Waterhemp Research Summary: What we have learned from 5 years of chemical waterhemp control in soybean.

Since the arrival of Dr. Rodrigo Werle in 2018, the Wisconsin Herbicide Evaluation Program has conducted several chemical manufacturer and commodity board sponsored trials assessing waterhemp control in soybeans. Results of this work has been summarized and presented in the Wisconsin Weed Science Research Report, distributed annually in December, as well as several Extension presentations and publications. The purpose of this report is to boil down 5 years of research from 32 trials and over 400 treatments into a single "easy to read" report. The bulk of the data presented in this report was collected from trials established over the past four years (2019-2022) at the O'Brien Hybrids Farm located near Brooklyn, WI. The waterhemp population at this location is naturally occurring and is known to be resistant to glyphosate (group 9) and ALS (group 2) herbicides. All other data came from the Lancaster Agricultural Research Station and an on-farm location in Fond du Lac County, WI.

**Disclaimer - Results presented in this report to not constitute an endorsement of any product and does not replace any information presented on the pesticide label.*

Preemergence Residual Waterhemp Control

Preemergence (PRE) herbicide selection is the most important decision to be made to achieve season long waterhemp control. Fortunately, there are several herbicides and herbicide combinations that provide excellent residual control for up to five weeks (Table 1). Results presented in Table 1 represent all the herbicides we have evaluated in test plots with at least 16 observations, most of which came from at least a 3-year period. Combining results from multiple years provides more confidence in a herbicides performance than just looking at data collected from a single year. While the sheer number of available PRE herbicides can make it daunting to decide on what herbicide best fits your farm, the following pick list can help simplify your selection.

It is not recommended to rely on a single herbicide active ingredient (ai) or site of action (SOA). Pick one ai from a herbicide SOA group and combine with an ai from at least one other effective SOA.

SOA	Active Ingredient	Product	Min Rate for Effective Control		Effectiveness Rating
			lb ai acre^{-1}	product acre^{-1}	
14	sulfentrazone	Spartan	0.125-0.156	4-5 fl oz	good
	flumioxazin	Valor EZ	0.063	2 fl oz	good
	fomesafen	Flexstar	0.235	1 pt	fair
15	pyroxasulfone	Zidua SC	0.082	3 fl oz	good
	S-metolachlor	Dual II Magnum	1.15	1.2 pt	good
	dimethenamid	Outlook	0.656	14 fl oz	good
	acetochlor	Warrant	1.13	48 fl oz	fair-good
5	metribuzin	Tricor DF	0.28-0.38	6-8 oz	rate dependent[a]

[a]High rates of metribuzin (>10 oz) will provide good control; <4 oz will provide very little residual control

1. Rates presented are for medium textured soils. Adjust rates as necessary depending on soil type.
2. In fields with a history of high waterhemp populations or if planting soybean early, it may be advisable to use higher rates within the ranges listed on the herbicide label.
3. If combining metribuzin with a group 15 herbicide, it is recommended to use higher rates of both herbicides than the minimums listed in the table.
4. If large-seeded broadleaves (velvetleaf, common ragweed, giant ragweed, etc.) are a concern, the addition of an ALS group 2 herbicide (chlorimuron, cloransulam, or imazethapyr) will improve control.
5. Several 2- and 3-way premixes of the active ingredients listed are available from many manufacturers. When selecting a premix be aware of the active ingredient load.

Table 1. Waterhemp residual control (%) 3 to 5 weeks after PRE application of herbicides evaluated by the Wisconsin Herbicide Evaluation Program from 2018-2022.

Herbicide	Rate(s)	Active Ingredient(s)	Rate Equivalents (rate acre^{-1})	Control[a]	n
metribuzin 75DF	10.7 oz	metribuzin		89 (14)	20
Warrant	48 fl oz	acetochlor		69 (20)	24
Warrant + metribuzin 75DF	48 fl oz + 6 oz	acetochlor + metribuzin		81 (13)	92
Warrant Ultra	48 fl oz	acetochlor + fomesafen	45 fl oz Warrant + 1 pt Flexstar	87 (9)	16
Dual II Magnum	1.3-1.67 pt	*S*-metolachlor		82 (15)	20
Boundary	1.8-2 pt	*S*-metolachlor + metribuzin	1.24-1.3 pt Dual II Magnum + 6-6.7 oz metribuzin 75DF	84 (10)	76
Prefix	2 pt	*S*-metolachlor + fomesafen	1.1 pt Dual II Magnum + 1 pt Flexstar	94 (7)	24
Outlook	18 fl oz	dimethenamid		88 (13)	20
Sharpen	1 fl oz	saflufenacil		76 (19)	16
Verdict	5 fl oz	saflufenacil + dimethenamid	1 fl oz Sharpen + 4.2 fl oz Outlook	83 (9)	48
Zidua SC	4.9 fl oz	pyroxasulfone		96 (5)	16
Zidua PRO	4.5-6 fl oz	pyroxasulfone + saflufenacil + imazethapyr	2.5-3.3 fl oz Zidua SC + 0.75-1 fl oz Sharpen + ALS	88 (9)	88
Valor EZ	2-3 fl oz	flumioxazin		83 (15)	28
Afforia	2.5 oz	flumioxazin + thifensulfuron + tribenuron	2 fl oz Valor EZ + ALS	83 (16)	20
Surveil	3-3.5 oz	flumioxazin + cloransulam	2.2-2.5 fl oz Valor EZ + ALS	86 (16)	20
Valor XLT	3-4 oz	flumioxazin + chlorimuron	1.8-2.4 fl oz Valor EZ + ALS	88 (10)	20
Fierce EZ	6 fl oz	flumioxazin + pyroxasulfone	2 fl oz Valor EZ + 2.5 fl oz Zidua SC	89 (8)	84
Fierce MTZ/Kyber	1 pt	flumioxazin + pyroxasulfone + metribuzin	2 fl oz Valor EZ + 2.5 fl oz Zidua SC + 4 oz metribuzin 75DF	88 (11)	84
Fierce XLT	3.75-4 oz	flumioxazin + pyroxasulfone + chlorimuron	1.8-2 fl oz Valor EZ + 2.2-2.4 fl oz Zidua SC + ALS	93 (6)	24
Spartan	8 fl oz	sulfentrazone		95 (6)	16
Authority Assist	10 fl oz	sulfentrazone + imazethapyr	8.3 fl oz Spartan + ALS	96 (6)	20
Authority First/Sonic	5-6.45 oz	sulfentrazone + cloransulam	6.2-8 fl oz Spartan + ALS	82 (12)	72
Authority MTZ	11-16 oz	sulfentrazone + metribuzin	4-5.8 fl oz Spartan + 4-5.8 oz metribuzin 75DF	83 (8)	100
Preview 2.1SC	18-21 fl oz		5-5.9 fl oz Spartan + 6.7-7.8 oz metribuzin 75DF	93 (5)	20
Authority Supreme	6.5-8 fl oz	sulfentrazone + pyroxasulfone	3.4-4.2 fl oz Spartan + 3.2-4 fl oz Zidua SC	95 (5)	72
Authority Elite/Broadaxe XC	25-30 fl oz	sulfentrazone + *S*-metolachlor	4.4-5.3 fl oz Spartan + 1.3-1.5 Dual II Magnum	92 (8)	28

[a]Average residual waterhemp control 3 to 5 weeks after application. Numbers in parenthesis represent the standard deviation.
[b]n values are the number of recorded observations (plots) included in the average.

Figure 1. Plot photos indicating categories of PRE herbicide waterhemp efficacy. Pictures were taken around 25 days after the PRE application from a trial located at the O'Brien Hybrids Farm near Brooklyn, WI

Postemergence Waterhemp Control

While there are several effective PRE herbicides for residual waterhemp control, the options for burndown postemergence control dwindle to only five active ingredients. Furthermore, most of these options rely on soybean herbicide resistance traits (glufosinate, dicamba, 2,4-D) to be able to be applied POST. A bareground trial was conducted at the Lancaster Ag Research Station and at the O'Brien Hybrids Farm near Brooklyn, WI in 2019 and 2020 to evaluate the effectiveness of single active ingredient postemergence soybean herbicides on waterhemp (Table 2).

Table 2. Waterhemp burndown control ratings 14 days after the POST application from a bareground trial conducted at Lancaster ARS and Brooklyn, WI in 2019 and 2020.

Herbicide (rate acre^{-1})	Active Ingredient	Group (SOA)	Control[a] (%)
Pursuit (4 fl oz) + COC 1% v/v + AMS (2 lb)	imazethapyr	2 (ALS)	8 (14)
Classic (0.75 oz) + COC 1% v/v + AMS (2 lb)	chloriumuron	2 (ALS)	15 (25)
FirstRate (0.3 oz) + COC 1.2% v/v + AMS (2 lb)	cloransulam	2 (ALS)	3 (10)
Python (1 oz) + COC 1% v/v + AMS (2 lb)	flumetsulam	2 (ALS)	6 (13)
Enlist One (32 fl oz) + AMS (2 lb)	2,4-D choline	4 (Auxin)	87 (8)
XtendiMax (22 fl oz) + Class Act Ridion 1% v/v	dicamba	4 (Auxin)	81 (11)
Basagran 5L (1.6 pt) + COC 1% v/v + AMS (2 lb)	bentazon	6 (PSII)	21 (34)
Roundup PowerMAX II (32 fl oz) + AMS (2 lb)	glyphosate	9 (EPSPS)	63 (27)
Liberty (32 fl oz) + AMS (2 lb)	glufosinate	10 (GS)	81 (18)
Cadet (0.9 fl oz) + COC 1% v/v + AMS (2 lb)	fluthiacet	14 (PPO)	50 (31)
Cobra (12.5 fl oz) + COC 1.5 (1.5 pt) + AMS (2 lb)	lactofen	14 (PPO)	90 (9)
Flexstar (1 pt) + MSO 1% v/v + AMS (2 lb)	fomesafen	14 (PPO)	89 (7)
Resource (8 fl oz) + COC (1 qt) + AMS (2 lb)	flumiclorac	14 (PPO)	64 (22)

[a]Numbers in parenthesis represent the standard deviation. n-value for all treatments was 16.

Take Home Message

Only five of the herbicides provided good (>80%) control of glyphosate-resistant waterhemp. POST herbicide programs containing multiple effective sites of action are recommended to broaden weed control spectrum and to reduce selection pressure for herbicide resistance. A PRE herbicide was not used in this study so weed densities were quite high at time of POST application. The use of an effective PRE, containing active ingredients in Table 1, is recommended to reduce the density and size of waterhemp at the time of application which in turn can improve POST efficacy. For enhanced season long weed control a group 15 herbicide (pyroxasulfone, *S*-metolachlor, dimethenamid, acetochlor) can be included in the POST application as part of a layered residual approach.

Postemergence Waterhemp Control

The following figures summarize waterhemp control from some of the soybean herbicide evaluation trials conducted from 2019-2022 at the Obrien Hybrids Farm near Brooklyn, WI. Waterhemp at this location is known to be resistant to glyphosate and ALS herbicides. All trials were conducted on soybeans with either the Enlist E3 or XtendFlex herbicide-resistant traits. Treatments were grouped by POST herbicide program: XtendiMax (dicamba), Enlist (2,4-D choline), Liberty (glufosinate), Liberty + Enlist, and Liberty + a PPO herbicide (fomesafen, lactofen, flumiclorac, fluthiacet). Some of the POST herbicide programs included glyphosate as tank-mix partner. Over one-half of the POST treatments also included a group 15 herbicide as part of a layered residual approach. To see how certain herbicides or herbicide tank mixes performed, see individual trial data presented in the annual research reports which can be found on our website wiscweeds.info

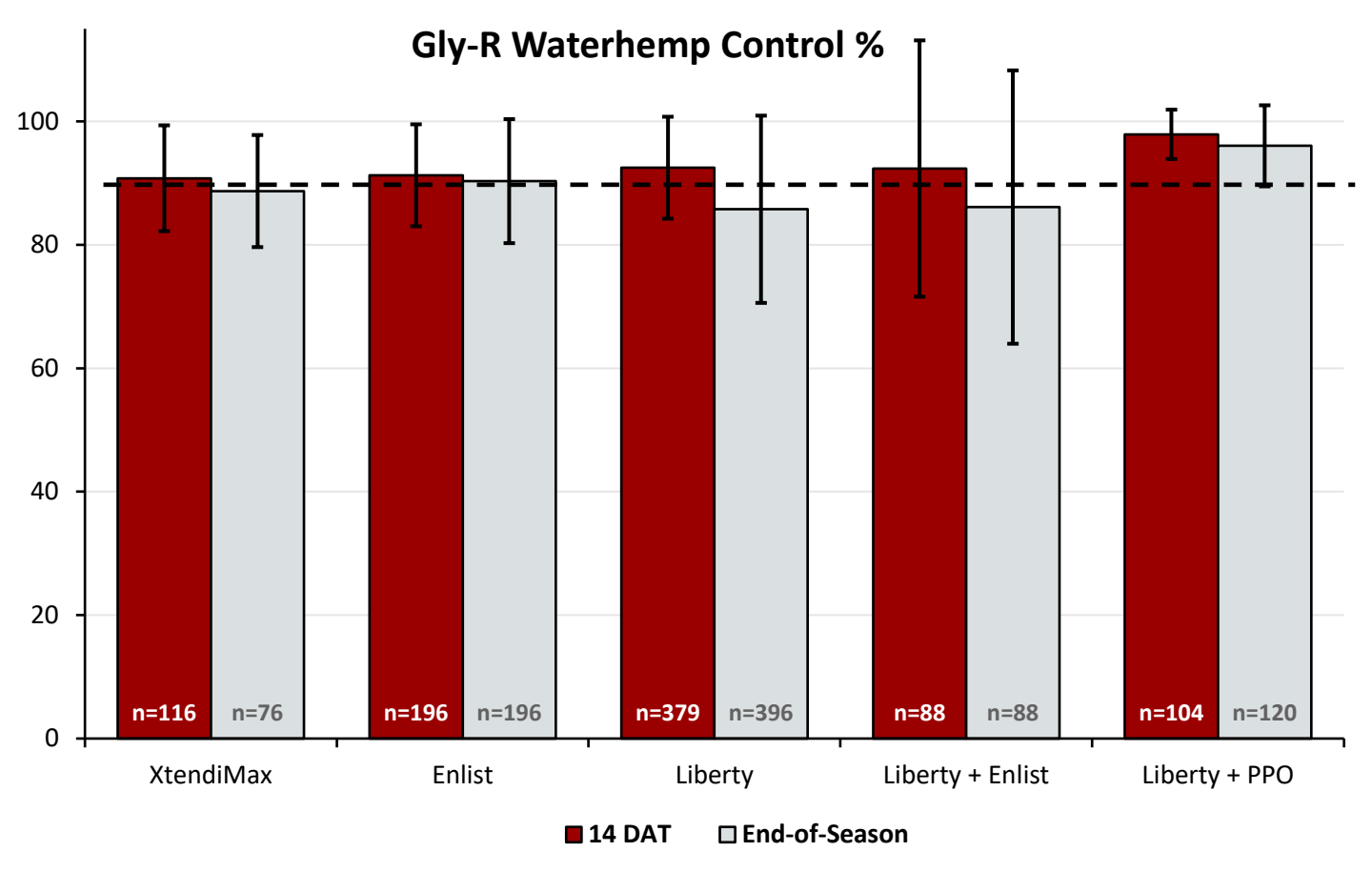

Figure 2. Glyphosate-resistant waterhemp control (%) of five soybean POST herbicide systems. Bars indicate the average % control ± the standard deviation 14 days after POST herbicide application and at the end of the growing season. n-values at the base of each bar represent the number of observations (plots) evaluated in each POST herbicide system. Some of the POST treatments included glyphosate as a tank-mix partner.

Postemergence Waterhemp Control

Waterhemp control was also broken down by the relative effectiveness of the PRE herbicide used prior to the POST herbicide application. PRE herbicide efficacy was evaluated at or near the time of POST application and was categorized as excellent (90-100%), good (80-89%), fair (60-79%), or poor (0-59%). See Figure 1 for a visual representation of each category. Waterhemp control averaged across all POST herbicide systems is presented in Figure 3.

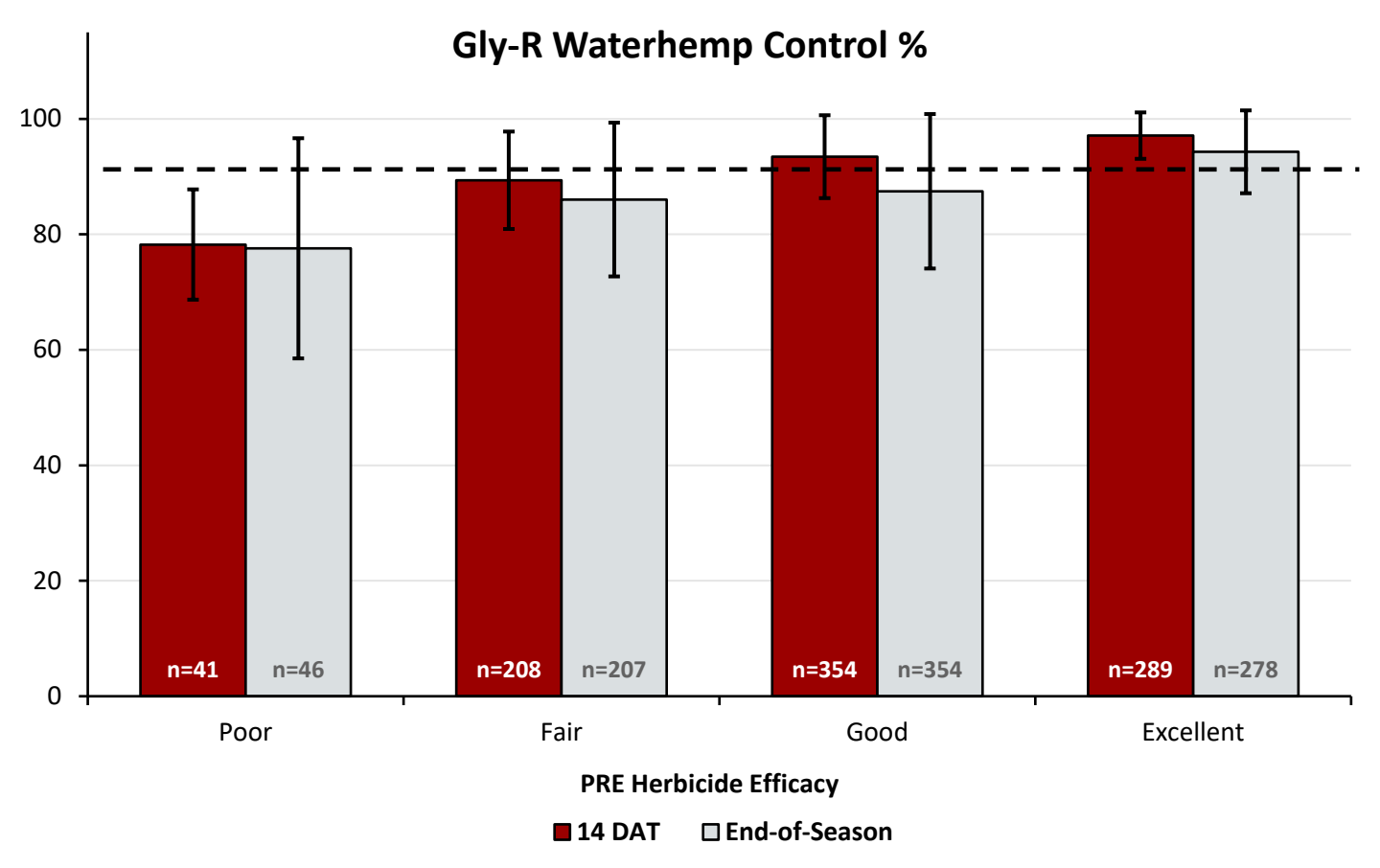

Figure 3. Glyphosate-resistant waterhemp control (%) of five soybean POST herbicide systems (XtendiMax, Liberty, Enlist, Liberty plus Enlist, Liberty + PPO) broken down by PRE herbicide efficacy. PRE herbicide efficacy was evaluated at or near the time of POST application. Bars indicate the average % control ± the standard deviation 14 days after POST herbicide application and at the end of the growing season. n-values at the base of each bar represent the number of observations (plots) within each PRE herbicide efficacy category.

Take Home Message

All POST systems provided relatively similar levels of waterhemp control at the end of the season (Figure 2). There was quite a bit of variability within each system which is mostly explained by the PRE herbicide effectiveness at the time the POST application was made (Figure 3). POST applications following PRE herbicides with excellent control (≥90%) provided excellent season long control regardless of what the POST herbicide system was. This is likely due to the greater efficacy resulting in fewer emerged and smaller weeds at the time of POST application.

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