

# SC Cotton Board Final Report

## General Information

**Principal Investigator(s) Name(s):** Michael W. Marshall

**Organization:** Clemson University

**Date:** 1/6/23

## Proposal Information

**Title:** Survey of Palmer Amaranth Resistance in South Carolina Cotton Production

**Amount expended to Date:** \$8472.00

## Project Summary

Palmer amaranth seed were planted and sprayed in the greenhouse at EREC from October 2022 through early January 2023. All populations from the 22 counties showed resistance to both the 1X and 2X rates of glyphosate (MOA 9) and Staple (MOA 2) [ALS-inhibitor]. This confirms results from past Palmer amaranth collections in that glyphosate and ALS-resistance is persisting in South Carolina populations. In contrast, all populations were sensitive to the 1X rates of Reflex, Liberty, Enlist One, and Dicamba postemergence herbicides. In the preemergence experiments, there were populations from 10 counties that we observed survivors from the atrazine at the 1X rate. In addition, there were populations from 5 of those counties with survivors from the 2X rate of atrazine. The remaining Palmer populations were controlled by atrazine at the 1X rate. In the Dual Magnum treatment, we observed populations from 3 counties with survivors at the 1X rate. There were no survivors at the 2X rate of Dual Magnum. The HPPD herbicide Balance (isoxaflutole, MOA 27) provided excellent control of all populations tested. Although atrazine is not used in cotton, we observed more survivors from the atrazine treatments compared to the 2021 population survey. Also, there were several populations that survived the Dual Magnum (MOA 15) preemergence treatments (@1X) which could indicate that this herbicide family may lose effectiveness soon. Further research is needed on populations that are surviving both atrazine (MOA 5) and Dual Magnum (MOA 15) herbicides.

## Key Performance Indicators

The results from the survey show so far that our key POST herbicides in cotton Liberty, 2,4-D, and Dicamba control Palmer amaranth populations in the South Carolina. These results demonstrate that SC Palmer amaranth populations are not yet developing other resistances because growers are using different modes-of-action in their herbicide programs. However, there were a few populations that survived the preemergence herbicides Dual Magnum (MOA 15) and atrazine (MOA 5). Of concern is the Dual Magnum survivors in the Dual Magnum treatment because this family is used frequently for POST residuals for Palmer amaranth control.

## Next Steps

These results will be disseminated to South Carolina cotton growers to aid in planning their future herbicide programs. We will also continue to evaluate suspected Palmer amaranth resistant populations after the end of this project.

### **Additional Information (2022 Final Report Summary)**

**Introduction:** The introduction of glyphosate tolerant cotton varieties resulted in lower input costs and simplicity of weed control for growers. Nearly 100% of the cotton acres contained glyphosate and/or other stacked trait tolerances. However, this ease and simplicity of this system pushed other products out of the market and put tremendous selection pressure on weeds. In less than a decade after its introduction, glyphosate resistance was confirmed in Palmer amaranth and waterhemp across the United States. The other significant impact of glyphosate only programs was the decrease in new herbicide discovery and development. In response to glyphosate resistance, trait technologies in cotton have been introduced with tolerance to several older MOA's, such as glufosinate, 2,4-D, and dicamba. Earlier surveys in South Carolina demonstrated Palmer amaranth resistance to both glyphosate and ALS-inhibitors. With reports of Palmer amaranth resistance to some of these herbicides in surrounding states and the potential uncertainty of dicamba herbicide availability due to off-site movement, a screening of Palmer amaranth populations is needed to determine, if any, resistance to additional herbicide MOA's in South Carolina.

### **Objectives:**

1. To collect Palmer amaranth seed samples across the state and conduct greenhouse herbicide screens for levels of resistance to glyphosate, Liberty, PPO-inhibitors, ALS-inhibitors, 2,4-D, and dicamba.
2. To disseminate these research results to South Carolina cotton growers through field days and grower meetings.

**Procedures:** Mature female Palmer amaranth seed heads were collected from cotton fields across the state (approximately 4 to 5 samples per county in the coastal plain and piedmont) from September to early November of 2022. At each sampling site, GPS coordinates for each field sample site were collected for potential long-term monitoring of the sites. A total of 65 Palmer amaranth seedhead samples across 22 counties were collected during the fall of 2022. The Palmer amaranth seedhead samples were dried in the oven for 5 days at 105F, threshed, and mature seed was screened from the chaff using different sized sieves. The herbicides and rates used for the population screening study are listed in Table 1. The experimental design was a randomized complete block with 6 replications. For the postemergence herbicides, Palmer amaranth seed was planted in 48 cell trays in the greenhouse (6 cells per population) containing Miracle Grow potting mix. The plants were allowed to grow to the 2-4 lf stage and treated with the 1 X and 2 X-rate of each herbicide (Table 1). All postemergence herbicide treatments included the recommended adjuvants according to label guidelines. An untreated check (0) was included. At 5 to 14 days after application, Palmer amaranth populations survivors were counted and scored using the following system (+) survivors present or (-) total death of all plants. In the

preemergence herbicide study, field soil was collected (Fuquay sandy loam) from EREC, sterilized, and placed in the 48 cell trays in the greenhouse. Palmer populations were seeded in the soil, covered slightly with more soil, and the preemergence herbicides were sprayed afterwards (Table 1). The trays were watered approximately 12 hours later to activate the herbicides. The same protocol as in the postemergence study where the Palmer amaranth populations were scored after 10-14 days for emergence (+) or no emergence (-)

**Table 1.** Herbicide treatments in the resistance screen (the normal use rate is bolded):

	<b>Product</b>	<b>Common Name</b>	<b>Timing</b>	<b>MOA</b>	<b>Rate/A</b>
1	Roundup	glyphosate	POST	9	0, <b>32</b> ,64 fl oz
2	Reflex	fomesafen	POST	14	0, <b>16</b> ,32 fl oz
3	Liberty	glufosinate	POST	10	0, <b>32</b> , 64 fl oz
4	Staple	trifloxysulfuron	POST	2	0, <b>2</b> , 4 fl oz
5	Enlist One	2,4-D	POST	4	0, <b>32</b> , 64 fl oz
6	Xtendimax	dicamba	POST	4	0, <b>16</b> , 32 fl oz
7	Atrazine	atrazine	PRE	5	0, <b>1</b> , 2 lb/A
8	Dual Magnum	s-metolachlor	PRE	15	0, <b>16</b> , 32 fl oz/A
9	Balance	isoxaflutole	PRE	27	0, <b>3</b> , 6 fl oz/A

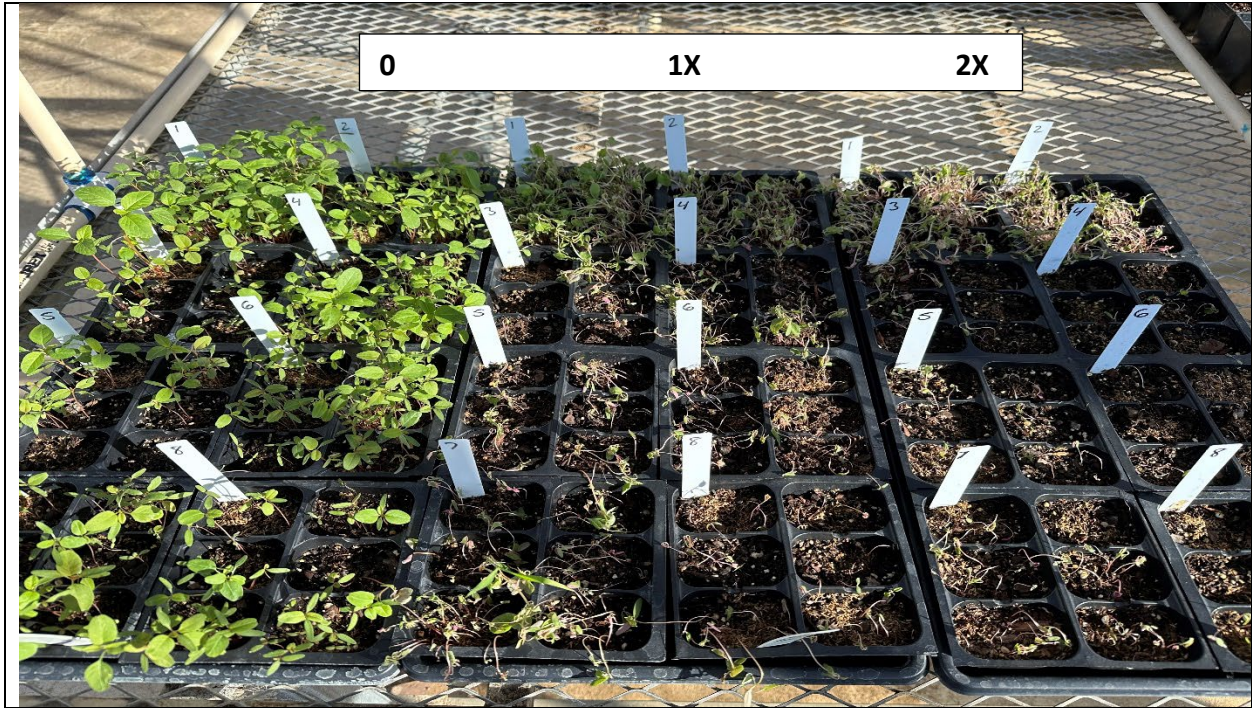
**Results and Discussion:** Palmer amaranth seed were planted and sprayed in the greenhouse at EREC from October 2022 through early January 2023. All populations from the 22 counties showed resistance to both the 1X and 2X rates of glyphosate (MOA 9) and Staple (MOA 2) [ALS-inhibitor]. This confirms results from past Palmer amaranth collections in that glyphosate and ALS-resistance is persisting in South Carolina populations. In contrast, all populations were sensitive to the 1X rates of Reflex, Liberty, Enlist One, and Dicamba postemergence herbicides. In the preemergence experiments, there were populations from 10 counties that we observed survivors from the atrazine at the 1X rate. In addition, there were populations from 5 of those counties with survivors from the 2X rate of atrazine. The remaining Palmer populations were controlled by atrazine at the 1X rate. In the Dual Magnum treatment, we observed populations from 3 counties with survivors at the 1X rate. There were no survivors at the 2X rate of Dual Magnum. The HPPD herbicide Balance (isoxaflutole, MOA 27) provided excellent control of all populations tested. Although atrazine is not used in cotton, we observed more survivors from the atrazine treatments compared to the previous 2021 survey samples. Also, there were several populations that survived the Dual Magnum (MOA 15) preemergence treatments (@1X) which could indicate that this herbicide family may soon lose effectiveness. More research is needed on populations that are surviving both atrazine (MOA 5) and Dual Magnum (MOA 15) herbicides.

**Table 3.** Palmer amaranth populations response to preemergence (PRE) and postemergence (POST) herbicides at 1 and 2X of the standard use rate (++) indicates survivors at both 1 and 2X rate, +- indicates survivors only at the 1X rate, -- indicates no survivors, and X is no germination observed from that population, even in the controls).

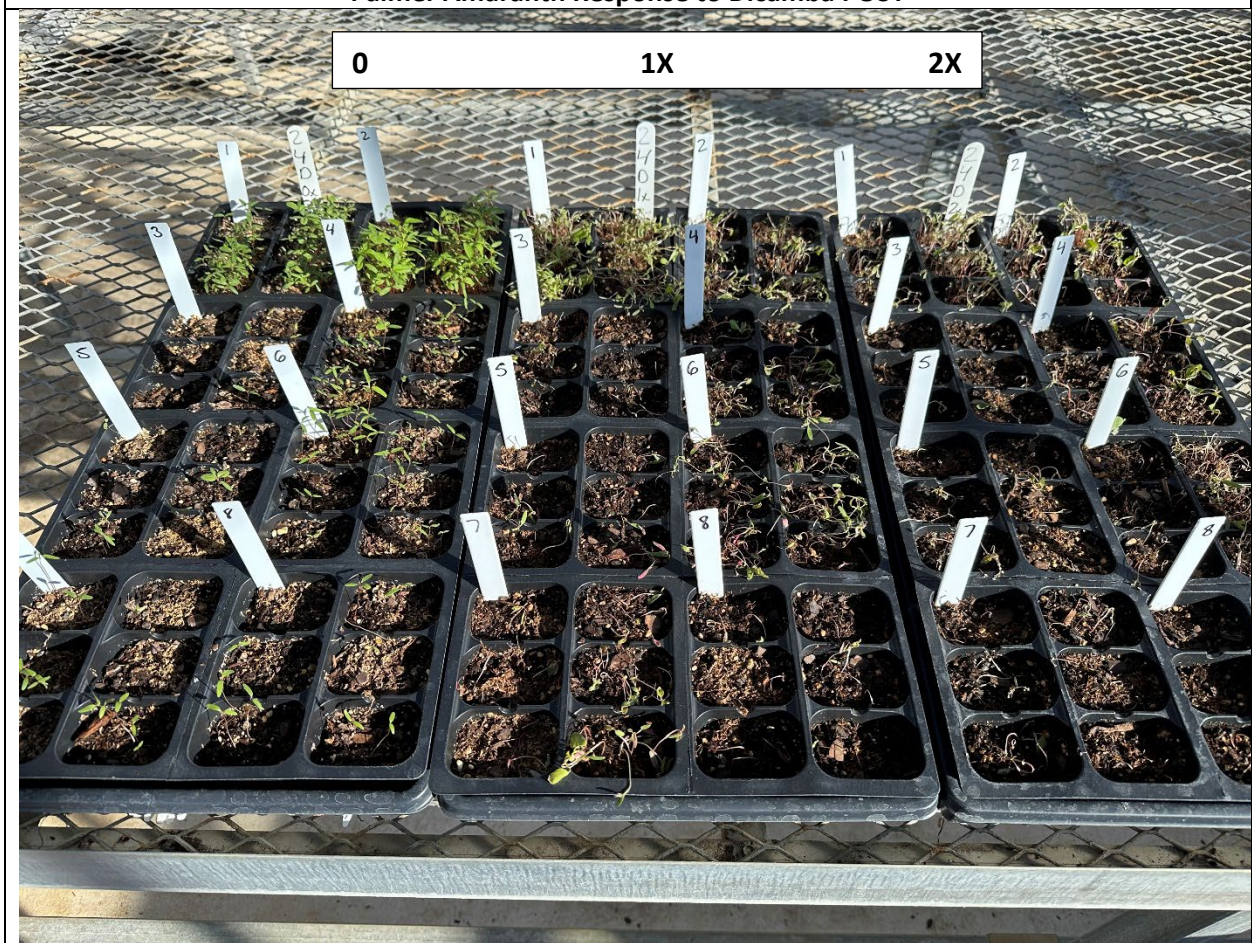
County Samples (n=4-5)	POST (1X,2X)						PRE (1X,2X)		
	GLY (9)	LIB (10)	REFLEX (14)	2,4D (4)	DIC (4)	HARM (2)	ATZ (5)	DUAL (15)	BAL (27)
<b>MOA</b>									
Dillon	++	--	--	--	--	++	--	--	--
Hampton	++	--	--	--	--	++	+-	--	--
Lexington	++	--	--	--	--	++	+-	--	--
Barnwell	++	--	--	--	--	++	--	--	--
Aiken	++	--	--	--	--	++	++	--	--
Marlboro	++	--	--	--	--	++	++	+-	--
Dorchester	++	--	--	--	--	++	++	+-	--
Florence	++	--	--	--	--	++	++	--	--
Richland	++	--	--	--	--	++	--	--	--
Anderson	++	--	--	--	--	++	--	+-	--
Williamsburg	++	--	--	--	--	++	--	--	--
Colleton	++	--	--	--	--	++	+-	--	--
Saluda	++	--	--	--	--	++	--	--	--
Orangeburg	++	--	--	--	--	++	--	--	--
PDREC	++	--	--	--	--	++	++	--	--
Darlington	++	--	--	--	--	++	--	--	--
Allendale	++	--	--	--	--	++	--	--	--
EREC	++	--	--	--	--	++	--	--	--
Calhoun	++	--	--	--	--	++	--	--	--
Bamberg	++	--	--	--	--	++	--	--	--
Edgefield	++	--	--	--	--	++	+-	--	--
Newberry	++	--	--	--	--	++	+-	--	--

\*Abbreviations: GLY = GLYPHOSATE, POST; LIB = LIBERTY, POST; DIC=DICAMBA, POST; HARM=HARMONY, POST; ATZ=ATRAZINE, PRE; DUAL=DUAL MAGNUM, PRE; and BAL=BALANCE (isoxaflutole), PRE.



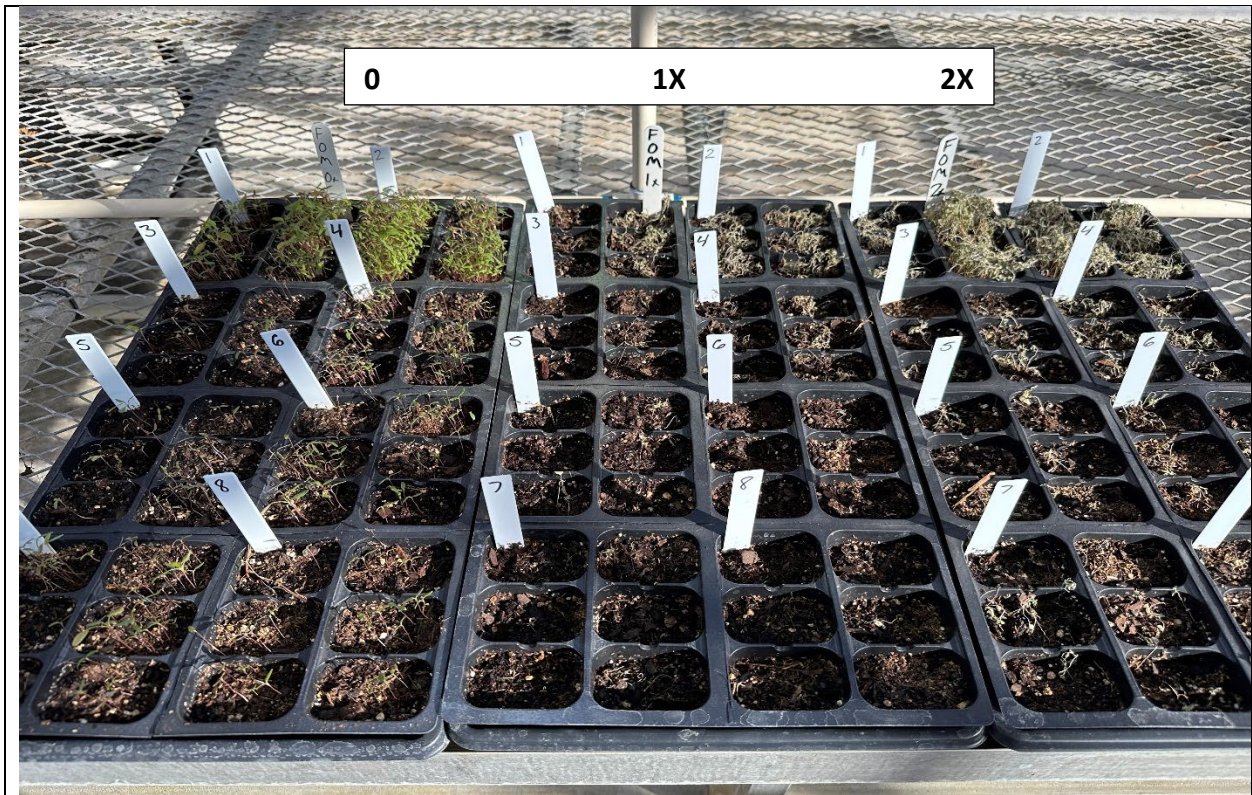


Palmer Amaranth Response to Dicamba POST

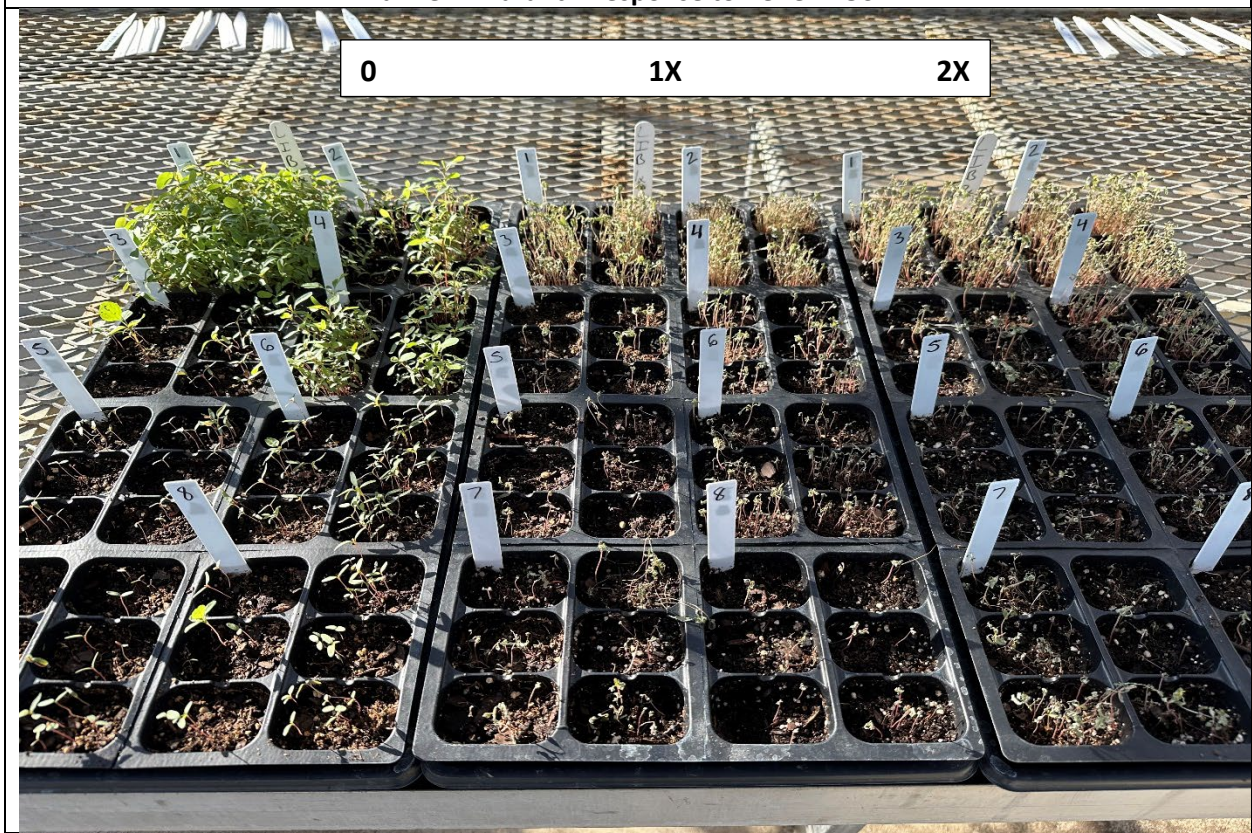


Palmer Amaranth Response to 2,4-D POST



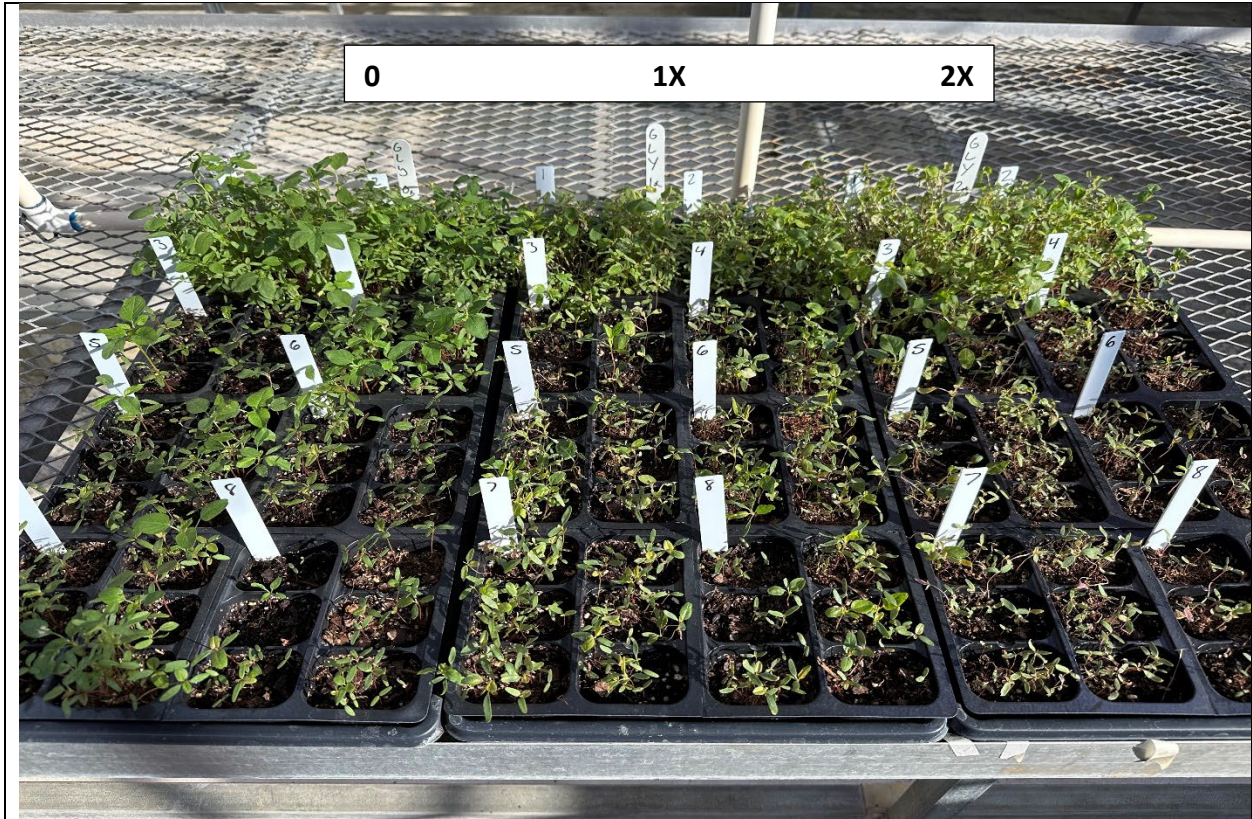


Palmer Amaranth Response to Reflex POST

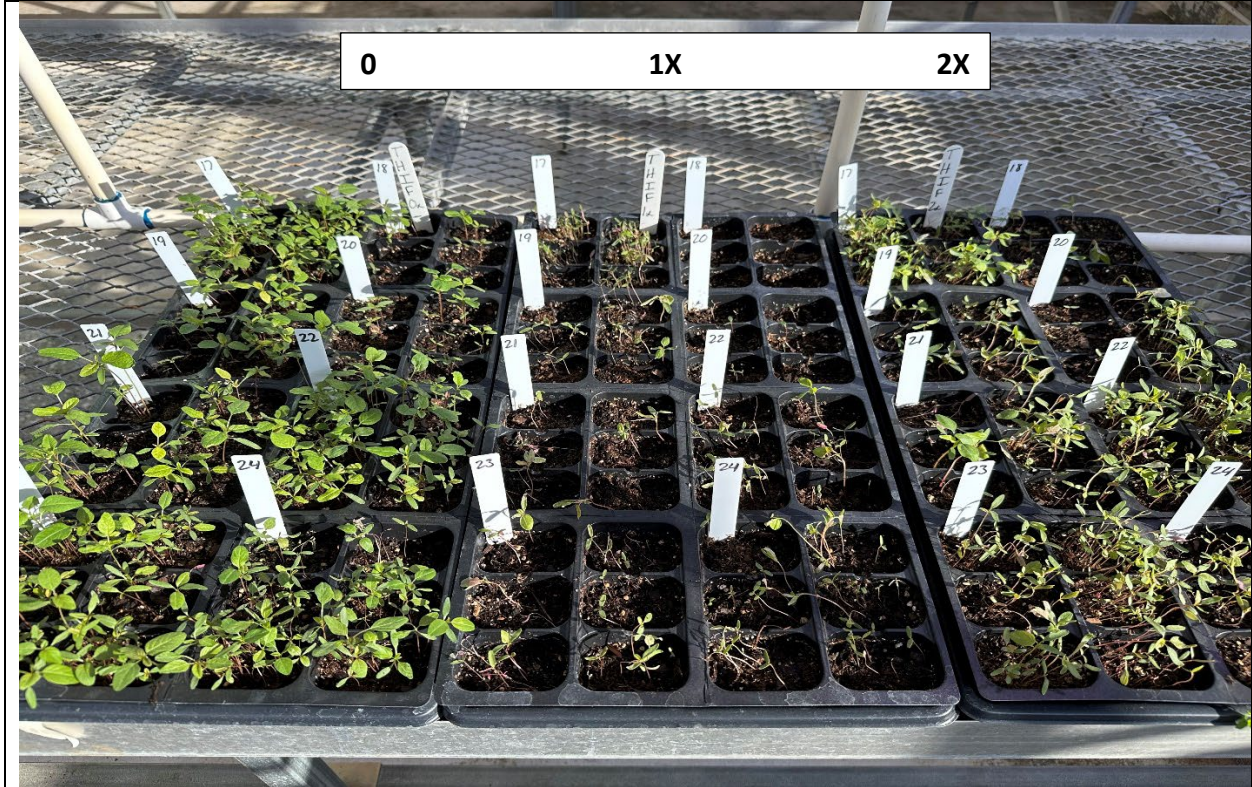


Palmer Amaranth Response to Liberty POST





Palmer Amaranth Response to Glyphosate POST



Palmer Amaranth Response to Staple POST