WEED CONTROL USING HIGH VOLTAGE ELECTRICITY

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Summary

1. The Weed Zapper™ provided greater than 80% waterhemp (primary stem) control, 14 days after treatment (DAT). Kochia (highly branched stem) control 14 DAT was less.
2. Operating speed did not influence waterhemp control (Univ of Missouri research).
3. One pass across the field controlled waterhemp in a dense canopy but multiple passes provided better control in an open canopy.
4. Seed viability experiments on harvested seed will be conducted in January to March 2021.
5. The Weed Zapper is not a replacement for soil residual herbicides but appears to be an effective approach for rescue control of glyphosate resistant weeds.

Introduction

Herbicide resistance is on the rise in many weed species, including waterhemp (Heap 2020). Herbicide resistance has redefined weed thresholds since weed escapes produce large quantities of resistant seed, adding to weed seedbanks and potentially affecting crops the following season (Oerke and Dehne 2004; Schweizer and Dexter 1987). One tool that is being utilized by growers to control weed escapes is the electric discharge system (EDS). This machine is comprised of a front-end tractor mounted boom/bar with a rear-mounted PTO-driven generator that creates high-voltage electricity. The front-end tractor mounted boom can unfold to provide up to a 44-foot swath and the generator can produce 200,000 watts or up to 15,000 volts. Voltage is adjusted with three settings based on target species and density; broadleaf (low), broadleaf (medium), and grass (high). The EDS is operated from and powered by a 275+ horsepower tractor. The boom height is set just above the sugarbeet canopy and operating speeds range from 2 to 6 mph. The boom contacts the stem and leaves of weed escapes that have grown above the canopy as the tractor moves through the field. Once contacted, the electricity heats cellular fluids and bursts vascular bundles. The EDS system is commercially marketed as the “Weed Zapper™” and manufactured in Sedalia, Missouri. The Weed Zapper is a modern-day prototype of the original EDS the “Lasco Lightening Weeder” developed in Grand Forks County in 1979. The Weed Zapper features more wattage and major safety improvements for the operator compared to the original EDS. Growers have been utilizing this equipment to manage weed escapes late in the growing seasons of 2019 and 2020.

Objectives

The objectives of this study were to: 1) determine waterhemp control using the Weed Zapper; 2) determine if increasing passes over the same area will improve waterhemp control; and 3) determine the viability of waterhemp seed at sugarbeet harvest.

Material and Methods

On-farm experiments were conducted in 2020 in collaboration with three local sugarbeet producers on eight production fields. In the first experiment, waterhemp control was estimated after operating the Weed Zapper at a consistent speed across the field beginning mid-July through late August or when waterhemp grew above the sugarbeet canopy. Waterhemp density was scored in each field (0 to 10, 0 indicating no waterhemp and 10 indicating a uniform and complete waterhemp infestation) and ranged from ‘1’ to ‘9’. Sugarbeet fields were considered replications and waterhemp control was evaluated in two 5 x 5 square foot quadrats within each field. Quadrats were placed in areas of each field that represented the weed density of that location. A second experiment was established to evaluate waterhemp control following one, two, or four passes of the Weed Zapper through each quadrat, with multiple passes immediately following one another. This experiment was conducted in two fields; the first field had a waterhemp density score of ‘4’ and the second field was scored a ‘9.’ A third experiment considered kochia control from the Weed Zapper and was conducted at a single location where quadrats corresponded to replications. The standard speed used was 4 mph and the controller voltage was adjusted to broadleaf (low).

Visible percent necrosis (0 to 100% with 100% being complete darkening of vegetation), visible percent wilting (0 to 100% with 100% being complete wilting phenotype), and visible percent weed control (0 to 100% with 100% being complete waterhemp control) were collected 1, 3, 7, and 14 DAT (days after treatment). Data were analyzed using SAS Data Management software PROC MIXED procedure to test for significant differences at p=0.05.

To evaluate the effect of the Weed Zapper on weed seed viability, seed samples were collected from representative kochia or waterhemp plants in each quadrat before sugarbeet harvest. Samples were dried in the greenhouse, were threshed, and seed was stored in the cold storage room at Waldron Hall, NDSU, at 52 degrees F and 37% humidity for 30 days to vernalize seed and break dormancy in preparation for growth room and greenhouse experiments to determine seed viability (germination and emergence).

Results and Discussion

Waterhemp control. Waterhemp wilting phenotype was observed immediately following Weed Zapper application and changed very little 1 to 14 DAT (Table 1). However, necrosis injury or blackening of the stem and leaves increased from 26% to 79%, 1 to 14 DAT, respectively. Waterhemp overall control corresponded more closely to necrosis injury than wilting and increased significantly from 3 to 14 DAT.

Table 1. Waterhemp wilting, necrosis, and overall control with the Weed Zapper from 1 to 14 days after treatments, averaged across eight locations, 2020.

	Waterhemp		
Days after treatment	Wilting Phenotype	Necrosis	Control
	------------------------------------	%	------------------------------------
1	72 a	0 d	15 c
3	73 a	26 c	39 b
7	74 a	71 b	76 a
14	70 a	79 a	85 a

Waterhemp control as influenced by number of passes. Waterhemp control was evaluated following 1, 2, or 4 passes of the Weed Zapper in two fields. The first field had a waterhemp density that scored '9' (Figure 1) and the second field had a waterhemp density that scored '4' (Figure 2). We were interested in determining if multiple passes affected waterhemp control, especially in the Kragnes field where waterhemp density scored '9'. We observed improved waterhemp control over time in both fields. Waterhemp control following four passes increased at 3 and 7 DAT compared to a single pass and tended to increase control 14 DAT at Kragnes. Waterhemp control was significantly improved from making two passes through the field compared to a single pass at Felton (Figure 2).

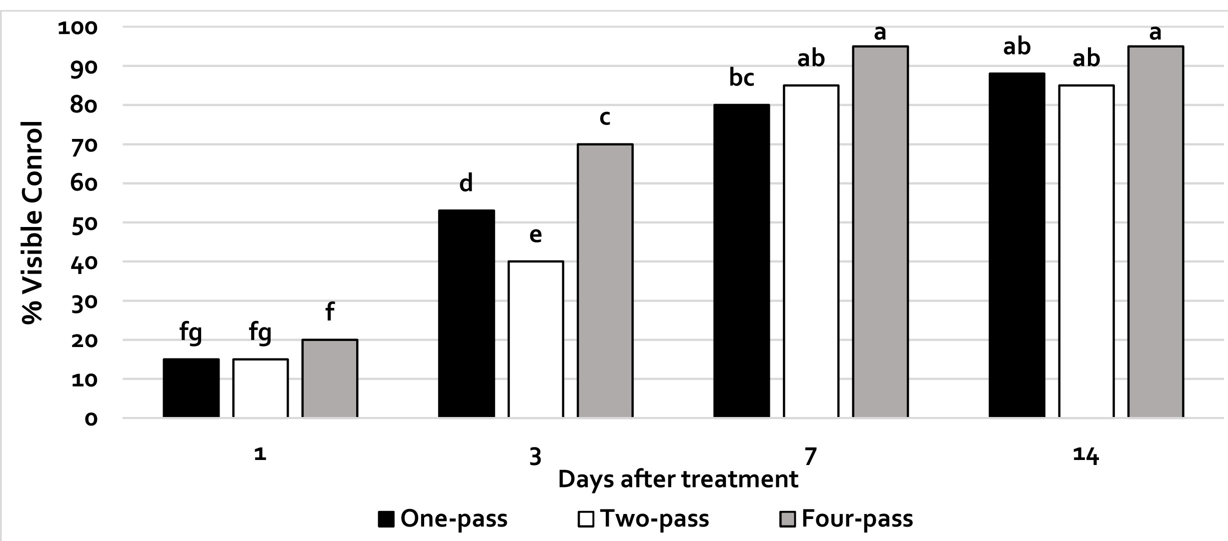

Figure 1. Waterhemp control by treatment, Kragnes, MN, 2020.

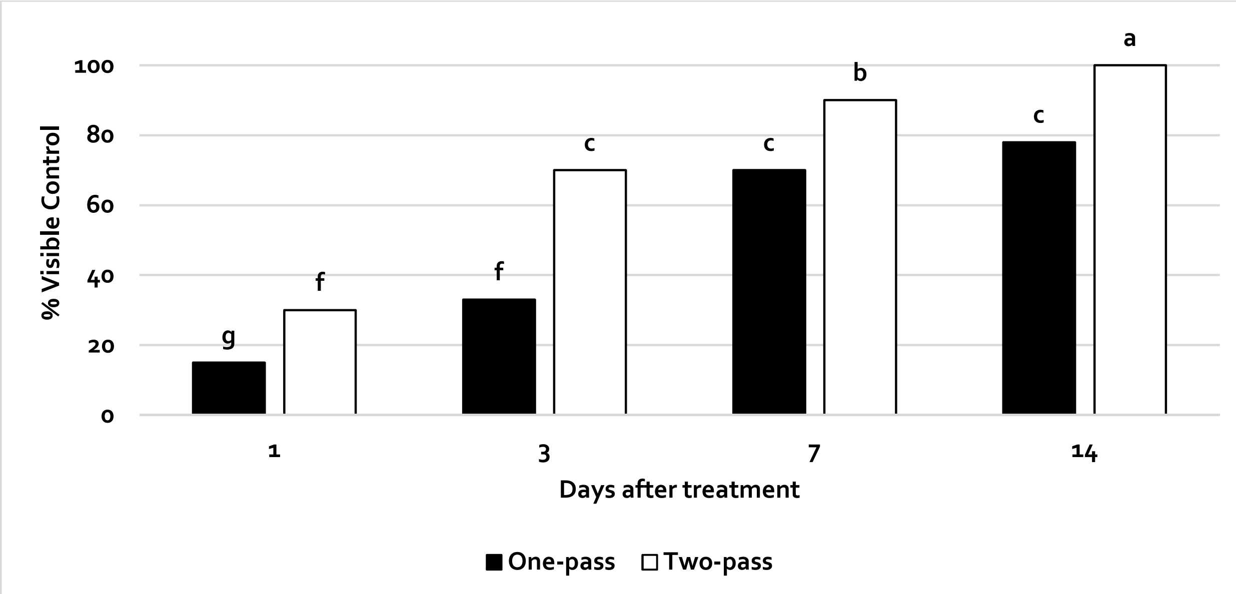

Figure 2. Waterhemp control by treatment, Felton, MN, 2020

Kochia control. Kochia control with the Weed Zapper was evaluated at one location in 2020. We observed the immediate wilting phenotype with kochia, similar to waterhemp, but observed less necrosis and overall kochia control compared with waterhemp (Table 2). Our results were similar to observations with the Lasco Lightening Weeder. Rasmusson et al. (1979) observed better control from the Lasco Lightening Weeder on weeds with a primary stem (i.e. giant ragweed or sunflower) than those with highly branched stems (kochia) or grasses. Our data, though limited to one kochia location, suggested the Weed Zapper gave greater waterhemp control than kochia control.

Table 2. Kochia wilting, necrosis, and overall control with the Weed Zapper from 1 to 14 days after treatment, Glyndon, MN, 2020.

	Kochia		
Days after treatment	Wilting Phenotype	Necrosis	Control
	---------------------------------%	-----------------------------------	
1	86 a	0 f	14 d
3	73ab	5 ef	19 d
7	65 ab	18 de	44 c
14	51 b	43 c	76 b

The Weed Zapper is used for weed control when weed height extends above the cultivated crop height. In Minnesota and North Dakota, waterhemp generally extends above the sugarbeet canopy and begins to flower in July. The Weed Zapper was used in July and early August in 2019. However, in 2020, we observed the Weed Zapper in use in fields in late August, well beyond when waterhemp typically begins flowering. Waterhemp seed becomes viable very rapidly following flowering. Researchers at the University of Illinois reported waterhemp seed was viable 9 to 12 days after flowering (Bell and Tranel, 2010), thereby leading to questions about how the Weed Zapper will affect weed seed viability.

Seed was collected in quadrats from waterhemp and kochia plants treated with the Weed Zapper. We hypothesize that waterhemp seed could be killed if the electrical treatment resulted in heating the seed to the extent that proteins were denatured. Growth room and greenhouse experiments are planned to examine seed viability and seed emergence.

Conclusions

Wilting was observed immediately after application and the Weed Zapper effectively controlled 80% of escaped waterhemp and 76% of escaped kochia, 7 to 14 days after treatment. Multiple passes may improve efficacy in moderately dense waterhemp infestation but may not improve efficacy in dense waterhemp infestations. However, weed interference resulting in reduced sugarbeet root yield and quality will presumably occur since the Weed Zapper is operated after weeds extended above the crop canopy. Growers that purchased the Weed Zapper indicate that treatment in July and August kills weeds and reduces weed biomass, thus improving harvest efficiency and storage. We believe the Weed Zapper can be a component of a weed management system in sugarbeet, much like a rescue herbicide treatment, but it is not a substitute for soil residual herbicides for waterhemp or kochia control. Replicated plot research will be needed to investigate the effect on yield, sucrose content, harvestability, seed viability, the relationship with soil applied herbicides, timing of application, voltage settings, speed, etc. to determine more precise evaluation of this equipment.

References

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