post-emergence Herbicides in Soybean

Jesse Yount, Trace Thompson, and Kevin Bradley

Mizzou weed science

UAV vs. Ground Sprayer
Post-emergence Herbicide Experiment

UAV: DJI Agras T40	Ground Sprayers: Case IH 3340/John Deere 4830/Rogator RG 900
• 3 Gallons per Acre (GPA) • Extra Coarse (2023) / Very Coarse (2024) nozzle settings • 16 mph • 10 ft height • 33 ft swath	• 15 or 20 GPA • MR110-10 Combo-jet; Teejet 11005; Twinjet 11005; John Deere PSLDMQ2006 • ~10 mph • 3 ft height • 100 ft swath

-60 | -55 | -50 | -40 | -30 | -20 | -10 | 0 | 10 | 20 | 30 | 40 | 50 | 55 | 60 | 70 | 90

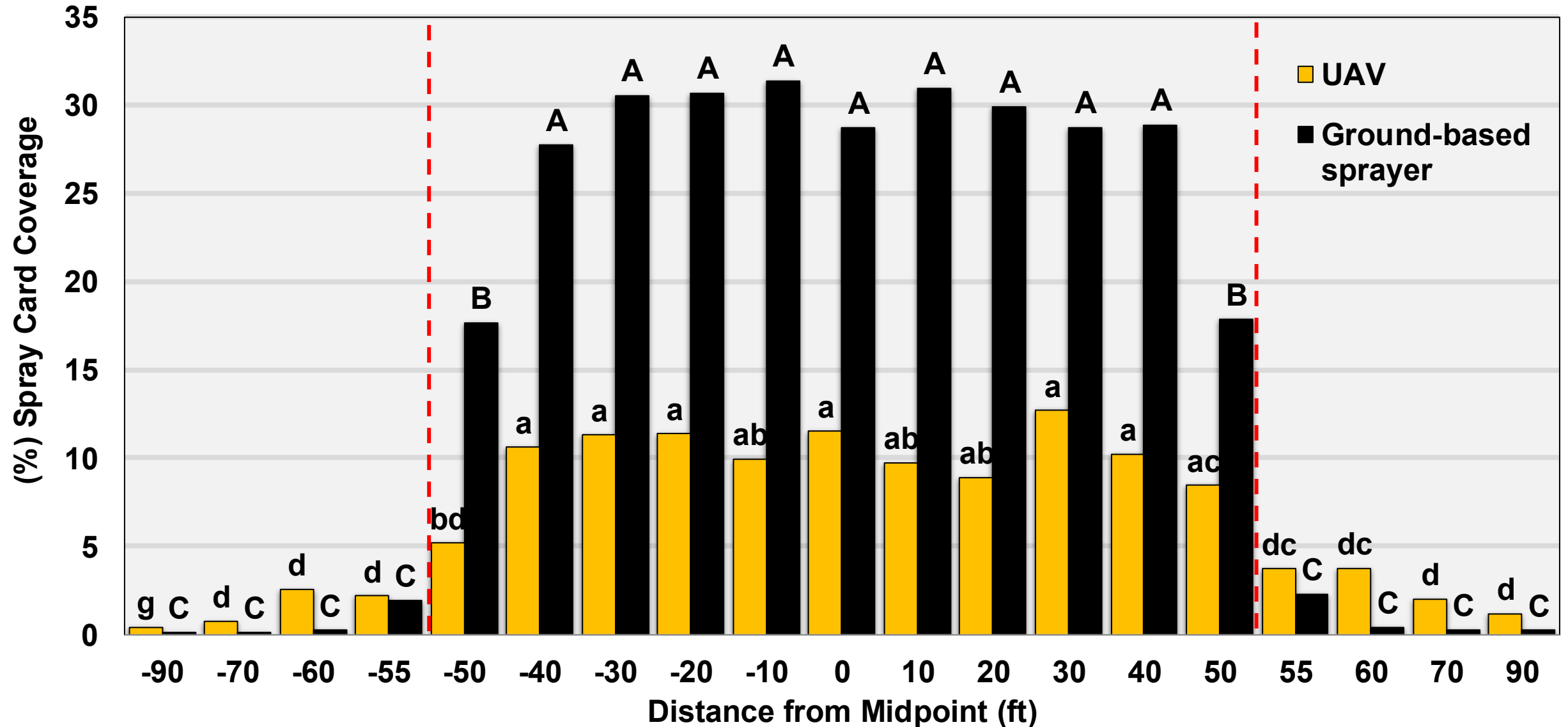-60 | -55 | -50 | -40 | -30 | -20 | -10 | 0 | 10 | 20 | 30 | 40 | 50 | 55 | 60 | 70 | 90

Spray Coverage & Uniformity Following Application with the T40 UAV vs. Ground Sprayer
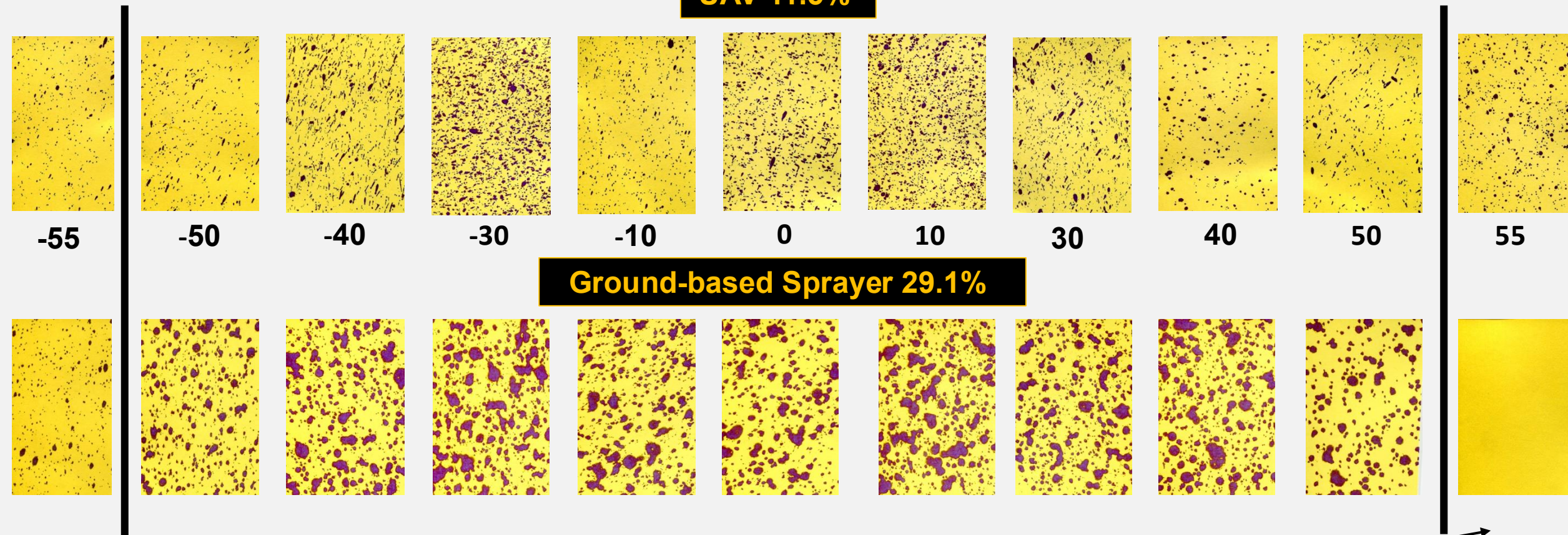(results combined across 4 locations in 2023 and 2024)

*Bars within a category followed by the same uppercase or lowercase letters are not different, LSD=0.05.

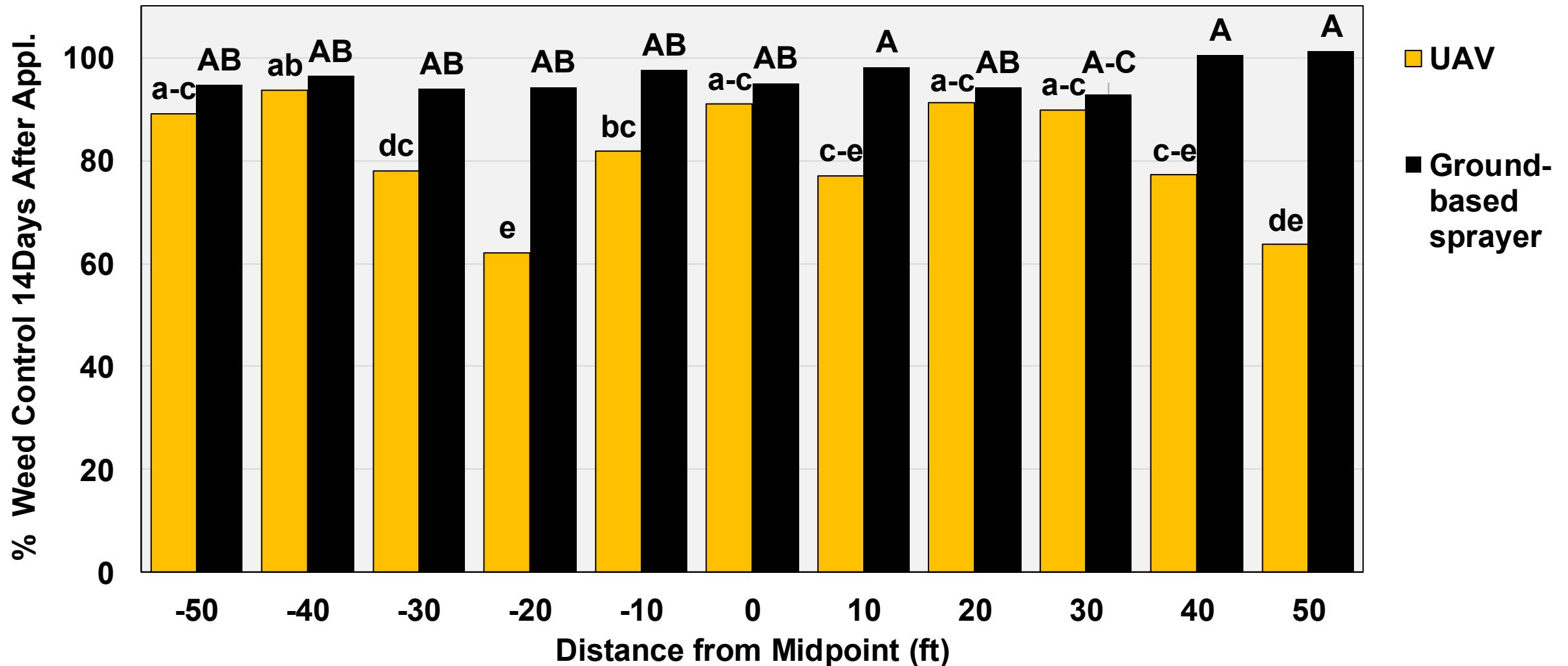Representative Spray Card Coverage Along the Swath Width

Weed Control 14 Days After Application with the T40 UAV vs. Ground Sprayer
(results combined across 4 locations in 2023 and 2024)

*Bars within a category followed by the same uppercase or lowercase letters are not different, LSD=0.05.

UAV vs. Ground Sprayer:
Pre-emergence Herbicide Experiment

Individual plots:

- 25 ft wide x 200 ft long
- 4 replications of each treatment
- Three site-years

PRE Herbicide Treatment:

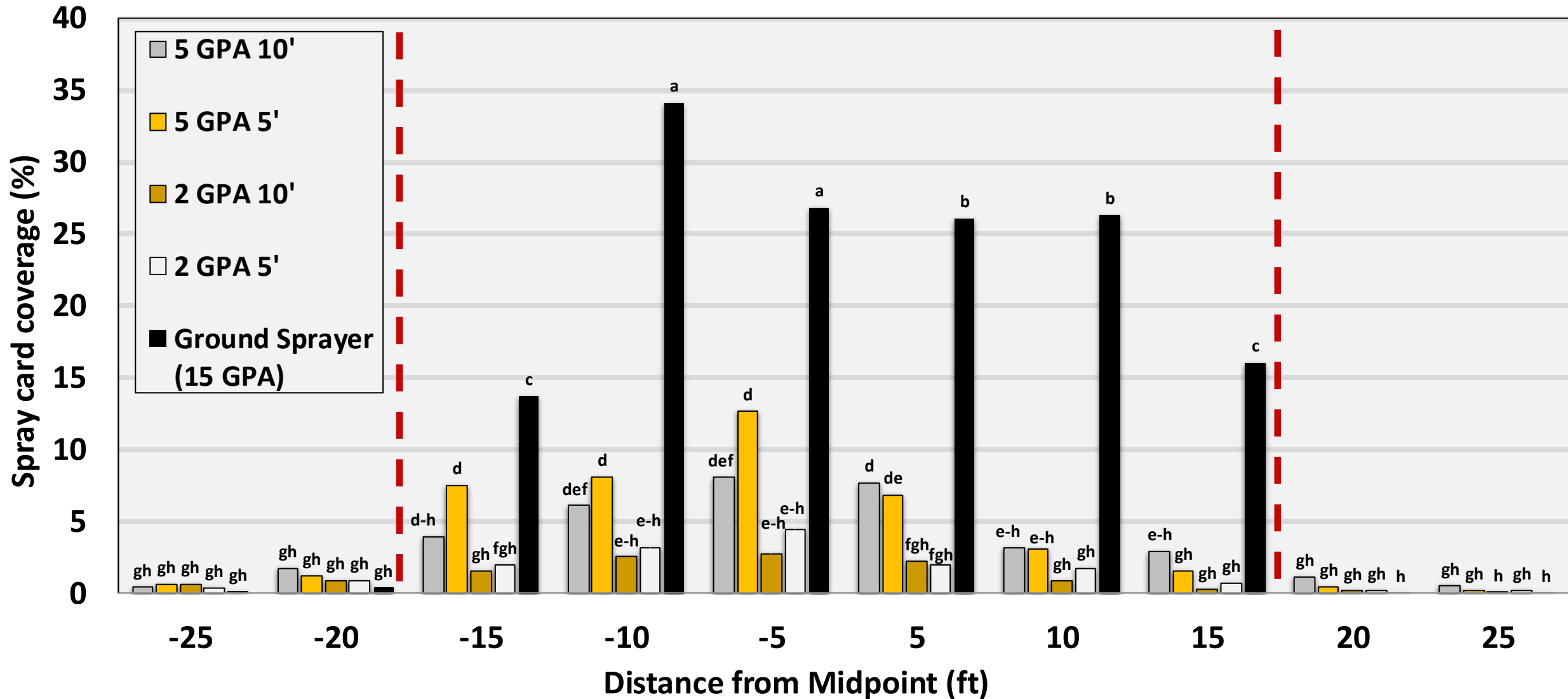- 6 fl ozs Zidua Pro / acre immediately after soybean planting

UAV Treatments:

1. 2 GPA, 5' height
2. 2 GPA, 10' height
3. 5 GPA, 5' height
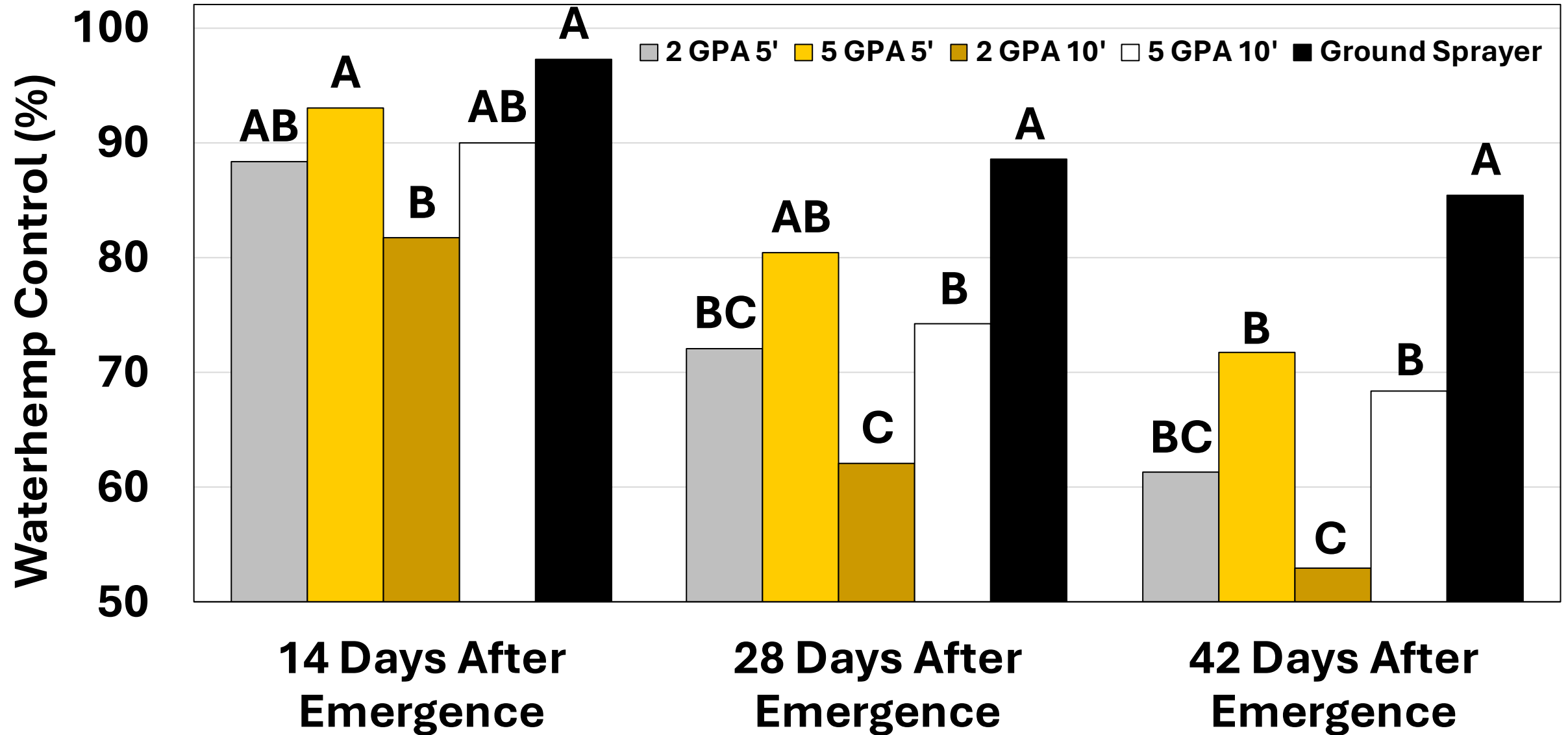4. 5 GPA, 10' height

Ground Sprayer Treatments:

- Ground sprayer equipped with AIXR 11005 nozzles, calibrated to deliver 15 GPA at 8 mph and 27-inch boom height

Spray Coverage by Treatment (Years combined)

Legend:
- 5 GPA 10'
- 5 GPA 5'
- 2 GPA 10'
- 2 GPA 5'
- Ground Sprayer (15 GPA)

Y-axis: Spray card coverage (%)

X-axis: Distance from Midpoint (ft)

*Bars within location followed by the same lowercase letters are not different, LSD=0.05.

Visual Waterhemp Control (Years Combined)

Legend: 2 GPA 5' | 5 GPA 5' | 2 GPA 10' | 5 GPA 10' | Ground Sprayer

Y-axis: Waterhemp Control (%)

X-axis: 14 Days After Emergence | 28 Days After Emergence | 42 Days After Emergence

*Bars within timing followed by the same uppercase letters are not different, LSD=0.05.

Using NDVI as a Measurement of Weed Control

NDVI Weed Control by Site-Year

Weed Control (% of NT NDVI)

Legend: 2 GPA 5', 5 GPA 5', 2 GPA 10', 5 GPA 10', Ground Sprayer

2024: BC, AB, BC, A, C
2025a: A, B, AB, AB, C
2025b: A, A, A, A, A
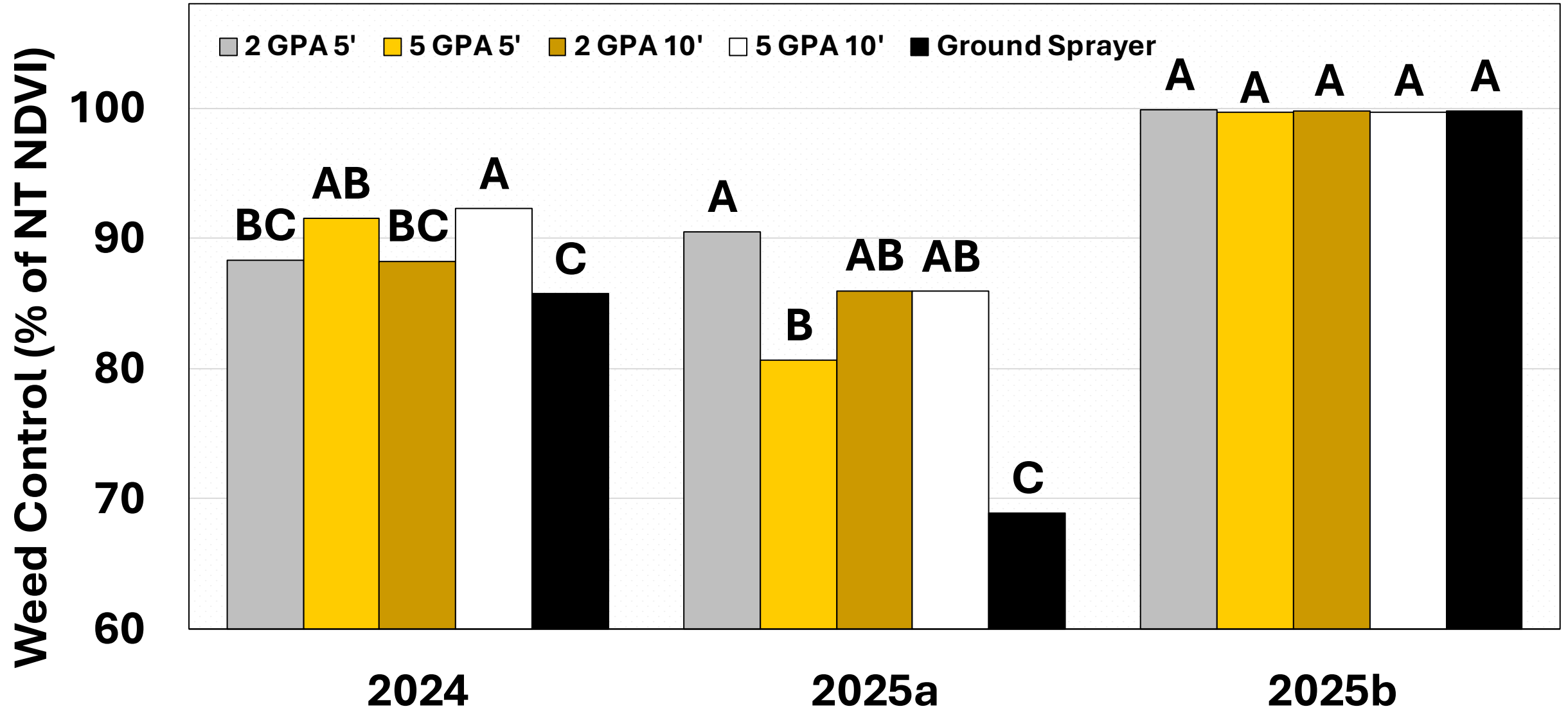
*Bars within site-year followed by the same uppercase letters are not different, LSD=0.05.

Evaluation of Targeted Spraying Utilizing DJI Agras UAV's and PIX4Dfields Software

Materials and Methods

UAV Parameters:
- Models: DJI Agras T40 & T50
- Spray Volume: 3 GPA
- Spray Classification: coarse droplet
- Spray Height: 10 ft
- Speed: ~32 ft/s
- 28 ft target swath

5 Replications (5 Targets) for each DJI Agras UAV Model
- Each UAV model conducted 1 flight attempting to hit the 5 pre-determined targets in the field.

Materials and Methods (continued)

- **PIX4Dfields**
  - 2 ft PIX grid size
  - UAV: DJI Mavic 3M
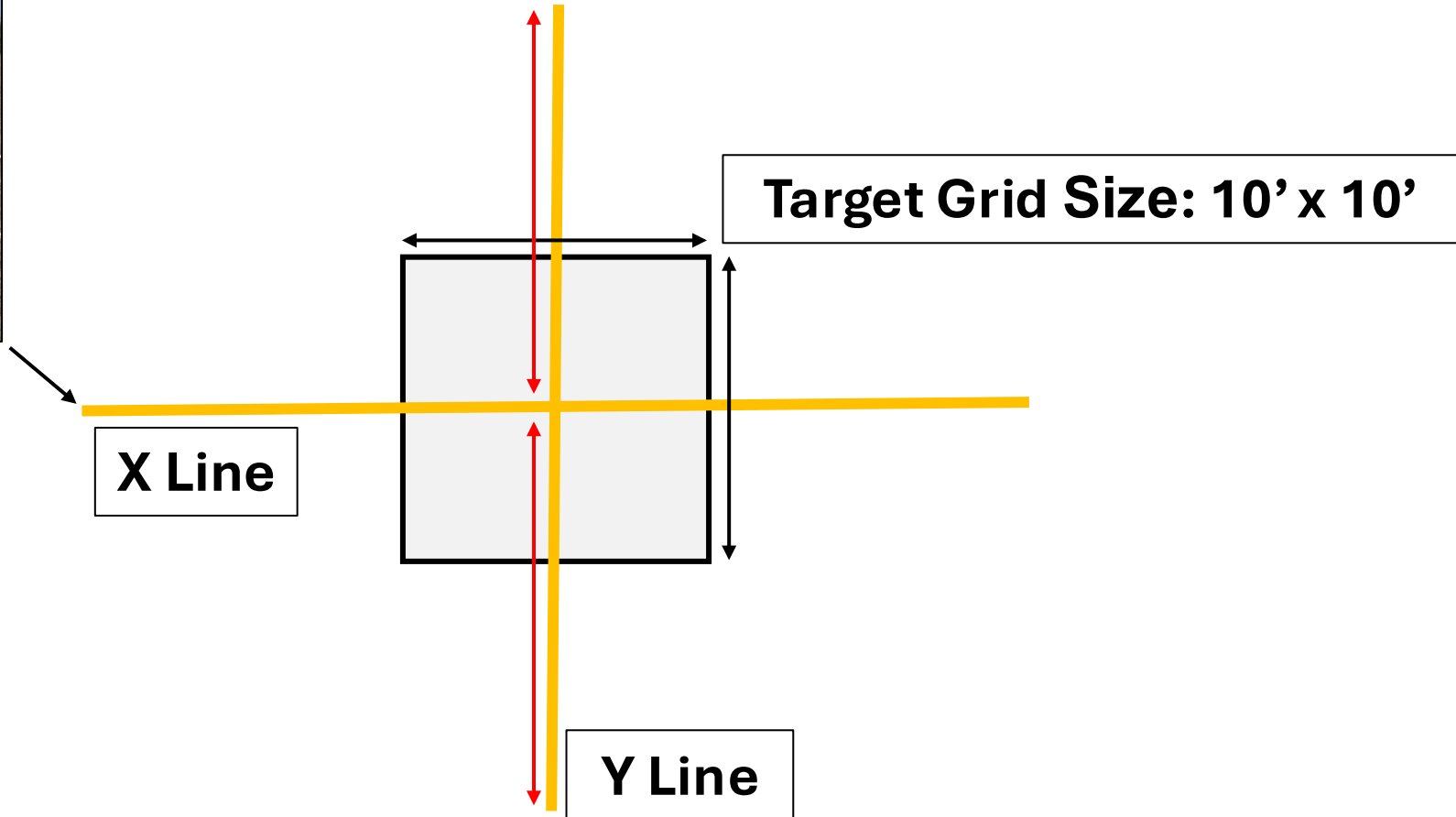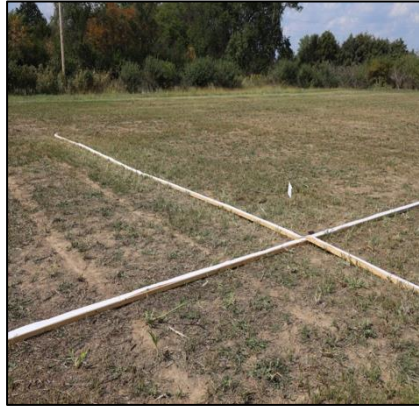
- **Paper**
  - 3"x165' 1-Ply Bond Receipt Paper
  - 0.3 % v/v Food Grade #1 Blue Dye

- **Data Analyzation**
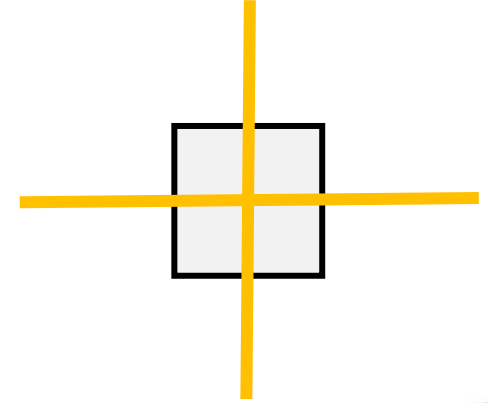 - Swath Gobbler
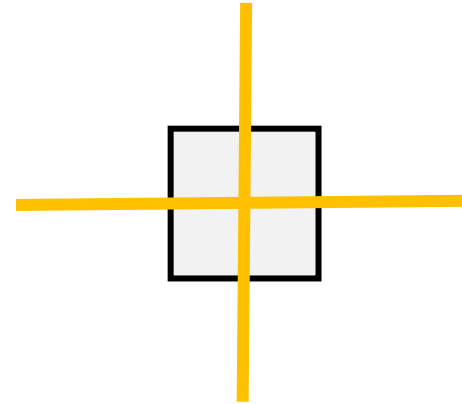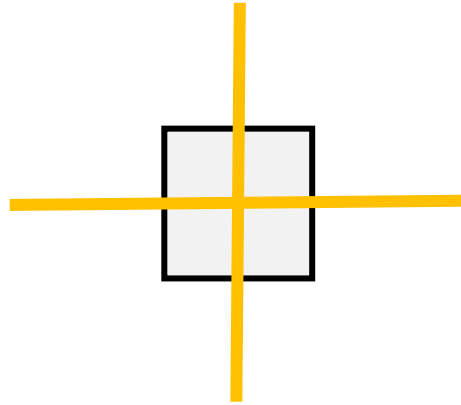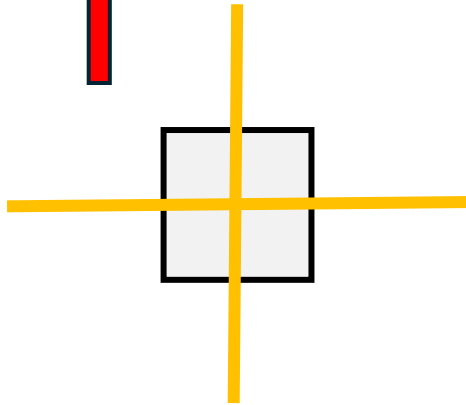 - R software, version 4.5.1

Target Setup

Target Grid Size: 10' x 10'

X Line

Y Line

X/Y Lines: 40 ft in every direction from center (total 80 ft for one line)

Spray Area Layout

Finish
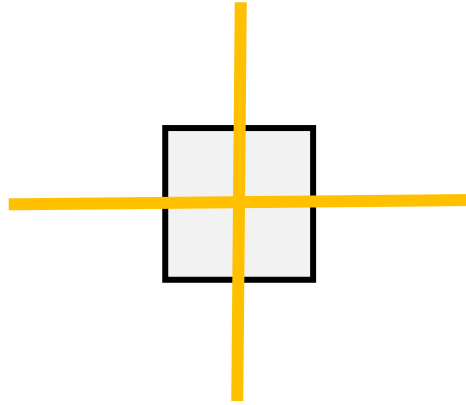
Start

Spray Area: 200' x 200'

Spray Coverage of a Targeted Area with the DJI Agras T40

- **Data averaged across 5 target passes**

- **Each bar = 1 ft interval**

- **Dotted line represents 10 ft target area**

- **Wind out of the N during application (Avg = 2.2 mph; Max = 3.2 mph)**

- **Colors represent significant differences in coverage (green = highest, red = lowest)**

Droplet Density of a Targeted Area with the DJI Agras T40

- **Data averaged across 5 target passes**

- **Each bar = 1 ft interval**
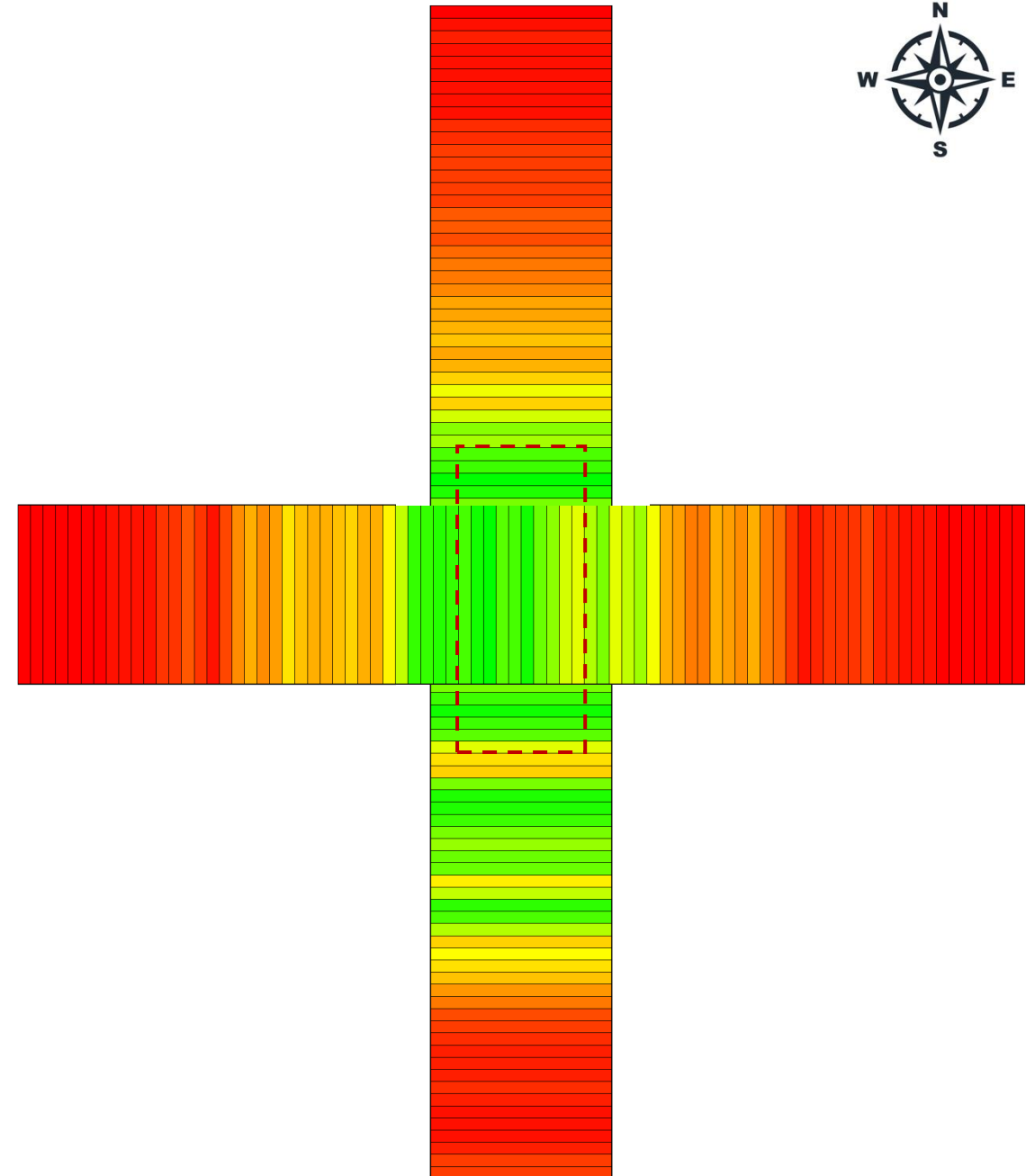
- **Dotted line represents 10 ft target area**

- **Wind out of the N during application (Avg = 2.2 mph; Max = 3.2 mph)**

- **Colors represent significant differences in coverage (green = highest, red = lowest)**

Spray Coverage of a Targeted Area with the DJI Agras T50

- **Data averaged across 5 target passes**

- **Each bar = 1 ft interval**

- **Dotted line represents 10 ft target area**

- **Wind out of the N during application (Avg = 2.5 mph; Max = 6.5 mph)**

- **Colors represent significant differences in coverage (green = highest, red = lowest)**

Droplet Density of a Targeted Area with the DJI Agras T50

- **Data averaged across 5 target passes**
- **Each bar = 1 ft interval**
- **Dotted line represents 10 ft target area**
- **Wind out of the N during application (Avg = 2.5 mph; Max = 6.5 mph)**
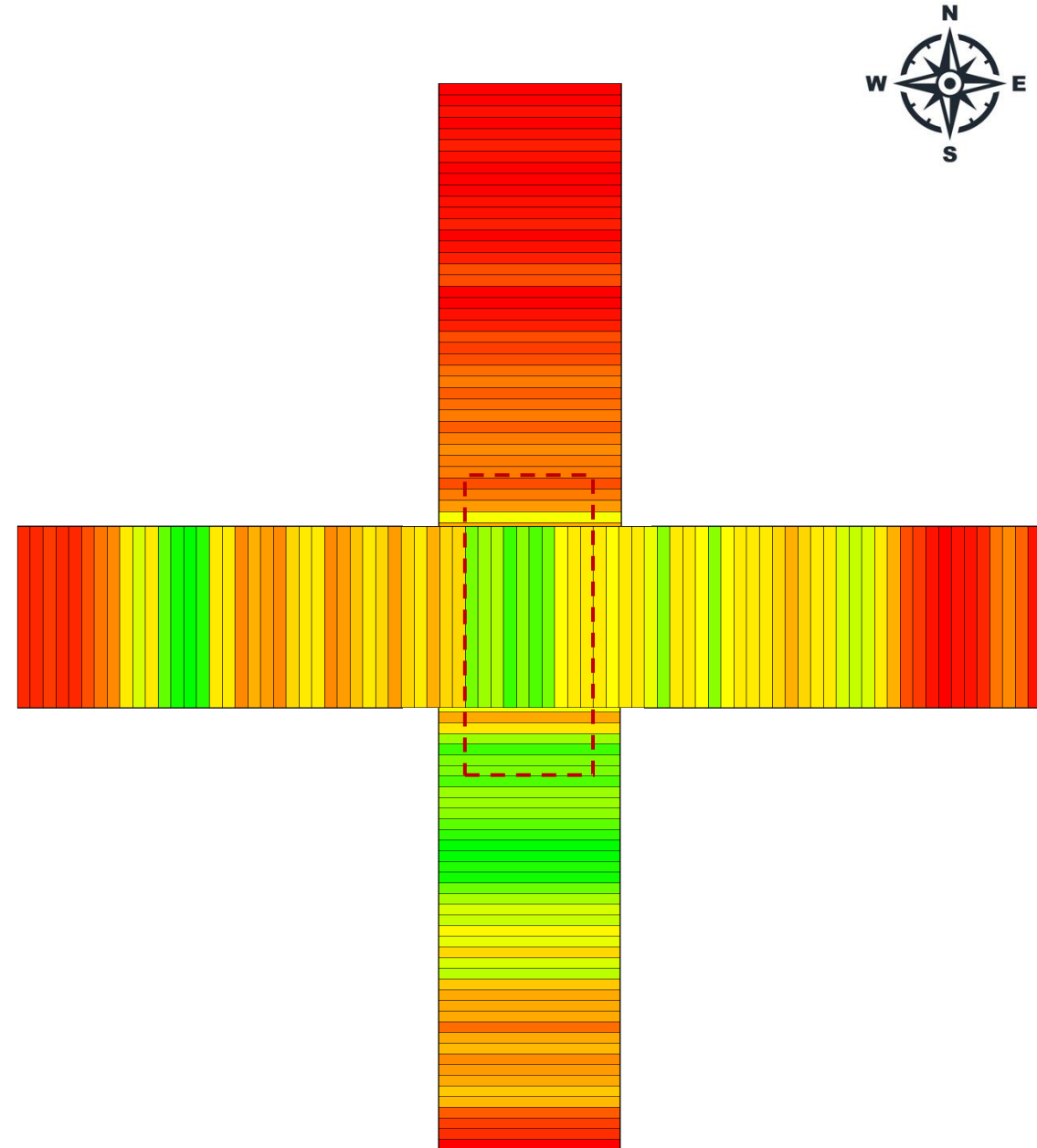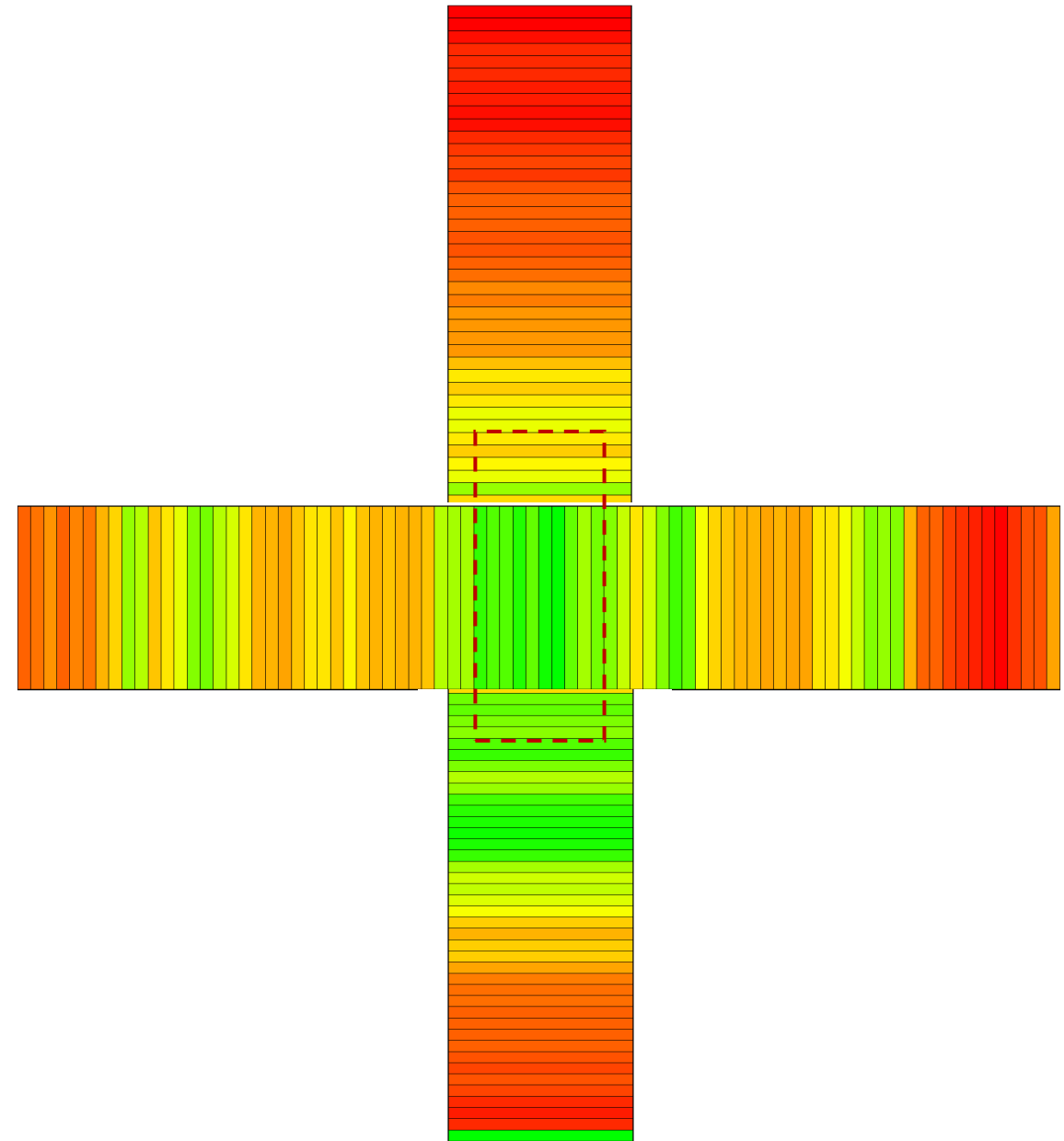- **Colors represent significant differences in coverage (green = highest, red = lowest)**

Acknowledgements

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- **Kurtz Aviation**

- **David Drewes**
- **Sam & Logan Dove**
- **Roy Cope**

Thoughts on Spray Drones from a Lowly Weed Scientist

Herbicides and Spray Drones

- **50+ years of research have taught us that carrier volume (GPA) and droplet size are important aspects of successful weed control.**

Review of Weed Science Literature Pertaining to the Effects of Carrier Volume on **Pre-emergence** Herbicide Performance

Study	Carrier Volumes Evaluated (GPA)	Weed(s) Evaluated	Herbicide(s) Evaluated	Effect of Decreasing Carrier Volume on Weed Control
Borger et al. 2015	5, 8, 10	Ryegrass	Treflan	↓
Borger et al. 2013	3, 5, 7, 10, 15	Ryegrass	Treflan Zidua	↓ ↓
Striegel et al. 2021	2.5, 5, 10, 15, 17.5	Ragweeds Annual Grasses	Resicore Acuron Flexi Anthem Maxx	= = =

Review of Weed Science Literature Pertaining to the Effects of Carrier Volume on Post-emergence Herbicide Performance

Study	Carrier Volumes Evaluated (GPA)	Weed(s) Evaluated	Herbicide(s) Evaluated	Effect of Reducing Carrier Volume on Weed Control
Meyer et al. 2016	10, 20	Barnyardgrass Palmer Amaranth Morningglories	Gly + Dicamba	↓ ↓ ↓
Ramsdale et al. 2001	5, 10, 20	Sunflower	Raptor Aim	= =
Creech et al. 2015	5, 7.5, 10, 15, 20, 30	Giant Ragweed	Cobra 2,4-D	↓ =
McWhorter & Hanks 1993	10, 40	Johnsongrass	Assure Fusilade	= =
Etheridge et al. 2001	5, 10	Cocklebur	Glufosinate Glyphosate	↓* ↑*
Ramsdale et al. 2003	2.5, 5, 10, 20	Annual Grasses	Glyphosate	↑
Krausz et al. 1996	10, 20	Velvetleaf Lambsquarters Morningglories	Glyphosate	↓ = =

*Results varied based on nozzle type evaluated.

Thoughts on Spray Drones from a Lowly Weed Scientist

Herbicides and Spray Drones

- **50+ years of research have taught us that carrier volume (GPA) and droplet size are important aspects of successful weed control.**

- **Future efforts should focus on reducing the variability that can exist w/ herbicides and spray drones.**

- **Are herbicide manufacturers/EPA/ state departments of ag ready for this?**

- **Targeted spraying may be where we need to "land" for now.**

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