Soybean response to simulated drift of herbicides commonly used to manage roadside vegetation in North Carolina

Estefania G. Polli*, Travis W. Gannon, Mathieu C. LeCompte, Ronald R. Rogers

SCAN HERE

Introduction

- The North Carolina Department of Transportation (NC DOT) manages the **second largest state-supported transportation network** in the nation which consist of 15,000 miles of primary road (interstates and highways) and 60,000 miles of secondary roads (NC DOT, 2022).
- **Herbicides** are the most effective, low-cost, and flexible method to manage vegetation along roadsides (Pellegrini et al. 2016).
- NC DOT has serious concerns about **herbicide spray drift** injuring sensitive crops due to the proximity of some roadsides to agricultural lands.
- Soybean is **the largest North Carolina crop** in terms of planted area (1,650,000 acres) and total value ($879 millions) (USDA, 2023).

Objective & Hypotheses

- The **objective** of this study was to investigate the response of soybean yield to simulated spray drift of five herbicides commonly used along roadsides at four rates and six application timings.

- The **hypotheses** are that post-planting applications will cause greater soybean yield loss (YL) than pre-planting applications (1) and synthetic-auxins herbicides will cause greater YL than other herbicides for post-planting applications (2).

Material & Methods

Study Site

- Study conducted at the Sandhills Research Station of North Carolina State University in Jackson Springs, NC from January to October of 2022.

Soybean Information

- Dicamba-glufosinate-glyphosate tolerant soybean.
- Planting date: May 18th.

Experimental Design

- Strip-plot design:
  Strip-plot: 6 application timings - 18, 12, 6, and 0 weeks before planting (WBP) and 4 and 8 weeks after planting (WAP).
  Sub-plots: Two-level factorial of 5 herbicides x 3 herbicides rates (1%, 5%, 10%, and 100% of field rate) **(Table 1).**
- 3 repetitions, 1 experimental run.

Herbicide Treatments

Table 1. Herbicide treatment solutions

Herbicide	Commercial name	Field rate [b]
		g ai ha^{-1}
sulfometuron-methyl	Oust® XP	78
triclopyr + clopyralid	Confront®	378 + 126
triclopyr	Garlon® 4	8967
2,4-D + dichlorprop	Patron® 170	1917 + 975
indaziflam	Esplanade® 200 SC	103

[a] Herbicides solutions were prepared using 1%, 5%, 10%, and 100% of herbicide field rate.
[b] Confront® and Garlon® 4: g ae ha^{-1}.

Application Parameters

- Applications were conducted using a CO_2 backpack sprayer calibrated to deliver carrier volumes recommended by the NC DOT: 140 L ha^{-1} of sulfometuron-methyl, triclopyr + clopyralid, and indaziflam, and 935 L ha^{-1} of triclopyr and 2,4-D + dichlorprop using DG80015 and XR8006 nozzles, respectively.

Data collection

- Soybean field was harvested on October 28th and yield data were converted into percent of yield loss (YL) as compared to untreated control using the equation **YL= 100 – ((X*100)/Y)** where X is yield of an individual experimental unit and Y is mean yield of the untreated control replicates.

Statistical Analysis

- YL data were subjected to analysis of variance in SAS® software version 9.4.
- Treatment means were computed using Fisher's least significant procedure (α=0.05).

Results and Discussion

Figure 1. Percent soybean yield loss (YL) from simulated drift at 18, 12, 6, 0 weeks before planting (WBP) and 4 and 8 weeks after planting (WAP) averaged over herbicide rates.

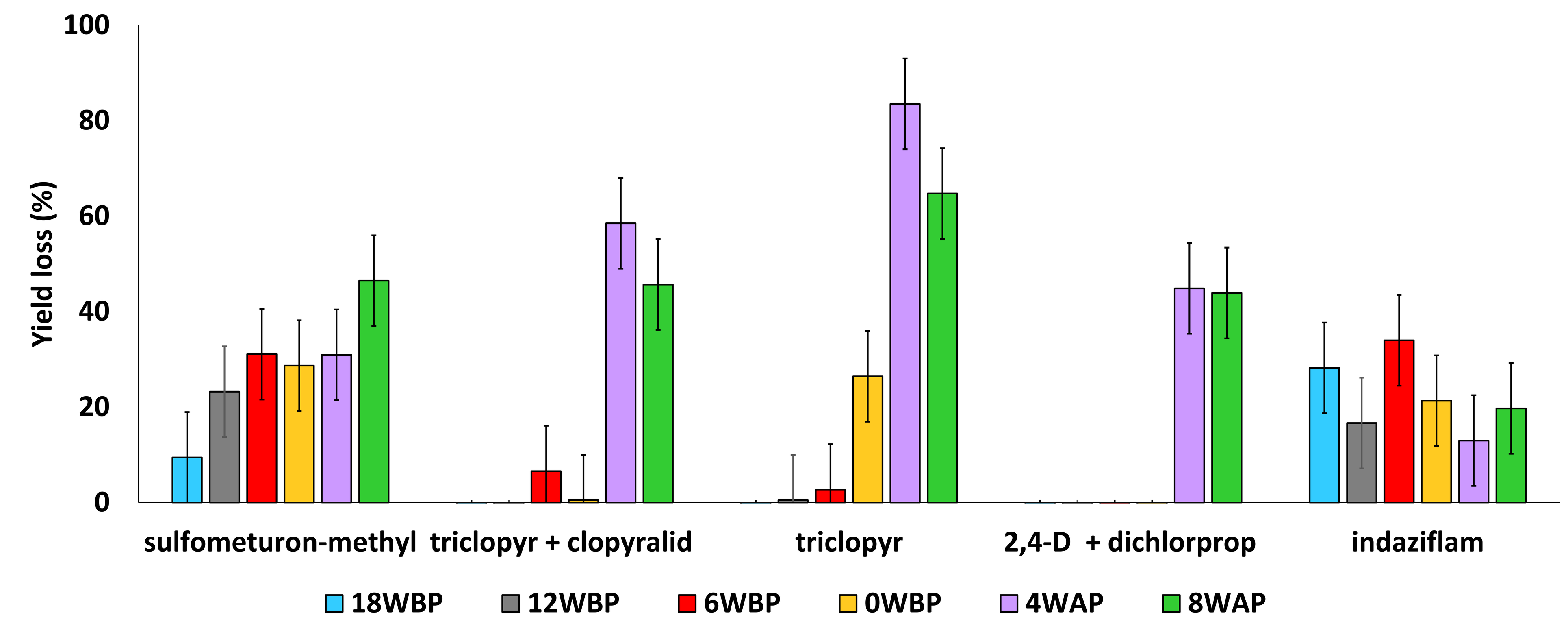
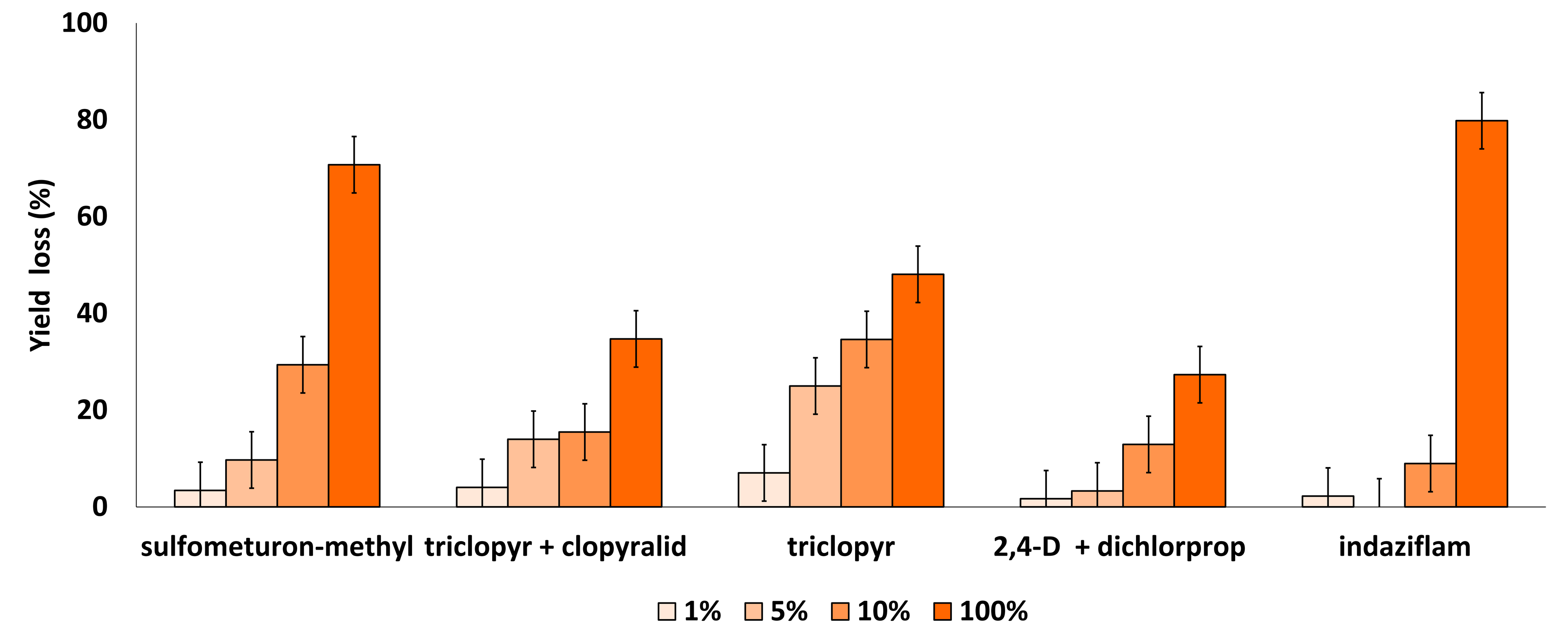
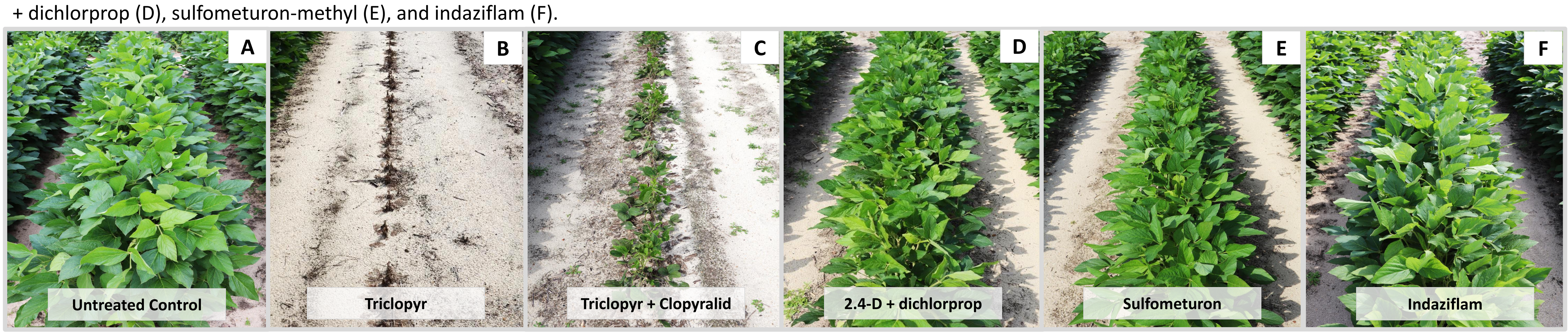


Figure 2. Percent soybean yield loss (YL) from simulated drift at 1%, 5%, 10%, 100% of field rates averaged over application timings.



- Analysis of variance indicated a significant two- way interaction between herbicide and application timing and between herbicide and rate at α=0.05
- Overall, higher soybean YL was observed for post-planting applications (44%) than to pre-planting applications (10%) **(Figure 1).**
- Soybean YL for indaziflan and sulfometuron was observed at all application timings. While for triclopyr, triclopyr + clopyralid, and 2-4-D + dichlorprop, YL was mostly observed for post-planting timings (4 WAP and 8 WAP).
- At 4 WAP, the highest soybean YL was observed for triclopyr (83%), followed by triclopyr + clopyralid (58%) , and 2,4-D + dichlorprop (45%) **(Figure 3)**.
- As expected, soybean YL increased as herbicide rate increased **(Figure 2).**
- Soybean YL was observed for all herbicides even at the lowest rates. YL by triclopyr was 7%, 25%, and 35% at 1%, 5%, and 10% of field rate, respectively.
- Findings of our study agree with **Jeffries et al., (2014)** in which spray drift of sulfometuron-methyl, triclopyr + clopyralid, and indaziflam at pre- and post-planting timings highly injured soybean plants.
- **Egan et al., (2014)** reported that soybean exposed to spray drift of 2,4-D presented natural high tolerance to this herbicide and none to low yield loss during vegetative and reproductive stages. However, in our study, an average yield loss of 44% was observed for 2,4-D + dichlorprop at 4 WAP and 8 WAP when soybean was at vegetative stage 2 (V2) and reproductive stage 1 (R1), respectively.

Figure 3. Soybean plants treated 4 weeks after planting (WAP) at 10% of field rate at 28 days after treatment: untreated control (A), triclopyr (B), triclopyr + clopyralid (C), 2,4-D + dichlorprop (D), sulfometuron-methyl (E), and indaziflam (F).



Conclusion & Future Research

- Soybean YL (%) was higher when herbicides were applied post-planting.
  Reject null hypothesis (1)
- For post-planting application timings, the highest soybean YL (%) was observed for synthetic-auxin herbicides (triclopyr > triclopyr + clopyralid > 2,4-D + dichlorprop).
  Reject null hypothesis (2)
- Indaziflam and sulfometuron-methyl caused soybean YL (%) at pre- and post-application timings. While triclopyr + clopyralid, triclopyr, and 2,4-D + dichlorprop caused soybean YL (%) mainly at post-application timings.
- A second experimental run is being conducted this year (2023).
- Visual estimation of injury and plant height will be included in the statistical analysis.

Relevance to North Carolina Agriculture

Triclopyr, triclopyr + clopyralid, and 2,4-D + dichlorprop are lower-risk options to manage roadside vegetation near soybean fields prior to soybean planting period since their impact on yield was minimal. However, from late April to July, herbicides investigated in this study may pose elevated risk of yield loss if spray drift occurs due to high sensitivity of soybean to those herbicides.

Literature Cited

- Egan, J.F., Barlow, K.M. and Mortensen, D.A. (2014) A meta-analysis on the effects of 2,4-and dicamba drift on soybean and Cotton. Weed Science, 62:193–206. Available at: https://doi.org/10.1614/ws-d-13-00025.1.
- Jeffries, M.D., Mahoney, D.J. and Gannon, T.W. (2014) Effect of simulated indaziflam drift rates on various plant species. Weed Technology, 28: 608–616. Available at: https://doi.org/10.1614/wt-d-14-00004.1.
- Pellegrini, E., Falcone, L., Loppi, S., Lorenzini, G., Nali, C. (2016) Impact of Mechanical Mowing and Chemical Treatment on Phytosociological, Pedochemical and Biological Parameters in Roadside Soils and Vegetation. Ecotoxicol 25:279–290
- USDA (2023) 2021 State Agriculture Overview for North Carolina. Retrieved from https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=NORTH%20CAROLINA
- NCDOT (2022) 2021 North Carolina Department of Transportation Annual Report. Retrieved from https://www.ncdot.gov/about-us/our-mission/Documents/2021-annual-report.pdf