Controlling Herbicide Resistant Weeds in Soybeans: 2019 Trials

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Summary

Herbicide resistant weeds have become a major problem for New York soybean farmers. This project aimed to regain control of these weeds through a mix of chemical, physical, and electrical tactics. From our replicated field trials attempting to control waterhemp in soybeans, the programs that included herbicides from WSSA groups 4, 14, or 15 were most effective, and our only treatment that provided 100% control included all three of those groups. Row cultivation performed well between-rows but missed some in-row weeds. Soybean yields generally reflected the effectiveness of each weed control treatment, with untreated plots incurring a 56% yield loss. Unfortunately, the most effective two-pass treatments were also the most expensive. In a separate demonstration, our informal evaluation of an electric discharge system was successful, with most of the herbicide resistant horseweed (marestail) exhibiting complete necrosis two weeks after application.

Background and justification

In the past few years, herbicide resistant weeds have become a large problem for New York soybean farmers (Figure 1). Horseweed that is likely resistant to glyphosate (WSSA 9) and ALS inhibitor (WSSA 2) herbicides has spread through much of the state. Herbicide resistant waterhemp, which was initially found in a few isolated cases where farms had purchased contaminated inputs or equipment from other states, has now been observed in 12 counties. Waterhemp is more competitive than horseweed and based on our initial greenhouse spray chamber trials, it is likely resistant to glyphosate, ALS inhibitors, and photosystem II inhibitors (WSSA 5). In Seneca County NY, waterhemp was reported to have caused 50% yield loss in a field where the farmer had attempted to control it with several different herbicide applications.

Control of weeds that have exhibited herbicide resistance in other states has been improved by adding more herbicide sites of action, or WSSA groups, to the spray mixes – especially if more than one effective herbicide group is used – such as synthetic auxins (WSSA 4), PPO Inhibitors (WSSA 14), or long chain fatty acid inhibitors (WSSA 15). There has also been an increased emphasis on residual herbicide applications to decrease the burden on the post-emergence applications. Furthermore, due to the extended emergence period of waterhemp, residual chemistries are recommended additions to post-emergence applications.

Beyond the diversification of herbicides, non-chemical tactics are also necessary. Horseweed and waterhemp emerge from very small seeds and are susceptible to physical control through tillage/cultivation or suppression by cover crop residue. Due to the short longevity of both species' seeds in soil, weed seedbank manipulation, sanitation, and practices that limit seed dispersal are also effective. In response to herbicide resistant weeds, one tactic that has been gaining in popularity in the last few years is the use of electrical discharge systems, which involve a front-mounted rod charged by a PTO-powered generator that is driven over the crop to electrocute weeds that escaped earlier controls.

In an attempt to regain control of these herbicide-resistant weeds in New York, we evaluated several strategies that *integrated* chemical, physical, and electrical tactics.

Objectives

Objective 1. Evaluate the effectiveness of several different programs for controlling waterhemp in soybeans.

Objective 2. Evaluate the potential for an electrical discharge system to control weeds that survived prior chemical control efforts in soybeans.

Figure 1. Waterhemp competing with soybeans at a farm in Seneca County, NY.

Procedures

Objective 1.

Two trial sites were established. Site A was in Seneca County, NY on a field of Odessa silt loam soil where waterhemp had survived various herbicide applications and produced seed in 2018. In 2019, the ground was prepared for planting with a field cultivator on May 22, and planted with soybeans (Channel 2119R2X, maturity group 2.1) on May 24. Pre-emergence applications were made on May 27. Post-emergence treatments were applied on July 8. All treatments are listed in Table 1. For fertilizer, muriate of potash (0-0-60, 125 lbs K_2O/A) was applied prior to tillage and urea nitrogen (46-0-0, 100 lbs N/A) was broadcast on July 12.

Table 1. A list of the treatments implemented to control of waterhemp in soybeans. Weed Science Society of America herbicide site of action group numbers are in parentheses following each herbicide.

Treatment	Pre-emergence	Post-emergence
1	–	–
2	FirstRate (2) 0.6oz	–
3	Metribuzin (5) 5oz	–
4	Warrant (15) 48 fl oz + RoundUp PowerMax (9) 22 fl oz	–
5	ValorSX (14) 3oz	–
6	ValorXLT (2, 14)4oz + Metribuzin (5) 5oz	–
7	Warrant Ultra (14, 15) 48 fl oz + Metribuzin (5) 5oz	–
8	–	Warrant (15) 48 fl oz + RoundUp PowerMax (9) 32 fl oz + XtendiMax (4) 22 fl oz + DRA 0.25% v/v
9	–	RoundUp PowerMax (9) 32 fl oz + XtendiMax (4) 22 fl oz + DRA 0.25% v/v
10	ValorXLT (2, 14) 4oz + Metribuzin (5) 5oz	Row Cultivation
11	ValorXLT (2, 14) 4oz + Metribuzin (5) 5oz	Cobra (14) 12 fl oz + COC 1% v/v
12	ValorXLT (2, 14) 4oz + Metribuzin (5) 5oz	RoundUp PowerMax (9) 32 fl oz + XtendiMax (4) 22 fl oz + DRA 0.25% v/v
13	Warrant Ultra (14, 15) 48 fl oz + Metribuzin (5) 5oz	RoundUp PowerMax (9) 32 fl oz + XtendiMax (4) 22 fl oz + DRA 0.25% v/v

Site B was in Oneida County, NY on a field of Conesus silt loam soil where a large patch of waterhemp had escaped herbicide applications and was hand removed the previous year. In 2019, soybeans (Asgrow 19x8, maturity group 1.9) were planted no-till on May 22 immediately followed by pre-emergence applications. Post-emergence treatments were applied July 5. All treatments listed in Table 1 except for treatments 4 and 8 were implemented at Site B. For fertility, muriate of potash (0-0-60, 120 lbs K_2O/A) was applied prior to planting and starter fertilizer added 20 lbs N/A, 60 lbs P_2O_5/A, and 20 lbs K_2O/A.

Plots were 25’ long and 10’ wide. Each treatment was replicated four times per site in a randomized complete block design. Spraying was conducted using a backpack CO_2 sprayer with a 10’ boom. Spray volume was 20 gal/A applied at 40 psi. Row cultivation was achieved using a Double Wheel Hoe (Hoss Tools) with two staggered 6” sweeps (12” effective width). Two passes were made per row so that 24” of the 30” rows were cultivated.

Weed control was assessed in mid-August by collecting all aboveground weed biomass within a 2 ft^2 quadrat. The quadrat was used four times per plot, placed randomly in the two middle rows of each plot. Weeds were placed in paper bags and dried at 113 degrees F for 7 days, then weighed. Control was calculated by subtracting the biomass of each treated plot from biomass of the untreated plots, dividing by the biomass of the untreated plots, and multiplying by 100. All waterhemp was manually removed immediately after the weed control assessments in order to prevent it from producing seeds.

Soybean yield was measured in mid-October by hand harvesting the pods from 10-row-feet of a middle row of each plot. Beans were separated from pods and collected using an Almaco thresher, then weighed. Yield loss in the treatments with single herbicide sites of action was determined by comparison to the more extensive treatments (Treatments 6-13). Yield loss of Treatment 11 was determined by comparison to the other extensive treatments. To provide an economic basis for comparison of each treatment, costs were estimated based on personal communications with several local custom applicators.

Objective 2.

In 2019, a 20-foot-wide electrical discharge system (“Weed Zapper ANNIHILATOR 8R30,” Old School Manufacturing LLC) was used in Cato, NY on August 1 in a soybean (R1) field with several different weed species that had survived an earlier herbicide application and were protruding up to 2’ above the crop canopy. The tractor was operated at 3 mph with 1000 rpm PTO speed, allowing the electrical discharge system to generate about 500 volts and up to 200 amps of alternating current electricity. Weed mortality was not evident on the day of implementation, therefore we returned on August 13 to informally assess control.

Results and discussion

Objective 1.

Weed control was greatest for the two-pass treatments (Table 2) and for the treatments that included more than one herbicide from WSSA groups other than 2, 5, and 9. One exception was that the addition of Warrant to the tank mix of Roundup and XtendiMax may have caused a slight antagonistic effect on waterhemp control.

Site A did not have complete soybean canopy closure, which likely reduced the effectiveness of most treatments. Additionally, much of the waterhemp present in the post-emergence applications was likely larger than the suggested maximum height of 4”.

Although waterhemp was abundant at Site B in 2018, hand removal efforts prevented most of the weed seed production and very little waterhemp emerged for the trial in 2019. Therefore, waterhemp control is not shown for Site B. Conversely, few weeds other than waterhemp were present at Site A.

Table 2. Weed control effectiveness and estimated total cost of each treatment.

			Site A	Site B		
Treatment	Pre-emergence	Post-emergence	Waterhemp control (%)	Other broadleaf control (%)	Monocot control (%)	Cost ($USD/A)
1	–	–	0	0	0	0
2	FirstRate	–	0	46	77	33
3	Metribuzin	–	22	47	80	18
4	Warrant (plus Roundup)	–	63	–	–	33
5	ValorSX	–	77	78	72	24
6	ValorXLT, Metribuzin	–	50	99	94	34
7	Warrant Ultra, Metribuzin	–	98	98	64	43
8	–	Warrant, RoundUp, XtendiMax	69	–	–	47
9	–	RoundUp, XtendiMax	83	94	100	32
10	ValorXLT, Metribuzin	Row Cultivation	83	100	100	50
11	ValorXLT, Metribuzin	Cobra	97	100	94	66
12	ValorXLT, Metribuzin	RoundUp, XtendiMax	97	100	100	66
13	Warrant Ultra, Metribuzin	RoundUp, XtendiMax	100	99	99	75

Soybean yield at Site A generally reflected effectiveness of waterhemp control. Yield losses would likely have been greater if the waterhemp had not been removed in mid-August. We found yield losses in Treatments 1, 2, 3, and 5 of 56%, 26%, 34%, and 20% respectively. Yields at Site B were less effected, reflecting less weed competition. Crop injury was visible from Cobra, with yield losses of 12% and 17% at Site A and Site B, respectively. Yield loss would likely have been greater in most treatments if waterhemp had not been manually removed in mid-August to prevent seed production.

The total cost for the materials and application of the more extensive treatments was generally more expensive (Table 2). But given that uncontrolled waterhemp could result in a loss of $300/A, more expensive weed control programs are justified. Even the most expensive treatment ($75/A) may make economic sense due to the short-lived seeds of waterhemp. That treatment provided 100% control of waterhemp, preventing the return of waterhemp seeds to the soil, thereby allowing the depletion of most of the waterhemp seedbank in four years (Mark Loux, personal communication) and return to less expensive control programs. Nonetheless, additional treatments will be investigated in 2020 to attempt to achieve 100% control with less cost.

Objective 2.

The electrical discharge system was very effective in controlling the contacted horseweed (marestail). Complete necrosis was observed for most treated plants. Some plants had green leaves near their base, but no new growth or lateral branching was observed. Common ragweed was also very effectively controlled. Annual sowthistle was mostly controlled, but green leaves persisted on about 25% of the plant. The highest branches of bull thistle (a biennial) exhibited complete necrosis, but lower branches that were untouched by the weed zapper remained unharmed.

It was evident that our August 1 application of the electrical discharge system was earlier than optimal because most of the horseweed had not yet exceeded the height of the crop canopy and was not contacted by the electrified rod. Therefore, to maximize the weed control from a single pass, scouting should be used to delay the application as late as possible, but before the weeds initiate seed production – likely mid- to late-August for most New York farms. For interested farmers, custom application of the electrical discharge system is available through Preferred Quality Grain LLC of Cato, NY.

Project location

Central and western New York.

Samples of resources developed

Online articles:

Brown, B., DiTommaso, A., Howard, K., Hunter, M., Miller, J., Morris, S., Putman, J., Sikkema, P., Stanyard, M. Waterhemp Herbicide Resistance Tests: Preliminary Results. Cornell Field Crops Blog. May 15, 2019. https://blogs.cornell.edu/ccefieldcropnews/2019/05/15/waterhemp-herbicide-resistance-tests-preliminary-results/

Video:

Marshall, G., Brown, B. Waterhemp Control in Soybeans: 2019 Trials. NYSIPM. December 20, 2019. [video] Accessed December 28, 2019. https://www.youtube.com/watch?v=WSAmMn2P7Wc

Marshall, G., Brown, B. Weed Zapper Demo 2019. NYSIPM. October 1, 2019. [video] Accessed December 28, 2019. https://www.youtube.com/watch?v=GVB33hB8Nes

Acknowledgements

Thank you to the New York Farm Viability Institute for supporting this project.