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Influence of Sulfentrazone and Metribuzin Applied Preemergence on Soybean Development and Yield[1]

Take Home Message

- PRE-emergence (PRE) herbicides like sulfentrazone (PPO-inhibitor) and metribuzin (PSII-inhibitor) are important tools for control of troublesome weed species with extended emergence window such as waterhemp.
- Early-season herbicide injury is a concern of soybean producers who adopt metribuzin and/or sulfentrazone PRE in soybeans.
- Sulfentrazone reduced soybean green canopy vegetation at the V2 growth stage and final plant stand at crop physiological maturity but did not reduce grain yield in this study.

Introduction

Due to widespread occurrence of glyphosate-resistant (GR) weeds, soybean producers are once again reintroducing PRE herbicides to their weed control programs. Effective PRE herbicides protect crop yield loss from early season weed competition and allow for more timely POST herbicide applications (Butts et al. 2017; Knezevic et al. 2019; Tursun et al. 2016). Although soil-applied PPO (sulfentrazone, flumioxazin) and PSII (metribuzin) inhibitor herbicides are labeled and commonly recommended as PRE herbicides for soybean, there is a concern that these herbicides may cause early-season soybean injury and affect yield. Adequate soil moisture is necessary for both PRE activation and for subsequent availability in soil solution for effective weed control. However, when soil conditions are cool and wet for extended periods of time during crop emergence, the ability of soybean to metabolize PRE herbicides is reduced, which leads to increased potential for crop injury (Moomaw and Martin 1978; Niekamp et al. 2000; Osborne et al. 1995). In addition, precipitation during the "soil cracking" stage of emergence can result in splashing of higher concentrations of PPO-inhibitor herbicides onto soybean hypocotyl, cotyledons, or growing points, which can lead to tissue necrosis (Fig. 1; Hartzler 2004; Wise et al. 2015).

Figure 1. Soybean seedling with typical symptomology (chlorosis and necrosis on cotyledon and hypocotyl) resulting from a PRE application of sulfentrazone.

Early-season herbicide injury and subsequent effect on yield is a concern of soybean producers who adopt metribuzin and/or sulfentrazone PRE in soybeans. Some seed companies provide information regarding soybean variety tolerance to soil-applied metribuzin and sulfentrazone; however, to our knowledge, information on their potential impact on soybean development and yield response under field conditions prone to early-season injury is not readily available.

Objectives

- Investigate the impact of soil-applied sulfentrazone and metribuzin on early-season growth and development of soybean using multiple varieties adapted to southwestern Nebraska
- Determine whether potential early-season herbicide-induced injury could impact soybean yield

Table 1: Soil and crop management information for field experiments conducted at Brule and North Platte, NE during 2016 and 2017 growing seasons.

Site	Year	Soil pH	Organic matter (%)	Soil texture[a]	Planting time	Herbicide application	Harvest
Brule	2016	6.7	2.2	Loam (19:44:37)	May 19	May 19	Oct 28
Brule	2017	6.8	2.1	Loam (20:42:38)	May 24	May 25	Oct 11
North Platte	2016	7.5	1.7	Loam (15:34:51)	May 10	May 11	Oct 13
North Platte	2017	7.4	1.7	Loam (20:32:48)	May 10	May 12	Oct 7

[a]Information presented in parentheses refers to clay, silt and sand % ratio of soil texture.

[1]Access the journal publication: https://doi.org/10.1017/wet.2020.99

Materials and Methods (Technical Description)

Field experiments were conducted in 2016 and 2017 at the University of Nebraska-Lincoln West Central Water Resources Field Laboratory, near Brule, NE (41.1597°N, 102.02871°W; hereafter referred to as Brule) and the University of Nebraska-Lincoln West Central Research and Extension Center in North Platte, NE (41.0865°N, 100.7780°W; hereafter referred to as North Platte) for a total of 4 site-years. The previous crop at all field sites was no-till corn (*Zea mays* L.). Experimental sites were selected due to loam soil type, relatively low organic matter, and high pH, which are representative field conditions across southwestern Nebraska and also suitable for early-season crop injury from metribuzin and sulfentrazone (Table 1; Grey et al. 1997).

The experiment was conducted as a 3 × 22 factorial with treatments consisting of two PRE herbicides applied at recommended label rates (metribuzin, 2/3 lb Sencor® 75 DF per acre and sulfentrazone, 8 fl oz Spartan® 4F per acre) plus a nontreated control (NTC), and 22 commercially available soybean varieties adapted to the region (provided by 3 companies and receiving respective company's base seed treatment; data not shown). At all site-years, soybeans were no-till planted at 140,000 seeds per ac (1.5-inch deep) and the PRE herbicide treatments were applied within 3 d after planting (DAP; Table 1) using a CO2-pressurized backpack sprayer equipped with a 10 ft boom with six TeeJet XR11002 flat-fan nozzles (Spraying Systems Co., Wheaton, IL) on 20-inch spacing, calibrated to deliver 10 gal of spray solution per acre. Experimental units were 10 ft wide (four soybean rows on 30-inch spacing) and 30 ft in length. Experimental units were maintained weed-free throughout the season by weekly hand weeding and/or hoeing to minimize the impact of weeds on soybean development and yield. The experiment was established in a strip-split-plot design employed in a randomized complete block design with four replications at each site-year. PRE herbicide treatments were considered as the strip-plot, whereas the soybean varieties were treated as the split-plot. Canopy cover (%) was measured 30 days after planting (DAP; when the crop reached the V2 growth stage) from photos taken using Canopeo phone application (Fig. 2; www.canopeoapp.com; Canopeo Software, Oklahoma State University, Division of Agricultural Sciences and Natural resources and the Soil Physics, Oklahoma, OK, USA). Final plant stand (plants per ac) and final yield (bu per ac) were measured at crop physiological maturity.

Statistical analysis – SAS version 9.4 Green canopy coverage (%), final plant stand (plants per ac), and final yield (bu per ac) were subjected to ANOVA using the PROC GLIMMIX procedure. PRE herbicide treatments were treated as fixed effects, whereas replications nested within site-years and soybean varieties nested within site-years were treated as random effects. Site-years and soybean varieties were treated as random because the objective of this study was to evaluate the potential impact of PRE herbicide treatments assuming a random irrigated site in southwestern Nebraska (with similar environmental conditions as observed in this study) and random selection of locally adapted soybean variety. For each response variable, means were separated when PRE herbicide treatment effect was less than $P = 0.05$ using Fisher's protected least-significant difference.

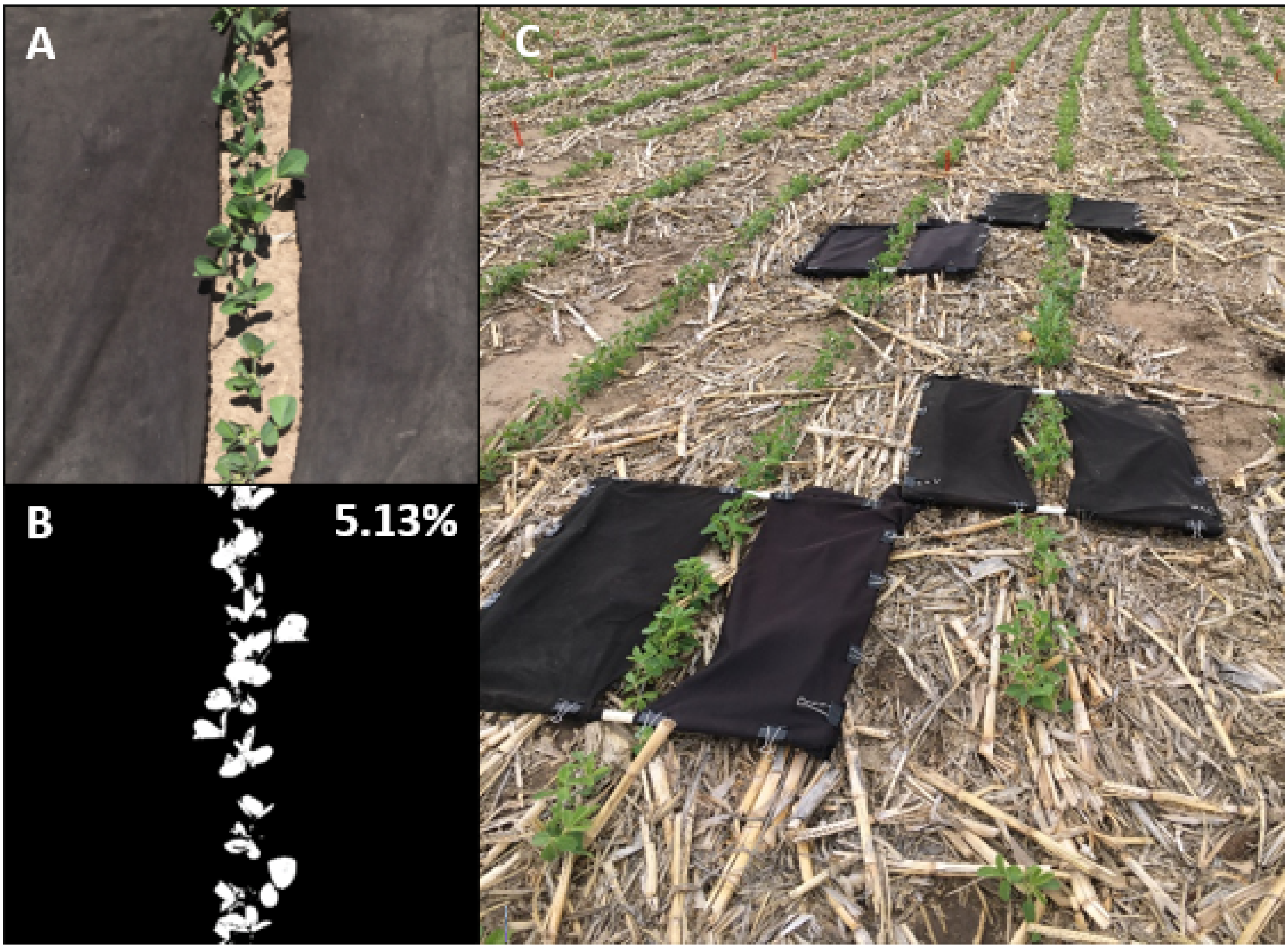

Figure 2. (A) original, unprocessed photo of sulfentrazone treatment, (B) processed photo of sulfentrazone treatment for estimating soybean green canopy cover at V2 growth stage. Photos were processed using Canopeo phone application platform (www.canopeoapp.com; Canopeo Software, Oklahoma State University, Division of Agricultural Sciences and Natural resources and the Soil Physics, Oklahoma, OK, USA) to estimate average green canopy coverage (%). On the right (C) is the placement of the squares on second and third soybean row designed for demarking the photo area.

Results and Discussion

Sulfentrazone reduced early season soybean growth by 22% (average canopy coverage across site-years and varieties for sulfentrazone was 5.4% while the average for Control was 6.9% at 30 DAP; Table 2). Sulfentrazone had an adverse impact on the final plant stand resulting in a 10% average reduction while metribuzin did not impact final plant stand when compared to the non-treated control (NTC; Table 2). Although sulfentrazone application led to both reduced green canopy coverage during early season (V2 growth stage; 30 DAP) and final plant stand at crop physiological maturity, these effects did not translate into a reduction in yield (Table 2). Conversely, both PRE herbicides resulted in slightly higher average yield (by 3%) when compared to the NTC (Table 2; P-value = 0.0008). Although plots were hand weeded and hoed on a weekly basis, there was a higher opportunity for early-season weed competition in the NTC treatment (no soil residual weed control from PRE herbicide treatment), which may partially explain the slightly higher yield in the metribuzin and sulfentrazone treatments.

Table 2: Summary of canopy cover 30 days after planting, final plant stand and final grain yield at harvest.[a]

Herbicide Treatment	Canopy Cover (%)	Final Plant Stand (plants per ac)	Yield[b] (bu ac^{-1})
Control	6.9 a	110,880 a	57.4 b
Metribuzin	6.8 a	110,880 a	59.4 a
Sulfentrazone	5.4 b	100,320 b	59.4 a
p-value	$<$0.0001	$<$0.0001	0.0008

[a]Means within a column followed by the same letter are not different according to Fisher's test (P=0.05).
[b]Adjusted to 13% moisture.

Recommendation for Soybean Growers

According to the results of this study, the weed control benefits provided by PRE herbicides likely outweigh concerns regarding early-season injury, assuming that such herbicides are applied following their label requirements and the crop is established according to local best management practices. Additionally, growers can opt for varieties with higher tolerance to PRE herbicides when such information is provided by seed companies as a means to reduce the likelihood of early-season crop injury.

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Additional Resources

- Residual Control of Waterhemp with PRE-emergence Herbicides in Soybean.
- Herbicide Comparison for Residual Waterhemp Control in Corn
- 2019 Wisconsin Weed Science Research Report.
- 2020 Wisconsin Weed Science Research Report.

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