Non-Target Site Resistance Mechanisms in Annual Bluegrass (*Poa annua*)

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Introduction

- Herbicide resistance can be divided into two groups, target site resistance (TSR) and non-target site resistance (NTSR) (Gaines et al., 2020)
- NTSR is characterized by reduced absorption, and/or translocation of an herbicide, sequestration in a plant part or increased metabolism of an herbicide (Rigon et al., 2020)
- A population of annual bluegrass in Alabama resistant to PS-II inhibiting herbicides demonstrated reduced absorption, translocation, and metabolism to an application of atrazine (Syvantek et.al., 2016)
- TSR and NTSR mechanisms can combine at the individual level to produce populations with higher resistance levels (Gaines et al., 2020)
- Multiple annual bluegrass populations from five states in the southeastern United States were evaluated

Objective

- Determine if select annual bluegrass (*Poa annua* L.) populations exhibit non-target site resistance mechanisms.

Materials and Methods

- Location
  - Raleigh, North Carolina
- Evaluated herbicide and rates
  - Simazine = 2.24 kg ai ha^{-1}
- Evaluated populations
  - All populations underwent a comprehensive dose response study to confirm resistance
  - Six suspected resistant and one susceptible population were evaluated
- Radiolabeled technical material
  - Radioactive solutions for each treatment consisted of a 1:1 v/v mixture of HPLC-grade water and methanol, with a non-ionic surfactant NIS (0.25% v/v)
  - 5 kBq radioactivity of ^{14}C-simazine
- Harvest timings
  - 0, 4, 12, 24, 96 and 192 hours after treatment (HAT)
- Evaluated plant parts
  - Treated leaf, treated leaf wash, other leaves, crown, and roots

Trial Initiation

- Prior to herbicide application, the third youngest leaf was covered with tinfoil.
- Herbicide applications were made using a CO_2-pressurized sprayer equipped with an 8002 EVS nozzle calibrated to deliver 187 L ha^{-1}.
- A 1 µl droplet of radioactive herbicide solution was placed on the adaxial surface of the covered third youngest fully expanded leaf.

Laboratory Methods

- Treated leaves were rinsed in a scintillation vial containing 20 ml 50:50 methanol: deionized water with the addition of a NIS (0.25% v/v) to remove any unabsorbed herbicide.
- All plant parts were dried for 48 hours at 60° C, weighed, and combusted with a biological oxidizer

Experimental Design and Data analysis

- Randomized block design with a factorial treatment arrangement
- Four replicates
- Two experimental runs

Statistical Analyses

- Data subjected to ANOVA ($\alpha \leq 0.05$)
- Means were separated using Fisher's Protected LSD ($\alpha = 0.05$)

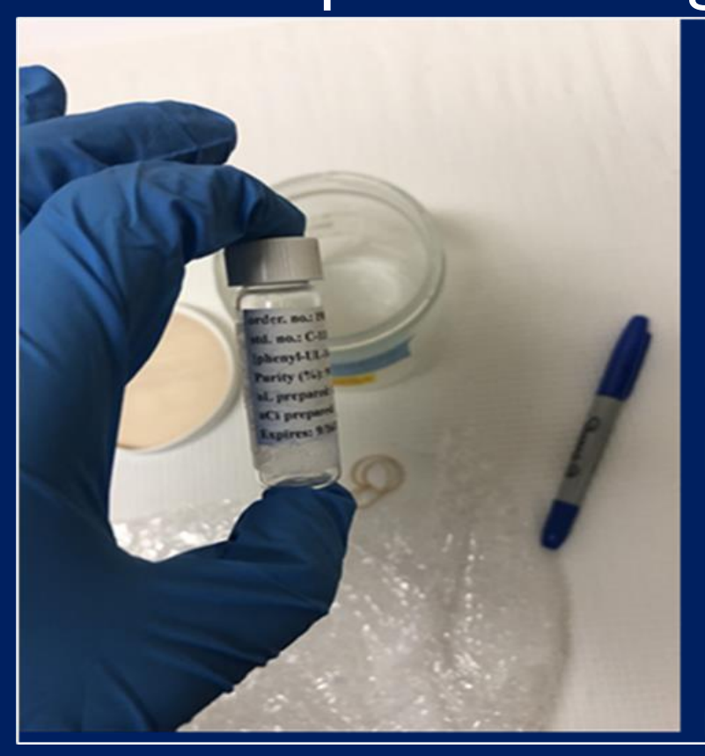

Figure 2a. ^{14}C-simazine solution

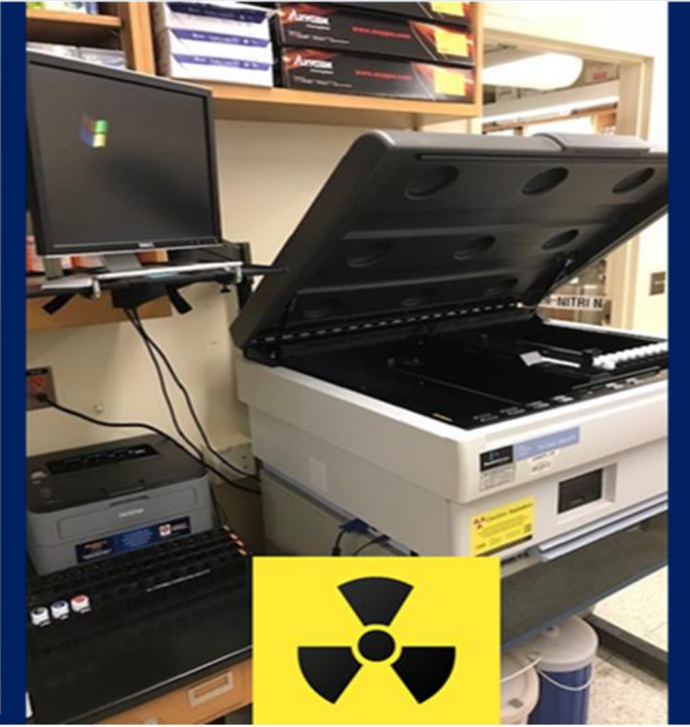

Figure 2b. Liquid Scintillation Analyzer

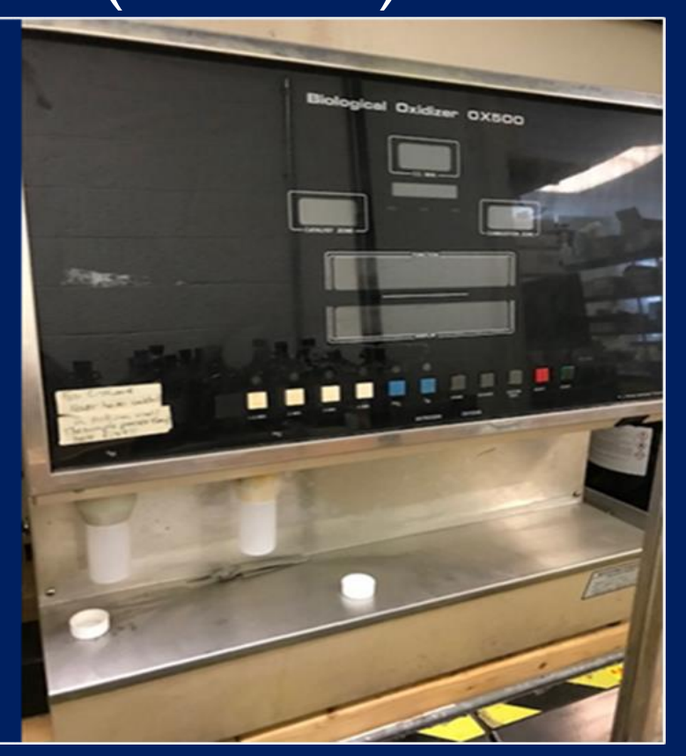

Figure 2c. OX-500 Biological Material Oxidizer

Results

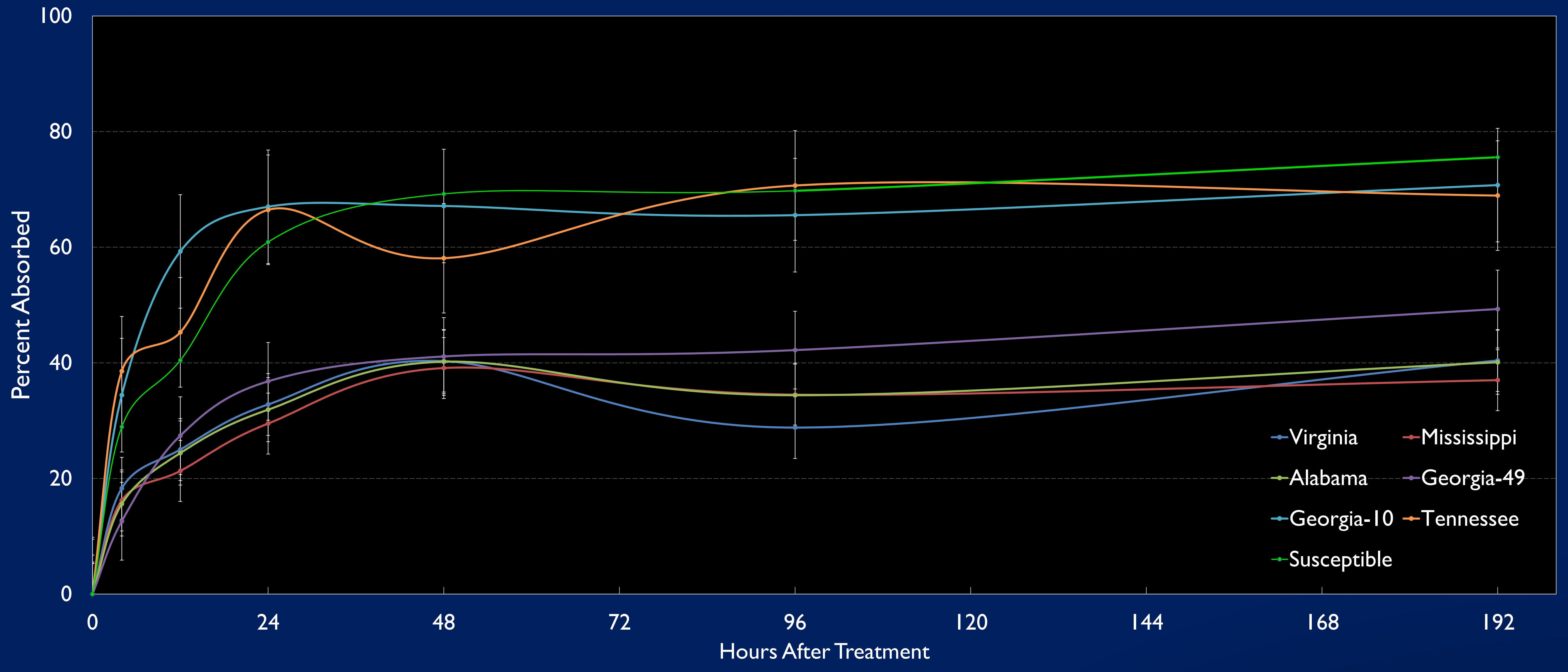

Figure 1. Two-way interaction of hours after treatment (HAT) and population on ^{14}C-simazine absorption in annual bluegrass

Table 1. Population-by-plant part interaction on ^{14}C-simazine translocation in annual bluegrass.[a]

	Alabama	**Georgia-49**	**Virginia**	**Mississippi**	**Georgia-10**	**Tennessee**	**Susceptible**
Plant Part	% of recovered [b]						
Wash	60.7	56.5	58.2	65.1	33.6	38.0	38.3
Treated Leaf	37.0	41.5	38.9	34.1	64.2	59.7	60.7
Shoot	2.0	1.8	2..8	0.7	1.3	1.7	0.7
Crown	0.2	0.04	0.1	0.06	0.4	0.4	0.1
Root	0.1	0.04	0.02	0.02	0.3	0.2	0.2
LSD $_{(0.05)}$ [c]	3.2						

[a]Data pooled over two experimental runs and six harvest timings.
[b]% of recovered = (total radioactivity in plant part) ÷ (total radioactivity recovered in plant) × 100
[c]Fishers Protected LSD conducted at P = 0.05

Discussion

- Analysis of variance indicated a significant two-way interaction between population and HAT for ^{14}C- simazine absorption
- Georgia-49, Alabama, Georgia-10, and Mississippi populations absorbed 13% to 19.1% less ^{14}C- simazine compared to the susceptible population at 12 HAT (Figure 1)
- This trend continues to 192 HAT where the Georgia-49, Alabama, Georgia-10, and Mississippi populations absorbed 26.2% to 38.5% less ^{14}C- simazine compared to the susceptible population
- Significant differences were not observed in ^{14}C- simazine absorption for the Virginia and Tennessee populations when compared to the susceptible population
- These data suggest reduced absorption does not contribute to resistance in the Virginia and Tennessee populations
- Findings in this study are similar to Syvantek et al., (2016) in which an annual bluegrass population resistant to atrazine absorbed 50% less than a susceptible population
- Analysis of variance indicated a significant two-way interaction between population and plant part for ^{14}C- simazine translocation
- Translocation data show 19.2 to 26.6 % more ^{14}C-simazine in the treated leaf of the susceptible population when compared to the Alabama, Georgia-49, Virginia and Mississippi populations (Table 1)

Conclusions

- Reduced absorption may contribute to resistance in the Georgia-49, Alabama, Georgia-10, and Mississippi populations
- Translocation data depict no statistical differences between populations in regards to movement of ^{14}C- simazine out of the treated leaf

Future Research

- Conduct metabolism research to determine if resistant populations exhibit increased metabolism of simazine
- Conduct absorption, translocation studies on additional annual bluegrass populations

Literature Cited

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