Weed Management Programs for Mississippi Soybean Production (MSPB 20-2024)
Annual Report

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Rationale/Justification for Research:

Glyphosate-resistant (GR) Palmer amaranth and Italian ryegrass are the greatest weed threats for Mississippi crops. Palmer amaranth competes for nutrients, water, light, and space because of its rapid, upright growth habit and allelopathic properties. Italian ryegrass can jeopardize burndown herbicide programs. Italian ryegrass residue will impede planting practices, contribute to competition between soybean seedlings and GR Italian ryegrass, and hinder herbicide programs due to inadequate coverage.

Paraquat is essential for weed control in Mississippi agriculture, and it is utilized in preplant herbicide programs in all major row crops. Paraquat is also used as a harvest aid in soybean. All herbicide products containing paraquat registered in the United States are designated as Restricted Use Pesticides (RUPs) by the United States Environmental Protection Agency (EPA). The US-EPA recently implemented new packaging, handling, and training requirements for paraquat, and label updates for 2024 will further restrict paraquat. Paraquat has been a staple of soybean production in Mississippi for many years. It is imperative that alternative suggestions are available to replace paraquat should it be removed as an option for Mississippi soybean producers.

Combing herbicide modes of action is imperative for control of Palmer amaranth and reducing further resistance development. Residual herbicides are critical in programs for Palmer amaranth management in soybean. However, real or perceived challenges with soybean injury from postemergence applications of residual herbicides threaten use of these products in Mississippi soybean. Characterizing the soybean response to different residual herbicides should alleviate concerns with these treatments.

Bog yellowcress and Virginia pepperweed are both native to Mississippi, but both have recently become management priorities in many counties in the Delta. Little is known about the growth and development of either of these species or their influence on soybean growth. Management suggestions for these species are needed to continue to improve soybean yields in Mississippi.

Objectives:

1. Evaluate new and/or currently registered herbicides and herbicide-resistant technologies for positioning into Mississippi weed management programs.
2. Refine soybean production practices by formulating herbicide and desiccant programs for Mississippi soybean that do not include paraquat.
3. Evaluate soybean response to different postemergence treatments of residual herbicide mixtures applied as different modes of action, at different timings, or as sequential treatments.
4. Characterize populations and growth patterns of bog yellowcress and Virginia pepperweed and identify herbicide products that may control either or both species.

Report of Progress/Activity:

Objective 1 – 2024

Fourteen studies were conducted at the Delta Research and Extension Center in 2024 to evaluate new and/or currently registered herbicides and herbicide-resistant soybean technologies for positioning into Mississippi weed management programs. Many of these studies focused on the efficacy of pre-mixes of currently registered herbicides or generic formulations of commercial herbicides. Use of Engenia, Xtendimax with VaporGrip, or Tavium with VaporGrip (dicamba plus *s*-metolachlor) continue to be evaluated in Roundup Ready 2 XtendFlex soybean. Additionally, weed control with Enlist Duo and Enlist One in E3 soybean is a focus area.

One study of interest evaluated single and sequential postemergence (POST) treatments of Zalo (glufosinate plus quizalofop) with and without a preemergence (PRE) treatment in soybean. The PRE herbicide products evaluated included Tendovo at 1.75 QT/A and Authority Edge at 8 FL OZ/A. The POST treatments were applied to V3 soybean with the sequential application 10 to 14 days later. Soil texture at the study site was a very fine sandy loam. Historically, soybean injury with residual herbicides applied at planting has been a concern for soybean growers in MS. However, demonstrated safety with higher rates along with a longer period of residual control could improve soybean weed management programs in the state. Tendovo and Authority Edge both controlled barnyardgrass ≥ 94% 20 days after application (Table 1). By 15 days following the second POST application, barnyardgrass control in plots with no PRE was ≤ 86%, and this control was similar to that from Tendovo with no POST application. A similar pattern was observed with entireleaf morningglory and Palmer amaranth where control was less in the absence of a PRE treatment. These data offered an evaluation of a new POST premix in Zalo and a relatively new PRE premix in Tendovo. Additionally, observations here offer more evidence to the validity of current MSU Extension recommendations that at-planting residual herbicide treatments followed by well-timed POST treatments are essential to optimize weed control in soybean.

Glufosinate has been applied as a POST herbicide in glufosinate-resistant crops for nearly three decades and is still one of the few effective options providing broad-spectrum weed control. Therefore, in-season foliar applications of glufosinate will prove vital for controlling problematic weeds and preserving crop yields. Another study was conducted in Stoneville, MS, in 2024 to evaluate Palmer amaranth and barnyardgrass control with herbicide programs containing sequential POST applications of Liberty 280 at various timings. Treatments were arranged as a two-factor factorial in a randomized complete block design with four replications. Factor A was preemergence (PRE) treatment and included no PRE, Xtendimax at 22 FL OZ/A, and Warrant at 3 PT/A plus Mauler (metribuzin) at 8.6 FL OZ/A. Factor B was sequential POST application timings and included no POST, 14 days after emergence (DAE) followed by (fb) 28 DAE, 28 fb 42 DAE, and 42 fb 56 DAE. Sequential POST treatment included Roundup PowerMax 3 at 30 FL OZ/A plus Liberty 280 at 32 FL OZ/A plus Warrant at 3 PT/A followed by Roundup PowerMax 3 at 30 FL OZ/A plus Liberty 280 at 32 FL OZ/A

Palmer amaranth and barnyardgrass control were 90% in the absence of a PRE herbicide treatment and sequential applications of Liberty 280 at 42 and 56 DAE, respectively. For each PRE treatment, soybean grain yields were similar across all sequential POST application timings of Liberty 280. These results demonstrate the ability of sequentially applied Liberty 280 to provide effective control of Palmer amaranth and barnyardgrass while preserving crop yields.

Table 1. Weed control with single and sequential postemergence (V3 GLYMA; 10-14 DA-B) treatments of Zalo (glufosinate plus quizalofop) with and without a preemergence (PRE) treatment in soybean at Stoneville, MS, in 2023.[a]

				Barnyardgrass control		Entireleaf morningglory control		Palmer amaranth control		Soybean yield
				20 DA-A	15 DA-C	20 DA-A	15 DA-C	20 DA-A	15 DA-C	
Treatment	Rate	Rate Unit	Timing	%						BU/A
Nontreated				0 b	0 e	0 c	0 d	0 c	0 e	0 d
Tendovo	1.75	QT/A	PRE	94 a	84 c	91 ab	83 c	88 b	79 d	62 bc
Authority Edge	8	FL OZ/A	PRE	98 a	93 ab	99 a	95 ab	99 a	95 ab	59 c
Zalo	32	FL OZ/A	V3 GLYMA		86 bc		85 bc		91 b	62 bc
Herbimax	19.2	FL OZ/A	V3 GLYMA							
Class Act NG	3	PT/A	V3 GLYMA							
Zalo	32	FL OZ/A	10-14 DA-B							
Herbimax	19.2	FL OZ/A	10-14 DA-B							
Class Act NG	3	PT/A	10-14 DA-B							
Zalo	32	FL OZ/A	V3 GLYMA		75 d		80 c		85 c	62 bc
Dual Magnum	1.33	PT/A	V3 GLYMA							
Herbimax	19.2	FL OZ/A	V3 GLYMA							
Class Act NG	3	PT/A	V3 GLYMA							
Tendovo	1.75	QT/A	PRE	97 a	98 a	85 b	89 abc	96 a	98 a	64 ab
Zalo	32	FL OZ/A	V3 GLYMA							
Herbimax	19.2	FL OZ/A	V3 GLYMA							
Class Act NG	3	PT/A	V3 GLYMA							
Zalo	32	FL OZ/A	10-14 DA-B							
Herbimax	19.2	FL OZ/A	10-14 DA-B							
Class Act NG	3	PT/A	10-14 DA-B							
Tendovo	1.75	QT/A	PRE	96 a	99 a	86 b	95 ab	98 a	99 a	66 a
Zalo	32	FL OZ/A	V3 GLYMA							
Dual Magnum	1.33	PT/A	V3 GLYMA							
Herbimax	19.2	FL OZ/A	V3 GLYMA							
Class Act NG	3	PT/A	V3 GLYMA							
Authority Edge	8	FL OZ/A	PRE	94 a	98 a	92 ab	99 a	98 a	98 a	64 ab
Zalo	32	FL OZ/A	V3 GLYMA							
Herbimax	19.2	FL OZ/A	V3 GLYMA							
Class Act NG	3	PT/A	V3 GLYMA							
Zalo	32	FL OZ/A	10-14 DA-B							
Herbimax	19.2	FL OZ/A	10-14 DA-B							
Class Act NG	3	PT/A	10-14 DA-B							
Authority Edge	8	FL OZ/A	PRE	98 a	99 a	98 a	97 a	99 a	99 a	63 ab
Zalo	32	FL OZ/A	V3 GLYMA							
Dual Magnum	1.33	PT/A	V3 GLYMA							
Herbimax	19.2	FL OZ/A	V3 GLYMA							
Class Act NG	3	PT/A	V3 GLYMA							
Liberty 280 SL	32	FL OZ/A	V3 GLYMA	-	96 a		93 ab		98 a	66 a
Dual Magnum	1.33	PT/A	V3 GLYMA							
Roundup PowerMax 3	30	FL OZ/A	10-14 DA-B							
Liberty 280 SL	32	FL OZ/A	10-14 DA-B							

[a]Means followed by same letter within a column do not significantly differ (P=.05, Duncan's New MRT).

Objective 2 – 2024

Alex Mangialardi successfully defended his dissertation on 18-Mar-2025 and has completed the requirements for his doctoral degree at MSU. Following is a portion of the data from one chapter of Dr. Mangialardi's dissertation. Other data will appear in his dissertation published by the MSU Library.

Previous research reported the effectiveness of residual herbicides for controlling problem weeds like *Amaranthus* and *Ipomoea* spp. Although 30 to 50 d of residual weed control is considered optimal, weeds such as Palmer amaranth have a prolonged germination period, allowing them to potentially germinate well after the residual herbicide has degraded. If these herbicides are applied before planting, it is possible new weed emergence could occur before crop canopy closure. Research was conducted to evaluate residual weed control from herbicide products containing one, two, and three MOA applied at different intervals prior to soybean planting.

The study was designed with a two-factor factorial treatment structure inside a randomized complete block design with four replications. Factor A was preplant herbicide treatment and included no preplant treatment, Outlook, Authority Elite, Tendovo applied 14 or 28 d preplant (DPP). Factor B was PRE herbicide treatment and included no PRE treatment and Kyber applied PRE immediately after soybean planting. All preplant treatments applied 14 and 28 d preplant included Gramoxone SL plus NIS at 0.5% (v/v).

Tendovo applied 28 d prior to planting (DPP) was the only treatment controlling all three weed species $\geq$ 88% without a sequential PRE treatment at planting (Table 2). Authority Elite 14 and 28 DPP provided similar control of Palmer amaranth and pitted morningglory with or without a PRE but without a PRE, barnyardgrass control was different. Outlook controlled Palmer amaranth similar to the other two treatments when applied 14 DPP and followed by the at planting PRE application. Soybean injury was greatest in plots that received Kyber PRE, but this did not affect soybean yield (Table 3). Data indicate that Outlook, Tendovo, and Authority Elite can all be used for broad spectrum weed control depending on when they are applied and what kind of system the producer prefers. When applying close to day of planting, Outlook may be utilized with an at planting PRE application for broad spectrum weed control. If no at planting PRE application is to be made, Tendovo, is needed for optimal control of all three weed species in the study.

Table 2. Control of Palmer amaranth, pitted morningglory, and barnyardgrass 21 d after soybean planting in a study evaluating weed control with sequential preplant followed by preemergence applications of residual herbicides at Stoneville, MS, from 2022 to 2024.[a,b]

Preplant treatment	Preplant timing	PRE treatment	Palmer amaranth	Pitted morningglory	Barnyardgrass
			-------------------------------	---%---	-------------------------------
No preplant treatment	-	No PRE	0 e	0 g	0 g
	-	PRE	29 d	38 f	18 f
Outlook	14 DPP	No PRE	63 c	71 cd	48 e
		PRE	91 a	88 ab	64 d
	28 DPP	No PRE	55 c	51 e	36 e
		PRE	79 b	65 d	66 d
Authority Elite	14 DPP	No PRE	88 ab	88 ab	89 abc
		PRE	97 a	96 a	96 a
	28 DPP	No PRE	89 a	82 bc	75 cd
		PRE	97 a	86 ab	82 bc
Tendovo	14 DPP	No PRE	92 a	86 ab	86 abc
		PRE	91 a	95 a	93 ab
	28 DPP	No PRE	94 a	93 a	91 ab
		PRE	93 a	88 ab	88 ab

[a] Data are pooled over three site years. Means followed by the same letter within a column are not different at $p \leq 0.05$.

[b] Abbreviations: DPP, days prior to planting; PRE, preemergence.

Table 3. Soybean yield following different herbicide treatments applied 14 and 28 d prior to planting (DPP) in a study evaluating weed control with sequential preplant followed by preemergence applications of residual herbicides at Stoneville, MS, from 2022 to 2024.[a]

Preplant treatment[b]	Preplant timing	Yield
		Kg ha^{-1}
No preplant treatment	-	2,220 c
Outlook	28 DPP	2,490 bc
Authority Elite		2,760 ab
Tendovo		2,760 ab
Outlook	14 DPP	2,900 a
Authority Elite		2,900 a
Tendovo		3,030 a

[a] Data are pooled over two preemergence treatments and three site years. Means followed by the same letter are not different at $p \leq 0.05$.

<u>Objective 3 – 2024</u>

Following the introduction of glyphosate-resistant soybean cultivars, postemergence (POST)-only herbicide programs became the most popular method of weed control. Due to POST-only herbicide programs, weeds have evolved resistance to some foliar-applied POST (POST foliar) herbicides in recent years. The evolution of these resistant weeds has influenced growers to incorporate residual herbicides into their weed control programs. Herbicides from groups 2 (ALS Inhibitors), 5 (PSll Inhibitors), 14 (PPO Inhibitors), and 15 (Long-Chain Fatty Acid Inhibitors) are often utilized for residual weed control in soybean. Some practitioners claim injury from these herbicides may cause stand reduction, chlorosis, necrosis, stunting, delays in canopy development, and ultimately yield loss. Research was conducted in 2024 in Stoneville, Mississippi to evaluate soybean injury from POST foliar herbicide mixtures.

Treatments were arranged as a two-factor factorial in a randomized complete block with four replications. Factor A was herbicide rates applied at one (1x) and two (2x) times the suggested use rates. Factor B was herbicide mixtures and included no herbicide, Prefix, Roundup Powermax 3 plus Prefix, Roundup Powermax 3 plus Xtendimax plus Prefix, Liberty 280 plus Prefix, and Roundup Powermax 3 plus Liberty 280 plus Prefix. Treatments were applied when soybean reached the V3 growth stage. Soybean injury was evaluated 3, 7, 14, 21, and 28 days after treatment (DAT). Soybean yield was collected at crop maturity.

Soybean injury was similar when comparing treatments within the same rate at 7 DAT. Soybean injury was greater with 2x rates compared with 1x rates 7 and 28 DAT. Roundup Powermax 3 plus Xtendimax plus Prefix, Roundup Powermax 3 plus Liberty 280 plus Prefix, and Liberty 280 plus Prefix applied at 2x rates produced greatest injury 7 and 28 DAT. By the end of the season, soybean had recovered from injury incurred during the vegetative stages, and yield was similar among all treatments (Figure 1). Herbicide mixtures including non-selective (Roundup Powermax 3 and Liberty 280) and residual (Prefix) herbicides produced visible injury after application, but yield indicated these treatments were safe for application to Mississippi soybean.

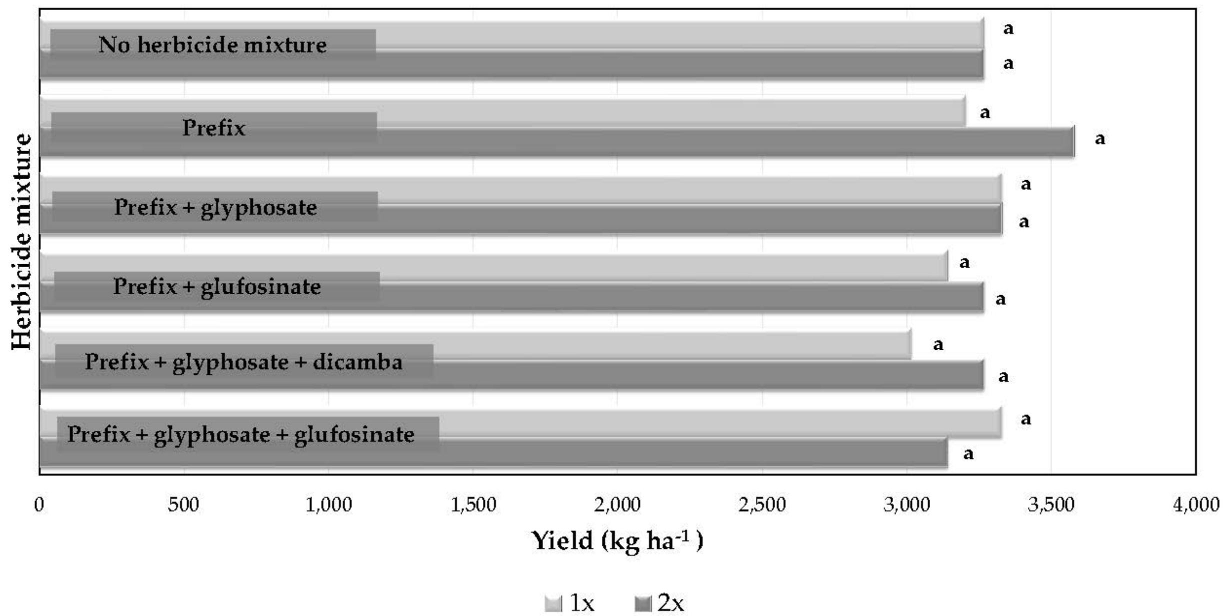

Figure 1. Soybean yield following applications of residual herbicide mixtures applied POST-foliar at different rates

Objective 4 – 2024

In the spring of 2024, mature Virginia pepperweed and bog yellowcress plants were collected from commercial fields across multiple counties in Mississippi. These counties included Tunica, Tallahatchie, Panola, Sunflower, Leflore, Sharkey, and Coahoma counties. The purpose of collecting seed from these populations was to grow offspring and assess PRE and POST herbicide options in hopes of reducing their occurrence in agricultural fields within Mississippi. Additionally, characterization of the growth parameters associated with both species will be performed to determine if there is a difference in morphology among the different accessions.

After collection, each plant was placed into an oven at 66 C for three weeks to be dried to a constant mass. After drying, each plant was threshed to collect seeds, and the residual plant material was separated from the seed using a sieve. Once the plants were threshed, the offspring from each accession were placed into its own container and labeled. The seeds were placed into a refrigerator at 38 F for two weeks to help initiate germination and mimic diurnal temperature fluctuations in a natural environment. After cooling, the offspring of three accessions were planted into trays with potting mix to be grown. Approximately three weeks after weed emergence, four plants from each accession were transplanted in individual pots to evaluate growth rate through measuring plant height, width, and leaf number on a weekly basis after transplanting.

The remaining weeds from the original trays were sprayed with various herbicides to determine the optimal or most effective POST herbicide control options for each species. After those plants reached approximately 3 inches tall, herbicides such as dicamba, paraquat, glyphosate, and saflufenacil were applied POST to the weeds. Weed control evaluations are currently ongoing ed on a weekly basis. In the future, we hope to establish experiments evaluating the effect of PRE herbicides on the suppression of both Viriginia pepperweed and bog yellowcress.

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3. Miller D.K., J.A. Bond, T.R. Butts, L.E. Steckel, D.O. Stephenson, IV, and K.J. Kouame. 2024. Impact of reduced rates of tiafenacil at vegetative growth stages on soybean growth and yield. Weed Sci. Published online 2024:1-5. doi:10.1017/wsc.2024.39.
4. Pieralisi, B., R.K. Sharma, B.R. Golden, J.A. Bond, D.R. Cook, J.T. Irby, M. Cox, and J. Dhillon. 2024 Planting time and variety effects on biomass, harvest index, and yield of irrigated soybean in mid-Southern United States. Crop, Forage, Turfgrass Manage. [Online]. Available at http://access.onlinelibrary.wiley.com. doi: 10.1002/cft2.70012.
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9. Mangialardi, G.A., J.A. Bond, T.W. Allen, T.J. Irby, L.A. Avila, T.W. Eubank, W.D. Crow, and H.D. Bowman. 2024. Alternative herbicide options to paraquat for weed control in Mississippi row crops. Proc. South. Weed Sci. Soc. 77:142.