

Residual Control of Waterhemp with Pre-emergence Herbicides in Soybean

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Take Home Message

- ✓ Due to its genetic variability, wide emergence window, vigorous growth potential, and prolific seed production, waterhemp has become a troublesome weed in soybean cropping systems.
- ✓ Wisconsin research summarized herein demonstrates the effectiveness of incorporating pre-emergence herbicides into waterhemp management programs.
- ✓ Effective herbicide programs should be determined on a field to field basis taking into consideration soil properties, geographic restrictions, subsequent crop(s), and soil seedbank weed species composition, pressure, and presence of herbicide resistance.
- ✓ Sustainable management of herbicide-resistant waterhemp populations requires a holistic integrated approach incorporating cultural and/or mechanical practices alongside chemical herbicide programs.
- ✓ Remember, don't let them seed. **No seed, no weed!**

Waterhemp Biology

Waterhemp (*Amaranthus tuberculatus*) is native to the United States and has become an increasingly troublesome weed in corn and soybean fields. Unlike other *Amaranthus* weeds commonly found in fields (e.g., smooth pigweed, redroot pigweed), waterhemp is a dioecious species comprising of both male and female plants. This defining characteristic allows the spread of genetic information amongst plants within and across populations which hastens the evolution and subsequent spread of herbicide resistance. As of 2019, resistance to Group 2 (ALS inhibitor), Group 9 (EPSP inhibitor), and Group 14 (PPO inhibitor) herbicides have been documented in waterhemp populations in Wisconsin. Waterhemp has a wide emergence window and vigorous growth which makes chemical control with a single herbicide application difficult. Waterhemp is also a prolific seed producer, capable of producing up to 500,000 seeds per plant which can remain viable in the soil seedbank for several years. These characteristics make waterhemp particularly difficult to manage in corn and soybean production systems.

Pre-emergence Herbicides

Pre-emergence (PRE) herbicides are applied before crop emergence, typically within 3 days after planting of soybeans. Some PRE herbicides persist in the soil to provide several weeks of residual control of small seeded weeds. PRE herbicide products available for soybeans consist of either a single active ingredient [site of action (SoA)], or a premix with multiple active ingredients from multiple SoAs.

Why Use PRE Herbicides? The use of PRE herbicides is gaining popularity in Wisconsin as an additional tool for managing herbicide-resistant weeds. Several experiments conducted in the North Central US and Canada have indicated adequate control of waterhemp with PRE herbicides containing multiple SoAs. Moreover, the use of PRE herbicides with effective SoAs is an especially important component of a diversified control program necessary for managing herbicide-resistant weeds. Utilizing PRE herbicides for waterhemp control early in the season reduces weed competition and the number of individuals that will need to be controlled with a post-emergence herbicide application.



Table 1: Site description and experimental information for the PRE comparison experiment conducted at UW-Lancaster Agricultural Research Station, Wisconsin in 2018 and 2019.

Site description	2018	2019
Previous crop	Corn	Corn
Soil type	Fayette	Fayette
Organic matter (%)	2.4	2.3
pH	7.3	7.0
Soybean planting date	5/24	5/23
Planting depth (in)	1.5	1.5
Planting population (seeds/acre)	140,000	140,000
Variety	AG21X8	AG21X7
Herbicide application date	5/25	5/26
Air temperature (°F)	78	79
Wind speed (mph)	1-3 NW	1-3 W
Nozzle tips	XR11002	XR11002
Nozzle spacing (in)	20	20
Boom height (in)	18-20	18-20
Carrier volume (gal/a)	15	15

Experiment Description: In 2018 and 2019, field experiments were conducted at the UW-Lancaster Agricultural Research Station (site information in Table 1) to evaluate multiple PRE herbicides and their residual control of waterhemp in soybean. These experiments were conducted in a RCBD with 4 replicates and were comprised of 34 total treatments which included products with single and multiple SoAs (Table 2) as well as a non-treated control for comparison. Experiment areas were fall chisel-plowed and spring cultivated prior to planting. Treatments were applied 1-3 days after planting (Table 1). For most products, specific application rates remained consistent across years; however, rates of Authority MTZ, Fierce, and Fierce XLT were adjusted to reflect the recommended rates for the soil at Lancaster Ag Research Station: Authority MTZ: 12 oz/a in 2018 to 16 oz/a in 2019; Fierce: 3.75 oz/a in 2018 to 3 oz/a in 2019; Fierce XLT: 4 oz/a in 2018 to 3.75 oz/a in 2019.

Visual evaluation of waterhemp residual control was taken at V2 soybean growth stage, approximately 25 days after treatment (DAT), and R1 growth stage, approximately 50 DAT. Percent residual control is reported on a 0–100% scale (Figure 1) which is relative to the non-treated control treatment, where the non-treated control provided 0% control. Waterhemp pressure was higher and more uniform in 2018 compared to 2019. No post-emergence herbicides were used throughout the duration of these experiments.

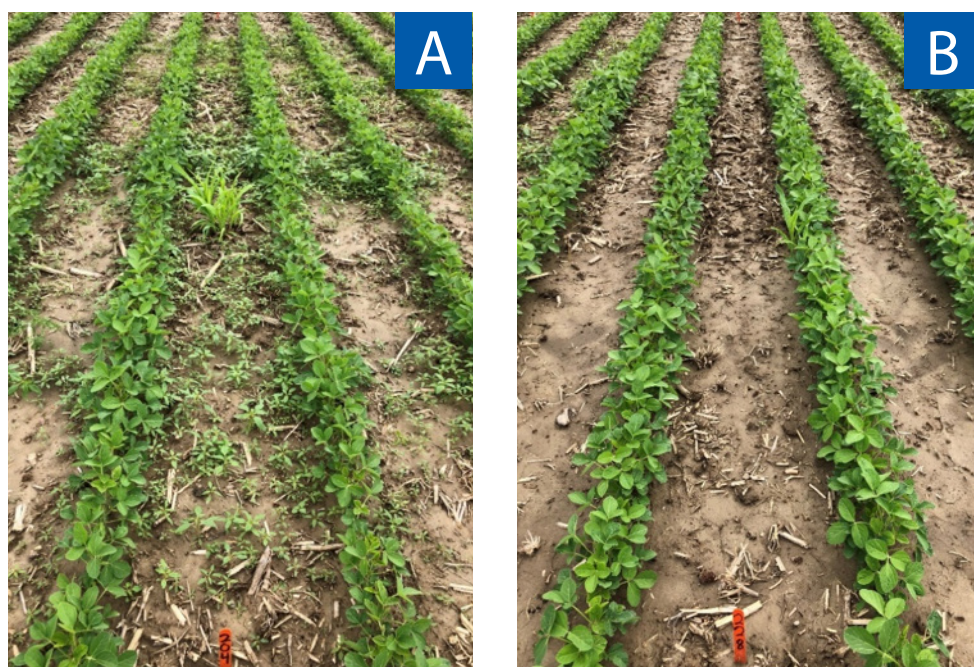


Figure 1: Visual depiction of 0% control (A) and 100% control (B) taken at 25 DAT (V3 growth stage) in the 2018 experiment held at Lancaster, WI.

Results Overview

For the purpose of this publication, effective waterhemp residual control is classified as $\geq 90\%$ control at the respective evaluation time (25 DAT or 50 DAT). In general, effective residual waterhemp control was more consistent when multiple SoAs were utilized.

2018 Results: Overall in 2018, 26 of the herbicide treatments provided effective residual control at 25 DAT (Table 3) while 21 herbicide treatments still provided effective residual control at 50 DAT (Table 3). Group 2 SoA herbicides alone did not provide effective control at either timing (Table 3).

2019 Results: Overall in 2019, 29 of the herbicide treatments provided effective residual control at 25 DAT (Table 3) while 12 herbicide treatments provided effective residual control at 50 DAT (Table 3). Group 2 SoA herbicides alone did not provide effective control at either timing (Table 3).

Conclusion

The results from these experiments indicate the importance PRE herbicides have for waterhemp management. In general, products that included multiple SoAs more consistently resulted in greater than 90% waterhemp residual control. Alone, group 2 (ALS inhibitor) herbicides did not provide adequate waterhemp control in either year. The waterhemp population from Lancaster Agricultural Research Station was screened by members of the UW-Madison Cropping Systems Weed Science Lab and determined to be resistant to Group 2 herbicides. This explains the relative ineffectiveness in residual control by Group 2 herbicides, when sprayed alone. Half rates were included in addition to full rates of Group 15 herbicides as some may look to reduce rates to save on overall herbicide costs. The results from these experiments indicate the importance of using full rates, as the full rates often improved the overall residual control compared to half rates. It should be noted that the authors of this publication support the use of labeled rates. Effective herbicide programs should be determined on a field to field basis taking into consideration weed species composition, pressure, and presence of herbicide resistance in the soil seedbank. Additionally, soil properties including soil texture, percent organic matter, pH, and geographic restrictions should be considered when selecting products and determining rates as these can have an impact on the efficacy of herbicides with residual activity and potential carryover into subsequent crops. Continued management of herbicide-resistant waterhemp populations will require an integrated weed management strategy incorporating cultural/or and mechanical practices alongside chemical herbicide programs.

Table 2: Herbicide information including application rates, site of action (SoA) group, active ingredient concentration and equivalent tank mix (when applicable).

For a full list of color-coded SoA groups for Wisconsin, search for the **Herbicide Mode of Action Chart** at ipcm.wisc.edu

Herbicide (application rate per acre)	SoA group (site of action)	Active ingredient [ai concentration]	Equivalent tank mix per acre
Pursuit (4 fl oz)	2 (ALS)	imazethapyr [2.0 lb/gal]	Not Applicable (NA)
Classic (3 oz)	2 (ALS)	chlorimuron-ethyl [25%]	NA
FirstRate (0.6 oz)	2 (ALS)	cloransulam-methyl [84%]	NA
Tricor DF (10.7 oz)	5 (PSII)	metribuzin [75%]	NA
Spartan (8 fl oz)	14 (PPO)	sulfentrazone [4.0 lb/gal]	NA
Valor SX (3 oz)	14 (PPO)	flumioxazin [51%]	NA
Sharpen (1 fl oz)	14 (PPO)	saflufenacil [2.85 lb/gal]	NA
Warrant (24 fl oz)	15 (LCFA)	acetochlor [3.0 lb/gal]	NA
Warrant (48 fl oz)	15 (LCFA)	acetochlor [3.0 lb/gal]	NA
Dual II Magnum (13.4 fl oz)	15 (LCFA)	S-metolachlor [7.64 lb/gal]	NA
Dual II Magnum (26.7 fl oz)	15 (LCFA)	S-metolachlor [7.64 lb/gal]	NA
Outlook (9 fl oz)	15 (LCFA)	dimethenamid-P [6.0 lb/gal]	NA
Outlook (18 fl oz)	15 (LCFA)	dimethenamid-P [6.0 lb/gal]	NA
Zidua (1.5 oz)	15 (LCFA)	pyroxasulfone [85%]	NA
Zidua (3 oz)	15 (LCFA)	pyroxasulfone [85%]	NA
Authority Assist (10 fl oz)	2 & 14	imazethapyr + sulfentrazone	3.3 fl oz Pursuit + 8.3 fl oz Spartan
Sonic (6.45 oz)*	2 & 14	cloransulam-methyl + sulfentrazone	0.6 oz FirstRate + 8.0 fl oz Spartan
Surveil (3.5 oz)	2 & 14	cloransulam-methyl + flumioxazin	0.5 oz FirstRate + 2.5 oz Valor SX
Valor XLT (3 oz)	2 & 14	chlorimuron-ethyl + flumioxazin	1.24 oz Classic + 1.8 oz Valor SX
Broadaxe XC (25 fl oz)	14 & 15	sulfentrazone + S-metolachlor	4.4 fl oz Spartan + 20.6 fl oz Dual II Magnum
Authority MTZ (16 oz)**	14 & 15	metribuzin + sulfentrazone	5.76 oz Tricor DF + 5.76 fl oz Spartan
Authority Supreme (8 fl oz)	14 & 15	sulfentrazone + pyroxasulfone	4.15 fl oz Spartan + 2.45 oz Zidua
Verdict (5 fl oz)	14 & 15	saflufenacil + dimethenamid-P	1.0 fl oz Sharpen + 4.15 fl oz Outlook
Prefix (32 fl oz)	14 & 15	fomesafen + S-metolachlor	16.2 fl oz Flexstar + 18.2 fl oz Dual II Magnum
Fierce (3 oz)**	14 & 15	flumioxazin + pyroxasulfone	1.97 oz Valor SX + 2.0 oz Zidua
Boundary (28.8 fl oz)	5 & 15	metribuzin + S-metolachlor	6.0 oz Tricor DF + 19.8 fl oz Dual II Magnum
Canopy DF (2.25 oz)	2 & 5	chlorimuron-ethyl + metribuzin	1.0 oz Classic + 1.95 oz Tricor DF
Enlite (2.8 oz)	2 & 14	chlorimuron-ethyl + thifensulfuron-methyl + flumioxazin	0.32 oz Classic + 0.05 oz Harmony + 2.0 oz Valor SX
Afforia (2.5 oz)	2 & 14	thifensulfuron-methyl + tribenuron-methyl + flumioxazin	0.25 oz Harmony + 0.25 oz Express + 2.0 oz Valor SX
Trivence (6 oz)	2 & 5 & 14	chlorimuron-ethyl + metribuzin + flumioxazin	0.94 oz Classic + 3.56 oz Tricor DF + 1.5 oz Valor SX
Zidua PRO (6 fl oz)	2 & 14 & 15	imazethapyr + saflufenacil + pyroxasulfone	4.0 fl oz Pursuit + 1.0 oz Sharpen + 2.0 oz Zidua
Fierce XLT (3.75 oz)**	2 & 14 & 15	chlorimuron-ethyl + flumioxazin + pyroxasulfone	1.0 oz Classic + 1.8 oz Valor SX + 1.38 oz Zidua
Fierce MTZ (16 fl oz)	5 & 14 & 15	metribuzin + flumioxazin + pyroxasulfone	6.0 fl oz metribuzin + 2.0 oz Valor SX + 1.5 oz Zidua

*Sonic at 6.45 oz/a is equivalent to Authority First at 6.45 oz/a

**Application rates of were adjusted: Authority MTZ: 12 oz/a in 2018 to 16 oz/a in 2019; Fierce: 3.75 oz/a in 2018 to 3 oz/a in 2019; Fierce XLT: 4 oz/a in 2018 to 3.75 oz/a in 2019

For more information about this and other Wisconsin Cropping Systems Weed Science projects, please visit:

www.wiscweeds.info

Table 3: Waterhemp control ratings at 25 and 50 days after treatment (DAT).



Additional Resources:

Faleco, F., D. Stoltenberg, M. Renz, and R. Werle. 2020. Wisconsin Waterhemp Herbicide Resistance Project – 2019 Update. <http://www.wiscweeds.info/post/wisconsin-waterhemp-herbicide-resistance-project-2019-update/>

Werle, R., R. DeWerff, M. Oliveira, S. Striegel, N. Arsenijevic, and V. Ribeiro. 2018 Wisconsin Weed Science Research Report. http://www.wiscweeds.info/img/2018%20Research%20Report/2018%20Wis-Weeds%20Research%20Report_Web.pdf

Smith, D.H, R. Proost, and R. Werle. 2019. UW Waterhemp Challenge: Preliminary Report, Comparison of Soil Residual Herbicides. http://www.wiscweeds.info/img/2018%20waterhemp%20challenge/Waterhemp%20Management%20PRE%20Comparison_Lancaster%20WI%202018.pdf

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2018 and 2019 Lancaster Waterhemp Residual Control Rating

Herbicide (application rate per acre)	SoA group (site of action)	2018		2019	
		Soybean growth stage (days after treatment)			
		V2 (25 DAT)	R1 (50 DAT)	V2 (25 DAT)	R1 (50 DAT)
Average % control (± standard error)					
Pursuit (4 fl oz)	2 (ALS)	24 (13)	18 (7)	24 (3)	11 (2)
Classic (3 oz)	2 (ALS)	33 (19)	29 (13)	51 (7)	13 (3)
FirstRate (0.6 oz)	2 (ALS)	13 (8)	7 (4)	50 (6)	14 (3)
Tricor DF (10.7 oz)	5 (PSII)	98 (1)	92 (3)	98 (3)	73 (8)
Spartan (8 fl oz)	14 (PPO)	90 (4)	85 (5)	99 (2)	89 (3)
Valor SX (3 oz)	14 (PPO)	99 (0)	96 (3)	98 (3)	89 (3)
Sharpen (1 fl oz)	14 (PPO)	83 (8)	65 (20)	99 (2)	86 (3)
Warrant (24 fl oz)	15 (LCFA)	68 (16)	66 (13)	98 (3)	64 (11)
Warrant (48 fl oz)	15 (LCFA)	91 (4)	82 (7)	98 (2)	76 (3)
Dual II Magnum (13.4 fl oz)	15 (LCFA)	94 (5)	94 (4)	99 (2)	91 (3)
Dual II Magnum (26.7 fl oz)	15 (LCFA)	95 (2)	94 (4)	98 (3)	91 (2)
Outlook (9 fl oz)	15 (LCFA)	96 (2)	88 (5)	99 (2)	81 (5)
Outlook (18 fl oz)	15 (LCFA)	97 (3)	92 (4)	98 (3)	88 (2)
Zidua (1.5 oz)	15 (LCFA)	92 (4)	86 (7)	99 (2)	93 (2)
Zidua (3 oz)	15 (LCFA)	99 (0)	98 (1)	99 (2)	90 (2)
Authority Assist (10 fl oz)	2 & 14	99 (1)	99 (0)	99 (1)	93 (2)
Sonic (6.45 oz)	2 & 14	95 (3)	95 (4)	99 (1)	93 (3)
Surveil (3.5 oz)	2 & 14	98 (1)	91 (5)	100 (0)	89 (4)
Valor XLT (3 oz)	2 & 14	97 (2)	94 (4)	100 (0)	83 (4)
Broadaxe XC (25 fl oz)	14 & 15	96 (4)	95 (4)	100 (0)	91 (2)
Authority MTZ (16 oz)*	14 & 15	84 (9)	75 (15)	100 (0)	89 (4)
Authority Supreme (8 fl oz)	14 & 15	96 (4)	92 (5)	100 (0)	93 (2)
Verdict (5 fl oz)	14 & 15	96 (3)	91 (5)	100 (0)	80 (7)
Prefix (32 fl oz)	14 & 15	99 (0)	99 (1)	100 (0)	91 (3)
Fierce (3 oz)*	14 & 15	99 (1)	98 (1)	100 (0)	89 (3)
Boundary (28.8 fl oz)	5 & 15	99 (0)	94 (6)	100 (0)	89 (3)
Canopy DF (2.25 oz)	2 & 5	64 (19)	47 (19)	84 (12)	50 (18)
Enlite (2.8 oz)	2 & 14	99 (0)	97 (1)	100 (0)	91 (4)
Afforia (2.5 oz)	2 & 14	97 (2)	91 (2)	100 (0)	84 (4)
Trivence (6 oz)	2 & 5 & 14	96 (2)	91 (4)	100 (0)	88 (4)
Zidua PRO (6 fl oz)	2 & 14 & 15	98 (1)	93 (6)	100 (0)	91 (2)
Fierce XLT (3.75 oz)*	2 & 14 & 15	99 (0)	97 (1)	100 (0)	96 (3)
Fierce MTZ (16 fl oz)	5 & 14 & 15	99 (0)	97 (1)	100 (0)	89 (3)

*Application rates of were adjusted: Authority MTZ: 12 oz/a in 2018 to 16 oz/a in 2019; Fierce: 3.75 oz/a in 2018 to 3 oz/a in 2019; Fierce XLT: 4 oz/a in 2018 to 3.75 oz/a in 2019



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