

# Enlist One (2,4-D) and Liberty (Glufosinate) Applied Alone or Mixed During the Day and Night: Weed Control and Soybean Yield Implications



**Eric A. L. Jones**, Assistant Professor and SDSU Extension Weed Management Specialist  
**Philip Rozeboom**, SDSU Extension IPM Coordinator  
**Jill Alms**, SDSU Ag Research Manager  
**David Vos**, SDSU Ag Research Manager

**December 2024**

## Introduction

Weed management in row crops primarily relies on herbicides. While herbicides are efficient and cost effective compared to other tactics, reliance and recurrent use has selected for herbicide-resistant weed populations. In South Dakota, the primary herbicide-resistant weeds are kochia and waterhemp. Two effective herbicides for weed management in soybean are Enlist One (2,4-D) and Liberty (glufosinate). There are now soybean varieties available that allows for the application of both Enlist One and Liberty to be applied alone or in mixture. These herbicides work in two very unique ways: Enlist One is a systemic herbicide that causes the overproduction of growth hormones that eventually result in plant death and Liberty is a contact herbicide that ultimately ceases the production of chlorophyll leading to cell membrane disruption to plant death (Grossman 2010; Takano et al. 2020). The effectiveness of these herbicides is greatly influenced by weed size; as weed size increases, the effectiveness decreases. While weed height and herbicide effectiveness are well known among farmers and applicators, another critical factor for herbicide effectiveness is the time of day when applied. Previous research has shown that the effectiveness of Liberty can be affected by the time (increased during the daytime, decreased during the night) and now the herbicide label specifies “apply within sunrise and two hours before sunset” (Sellers et al. 2003). There is no labeling that restricts Enlist One from being applied within a specific time of day to ensure activity. Since many farmers may be applying these herbicides tank-mixed, data is

needed to know how the application time of day affects the effectiveness of this mixture. The objective of this research was to determine weed control effectiveness with Enlist One and Liberty alone and tank mixed when applied during the daytime and nighttime.

## Materials and methods

The experiment was conducted at the Volga Research Station in Volga, South Dakota. The field was cultivated and planted on May 15, 2024. Soybean seeds (AE1520 [Enlist E3 herbicide traited]) were planted at a density of 160,000 seeds per acre. No preemergence herbicides were applied to ensure maximum weed seed emergence. The experimental design was a randomized complete block with four replications. Each plot was 4-rows wide and 40 feet long. The postemergence herbicide treatments were applied on June 25, 2024. Waterhemp plants were 3 to 6-inches in height, common lambsquarters plants were 4 to 7-inches in height, and giant foxtail plants were 8 to 12-inches in height at the time of applications. The daytime application occurred at 1:30 pm while the nighttime application occurred at 9:30 pm. All postemergence herbicide treatments were applied with a CO<sub>2</sub>-powered backpack sprayer with TeeJet AIXR nozzles calibrated to an output of 20 gallons per acre. Enlist One and Liberty were applied at 32 fluid ounces per acre. Two mixtures of these herbicides were applied: Enlist One and Liberty both applied at 32 fluid ounces per acre and Enlist One applied at 32 fluid ounces and Liberty applied 43 fluid ounces per acre. The second tank mixture was applied to determine if Liberty applied at a

higher rate influenced weed control during the day and night. Since Enlist One does not have grass activity, Select Max (clethodim) was applied at 16 fluid ounces per acre to minimize confounding broadleaf control from surviving grass weeds.

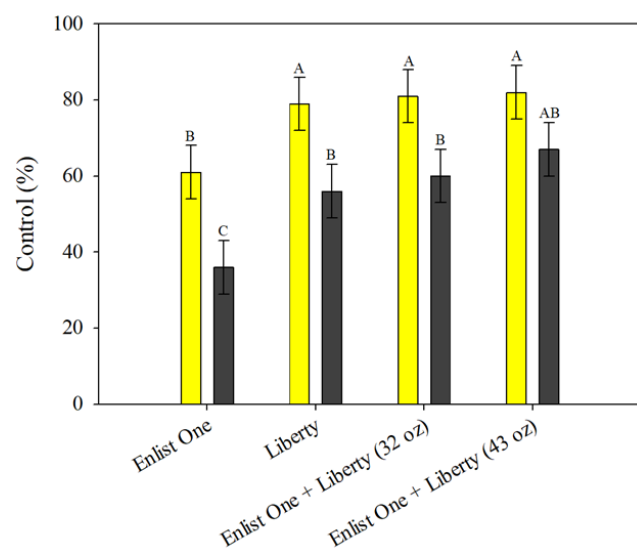
Visual weed control estimates occurred 1 week and 3 weeks after treatment (WAT) on a rating scale ranging from 0 to 100%. Where 0 = no control and

100 = complete control. At the end of the growing season (September 26, 2024), the two center rows of the plot were harvested. Weed control and yield data were subjected to analysis of variance ( $\alpha = 0.05$ ) and means were separated using Fisher's Least Significant Difference ( $P < 0.05$ ) in Agricultural Research Manager software. This statistical analysis considers plot-to-plot data variation and determines if treatment means are statistically similar or different.

## Results

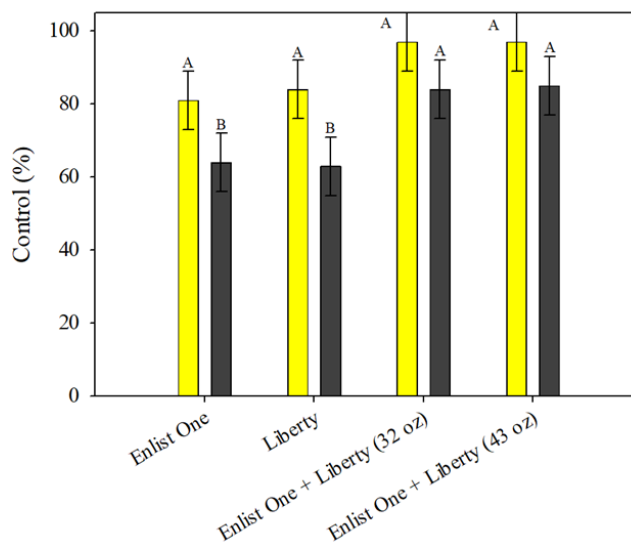
### Waterhemp

Enlist One applied during the day provided less control (~60%) compared to the other treatments applied during the day (~80%) (Figure 1) 1 WAT. Enlist One applied during the night provided less control (~40%) than the other treatments applied during the night (~60%) (Figure 1). Liberty and Enlist One + Liberty (32 fluid ounces) applied at night were less effective when the same treatments were applied during the day (Figure 1). Enlist One + Liberty (43 fluid ounces per acre) was as effective as the treatments applied during the day (Figure 1).



**Figure 1.** Waterhemp control with the herbicide treatments applied in the day (yellow) or night (gray) 1 WAT. The error bars represent the least significant difference. If the error bars overlap, then there is no difference between the treatments and bars share a similar letter. If the error bars do not overlap, then there is a difference between the treatments and bars will have dissimilar letters.

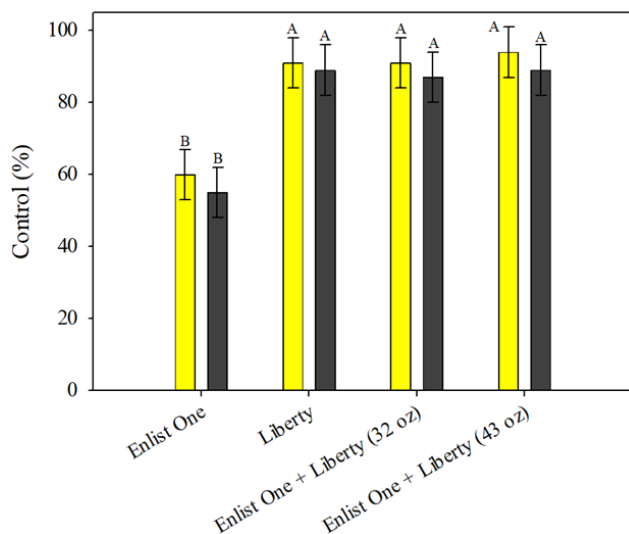
Overall waterhemp control increased from 1 to 3 WAT; however, treatment differences were observed between day and night applications (Figure 2). Enlist One and Liberty applied at night provided less waterhemp control than the remaining treatments (Figure 2).



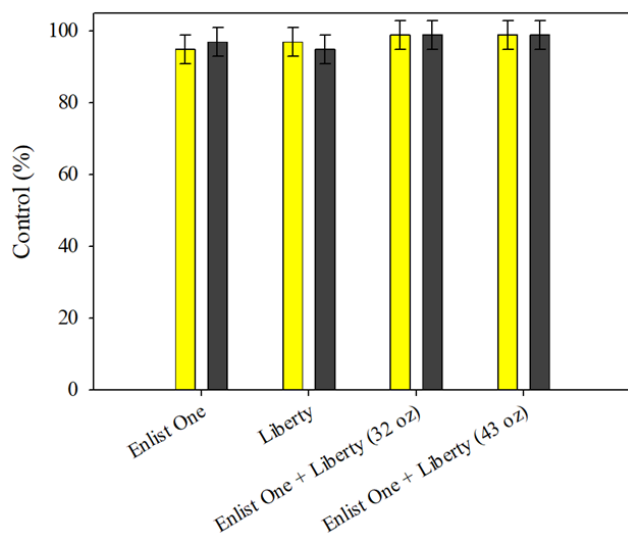
**Figure 2.** Waterhemp control with the herbicide treatments applied in the day (yellow) or night (gray) 3 WAT. The error bars represent the least significant difference. If the error bars overlap, then there is no difference between the treatments and bars share a similar letter. If the error bars do not overlap, then there is a difference between the treatments and bars will have dissimilar letters. The error bars exceed 100% control for the tank mixture treatments which is not possible, but the error bars remain for consistency.

### Common lambsquarters

Enlist One at both application timings was less effective (~60%) than the other treatments (~90%) 1 WAT (Figure 3). Common lambsquarters control with Enlist One at both timings from 1 to 3 WAT (~90%) was similar to the other treatments (Figure 4).



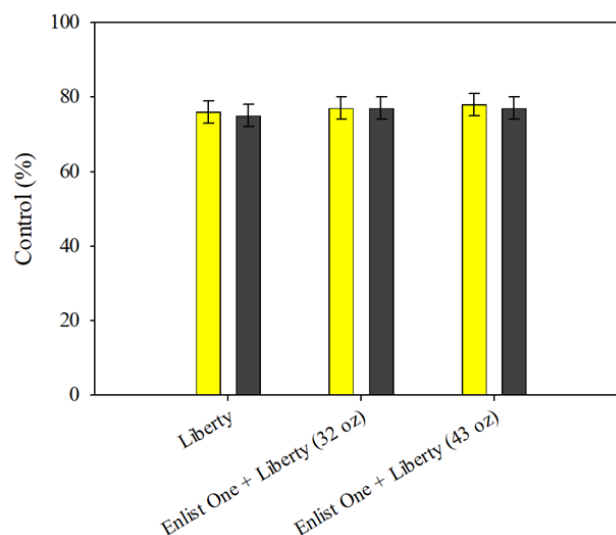
**Figure 3.** Common lambsquarters control with the herbicide treatments applied in the day (yellow) or night (gray) 1 WAT. The error bars represent the least significant difference. If the error bars overlap, then there is no difference between the treatments and bars share a similar letter. If the error bars do not overlap, then there is a difference between the treatments and bars will have dissimilar letters.



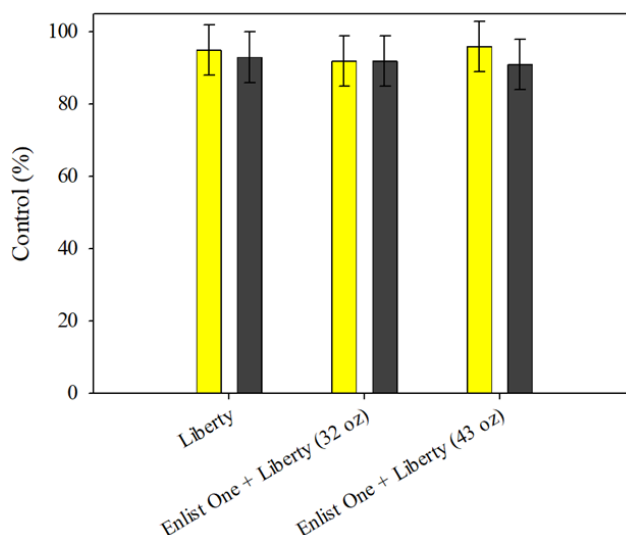
**Figure 4.** Common lambsquarters control with the herbicide treatments applied in the day (yellow) or night (gray) 3 WAT. The error bars represent the least significant difference. No differences between the treatment yields were observed.

### Giant foxtail

Giant foxtail control was not different among the treatments 1 WAT (Figure 5). Control increased from ~75% to ~90% for all treatments 3 WAT (Figure 6).



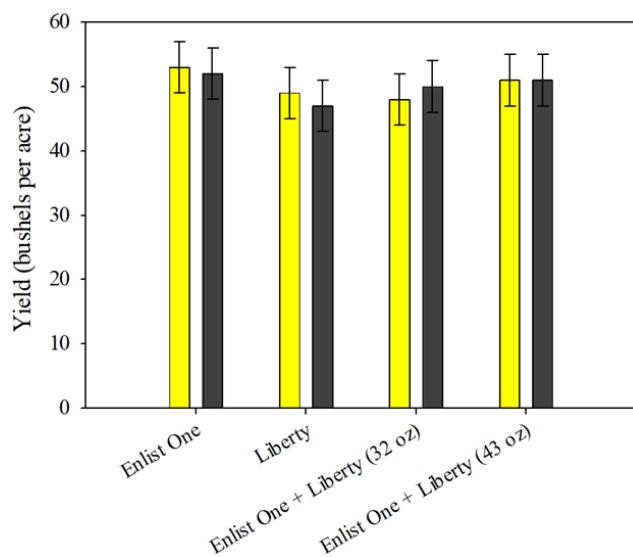
**Figure 5.** Giant foxtail control with the herbicide treatments applied in the day (yellow) or night (gray) 1 WAT. The error bars represent the least significant difference. No differences between the treatment yields were observed.



**Figure 6.** Giant foxtail control with the herbicide treatments applied in the day (yellow) or night (gray) 3 WAT. The error bars represent the least significant difference. No differences between the treatment yields were observed.

## Yield

Despite differences in weed control, soybean yield was not different among the different treatments (Figure 7). Soybean yield was 50 bushels per acre, on average.



**Figure 7.** Soybean yield with the herbicide treatments applied in the day (yellow) or night (gray). The error bars represent the least significant difference. No differences between the treatment yields were observed.

## Discussion

While Enlist One and Liberty are effective herbicides for weed distributed in row crops across South Dakota, how these herbicides are applied can influence effectiveness. Therefore, the results of this study reinforce applying Liberty between sunrise and 2 hours before sunset. There is no language on the Enlist One label about applying within a certain timeframe of the day. Previous research has showed that 2,4-D effectiveness can be influenced by the time of day (Johnston et al. 2020); therefore, applying this herbicide should be done within a similar timeframe. These results also suggest that the time of day when these herbicide treatments are applied can influence the effectiveness differently between weed species. Common lambsquarters and giant foxtail control was not affected by the time of day when the treatments were applied. Waterhemp control was decreased when Enlist One and Liberty were applied at night. Even though common lambsquarters and giant foxtail control was not affected by the time of day, applying these herbicides at night is not recommended. The tank mixture treatments provided the greatest control when applied during the day or night for the broadleaf weeds. These tank mixtures should be utilized for general weed management as using multiple herbicide groups increase effectiveness and the spectrum of weed control as well as reduce selection pressure on

herbicide-resistant weeds. Other herbicides and tactics should be utilized with giant foxtail or other grass weeds are present. While the tank mixtures were effective at the nighttime application, this timing is still not recommended.

Despite the soybean yield being relatively high and not different among the treatments, the implications of waterhemp surviving Enlist One and Liberty should be taken very seriously (Figure 8). Previous research shows that waterhemp and similar weeds surviving these herbicide treatments continue to grow throughout the season and produce approximately 1,000 to 10,000 seeds per plant (Jones et al. 2024). Hypothetically, if a field had 100 waterhemp plants and was treated with Enlist One/Liberty at night, approximately 40 of those plants would survive. Since waterhemp is a dioecious species (separate male and female plants), assume 20 of those 40 plants will produce 1,000 seeds each. In this hypothetical situation there is a potential to increase the number of weeds inhabiting the field by 200-fold (100 to 20,000 weeds).



**Figure 8.** Waterhemp plants surviving Enlist One (left) and Liberty (right) applied at night, 3 WAT. While the surviving weeds did not result in a yield loss, these weeds will produce a significant amount of seeds that will have to be controlled in future growing seasons.

As these two herbicides become more commonly applied, it is critical that the applications be made at the correct timing. While many farmers and applicators already know not to apply Liberty and other herbicides at night, these data serve as a reinforcement to not start doing such. This research will be repeated in the 2025 to ensure results are consistent from year-to-year.

## Acknowledgements

Partial funding for this experiment was provided by the South Dakota Soybean Research and Promotion Council.

## References

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P-00317