Cropping Systems Weed Science
UNIVERSITY OF WISCONSIN-MADISON

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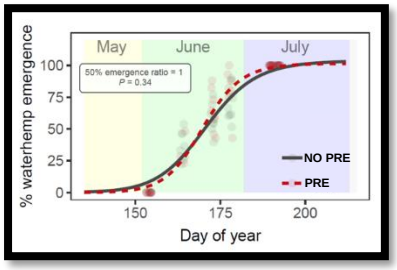
The Six R's of Waterhemp Management in Soybeans: What it Takes to Keep it Under Control

- **R**esistance – Know What Kind of Herbicide **Resistance** You Are Up Against in Your Fields
- **R**esidual – Use Soil **Residual** Herbicides from Multiple Effective Sites of Action in PRE & Layered POST
- **R**espect – **Respect** the Herbicide Labels - Full Rates, Weed Size (< 4 in), Adjuvants, Carrier Rate; Environment
- **R**otate – **Rotate** Crops and Effective Chemistries; Mix Effective SOAs; Rotate Effective Mixtures
- **R**apid – Use the Crop to Your Advantage; Adopt Management Strategies That Promote **Rapid** Canopy Closure
- **R**ogue – Go **Rogue**; Remove End-of-Season Escapes to Reduce Seedbank Replenishment & Seed Dispersal

A More Problematic Pigweed:
Waterhemp (*Amaranthus tuberculatus*) is native to the United States and is an increasingly troublesome weed in corn and soybean fields across the Midwest. In Wisconsin, waterhemp emergence starts in mid- to late-May and continues throughout the season.



Herbicide **Resistance** in waterhemp is widespread across Wisconsin. From 2018-2022, 90 Wisconsin populations were screened for resistance. As of 2022, populations have been determined to be resistant to the following herbicides: (SOA Group) – # WI counties

- **glyphosate (Group 9, EPSPS) – 38 counties**
- **imazethapyr (Group 2, ALS) – 23 counties**
- **fomesafen (Group 14, PPO) – 22 counties**
- **atrazine (Group 5, PSII) – 6 counties**
- **2,4-D or dicamba (Group 4, Auxin mimic) – 4 counties**

Targeting Waterhemp's Weaknesses:
Waterhemp is weakest when it is germinating. It's important to take advantage of this vulnerable stage through reliance on soil-applied **Residual** herbicides. Our research has shown that there are multiple PRE herbicides available in soybean that can provide excellent early season residual control. (**Table 1**, see 2019 pub for more info).

Relying on PREs alone is not sustainable as waterhemp will continue to emerge throughout the season. Moreover, resistance to PRE herbicides is a growing concern. Including a residual herbicide with your burndown POST, as part of a 'layered residual approach', can help achieve season long waterhemp control. Furthermore, 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 herbicide application. POST options in soybeans are limited and when applied alone may not achieve effective control (**Table 2**).

When selecting herbicides for your PRE fb POST layered residual waterhemp program, it is important that you select and mix ***at least 2 of the effective (>90%) PRE herbicides*** and then ***select a burndown POST herbicide to be mixed with a residual product*** to ensure season long control.

Table 1: Preemergence herbicide evaluation in 2018 and 2019 at Lancaster ARS

Product (rate ac^{-1})	Active Ingredient	Group (SOA)	2018 Waterhemp Control		2019 Waterhemp Control	
			V2 (25 DAA)	R1 (50 DAA)	V2 (25 DAA)	R1 (50 DAA)
Pursuit (4 floz)	imazethapyr	2 (ALS)	24 (13)	18 (7)	24 (3)	11 (2)
Classic (3 oz)	chlorimuron-ethyl	2 (ALS)	33 (19)	29 (13)	51 (7)	13 (3)
FirstRate (0.6 oz)	cloransulam-methyl	2 (ALS)	13 (8)	7 (4)	50 (6)	14 (3)
Tricor DF (10.7 oz)	metribuzin	5 (PSII)	98 (1)	92 (3)	98 (3)	73 (8)
Spartan (8 fl oz)	sulfentrazone	14 (PPO)	90 (4)	85 (5)	99 (2)	89 (3)
Valor SX (3 oz)	flumioxazin	14 (PPO)	99 (0)	96 (3)	98 (3)	89 (3)
Sharpen (1 floz)	saflufenacil	14 (PPO)	83 (8)	65 (20)	99 (2)	86 (3)
Warrant (48 floz)	acetochlor	15 (LCFA)	91 (4)	82 (7)	98 (2)	76 (3)
Dual II Magnum (26.7 fl oz)	S-metolachlor	15 (LCFA)	95 (2)	94 (4)	98 (3)	91 (2)
Outlook (18 floz)	dimethenamid-P	15 (LCFA)	97 (3)	92 (4)	98 (3)	88 (2)
Zidua (3 oz)	pyroxasulfone	15 (LCFA)	99 (0)	98 (1)	99 (2)	90 (2)

% control ratings evaluated at V2 (25 Days After PRE application; DAA) and R1 (50 DAA) growth stages
Numbers represent mean of 4 replications and (standard error)

Note on Challenging Soils: Herbicide label restrictions for sand and loamy sand soils with low soil organic matter and/or high pH complicate herbicide selection and application rate decisions. Herbicide performance may be challenged under these conditions and a plan should be developed for these fields, relying on an integrated strategy. Not all products listed in this publication will translate to these challenging conditions and oftentimes the label, under these soil conditions, will require a reduced application rate.

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Table 2: Postemergence herbicide evaluation on 2 – 4" waterhemp in 2019 and 2020 at Brooklyn, WI

Product (rate ac^{-1})	Active Ingredient	Group (SOA)	2019	2020
			Waterhemp Control 14 DAA	
Pursuit (4 floz)	imazethapyr	2 (ALS)	0 (0)	3 (3)
Classic (0.75 oz)	chlorimuron-ethyl	2 (ALS)	0 (0)	1 (1)
FirstRate (0.3 oz)	cloransulam-methyl	2 (ALS)	0 (0)	0 (0)
Python (1 oz)	flumetsulam	2 (ALS)	0 (0)	9 (3)
Enlist One (24 floz in 2019, 32 floz in 2020)	2,4-D choline	4 (Auxin)	77 (1)	90 (0.3)
Xtendimax (22 floz)	dicamba	4 (Auxin)	66 (2)	87 (1)
Basagran 5L (25.6 floz)	bentazon	6 (PSII)	3 (3)	0 (0)
Roundup PowerMAX (32 floz)	glyphosate	9 (EPSPS)	24 (2)	61 (1)
Liberty (32 floz)	glufosinate	10 (GS)	63 (2)	95 (2)
Cadet (0.9 floz)	fluthiacet-methyl	14 (PPO)	64 (3)	9 (3)
Cobra (12.5 floz)	lactofen	14 (PPO)	91 (3)	80 (4)
Flexstar (16 floz)	fomesafen	14 (PPO)	94 (2)	82 (4)
Resource (8 floz)	flumiclorac	14 (PPO)	65 (4)	43 (4)

% control ratings evaluated 14 Days After POST application (14 DAA)
Numbers represent mean of 4 replications and (standard error)
Enlist One is recommended to be applied at 32 floz/acre POST
POSTs applied with recommended adjuvants (click for more info; BG04)

Crop Impact on Waterhemp: Presence of corn or soybean crop influences waterhemp growth. *Right to left:* waterhemp growing on fallow ground (no crop), waterhemp growing in 15 inch soybean, 30 inch soybean, and 30 inch corn. Read more about this experiment!

Rogue it Out!: Waterhemp is 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. In general, the larger the waterhemp female plant the more seeds it will produce. If your management tactics are not entirely effective at cleaning your field of waterhemp, it is imperative that you remove (**Rogue**) those weeds from your field before seed shattering and crop harvest. Moreover, our research has shown that combines are extremely effective at spreading weed seeds. Taking the time to clean the front of the combine (head & feeder house) can serve as an additional tool for limiting weed seed dispersal.

Remember, no seed = no weed.

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The Label is the Law: It is imperative that you follow and **Respect** the label guidelines when considering herbicide applications for control of waterhemp and other weeds. Scout your fields to deliver herbicides at the proper timing, use maximum label rates, include recommended adjuvants & water conditioners, and use proper carrier rate volume to ensure maximum control. Soil residual herbicides need rainfall / irrigation for activation to be effective on germinating waterhemp. POST herbicides must be applied before waterhemp reaches 4-inch height.

Keep a Large Toolbox: There are no off years when managing waterhemp. A diverse crop **Rotation** allows greater flexibility with chemical options available in some crops that cannot be used in others. For example, rotating to corn after soybeans allows for a wider selection of herbicides including HPPD inhibitors (Group 27), PSII inhibitors (Group 5), & additional auxins (Group 4), reducing selection pressure on other sites of action. Reducing selection pressure is key to slowing down herbicide resistance evolution. This means relying on a diverse set of herbicide chemistries that represent different sites of action; however, it is important to rely on effective sites of action as rotating to herbicides with limited activity on waterhemp will not give you any advantages. It is important to remember plant-back restrictions for soil-residual herbicides when diversifying your crop rotation (e.g., winter wheat following soybean, alfalfa following corn). Another tool that can be added to your box is a fall-seeded cereal rye cover crop. Research at UW-Madison has shown that when a cereal rye cover crop is allowed to achieve a large amount of biomass (> 4,500 lb dry matter per acre) it can suppress waterhemp (and other small-seeded weeds) by 50% or more.

The Best Defense is a Good Offense: Your soybean crop can serve as an additional tool in the fight against herbicide-resistant waterhemp. Like all plants, waterhemp needs access to sunlight to grow and if we can promote **Rapid** crop canopy closure, we can affect waterhemp growth patterns. We like to call this '**Promoting Darkness**'. As many farmers are already doing, moving soybean planting dates earlier will likely result in faster canopy closure. Furthermore, UW-Madison research showed that narrow row spacing (15 inch) resulted in canopy closure 5-10 days earlier than 30 inch spacing. Additional research from UW-Madison suggests that the mere presence of a crop (soybean or corn) can significantly reduce the size (height and weight) of waterhemp. These effects on waterhemp growth can be very impactful for your management strategy. Delaying the time for waterhemp to reach 4 inches allows for more flexibility with your POST application timing, minimizes competition with your crop, and reduces the need of multiple POST applications.

HELPFUL RESOURCES:

Resistance:
- Waterhemp Got Your Worried? WiscWeeds' Been There Done That

Residual:
- 2022 Wisconsin Weed Science Research Report
- Residual Control of Waterhemp with Pre-emergence Herbicides in Soybean
- What We Have Learned From 5 Years of Chemical Waterhemp Control in Soybean

Respect:
- Application Window for Soybean Herbicides with Soil Residual Activity

Rotate:
- Winter Wheat Rotational Restrictions Following Common Soybean Residual Herbicides
- Weed Suppression in Corn-Soy Systems with Cereal Rye
- Evaluation of Foliar-applied Post-emergence Corn-Soybean Herbicides on Giant Ragweed & Waterhemp Control in Wisconsin
- Cereal Rye Cover Crop Management in Wisconsin

Rapid:
- Influence of Integrated Agronomic & Weed Management Practices on Soybean Canopy Development & Yield

Rogue:
- Weed Seed Management at Crop Harvest
- Weed Seed Movement via Combines

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