Season-Long Control of Glyphosate-Resistant Common Waterhemp as Influenced by Split-Applications of Very Long Chain Fatty Acid Synthesis Inhibitors in Soybean

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Introduction

- Glyphosate-resistant common waterhemp (*Amaranthus rudis* Sauer) is one of the most encountered and troublesome weeds in the midwestern United States.
- It has an extended period of emergence; therefore, preemergence and early-postemergence herbicide applications may not be effective to control later-emerging flushes.

7th June | 15th July | 20th Aug | 24th Sept

Figure 1: Extended emergence period of common waterhemp

- Several very long chain fatty acid (VLCFA) inhibitors have been registered for sequential applications in soybean; however, limited information is available on season-long control of glyphosate-resistant common waterhemp with sequential-applications of VLCFA inhibitors.

Objective

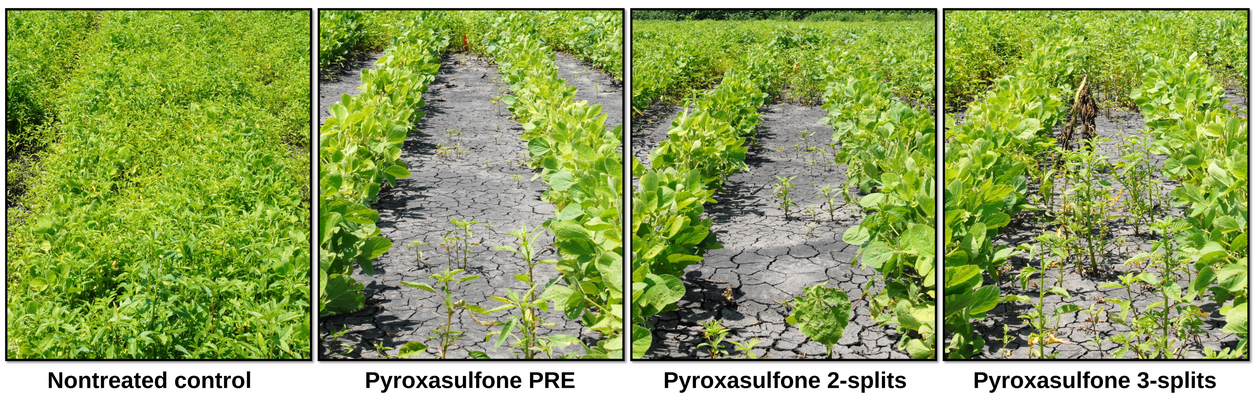
1. To evaluate the relative efficacy of VLCFA inhibitors for common waterhemp control
2. To determine if the duration of common waterhemp control could be extended with sequential applications, compared to PRE applications once at a full rate

Materials and Methods

- Field experiments were conducted in 2013 and 2014 in Dodge County, NE in a field heavily-infested (≈ 300 plants m^{-2}) with glyphosate-resistant common waterhemp.
- Experiments were laid out in randomized complete block design with four replications.
- PRE herbicides were applied at soybean planting, whereas early- and late-POST herbicide applications were made at 15- and 30- d after PRE (DAPRE) applications, respectively.
- Visual common waterhemp control, density, percent biomass reduction; and soybean injury and yield were recorded.
- Data were subjected to ANOVA using PROC GLIMMIX in SAS.
- Year-by-treatment interaction was not significant; therefore, data from both the years were combined.

Table 1: Details of herbicide treatments, and rates for control of glyphosate-resistant common waterhemp in field experiments conducted in Nebraska in 2013 and 2014

Herbicides	PRE (only)	Sequential applications		Soil info.
	— g ai ha^{-1} —	2- splits	3- splits	
Acetochlor	3,360	Half (50%) of the season-cumulative maximum rate was applied at PRE and rests at early-POST	One-third (33.3%) of season-cumulative maximum rate was applied at PRE, at early-POST, and at late-POST	• pH: 6.7 • Sand: 29% • Silt: 30% • Clay: 41% • "Clay" type soil • OM: 4%
Alachlor	2,800			
Dimethenamid-P	950			
Pyroxasulfone	179			
S-metolachlor	2,680			



Nontreated control | Pyroxasulfone PRE | Pyroxasulfone 2-splits | Pyroxasulfone 3-splits

Figure 2: Common waterhemp control at 30 DAPRE with PRE and sequential applications of pyroxasulfone

Results and Discussion

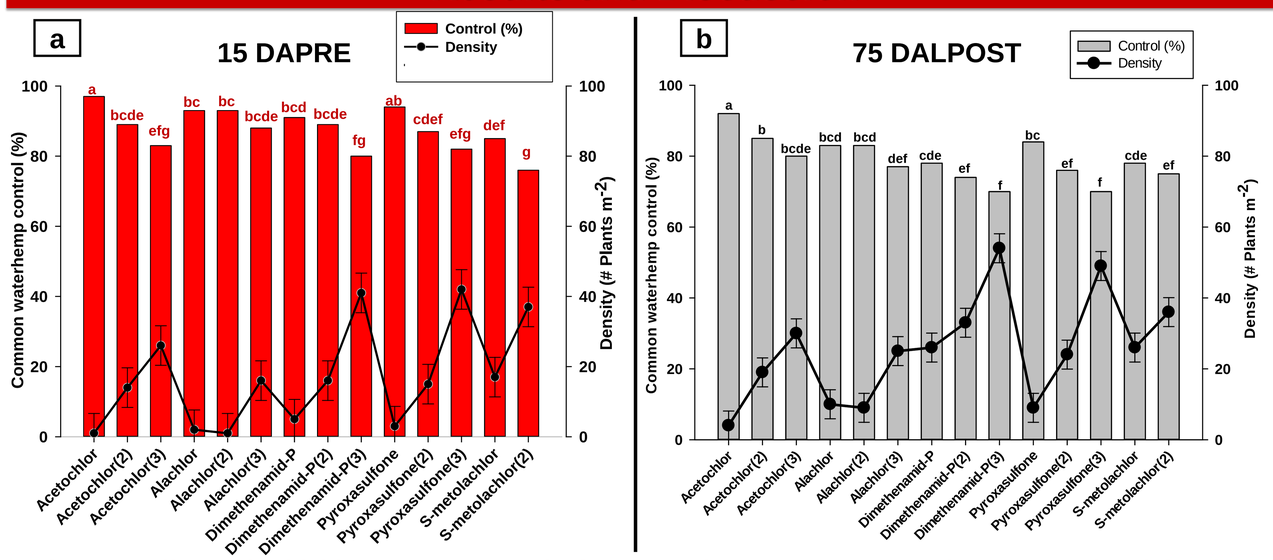


Figure 3: Effect of herbicide treatments on glyphosate-resistant common waterhemp control and density

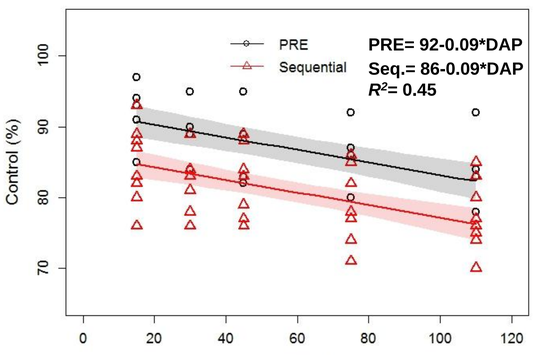


Figure 4: Common waterhemp control with PRE and sequential applications of VLCFA inhibitors

Table 2: *a priori* orthogonal contrast

Treatments	Common waterhemp control (%)			Soybean yield (MT ha^{-1})
	15 DAPRE	15 DALPO	75 DALPO	
PRE vs. Seq	92 vs. 85**	88 vs. 83**	83 vs. 77**	2.1 vs. 1.8*
PRE vs. 2-spl	92 vs. 87**	88 vs. 84*	83 vs. 79**	2.1 vs. 1.9 NS
2- vs. 3-spl	87 vs. 83 NS	84 vs. 81*	79 vs. 74*	1.9 vs. 1.8 NS

**P < 0.01; *P < 0.05; NS- Non-significant DAPRE- d after PRE DALPO- d after late-POST

- Micro-encapsulated acetochlor or pyroxasulfone applied as PRE at season-cumulative maximum rate, resulted in ≥ 94% common waterhemp control and reduced density up to 1 plant m^{-2} at 15 DAPRE (Figure 3a). Similarly, Jhala et al. (2015) reported that common waterhemp control was 99% at 15 DAPRE with acetochlor application at the same rate.
- Acetochlor as PRE (only) provided > 90% control throughout the growing season and produced highest yield of soybean (2.3 MT ha^{-1}) (Figure 3a and 3b).
- Advantages of VLCFA inhibitors:
  - Common waterhemp biotypes resistant to six herbicide sites-of-action groups have been confirmed; reducing POST herbicide options for soybean growers. PRE is a good option.
  - VLCFA inhibiting herbicides interact with many primary target sites in plants; therefore, development of resistance to these herbicides is very slow (Busi 2014).
  - For having a wide range of application flexibilities residual VLCFA inhibitors can be tank-mixed with other foliar active herbicides. Acetochlor can be applied up to R2 soybean stage.

Conclusions

- VLCFA inhibitors applied as PRE at season-cumulative maximum rate provided sufficient early season control of glyphosate-resistant common waterhemp and resulted in highest soybean yield, compared to the sequential applications of these herbicides.
- Practical implications:
  - PRE herbicides are essential for effective control of glyphosate-resistant common waterhemp.
  - Sequential application (as POST) of VLCFA inhibitors can only be done if it is tank-mixed with other foliar active herbicides. Otherwise, the sublethal dose of herbicides may hasten the evolution of resistance in weed species (Gressel 2011).
  - Diverse weed management programs including tillage, rotation of herbicide sites-of-action groups, crop rotation, and rotational use of herbicide-tolerant crops are very important.

Literature Cited

- Busi R (2014) *Pest Manag Sci* 70:1378-1384
- Gressel J (2011) *Pest Manag Sci* 67:253-257
- Jhala AJ, Malik MS, Wills JB (2015) *Can J Pl Sci* 95:973-981