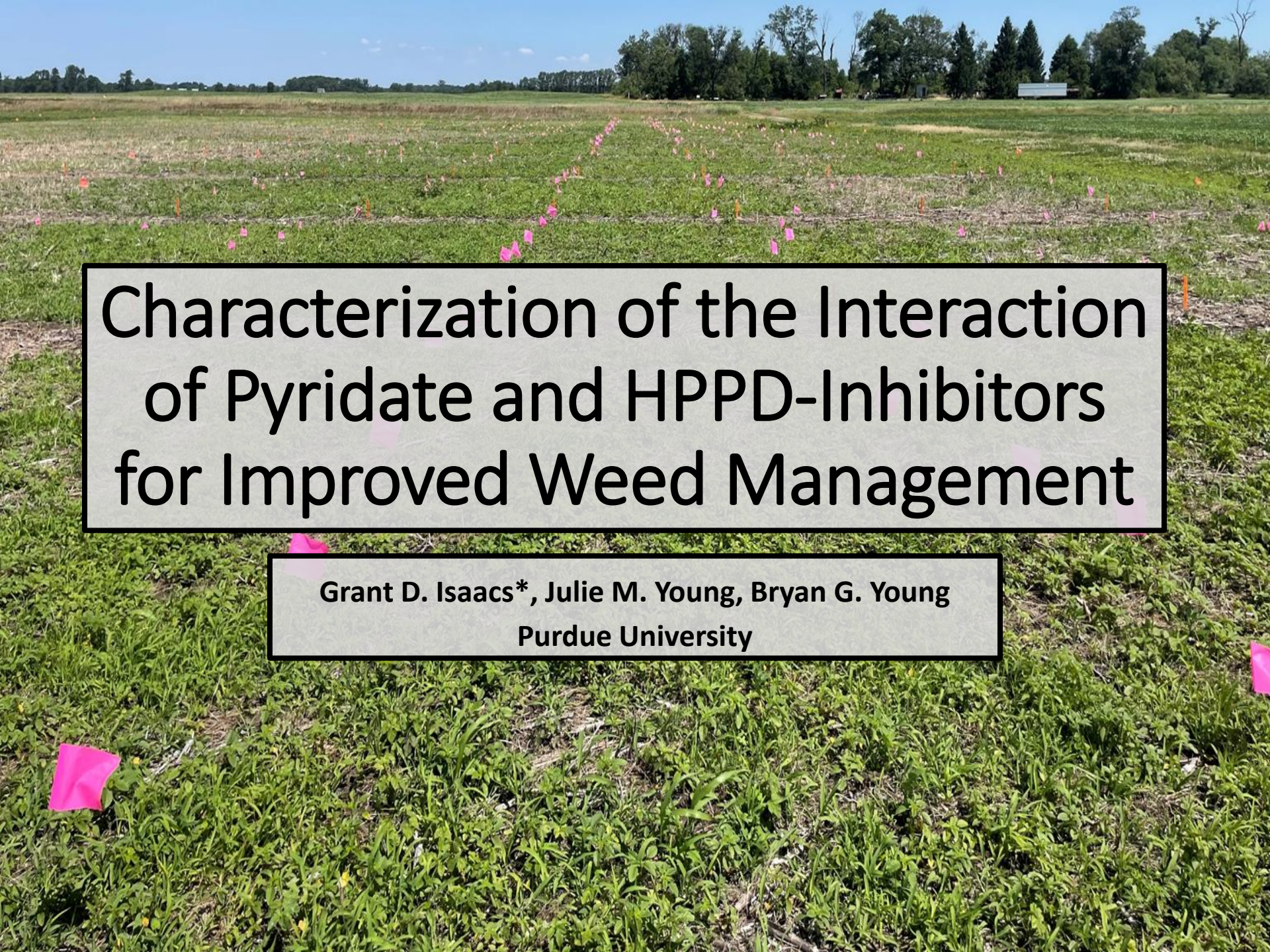


Characterization of the Interaction of Pyridate and HPPD-Inhibitors for Improved Weed Management

Grant D. Isaacs*, Julie M. Young, Bryan G. Young

Purdue University

Pyridate

- HRAC Group 6 inhibitor of PSII – histidine 215 binder [1]

- Contact foliar activity, selective to broadleaf weeds, including waterhemp (*Amaranthus tuberculatus*) and Palmer amaranth (*Amaranthus palmeri*) [1]

[1]Anonymous (2022)

Photosystem II Herbicide Interactions

- Synergistic interactions between PSII- and HPPD-inhibitors, such as atrazine and mesotrione [1,3,4]
- PSII- and HPPD-inhibitors often tank mixed for increased control and to broaden the weed control spectrum [2]

[1]Chahal et al. 2018
[2]Fluttert et al. 2022
[3]Hess 2000
[4]Woodyard et al. 2009

Photosystem II Herbicide Interactions

- Numerous corn herbicide premixes contain atrazine and a Group 27 herbicide [1]
- Documented resistance to atrazine in waterhemp [2,3,5]
  - Target site resistance to Group 5 herbicides
  - Non-target site resistance to atrazine (metabolism) [4]
- Limited research on the interaction between pyridate and HPPD-inhibitors

[1]Essman et al. 2024
[2]Foes et al. 1998
[3]Hirschberg et al. 1983
[4]O'Brien et al. 2018
[5]Woodyard et al. 2009

Alternate Hypothesis

Pyridate applied in combination with mesotrione or tembotrione will have a synergistic interaction, increasing the control of atrazine-sensitive and atrazine-resistant *Amaranthus* species.

Objective

Characterize the interaction between pyridate and HPPD-inhibitors (mesotrione, tembotrione) on atrazine-sensitive waterhemp, atrazine-resistant waterhemp, and atrazine-sensitive Palmer amaranth biotypes.

Materials and Methods – Field

- Biotypes
  - Atrazine-sensitive
    - Waterhemp
    - Palmer amaranth
  - Atrazine-resistant
    - Waterhemp
- 5 plants per plot marked prior to herbicide application (13 cm)
- Application
  - CO_2 backpack sprayer, 2 m hand boom, XR 8002 nozzles
  - Calibrated to deliver 140 L ha^{-1} at 207 kPa

Herbicide Treatment	Rate (g ai ha^{-1})
Nontreated	---
Pyridate	350
Mesotrione	53
Tembotrione	46 or 92
Pyridate + Mesotrione	350 + 53
Pyridate + Tembotrione	350 + 46 or 92
*All treatments contained COC and AMS at 1% v/v	

Materials and Methods – Field

- RCBD with 4 replicates
- Data Collection:
  - Visual weed control estimates at 7, 14, 21, and 28 days after treatment (DAT)
  - Aboveground biomass collected at 28 DAT

Materials and Methods – Greenhouse

Herbicide Treatment	Rate (g ai ha^{-1})
Nontreated	---
Pyridate	350
Mesotrione	20
Tembotrione	2
Pyridate + Mesotrione	350 + 20
Pyridate + Tembotrione	350 + 2
*All treatments contained COC and AMS at 1% v/v	

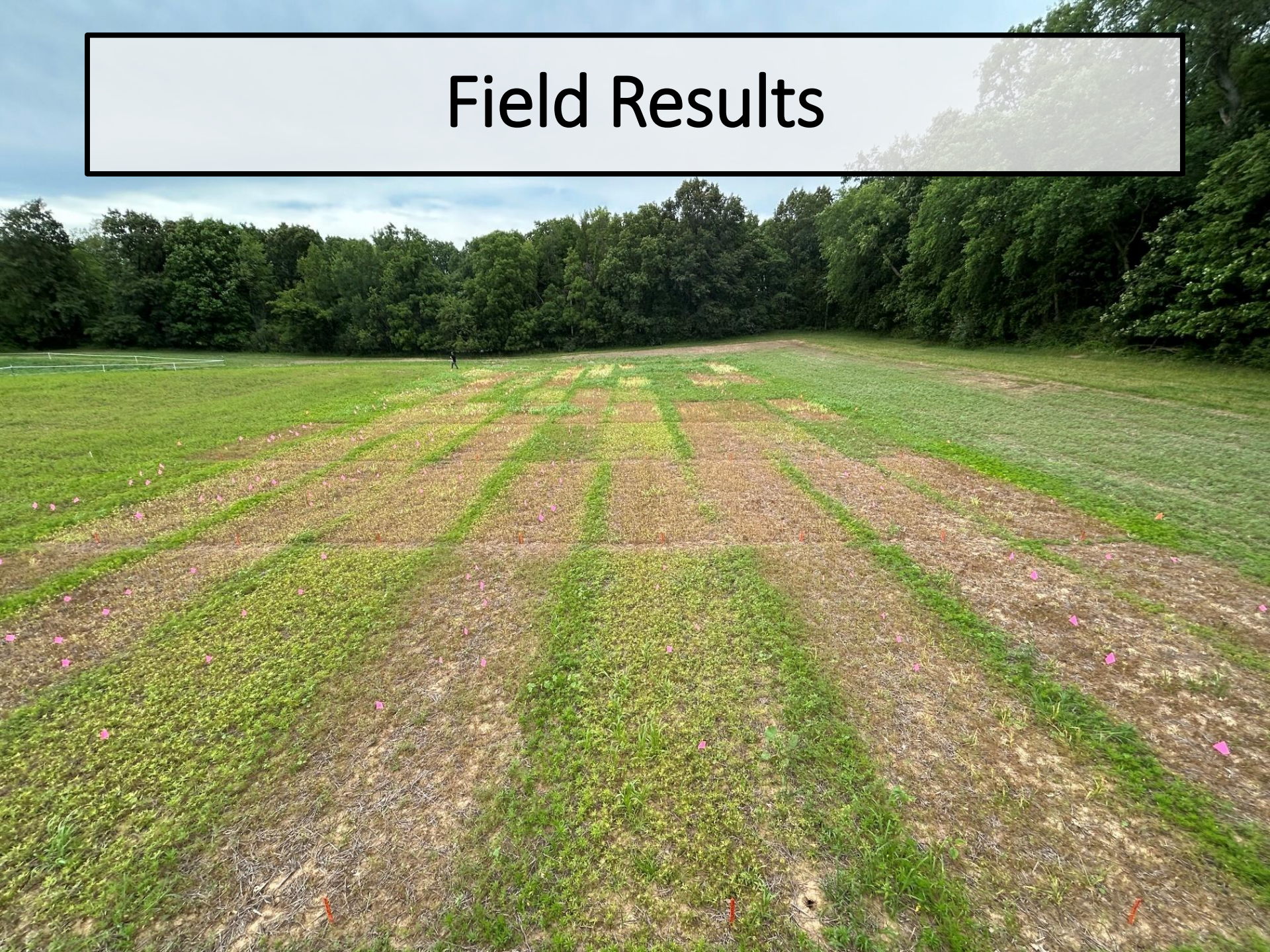
- RCBD, conducted twice
- Herbicides applied at 140 L ha^{-1} with XR 8002 nozzle
- Waterhemp biotypes
  - Atrazine-sensitive
  - Atrazine-resistant (NTS)
- Weed height: 7 to 10 cm
- Data collection
  - Visual weed control estimates at 7 and 14 DAT
  - Aboveground biomass at 14 DAT

Materials and Methods
Data Analysis

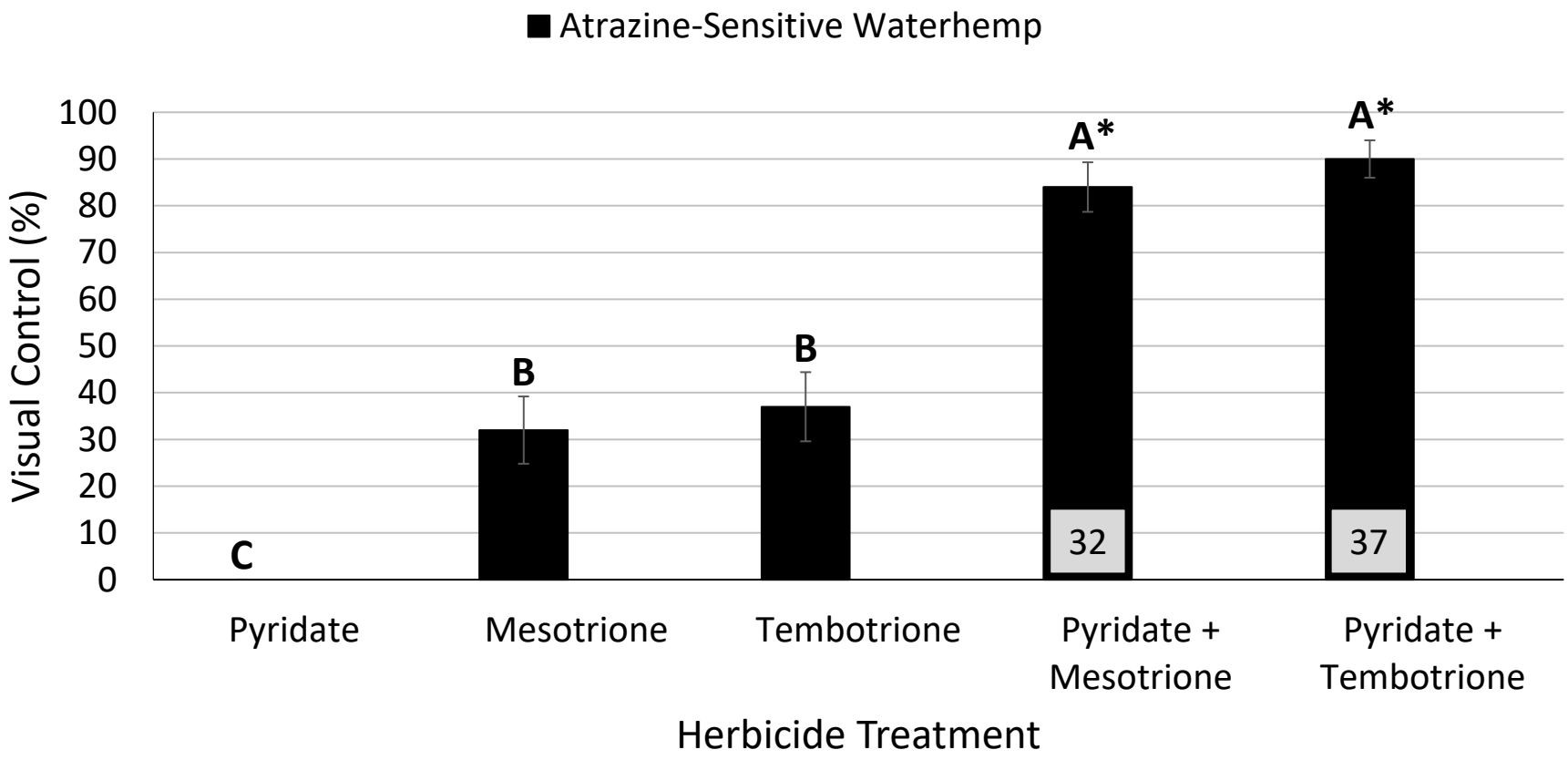
- Visual control estimates and biomass reduction subjected to ANOVA using Tukey's HSD ($\alpha = 0.05$)
- Colby's Method[1] was used to determine the interaction between pyridate + mesotrione and pyridate + tembotrione
  - $Expected\ control = \frac{(X*Y)}{100}$
  - Observed and expected values used in two sided t-test ($P < 0.05$)
- Statistical analyses performed using RStudio (4.3.2)

[1]Colby 1967

Field Results



Field Results
Atrazine-Sensitive *Amaranthus* Species 28 DAT



(*) = synergism based on Colby's Method
Values at base of bar is the expected control based on Colby's Method
Uppercase letters represent mean separation for waterhemp
Bars represent mean standard error

Atrazine-Sensitive Waterhemp 28 DAT

Nontreated

Pyridate

Mesotrione

Pyridate + Mesotrione

Atrazine-Sensitive Waterhemp 28 DAT

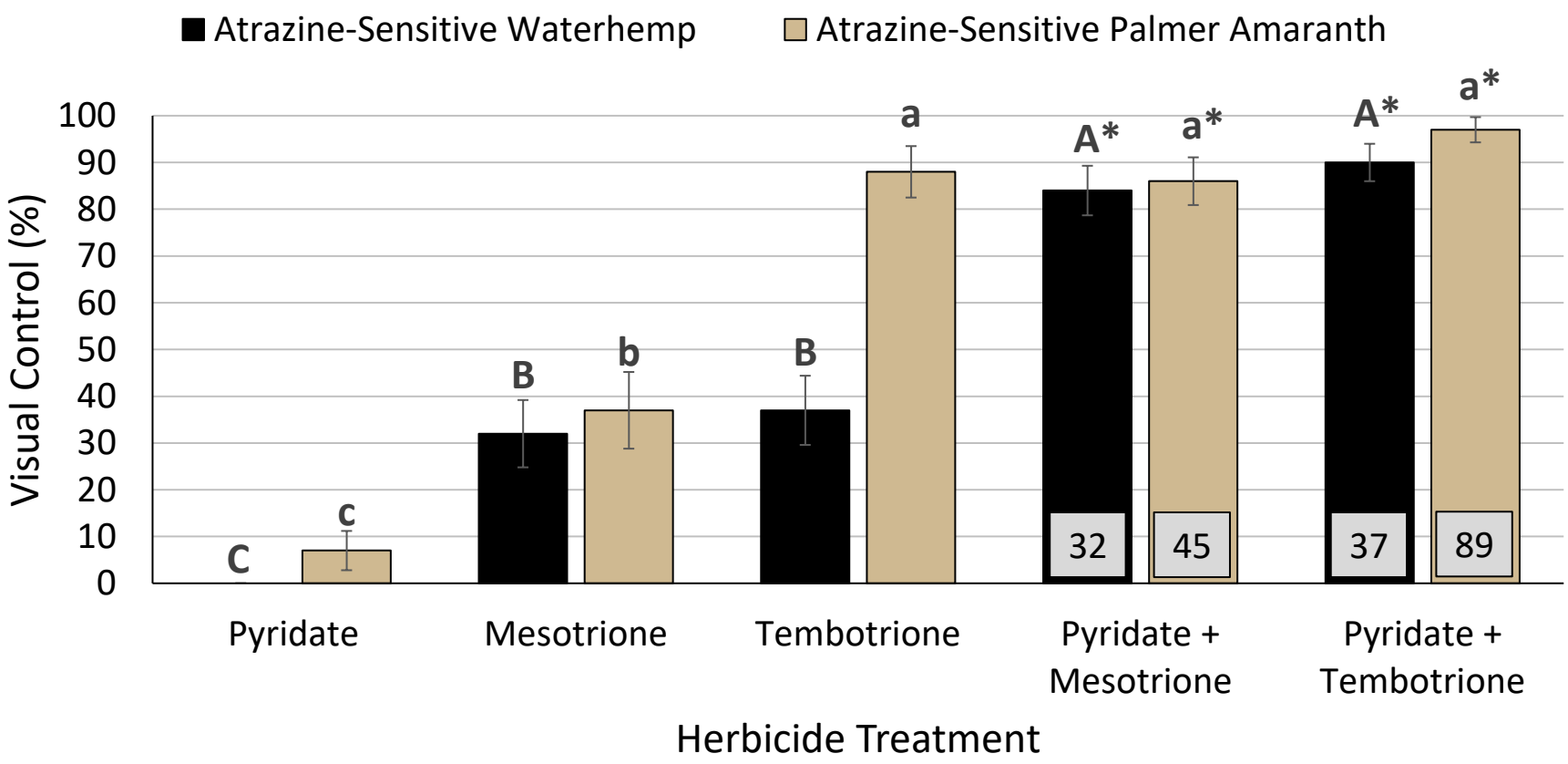
Nontreated

Pyridate

Tembotrione

Pyridate + Tembotrione

Field Results
Atrazine-Sensitive *Amaranthus* Species 28 DAT

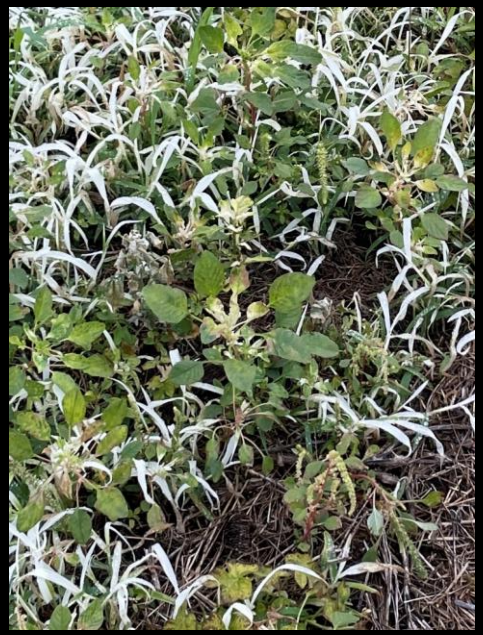


(*) = synergism based on Colby's Method
Values at base of bar is the expected control based on Colby's Method
Uppercase letters represent mean separation for waterhemp
Lowercase letters represent mean separation for Palmer amaranth
Bars represent mean standard error

Atrazine-Sensitive Palmer amaranth 7 DAT

Nontreated

Pyridate



Mesotrione

Pyridate + Mesotrione

Atrazine-Sensitive Palmer amaranth 7 DAT

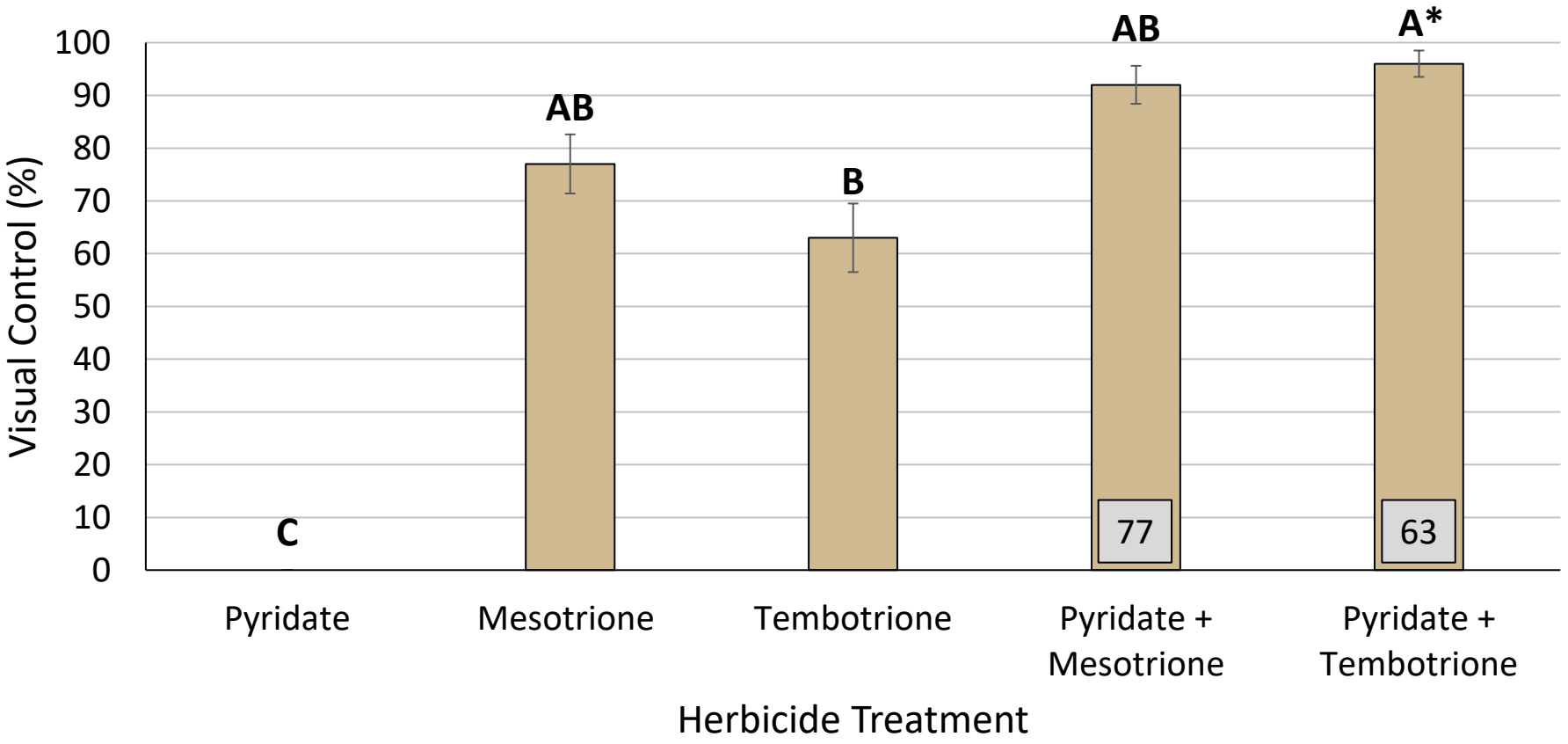
Nontreated

Pyridate

Tembotrione

Pyridate + Tembotrione

Field Results
Atrazine-Resistant Waterhemp 28 DAT



(*) = synergism based on Colby's Method
Values at base of bar is the expected control based on Colby's Method
Letters represent mean separation at 28 DAT
Bars represent mean standard error

Atrazine-Resistant Waterhemp 28 DAT

Nontreated

Pyridate

Mesotrione

Pyridate + Mesotrione

Atrazine-Resistant Waterhemp 28 DAT

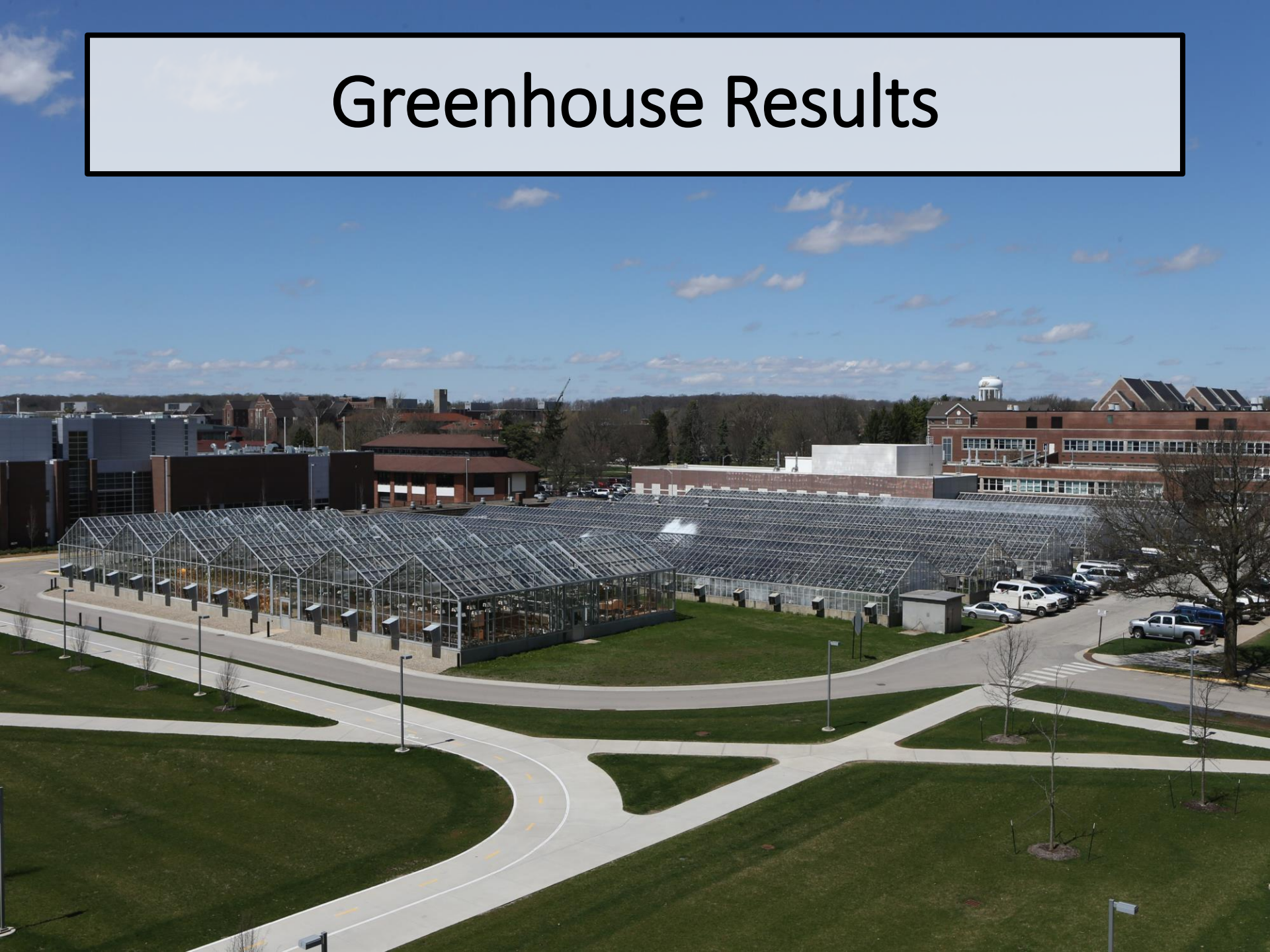
Nontreated

Pyridate

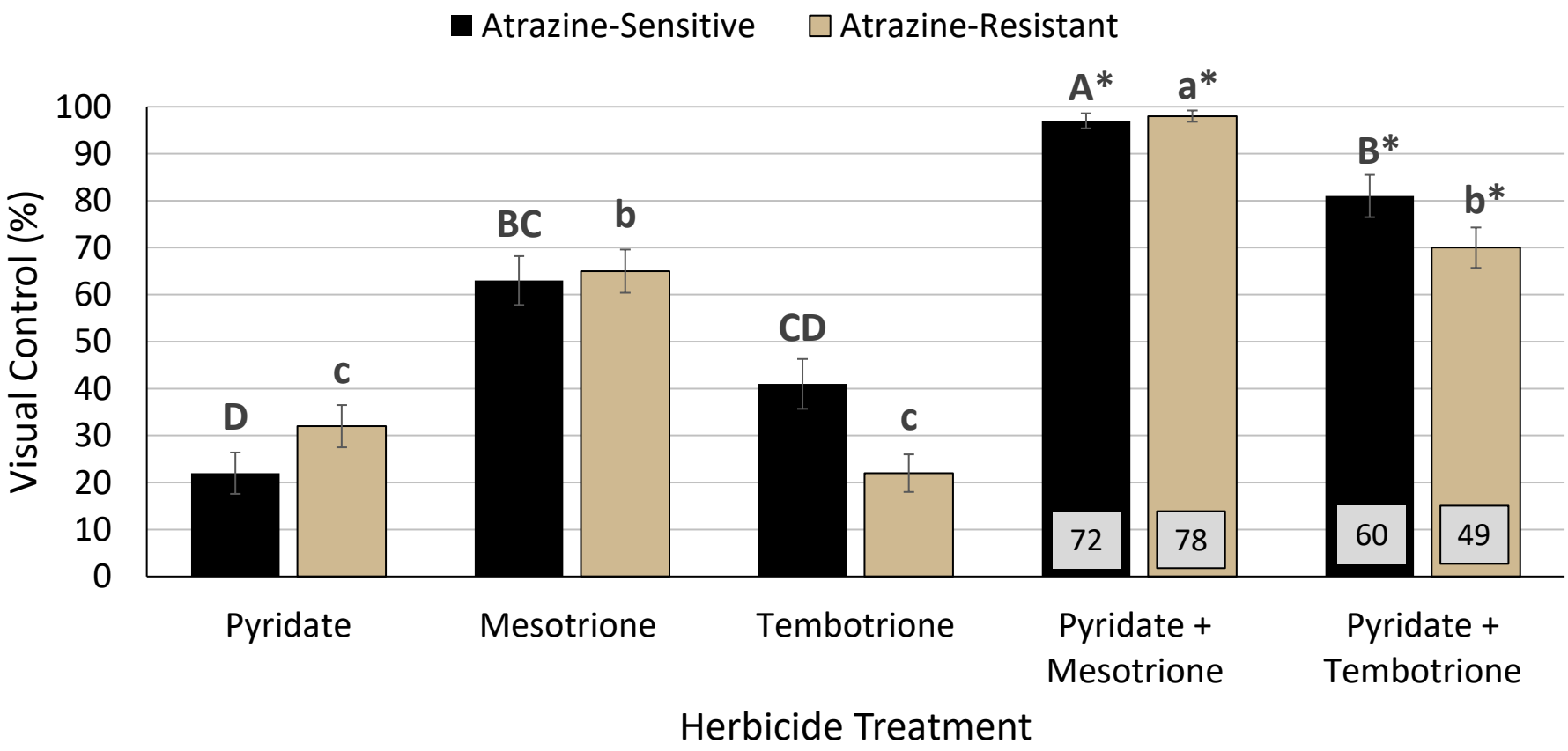
Tembotrione

Pyridate + Tembotrione

Greenhouse Results



Greenhouse Results
Waterhemp Control 14 DAT



(*) = synergism based on Colby's Method
Values at base of bar is the expected control based on Colby's Method
Uppercase letters represent mean separation in the atrazine-sensitive biotype
Lowercase letters represent mean separation in the atrazine-resistant biotype
Bars represent mean standard error

Atrazine-Sensitive Waterhemp 14 DAT

Nontreated

Pyridate

Mesotrione

Pyridate + Mesotrione

Nontreated

Pyridate

Tembotrione

Pyridate + Tembotrione

Atrazine-Resistant Waterhemp 14 DAT

Nontreated

Pyridate

Mesotrione

Pyridate + Mesotrione

Nontreated

Pyridate

Tembotrione

Pyridate + Tembotrione

Conclusions and Implications

Conclusions:

- Efficacy on atrazine-sensitive *Amaranthus* species was synergistic for pyridate applied with both mesotrione and tembotrione from 7 to 28 DAT
- Additive responses were observed from the combination of pyridate and HPPD-inhibitors on atrazine-resistant waterhemp

Implications:

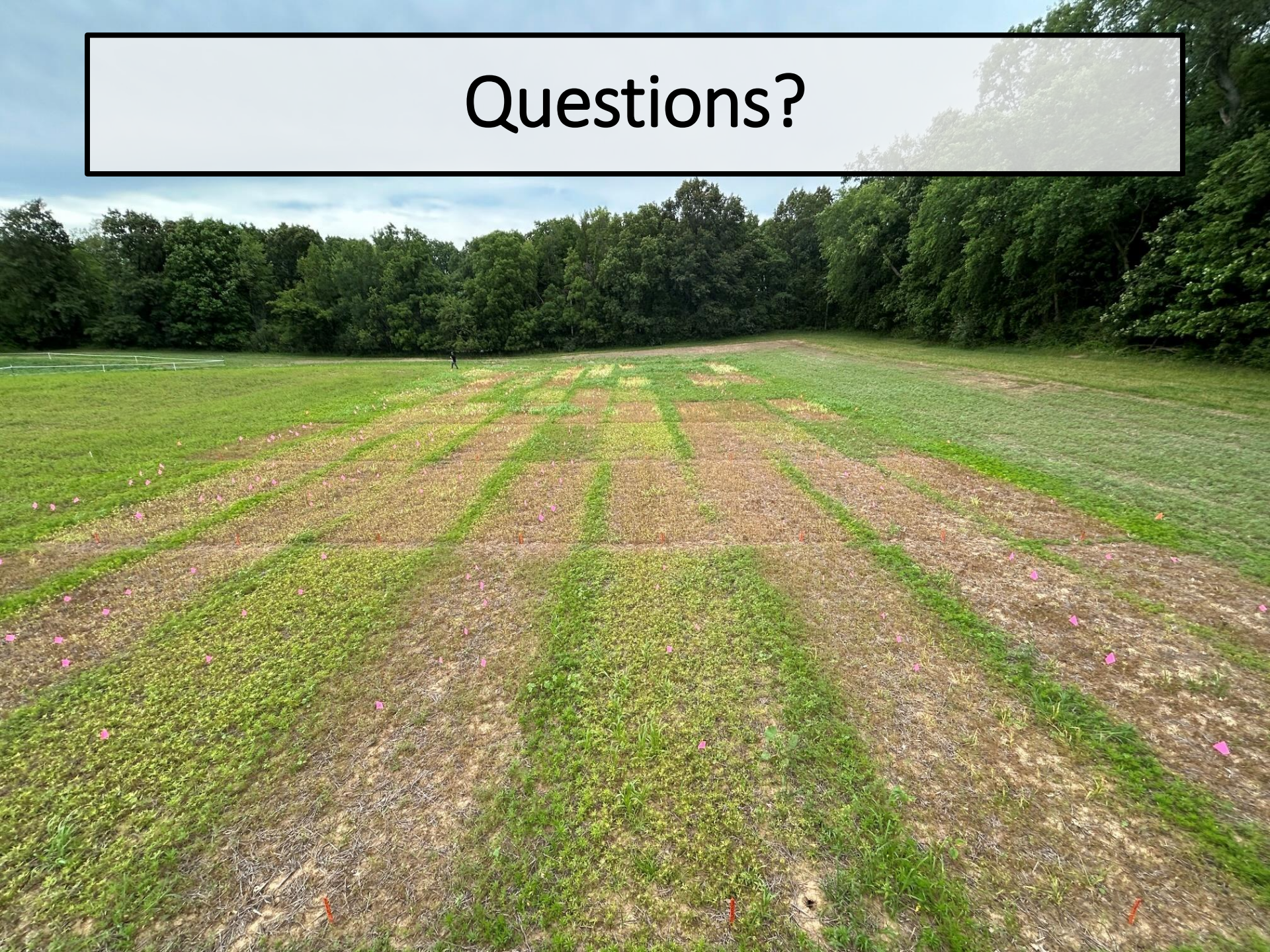
- Combining pyridate with mesotrione or tembotrione may increase the control of problematic *Amaranthus* species
- Postemergence applications of pyridate with HPPD-inhibitors remains efficacious on atrazine-resistant (metabolic) waterhemp

Future Research

- Repeat field trials in 2025
- Investigate the influence of adjuvants on the interaction between pyridate and HPPD-inhibitors
- Evaluate the efficacy of pyridate and HPPD-inhibitors with other tank-mix partners for broad-spectrum weed control

Acknowledgements

- Special thanks to the Purdue Weed Science team for the help and support


Questions?