Soybean Board Final Report – Palmer Resistance Survey 2021

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Introduction: The introduction of glyphosate tolerant soybean varieties resulted in lower input costs and simplicity of weed control for growers. Nearly 100% of soybean and 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 and soybean 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 neighboring 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 other 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 soybean growers through field days and grower meetings.

Procedures: Mature female Palmer amaranth seed heads were collected from soybean fields across the state (approximately 4 to 5 samples from each county with significant row crop production in the coastal plain and piedmont) from September to early November of 2021. At each sampling site, GPS coordinates were collected for potential long-term monitoring of the sites. A total of 126 seed samples were collected during the fall of 2021. 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 for the study are listed in Table 1. The experimental design will be a randomized complete block with 6 replications. Due to the limited time left in the project, a subset of 1 population per county was chosen for this part of the study for a total of 24 populations for the initial screen (Table 2). 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. An untreated check (0) was included. At 14 days after application, Palmer amaranth populations were scored using the following system (+) survivors present or (-) total death of all plants. An untreated control will be included for comparison. In the preemergence herbicide study, field soil was collected (Fuquay sandy loam), sterilized, and placed in the 48 cell trays in the greenhouse. Palmer populations were seeded in the soil and the preeemerence herbicides were sprayed afterwards. The trays were watered 12 hours later to activate the herbicides. The same protocol as in the postemergence study where the Palmer amaranth populations were scored after 14 days for emergence (+) or no emergence (-)

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

	Herbicide	MOA	Rate/A
1	Glyphosate	9	0,**32**,64 fl oz
2	Reflex	14	0,**16**,32 fl oz
3	Liberty	10	0, **32**, 64 fl oz
4	Harmony	2	0,**0.125**, 0.25 oz
5	2,4-D	4	0, **32**, 64 fl oz
6	Dicamba	4	0,**16**, 32 fl oz
7	Atrazine		0, **1**, 2 lb/A
8	Dual Magnum		0, **16**, 32 fl oz/A
9	Balance		0, **3**, 6 fl oz/A

Table 2. Counties surveyed for Palmer amaranth resistance in fall of 2021 with the corresponding location coordinates of the fields.

County	GPS location (N, W) of field	
Dillon	34.486264	79.492402
Darlington	34.196142	79.933182
Marlboro	34.545063	79.497537
Horry	34.075579	79.137898
Bamberg	33.342500	81.178333
Edgefield	33.817344	81.804295
Florence	34.154582	79.918055
Allendale	33.053333	81.250685
Richland	33.904157	80.671992
Williamsburg	33.756061	79.882046
Chesterfield	34.773843	80.229596
Colleton	33.076035	80.971710
Hampton	32.923238	81.191573
Marion	34.166258	79.234533
Anderson	34.471792	82.738052
Aiken	33.533399	81.663002
Lexington	33.839076	81.335620
Saluda	34.100980	81.749392
Calhoun	33.729549	80.651400
Dorchester	33.154610	80.673082
Orangeburg	33.396614	80.620694
Barnwell	33.322027	81.262463
Newberry	34.293154	82.725887
Laurens	34.402409	82.051670

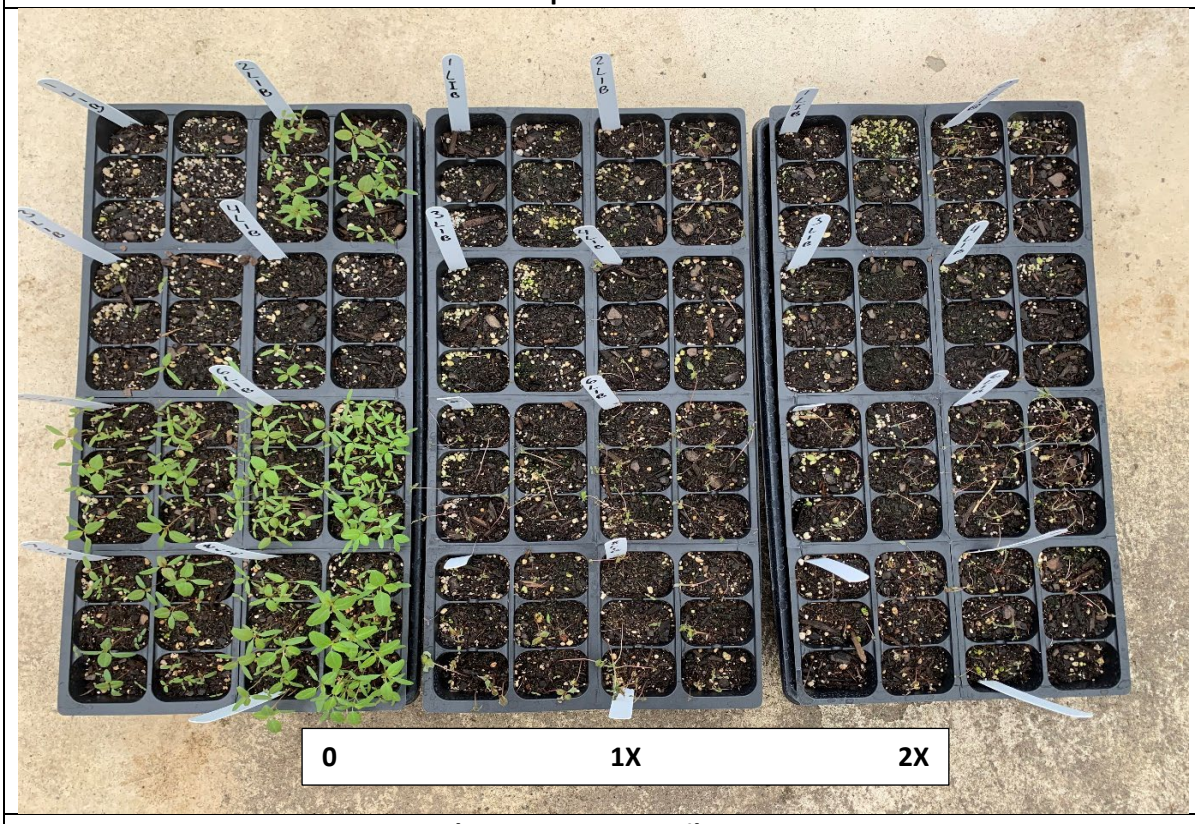
Results and Discussion: Palmer amaranth seed were planted in the greenhouse at Edisto REC and sprayed in December 2022 and January 2022. The results from the greenhouse treatments are shown in Table 2.As expected, all populations were resistant to the 1X rate of glyphosate (MOA 9) and Harmony (MOA 2). In the Marion and Colleton seed samples, Harmony controlled these populations at the 2X rate. The remaining populations were not controlled at the 2X rate. Reflex, 2,4-D, and Dicamba POST controlled all Palmer populations are the 1X rate. In the preemergence experiments, there was one population (Laurens) that we observed survivors from the atrazine preemergence treatment at the 1X rate. The rest of the Palmer populations were controlled at the 1X rate of atrazine. In the Dual Magnum treatment, we observed one population that survived the 2X rate and 7 populations that survived the 1X rate. For the last preeemergence treatment, the Barnwell and Laurens populations survived the 1X rate of Balance. The number of survivors in the Dual Magnum treatments (1X and 2X) was surprising given the amount used for Palmer control in South Carolina.

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).

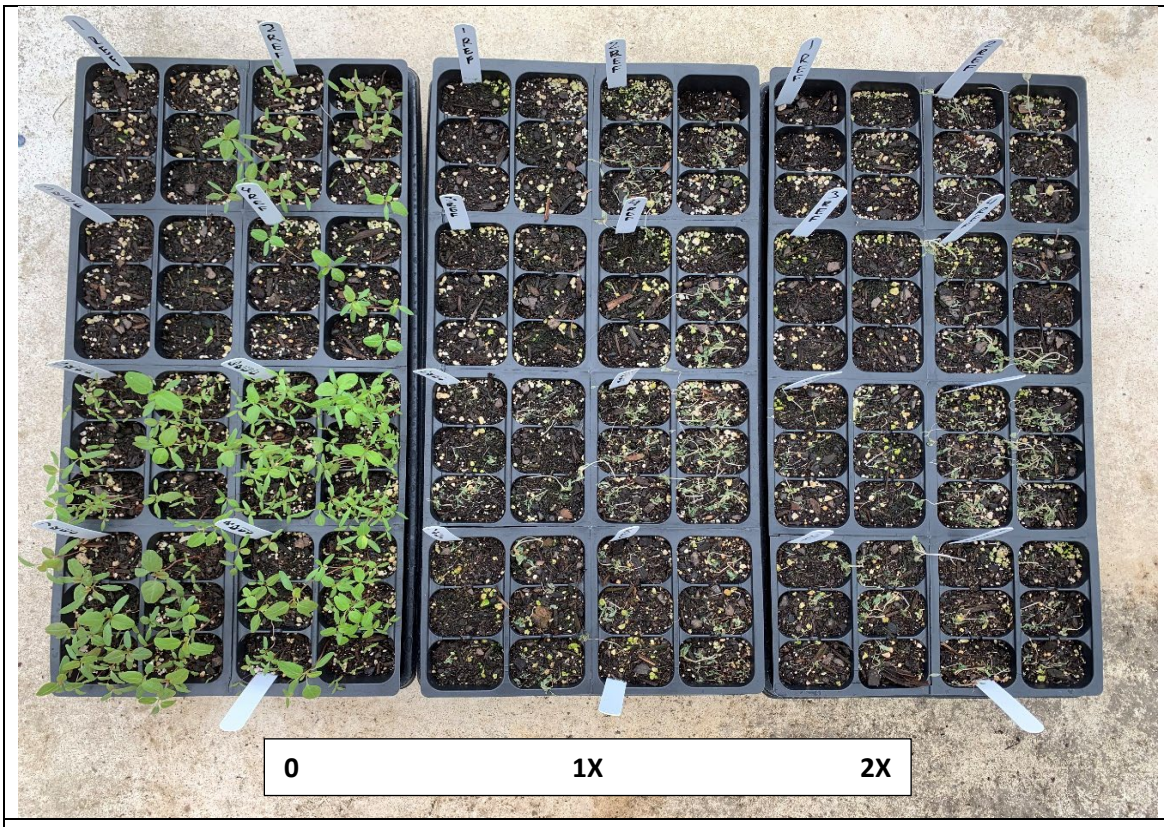
County	POST (1X,2X)						PRE (1X,2X)		
	GLY	LIB	REFLEX	2,4D	DIC	HARM	ATZ	DUAL	BAL
Dillon	X	X	X	X	X	X	X	X	X
Darlington	++	--	--	--	--	++	--	--	--
Marlboro	X	X	X	X	X	X	X	X	X
Horry	++	--	--	--	--	++	--	--	--
Bamberg	++	--	--	--	--	++	--	--	--
Edgefield	++	--	--	--	--	++	--	++	--
Florence	++	--	--	--	--	++	--	+-	--
Allendale	++	--	--	--	--	++	--	+-	--
Richland	++	--	--	--	--	++	--	+-	--
Williamsburg	++	--	--	--	--	++	--	--	--
Chesterfield	++	--	--	--	--	++	--	--	--
Colleton	++	--	--	--	--	+-	--	--	X
Hampton	++	--	--	--	--	++	--	+-	--
Marion	++	--	--	--	--	+-	--	+-	--
Anderson	++	--	--	--	--	++	--	--	X
Aiken	++	--	--	--	--	++	--	+-	--
Lexington	++	--	--	--	--	++	--	--	--
Saluda	++	--	--	--	--	++	--	+-	--
Calhoun	X	X	X	X	X	X	X	X	X
Dorchester	++	--	--	--	--	++	--	--	--
Orangeburg	++	--	--	--	--	++	--	--	--
Barnwell	++	--	--	--	--	++	--	--	+-
Newberry	++	--	--	--	--	++	--	--	--
Laurens	++	--	--	--	--	++	+-	--	+-

*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 Response to Dicamba POST



Palmer Response to Liberty POST



Palmer Response to Reflex POST

Palmer Response to 2,4-D Choline POST