

Introduction

The use of multiple, effective herbicide modes of action in a tank mixture has been recommended to slow resistance evolution in waterhemp (*Amaranthus tuberculatus*), which potentially allows growers to prolong the use of current herbicides.¹ Synergistic herbicide interactions have been reported between photosystem II (PSII) and HPPD-inhibitors, most commonly for the herbicides atrazine plus mesotrione.^{1,2,3,4} Pyridate is a Group 6 PSII-inhibitor – Histidine 215 Binder, which has a different binding site than atrazine. Limited research has been conducted on the interaction between pyridate and HPPD-inhibitors.

Objectives / Hypothesis

Alternate Hypothesis:

The application of pyridate in combination with mesotrione or tembotrione will have a synergistic interaction on the control of waterhemp that is equivalent to atrazine sprayed with HPPD-inhibitors.

Objectives:

1. Characterize the potential interaction between pyridate and mesotrione/tembotrione herbicides on waterhemp.
2. Determine if the combination of pyridate with HPPD-inhibitors has equivalent weed control of waterhemp to a tank-mix of atrazine with HPPD-inhibitors.

Materials and Methods

- Non-crop field trial conducted at Meigs Purdue Agricultural Center in 2024 as a randomized complete block design with four replicates.
- Waterhemp targeted at 10 to 15 cm in height.
- Applications were made with a pressurized CO₂ backpack sprayer calibrated to deliver 140 L ha⁻¹ at 172 kPa with a 2 m hand boom equipped with four XR 8002 nozzles.

Table 1: Herbicide Treatments (g ai ha⁻¹)

PSII-Inhibitor		HPPD-Inhibitor	
		Mesotrione	Tembotrione
None	-	53	46
Pyridate	350	350 + 53	350 + 46
Atrazine	280	280 + 53	280 + 46

*All treatments included COC and AMS at 1% v/v

Data Collection:

- Five waterhemp plants per plot marked before herbicide application for biomass collection.
- Visual weed control estimates assessed at 7, 14, 21, and 28-days after treatment (DAT).
- Aboveground biomass collection at 28 DAT, dried and weighed, then converted to percent dry biomass reduction.

Analysis:

- Analysis of variance with means separation using Tukey's HSD ($\alpha=0.05$).
- Colby's Method used to classify herbicide combinations.^{5,6}

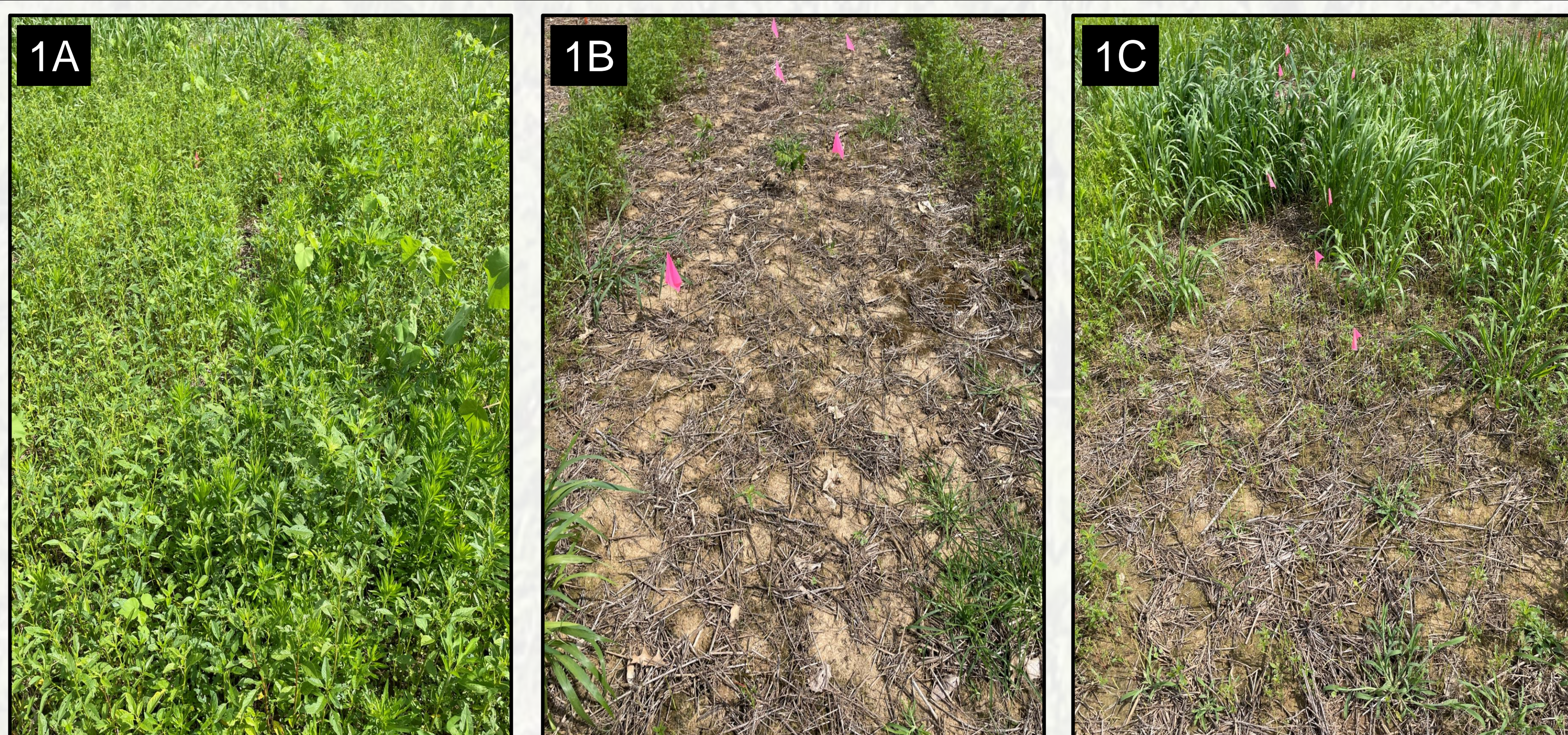


Figure 1. Whole plot photos displaying waterhemp control 28 DAT. (1A) Nontreated; (1B) Pyridate + Mesotrione; (1C) Atrazine + Mesotrione.

Control of Waterhemp 28 DAT

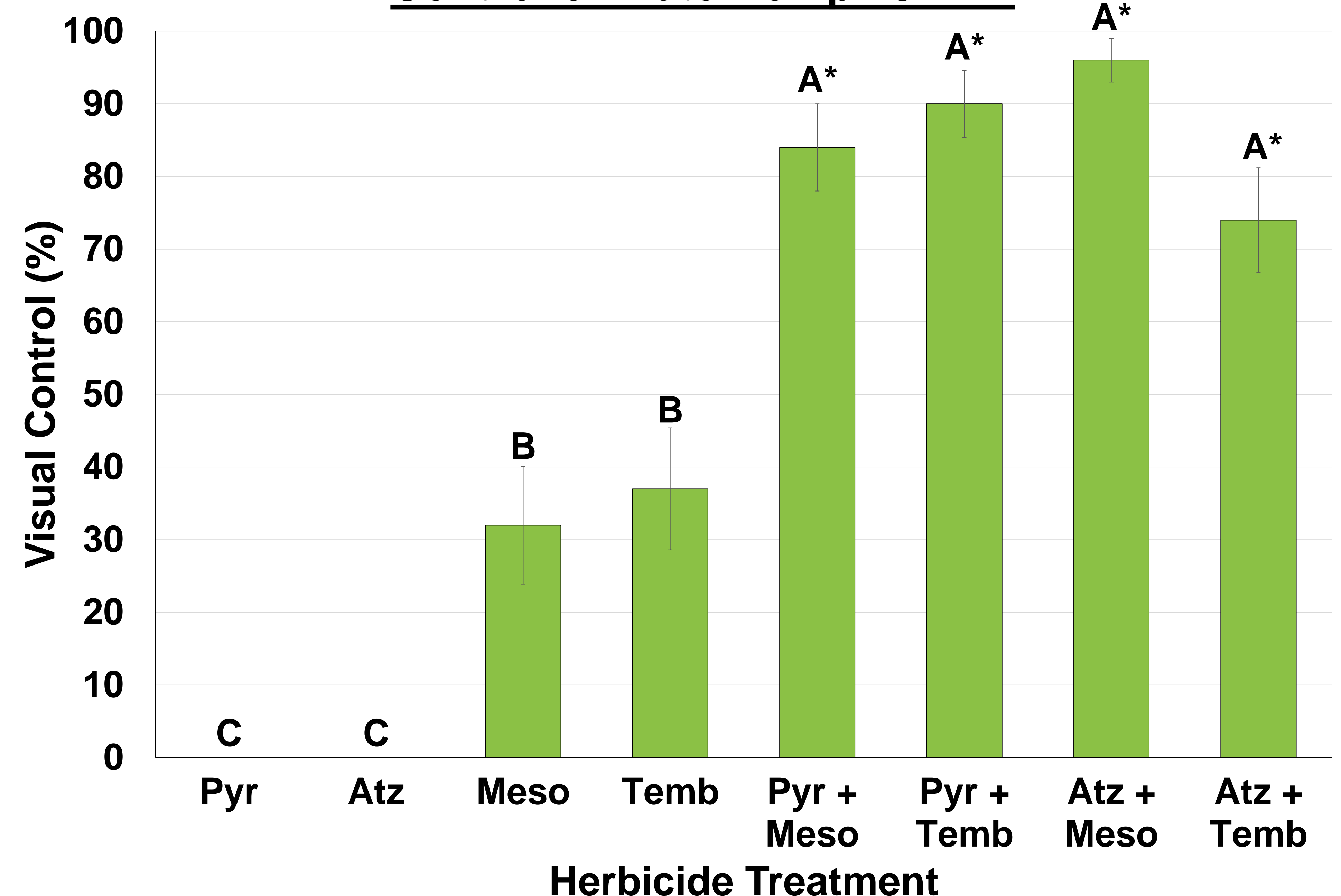


Figure 2. Weed control of waterhemp from visual control estimates 28 days after treatment. (*) = synergism based on Colby's Method; Pyr = Pyridate; Atz = Atrazine; Meso = Mesotrione; Temb = Tembotrione.

Results

- Synergistic control of waterhemp was observed for pyridate plus either mesotrione or tembotrione, with up to 53% increase in control compared to the Group 27 herbicides applied alone (Figure 2).
- Biomass reduction data aligned with visual control ratings (data not shown).
- The synergy for pyridate with the Group 27 herbicides was similar to the interactions observed for combinations with atrazine (Figure 2).
- Pyridate mixed with HPPD-inhibitors had greater than 84% control while atrazine combined with HPPD-inhibitors had greater than 74% control (Figure 2).

Conclusions

Herbicide resistance in waterhemp is becoming more prevalent, which limits the number of herbicide active ingredients that can be used for effective control of these robust weeds. This research supports the alternate hypothesis by demonstrating that the combination of pyridate and triketone herbicides has a synergistic interaction on the control of waterhemp, with pyridate tank mixtures providing comparable weed control to the combination of atrazine with HPPD-inhibitors. This may provide producers an alternative to atrazine tank mixtures for postemergence weed control.

Future Research

- Investigate the efficacy of the herbicide interaction between pyridate and HPPD-inhibitors when applied post-emergence with different types of adjuvants.
- Evaluate the efficacy of pyridate and HPPD-inhibitors with other tank-mix partners on overall weed control.

References

- ¹Abendroth JA, Martin AR, Roeth FW (2006) Plant Response to Combinations of Mesotrione and Photosystem II Inhibitors. *Weed Technology* 20:267–274
- ²Hess FD (2000) Review Light-dependent herbicides: an overview. *Weed Science* 48:160–170
- ³Woodyard AJ, Bollero GA, Riechers DE (2009) Broadleaf weed management in corn utilizing synergistic postemergence herbicide combinations. *Weed Technology* 23:513–518
- ⁴Willemsse C, Soltani N, Benoit L, Jhala AJ, Hooker DC, Robinson DE, Sikkema PH, Soltani C, Benoit N, Jhala L, Hooker AJ, Robinson DC, Sikkema DE (2019) Early postemergence herbicide tank-mixtures for control of waterhemp resistant to four herbicide modes of action in corn. *Agricultural Sciences* 12:354–369
- ⁵Barbieri GF, Young BG, Dayan FE, Streibig JC, Takano HK, Merotto A, Avila LA (2022) Herbicide mixtures: interactions and modeling. *Advances in Weed Science* 40
- ⁶Colby SR (1967) Calculating synergistic and antagonistic responses of herbicide combinations. *Weeds* 15:20–22