MISSISSIPPI SOYBEAN PROMOTION BOARD
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Title: Weed Management Programs for Mississippi Soybean Production

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BACKGROUND AND OBJECTIVES

Glyphosate-resistant (GR) Palmer amaranth and Italian ryegrass represent the largest threats to crop production in Mississippi. Palmer amaranth competes for nutrients, water, light, and space because of its rapid, upright growth habit and allelopathic properties. Large populations of GR Italian ryegrass jeopardize burndown herbicide programs. Fields with GR Italian ryegrass not controlled at burndown will contain significant residue at planting. Residue will impede planting practices, contribute to competition between soybean seedlings and GR Italian ryegrass, and hinder herbicide programs due to inadequate coverage.

Herbicide-resistant (HR) weed species continue to spread across Mississippi and the U.S. Large populations of HR weeds can threaten weed management programs. Novel herbicides and technologies such as dicamba-, 2,4-D-, and 4-HPPD-resistant soybean have recently been or are approaching commercialization. Therefore, it is important to identify effective weed management programs using these new HR technologies to prevent competition and yield reductions in Mississippi soybean. However, with three new. HR technologies introduced to soybean production within one or two years, problems with off-target herbicide movement, or drift, will likely escalate as fields in proximity are planted with different HR technologies.

Off-target herbicide movement can be a serious problem, especially when applications are made under windy conditions or when ambient factors are favorable for volatilization and redeposition. Herbicide drift is most often the result of improper application, and depending on the susceptibility of plants to a specific herbicide, injury can occur at a considerable distance from the target. Understanding soybean response to off-target herbicide movement is imperative, especially in areas where soybean representing multiple herbicide-resistant technologies are grown in proximity.

1. Evaluate new and/or currently registered herbicides and HR technologies for positioning into Mississippi weed management programs.
2. Characterize the soybean performance following multiple exposures to a sub-lethal rate of dicamba at vegetative and reproductive growth stages.
3. Assess management of GR Italian ryegrass by (a) determining if Italian ryegrass can be suppressed by different cover crop species and if planting date influences the level of suppression, and (b) evaluating sequential applications of residual herbicides for control of Italian ryegrass.

REPORT OF PROGRESS/ACTIVITY

Objective 1 – 2018

Eighteen studies were conducted at the Delta Research and Extension Center in 2018 to evaluate new and/or currently registered herbicides and HR soybean technologies for positioning into Mississippi weed management programs. Unfortunately, many of these studies focused on the efficacy of pre-mixes of currently registered herbicides or generic formulations of commercial herbicides. "New" herbicides under evaluation are Enlist Duo (glyphosate plus 2,4-D choline), Enlist One (2,4-D choline), flumioxazin plus pyroxasulfone plus metribuzin (Fierce MTZ), a liquid formulation of pyroxasulfone plus flumioxazin (Fierce EZ), a liquid formulation of pyroxasulfone (Zidua SC), and a new premix of pyroxasulfone plus fluthiacet-methyl (Anthem Maxx). Use of Engenia, Xtendimax with VaporGrip, FeXapan with VaporGrip, or Tavium with VaporGrip (dicamba plus *s*-metolachlor) continue to be evaluated in Roundup Ready 2 Xtend soybean. Other studies evaluated herbicide applications in HPPD-resistant soybean being developed by Bayer Cropscience.

Research has been conducted annually since 2010 at different sites in the Mississippi Delta to evaluate weed control programs in the Roundup Ready Xtend weed control system, which was developed by Bayer Crop Science, formerly Monsanto Company. Previous research (MSPB 20- 2017) at the Delta Research and Extension Center clearly demonstrated that a PRE treatment was critical for Palmer amaranth control in Roundup Ready 2 Xtend soybean and that the inclusion of Dual Magnum in mixtures of Roundup PowerMax plus Engenia applied to V3 soybean controlled more Palmer amaranth than mixtures with no Dual Magnum. Additionally, Palmer amaranth control 14 days after a sequential POST application was best with treatments containing at least three effective herbicide modes of action. Even though extensive research (MSPB 20-2015) has been conducted at the Delta Research and Extension Center evaluating different residual herbicides applied PRE in soybean, this work was done utilizing Roundup Ready and LibertyLink technologies rather than the Roundup Ready 2 Xtend technology. Additionally, new residual herbicide pre-mixes have been commercialized since completion of the original research. Therefore, research was conducted in 2018 to evaluate residual herbicides in Roundup Ready 2 Xtend soybean.

One study evaluated different residual herbicides applied as PRE treatments with sequential applications of Roundup PowerMax plus Xtendimax with VaporGrip. Control of barnyardgrass and browntop millet was ≥ 91% at 21 days after POST application for all treatments except Roundup PowerMax plus Xtendimax with VaporGrip with no PRE treatment and Warrant PRE followed by Roundup PowerMax plus Xtendimax with VaporGrip (**Table 1**). Earlier research (MSPB 20-2017) reported that grass control can be compromised when applications of Roundup PowerMax-based herbicide mixtures is delayed. The poor grass control with these two treatments in the current work may have been due to barnyardgrass and browntop millet being larger at the time of POST application in those plots receiving no PRE or plots treated with Warrant.

Ivyleaf morningglory control 21 days after POST application followed a similar trend as observed for barnyardgrass and browntop millet control. Control was ≥ 96% for all treatments except Roundup PowerMax plus Xtendimax with VaporGrip with no PRE treatment and Warrant PRE followed by Roundup PowerMax plus Xtendimax with VaporGrip (**Table 1**). Palmer amaranth control was ≤65% with no PRE or those treated with Warrant PRE. Although Authority Supreme provided greater control than no PRE or Warrant, control with that treatment was less than with others. The lower Palmer amaranth control with the Warrant-based treatment demonstrates that utilizing only a Group 15 herbicide as a PRE does not provide adequate control of Palmer amaranth. This practice should be avoided. Despite differences in weed control, all treated plots produced similar soybean yield by season's end.

Table 1. Weed control 21 days after POST treatment with herbicide programs including different residual herbicides applied PRE and Roundup PowerMax plus Xtendimax with VaporGrip applied POST at the V3 soybean growth stage at Stoneville, MS in 2018.[a]

Treatment[b]	Rate	Timing	Barnyardgrass		Browntop millet		Ivyleaf morningglory		Palmer amaranth		Soybean yield	
	Fl oz or wt oz/acre		---------------------------%---------------------------								bu/acre	
Nontreated 1			-		-		-		-		25	b
Roundup PowerMax Xtendimax with VaporGrip	32 22	POST POST	74	b	73	b	88	b	65	c	44	a
Zidua PRO Roundup PowerMax Xtendimax with VaporGrip	4.5 32 22	PRE POST POST	95	a	97	a	97	a	89	ab	48	a
Valor EZ Roundup PowerMax Xtendimax with VaporGrip	2.5 32 22	PRE POST POST	97	a	93	a	98	a	93	a	44	a
Fierce Roundup PowerMax Xtendimax with VaporGrip	3 32 22	PRE POST POST	98	a	98	a	98	a	95	a	46	a
Fierce MTZ SC Roundup PowerMax Xtendimax with VaporGrip	16 32 22	PRE POST POST	98	a	97	a	98	a	97	a	48	a
Authority MTZ Roundup PowerMax Xtendimax with VaporGrip	11 32 22	PRE POST POST	96	a	92	a	96	a	90	ab	46	a
Authority Supreme Roundup PowerMax Xtendimax with VaporGrip	7.7 32 22	 POST POST	95	a	94	a	98	a	85	b	45	a
Fierce Roundup PowerMax Xtendimax with VaporGrip	3.75 32 22	PRE POST POST	94	a	91	a	98	a	92	ab	47	a
Warrant Roundup PowerMax Xtendimax with VaporGrip	6 32 22	PRE POST POST	75	b	74	b	87	b	63	c	44	a

[a]Means within a column followed by the same letter are not different at $p \leq 0.05$.
[b]All POST treatments included Intact at 0.5% (v/v) and Activator 90 at 0.25% (v/v).

A perennial concern for soybean growers is injury with residual herbicides applied as PRE treatments. This is especially true with residual herbicide products containing flumioxazin (Valor, Fierce, etc.). The Mississippi State University Extension Service has suggested use of residual herbicides applied 10 to 14 days prior to planting for several years. Research indicates that if beds are not disturbed between the time of herbicide application and planting, then Palmer amaranth control remains high after planting. Additionally, concerns with soybean injury are much lower with preplant treatments if an incorporating rainfall is received prior to soybean emergence. Therefore, a second study was conducted in 2018 to compare weed control with different residual herbicides applied PRE or 14 days prior to planting.

When evaluated the same day as soybean planting, control of barnyardgrass, ivyleaf morningglory, and Palmer amaranth was similar for all treatments and ranged from 87 to 98% (**Table 2**). Barnyardgrass control 10 days after planting was 83 to 88% with all treatments except Authority MTZ, which provided only 73% control. Authority MTZ and Fierce MTZ controlled less ivyleaf morningglory than Zidua PRO at 10 days after planting. Zidua PRO is a pre-mix of Zidua, Sharpen, and Pursuit, but the manufacturer does not offer Zidua PRO in the southern region. Palmer amaranth control was better with Fierce at 3.75 oz wt/acre than with Authority Supreme and Authority MTZ at 10 days after planting. Soybean injury 10 days after planting was ≤8% for all treatments (data not presented). Soybean yields were similar and were ≥52 bushels/acre following all treatments except Roundup PowerMax plus Xtendimax with VaporGrip with no residual herbicide (data not presented). These data verify that applying residual herbicide as preplant applications are safe and effective in Mississippi soybean; however, the need for timely POST treatments is also highlighted as control of all three species was ≤90% at 10 days after planting.

Table 2. Weed control at different intevals following residual herbicide treatments applied in mixtures with Roundup PowerMax plus Xtendimax with VaporGrip at 14 days prior to planting at Stoneville, MS in 2018.[a]

Treatment[b]	Rate	Barnyardgrass		Ivyleaf morningglory		Palmer amaranth	
		Day of planting	10 d after planting	Day of planting	10 d after planting	Day of planting	10 d after planting
	Fl oz or wt oz/acre	--------%--------					
Roundup PowerMax Xtendimax with VaporGrip	32 22	75 b	58 c	55 b	65 c	70 b	58 c
Zidua PRO Roundup PowerMax Xtendimax with VaporGrip	6 32 22	94 a	83 a	94 a	85 a	98 a	83 ab
Valor EZ Roundup PowerMax Xtendimax with VaporGrip	2.5 32 22	98 a	83 a	94 a	80 ab	97 a	83 ab
Fierce Roundup PowerMax Xtendimax with VaporGrip	3 32 22	98 a	88 a	92 a	80 ab	98 a	85 ab
Fierce Roundup PowerMax Xtendimax with VaporGrip	3.75 32 22	98 a	88 a	98 a	83 ab	98 a	90 a
Fierce MTZ SC Roundup PowerMax Xtendimax with VaporGrip	16 32 22	98 a	85 a	96 a	73 bc	98 a	85 ab
Authority Supreme Roundup PowerMax Xtendimax with VaporGrip	7.7 32 22	96 a	83 a	96 a	75 abc	98 a	75 b
Authority MTZ Roundup PowerMax Xtendimax with VaporGrip	11 32 22	92 a	73 b	87 a	73 bc	94 a	78 b

[a]Means within a column followed by the same letter are not different at $p \leq 0.05$.
[b]All POST treatments included Intact at 0.5% (v/v) and Activator 90 at 0.25% (v/v).

Objective 2 – 2018

Roundup Ready 2 Xtend soybean varieties are grown in proximity to those representing other HR technologies, creating the potential for problems with off-target movement. Therefore, research was conducted to characterize the soybean response following exposure to different dicamba rates and evaluate the performance of soybean following multiple exposures to a sub-lethal rate of dicamba.

Two studies were established at the Delta Research and Extension Center in Stoneville, MS, and R.R. Foil Plant Science Research Center in Starkville, MS, to characterize soybean response to different sub-lethal rates of dicamba at multiple growth stages and evaluate the performance of soybean following multiple exposures to a sub-lethal rate of dicamba.

Treatments in the Dicamba Rate Study were arranged as a two-factor factorial in a randomized complete block design with four replications. Factor A was dicamba rate and consisted of a diglycolamine (DGA) salt of dicamba applied at 0.0039 ($1/128^{th}$ of labeled rate) and 0.00098 lb ae/acre ($1/512^{th}$ of the labeled rate). Factor B was timing of dicamba exposure and included dicamba applied at V3, R1, and R5 soybean growth stages. A nontreated control was included for comparison.

Treatments in the Multiple Exposure Study were arranged as a two-factor factorial in a randomized complete block design with four replications. Factor A was timing of vegetative exposure to dicamba and included no vegetative exposure and dicamba exposure at V3 soybean growth stage. Factor B was timing of reproductive exposure to dicamba and included no reproductive exposure and dicamba exposure at R1, R3, R5, R1 followed by (fb) R3, R1 fb R5, R3 fb R5, and R1 fb R3 fb R5 soybean growth stages. Dicamba was applied as DGA salt at 0.0025 lb/acre ($1/200^{th}$ of the labeled use rate).

In the Dicamba Rate Study, exposing soybean to dicamba at 0.0039 lb/acre during V3 and R1 growth stages resulted in greater injury 14 days after treatment (DAT) compared with 0.00098 lb/acre (**Table 3**). Additionally, injury 14 DAT was greater at V3 than R1 across both rates of dicamba. Soybean injury 28 DAT was 12 and 21% greater following V3 and R1 applications, respectively, from dicamba at 0.0039 compared with 0.00098 lb/acre. Injury 28 DAT at R1 was 6% greater than that following V3 dicamba at 0.0039 lb/acre. In contrast to 14 DAT, soybean injury was similar for V3 and R1 exposure timings following dicamba at 0.00098 lb/acre. Soybean heights 14 DAT were reduced >5% for V3 and R1 timings following dicamba at 0.0039 compared with 0.00098 lb/acre. Greatest reduction in mature soybean height occurred during the R1 growth stage following dicamba at 0.0039 lb/acre. A 16% reduction in mature soybean height occurred following dicamba at 0.0039 compared to 0.00098 lb/acre with R1 exposure.

A 27% reduction in soybean dry weight 28 DAT was observed following exposure to dicamba during the R1 growth stage (**Table 4**). Soybean exposure during R1 reduced dry weight 10% compared to V3 exposure. Soybean yield was reduced ≥18% following dicamba exposure at V3 or R1 compared with R5 exposure. Soybean yield was 84% of the nontreated following exposure to dicamba during the R1 growth stage and was comparable to that when soybean was exposed at V3. No reduction in yield occurred following dicamba exposure at R5 soybean growth stage.

Table 3. Influence of soybean growth stage on soybean injury 7 d after exposure (DAT), canopy closure 14 and 28 DAT, dry weight 28 DAT, and yield in the Rate and Timing Study, Stoneville, MS, in 2018[a,b].

Dicamba Rate	Timing	Injury 14 DAT	Injury 28 DAT	Height 14 DAT	Height Maturity
lb ae/A		% of nontreated			
0.0039	V3	49 a	55 b	59 d	85 c
	R1	42 b	61 a	67 c	68 d
	R5	5 d	5 d	100 a	100 ab
0.00098	V3	43 b	43 c	78 b	93 b
	R1	33 c	40 c	72 b	84 c
	R5	5 d	5 d	98 a	102 ab

[a]Data are pooled across two dicamba rates (0.0039 and 0.00098 lb ae/acre) and three experiments. Means followed by the same letter for each parameter are not different at $p \leq 0.05$.

[b]Data for canopy closure, dry weight, and yield are expressed as a percentage of nontreated control.

Table 4. Influence of dicamba exposure timing on soybean injury 7 d after exposure (DAT), canopy closure 14 and 28 DAT, dry weight 28 DAT, and yield in the Rate and Timing Study at Stoneville, MS in 2018[a,b].

Timing	Injury 7 DAT	Canopy closure 14 DAT	Canopy closure 28 DAT	Dry weight	Yield
	%	% of nontreated			
V3	16 a	77 b	90 b	83 b	88 b
R1	13 b	81 b	93 b	73 c	84 b
R5	5 c	98 a	101 a	96 a	106 a

[a]Data are pooled across two dicamba rates (0.0039 and 0.00098 lb ae/acre) and three experiments. Means followed by the same letter for each parameter are not different at $p \leq 0.05$.

[b]Data for canopy closure, dry weight, and yield are expressed as a percentage of nontreated control.

In the Multiple Exposure Study, soybean injury was influenced by the interaction of vegetative and reproductive dicamba treatments. At 7 days after R1 (DA-R1), injury was >43% with prior exposure at V3 (**Table 5**). However, R3 and R5 treatments had not been applied at 7 DA-R1 evaluation. Soybean injury 7 DA-R3 was at least 11% greater for all reproductive exposure treatments with prior exposure at V3; however, R5 treatment had not been applied. Greatest injury (72%) at 7 DA-R5 occurred following dicamba at V3 fb R1 fb R3 fb R5.

Soybean exposure to dicamba at V3 did not always translate into greater injury following exposure during reproductive growth stages. Soybean injury 14 and 21 DA-R5 was ≥65% with dicamba at R1 fb R3 fb R5 regardless of prior exposure at V3. In addition, injury at 21 DA-R5 was greatest with treatments including R1, R3, and R5 with prior exposure at V3. Soybean injury was ≤9% for R5 treatment with no prior exposure at V3 for all evaluation intervals following R5 treatment.

Mature soybean height was reduced more following exposure to dicamba during reproductive growth stages with prior exposure at V3 for all treatments except R5, R3, R1 fb R5 R3 fb R5, and R1 fb R3 fb R5 (**Table 6**). Height at maturity was reduced ≥12 cm for all treatments except R5 compared to plots not exposed to dicamba. Soybean yield was affected more with prior exposure at V3 for all reproductive treatments except R1, R1 fb R3, R1 fb R5 and R1 fb R3 fb R5. Soybean yield and dry weight following R5 dicamba exposure were not affected compared to plots not exposed to dicamba.

Reduction in soybean nodes/plant was two greater following R1 exposure compared to R3 and V3 regardless of R5 exposure or prior exposure during vegetative growth stage (**Table 7**). Soybean nodes/plant was seven greater with no dicamba exposure and R5-only treatment compared to all soybean exposure timings. Soybean nodes/plant was least following V3 fb R1 fb R3 fb R5 for all exposure timings. Soybean pods/node was 4 less compared to R3 with no prior exposure at V3.

Observations from the current and previous research were that soybean plants exposed to dicamba during vegetative growth stages exhibited lateral development and branching, notably following death of apical meristem. Therefore, following death of apical meristem, soybean plants began producing branches similar to the mainstem from unifoliate and cotyledonary nodes. In contrast, following death of apical meristem from reproductive (R1) dicamba exposure, a similar meristem branch is not produced. Often, small branches produced many malformed or twisted pods not reaching full development.

Results from vegetative and reproductive treatments would be attributed to the physiological condition of the plant. Soybean was least sensitive to dicamba when exposure occurred at R5 growth stage for all parameters.

Reproductive growth stage at time of exposure to dicamba was more indicative of soybean agronomic performance than whether or not there was prior exposure at V3. Soybean was unable to recover following single or multiple dicamba exposures up to the R3 growth stage. Growers should take extreme caution when applying dicamba in proximity to non-dicamba-resistant soybean regardless of soybean growth stage.

Table 6. Interaction of vegetative and reproductive exposure timings on soybean injury 7, 14, and 21 d exposure (DAT) following multiple exposures to a sub-lethal rate of dicamba at Stoneville, MS, 2018[a,b].

Vegetative	Reproductive	7 DA (R1)[c]	7 DA (R3)[c]	7 DA (R5)	14 DA-R5	21 DA-R5
		%				
None	None	0	0	0	0	0
	R1	12 d	40 ef	32 fg	30 ef	31 d
	R3	-	19 g	51 d	48 d	47 c
	R5	-	-	3 i	5 i	9 f
	R1 fb R3	15 d	45 cde	60 b	55 c	56 b
	R1 fb R5	15 d	41 ef	41 e	37 e	36 d
	R3 fb R5	-	20 g	50 d	48 d	47 c
	R1 fb R3 fb R5	13 d	43 def	60 b	65 ab	61 ab
V3	None	43 c	37 f	22 h	20 h	20 e
	R1	48 a	55 b	30 fg	22 gh	23 e
	R3	44 bc	52 bc	52 cd	50 cd	47 c
	R5	45 abc	40 ef	26 gh	28 fg	30 d
	R1 fb R3	47 ab	63 a	58 bc	57 c	55 b
	R1 fb R5	45 abc	52 bc	35 ef	37 e	37 d
	R3 fb R5	47 ab	50 bcd	55 bcd	58 bc	56 b
	R1 fb R3 fb R5	45 abc	69 a	72 a	66 a	67 a

[a] Column headings of 7 DA (R1), 7 DA (R3), 7 DA (R5), 14 DA (R5), and 21 DA (R5) designate evaluation intervals of 7, 14, and 21 d following exposure at vegetative (V3) and reproductive (R1, R3, and R5) growth stages.

[b] Data are pooled across three site-years. Means followed by the same letter for each evaluation are not different at $p \leq 0.05$.

[c] Treatments not applied: no vegetative R3, R5, and R3 fb R5 at 7 DA(R1) and no vegetative R5 at 7 DA (R3).

Table 7. Interaction of vegetative and reproductive exposure treatments on soybean height at maturity, dry weight 28 d after R5, yield and harvest parameters in the multiple Exposure Study at Stoneville, MS, 2018[a,b].

Vegetative	Reproductive	Height Maturity	Dry Weight	Yield	Nodes/plant	Pods/node
None	None	97 a	1,726 a	3,470 a	18 a	14 a
	R1	68 d	1,207 bcd	2,800 b	7 cde	3 cd
	R3	57 ef	1,221 bc	2,740 b	11 b	7 bc
	R5	96 a	1,651 a	3,380 a	18 a	14 a
	R1 fb R3	42 h	917 fg	1,970 ef	8 cd	4 cd
	R1 fb R5	63 de	1,150 cd	2,740 b	8 cd	3 d
	R3 fb R5	56 ef	1,160 cd	2,700 bc	11 b	8 b
	R1 fb R3 fb R5	42 h	959 efg	1,900 f	8 cd	4 cd
V3	None	85 b	1,332 b	2,630 bc	11 b	7 bc
	R1	76 c	1,070 cdef	2,480 bcd	6 de	3 d
	R3	59 ef	1,050 def	2,270 de	9 bc	5 cd
	R5	80 bc	1,139 cd	2,600 bcd	7 cde	4 cd
	R1 fb R3	54 fg	857 g	1,920 f	8 cd	6 cd
	R1 fb R5	67 d	1,100 cde	2,620 bc	6 de	3 d
	R3 fb R5	47 gh	1,070 cdef	2,060 ef	9 bc	5 cd
	R1 fb R3 fb R5	45 h	823 g	2,290 cdef	5 e	3 d

[a]Data are pooled across three sites and two locations. Means followed by the same letter for each parameter are not different at $p \leq 0.05$.
[b]Abbreviation: fb, followed by.

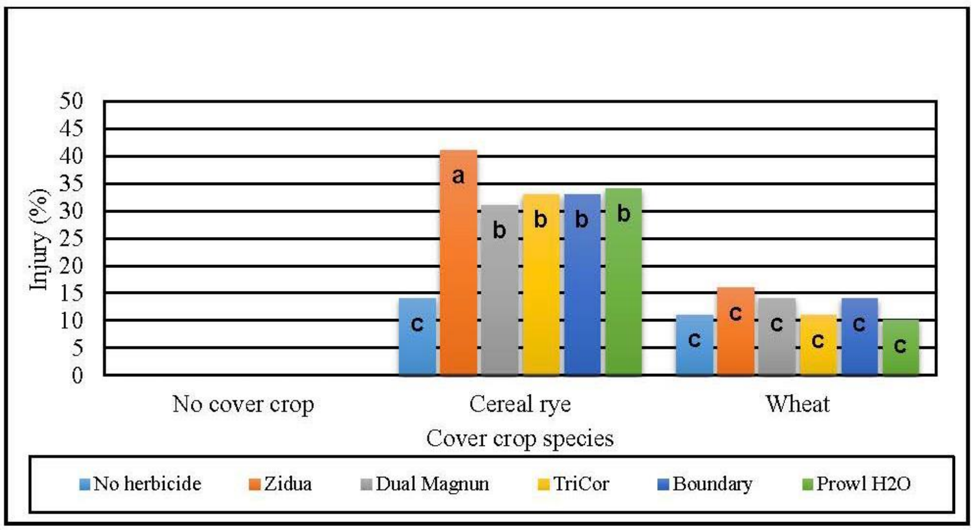
<u>Objective 3 – 2018</u>

A study to determine if GR Italian ryegrass can be suppressed by different cover crop species and if planting date influences the level of suppression was initiated in September 2017. Due to dry conditions during the fall, not all targeted planting dates were implemented. A second study evaluating sequential applications of residual herbicides for control of Italian ryegrass was also initiated in the fall of 2017. Treatments were applied throughout the fall and winter during 2017 and 2018. Due to prolonged wet and cold conditions during winter of 2018, a population of Italian ryegrass to adequately test the stated objectives was not achieved.

However, a related study was successfully completed. The objectives of that study were 1) evaluate control of GR Italian ryegrass with a combination of cover crop and fall-applied residual herbicides, and (2) determine tolerance of wheat or cereal rye cover crops to residual herbicides targeting GR Italian ryegrass. The experimental design was a split-plot with four replications. Whole plots were cover crop and consisted of no cover crop, cereal rye, or winter wheat. Sub-plots were fall-applied residual herbicide treatments and included no herbicide, Zidua at 2.5 oz wt/acre, Dual Magnum at 1.33 pt/acre, TriCor at 4 oz wt/acre, Boundary at 2 pt/acre, and Prowl H2O at 2 pt/acre.

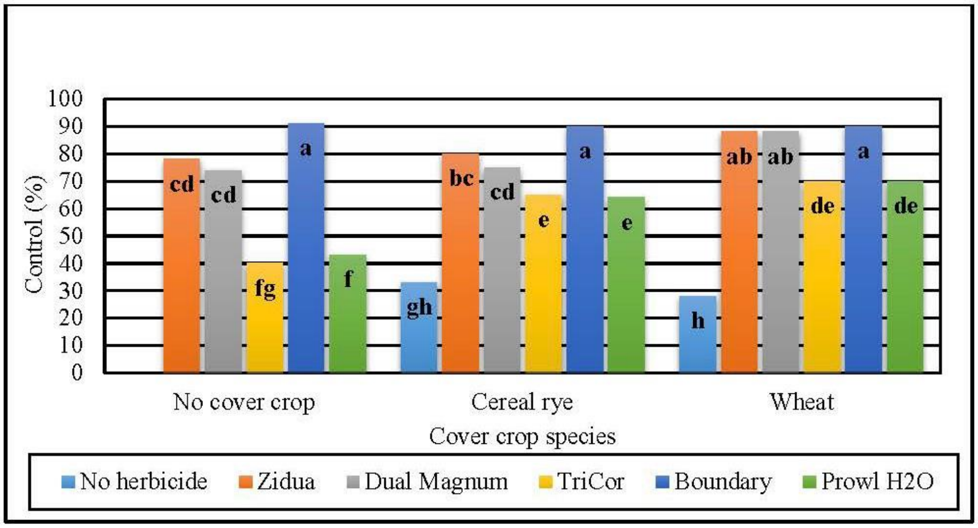
Greatest cover crop injury 30 days after treatment (DAT) was 16% on winter wheat following Zidua. Zidua injured winter wheat more than it did cereal rye; however, TriCor and Boundary were more injurious to cereal rye. By 130 DAT, cereal rye and winter wheat were injured 14 and 11%, respectfully, with no fall-applied residual herbicide (**Figure 1**). This was due to wet and cold conditions that persisted at the site. Injury to winter wheat 130 DAT was similar following all fall-applied residual herbicide treatments and in plots receiving no herbicide. In contrast, injury to cereal rye was at least 19% greater from all herbicide treatments compared with the no herbicide treatment. Cereal rye injury was 19 to 25% greater than winter wheat injury for all fall-applied residual herbicides.

Figure 1. Cover crop injury 130 days following fall application of residual herbicides targeting GR Italian ryegrass.



Italian ryegrass control was 40 and 41% 30 DAT with cereal rye or winter wheat, respectively, and no fall-applied residual herbicide (**Figure 2**). Control with cover crop only was less than that in any plot receiving a fall-applied residual herbicide. Italian ryegrass control with Zidua and Boundary was similar for all cover crop treatments. By 130 DAT, Italian ryegrass control from cover crops was only ≤33%. Only Boundary controlled Italian ryegrass >78% 130 DAT when applied to bare ground. Both cover crops improved control with Zidua, TriCor, and Prowl H2O. The combination of Dual Magnum and winter wheat provided greater control than when Dual Magnum was applied in cereal rye or to bare ground.

Figure 1. Control of GR Italian ryegrass 130 days following fall application of residual herbicides.



Although Italian ryegrass control 130 DAT was improved when fall-applied residual herbicides were combined with cereal rye cover crop, injury was ≥33% following all herbicides applied to cereal rye. This level of injury would prohibit cereal rye from use as a cover crop to suppress Italian ryegrass. Winter wheat injury 130 DAT was mainly due to poor growing conditions because visible injury was similar across all fall-applied residual herbicide treatments. Furthermore, with the exception of Boundary, Italian ryegrass control was greater following fall-applied residual herbicides applied in winter wheat compared with bare ground. Italian ryegrass should be targeted with Boundary if no cover crop is utilized. Where a cover crop is desirable and Italian ryegrass is problematic, Boundary, Zidua, or Dual Magnum should be combined with a winter wheat cover crop.

IMPACTS AND BENEFITS TO MISSISSIPPI SOYBEAN PRODUCERS

Mississippi has averaged 1.98 million acres of soybean over the past five years, and a majority of soybean-producing counties contain at least one GR weed species. The data generated from this research will allow producers to implement effective control options for GR weeds, become aware of developing resistance problems, receive information on prevention and control tactics for resistant weeds, and allow Mississippi soybean producers to remain competitive regionally while improving economic returns.

Publications (26):

1. Lawrence, B. H., J. A. Bond, T. W. Eubank III, B. R. Golden, D. R. Cook, and J. P. Mangialardi. Evaluation of 2,4-D-based herbicide mixtures for control of glyphosate-resistant Palmer amaranth. Weed Technol. (*In Press*)
2. Montgomery, G. B., A. T. McClure, R. M. Hayes, F. R. Walker, S. A. Senseman, J. A. Bond, and L. E. Steckel. 2018. Fall-applied herbicides for controlling Italian ryegrass and henbit in cover crops. Weed Technol. (*Submitted for Review*).
3. Nandula, V. K., D. A. Giacomini, W. T. Molin, and J. A. Bond. Resistance to clethodim in Italian ryegrass (*Lolium perenne* ssp. *multiflorum*) from Mississippi and North Carolina. Pest Manage Sci (*Submitted for Review*).
4. McCoy, J. M., G. Kaur, B. R. Golden, J. M. Orlowski, D. R. Cook, and J. A. Bond. 2018. Nitrogen fertilization of soybeans in Mississippi increases seed yield but not profitability. Agron. J. 110:1505-1512.
5. McCoy, J. M., G. Kaur, B. R. Golden, J. M. Orlowski, D. R. Cook, and J. A. Bond. 2018. Nitrogen fertilization of soybean affects root growth and nodulation on two soil types in Mississippi. Commun. Soil Sci. Plant Anal. [Online]. Available at https://doi.org/10.1080/00103624.2017.1421649 doi: 10.1080/00103624.2017.1421649.
6. Nandula, V. K., G. B. Montgomery, M. Jugulam, D. A. Giacomini, J. D. Ray, J. A. Bond, L. E. Steckel, and P. J. Tranel. 2018. Glyphosate-resistant junglerice (*Echinochloa colona*) from Mississippi and Tennessee: confirmation and resistance mechanisms. Weed Sci. 66:603-610.
7. Schwarz, L. M., J. K. Norsworthy, L. N. Steckel, D. O. Stephenson, IV, K. Bradley, and J. A. Bond. 2018. A midsouthern consultant’s survey on weed management practices in soybean. Weed Technol. 32:116-125.
8. 2018 Weed Control Guidelines for Mississippi. 2018. Mississippi State University Extension Service Publication P-1532.
9. Bond, J.A., B.H. Lawrence, T.M. Bararpour, D.M. Dodds, B.R. Golden, J.T. Irby, E.J. Larson, and D.B. Reynolds. 2018. 2019 Weed Management Suggestions for Mississippi Row Crops. Mississippi State University Extension Service Publication P-3171. 74 pp.
10. Falconer, L., D.M. Dodds, J.A. Bond, A.L. Catchot, D. Cook, B.R. Golden, J. Gore, L. Oldham, and H.C. Pringle. 2018. Cotton 2019 Planning Budgets. Mississippi State University Extension Service Publication P-3168.
11. Falconer, L., B.R. Golden, T.W. Allen, J.A. Bond, J. Gore, L.J. Krutz, and H.C. Pringle. 2018. Rice 2019 Planning Budgets. Mississippi State University Extension Service Publication P-3167.
12. Falconer, L., J.T. Irby, J. Orlowski, T.W. Allen, J.A. Bond, N.W. Buehring, A.L. Catchot, D. Cook, B.R. Golden, J. Gore, L.J. Krutz, and H.C. Pringle. 2018. Soybeans 2019 Planning Budgets. Mississippi State University Extension Service Publication P-3166.
13. Williams, B., E. Larson, J.A. Bond, A.L. Catchot, D. Cook, B.R. Golden, J. Gore, L.J. Krutz, L. Oldham, and H.C. Pringle. 2018. Corn, Grain Sorghum, and Wheat 2019 Planning Budgets. Mississippi State University Extension Service Publication P-3169.
14. Bond, J. A. 2018. Clethodim-resistant Italian ryegrass in Mississippi. [Online] Available at http://www.mississippi-crops.com/2018/01/11/clethodim-resistant-italian-ryegrass-in-mississippi/. (01/11/2018)
15. Hydrick, H. T., J. A. Bond, B. R. Golden, B. H. Lawrence, H. M. Edwards, J. D. Peeples, and T. L. Sanders. 2018. Some additives antagonize weed control with glyphosate-based herbicide mixtures in soybean. Pages 22-23 in Mississippi State University Delta Research

and Extension Center 2017 Annual Report. Stoneville, MS: Delta Research and Extension Center.

16. Barber, T., J. K. Norsworthy, M. Houston, R. C. Scott, L. E. Steckel, J. Copeland, and J. A. Bond. 2018. Managing weeds with multiple herbicide resistance in the Midsouth. Proc. South. Weed Sci. Soc. 71: (*In Press*)
17. Corban, N. G., J. A. Bond, B. H. Lawrence, T. L. Sanders, B. K. Pieralisi, and B. R. Golden. 2018. Soybean response to sub-lethal rates of dicamba. Proc. South. Weed Sci. Soc. 71: (*In Press*)
18. Edwards, H. M., T. L. Sanders, B. H. Lawrence, J. D. Peeples, N. G. Corban, and J. A. Bond. 2018. Barnyardgrass control with glyphosate-based herbicide mixtures. Proc. South. Weed Sci. Soc. 71: (*In Press*)
19. Edwards, H. M., T. L. Sanders, B. H. Lawrence, J. D. Peeples, N. G. Corban, and J. A. Bond. 2018. Performance of preplant applications of glyphosate-based herbicide mixtures. Proc. Rice Tech. Wrkg. Grp. 37:119.
20. Kaur, G., B. R. Golden, K. K. Crouse, J. L. Oldham, and J. A. Bond. 2018. Comparison of Lancaster, Mehlich 1, and Mehlich 3 soil test methods. [Online]. ASA, CSSA, and SSSA, Madison, WI. Baltimore, MD. Nov. 4-7, 2018. Available at: https://scisoc.confex.com/scisoc/2018am/meetingapp.cgi/Paper/112106
21. Pieralisi, B. K., J. A. Bond, B. R. Golden, N. G. Corban, and J. D. Peeples. 2018. Simulated dicamba tank contamination in non Roundup Ready Xtend herbicide programs. Proc. South. Weed Sci. Soc. 71: (*In Press*)
22. Pieralisi, B. K., B. R. Golden, J. A. Bond, and N. G. Corban. Peeples. 2018. Simulated dicamba tank contamination in non Roundup Ready Xtend herbicide programs. [Online]. ASA, CSSA, and SSSA, Madison, WI. Baltimore, MD. Nov. 4-7, 2018. Available at: https://scisoc.confex.com/scisoc/2018am/meetingapp.cgi/Paper/113854
23. Sperry, B. D. B. Reynolds, J. A. Bond, J. Ferguson, G. Kruger, A. Brown-Johnson. 2018. Effect of nozzle, carrier volume, and cover crop residue on residual herbicide efficacy. Proc. South. Weed Sci. Soc. 71: (*In Press*) Proc. South. Weed Sci. Soc. 71: (*In Press*)
24. Walker, D. C., D. B. Reynolds, and J. A. Bond. 2018 The effect of Grasp (penoxsulam) and Regiment (bispyribac) application timing on BOLT soybean (*Glycine max*) growth and yield. Proc. South. Weed Sci. Soc. 71: (*In Press*)
25. Walker, D. C., D. B. Reynolds, and J. A. Bond. 2018 The effect of Grasp (penoxsulam) and Regiment (bispyribac) concentration on BOLT soybean (*Glycine max*) growth and yield. Proc. South. Weed Sci. Soc. 71: (*In Press*)
26. Wesley, M. T., D. B. Reynolds, J. A. Bond, E. J. Larson, P. H. Urach Ferreira, and J. Ferguson. 2018. Droplet size effects on preemergence herbicide efficacy for Italian ryegrass (*Lolium perenne* ssp. *multiflorum*) control in corn. Proc. South. Weed Sci. Soc. 71: (*In Press*)

Digital Media (17):

1. Justin Ferguson from Mississippi Farm Bureau on new farm bill; Mississippi Crop Situation Podcast (February 12, 2019)
2. Frank Carey from Valent USA on 2019 crop year; Mississippi Crop Situation Podcast (January 30, 2019)
3. Soybean producer Tim Clements weighs in on weather impacts on preparation for 2019; Mississippi Crop Situation Podcast (January 16, 2019)

4. Conversation with Trent Irby and Jeremy Ross from the Tri-state Soybean Forum; Mississippi Crop Situation Podcast (January 8, 2019)
5. Michael Ledlow from Mississippi Bureau of Plant Industries. Mississippi Crop Situation Podcast (November 6, 2018)
6. Bald pathologist takes on seed quality. Mississippi Crop Situation Podcast (November 1, 2018)
7. All about potash. Mississippi Crop Situation Podcast (October 25, 2018)
8. Italian ryegrass management. Mississippi Crop Situation Podcast (October 11, 2018)
9. Crop marketing with Dr. Larry Falconer. Mississippi Crop Situation Podcast (October 4, 2018)
10. Late-season soybean diseases. Mississippi Crop Situation Podcast (September 20, 2018)
11. Things to think about postharvest. Mississippi Crop Situation Podcast (September 12, 2018)
12. Tropical storm Gordon effects. Mississippi Crop Situation Podcast (September 4, 2018)
13. Management of sting bugs in soybeans. Mississippi Crop Situation Podcast (August 9, 2018)
14. Rice and soybeans. Mississippi Crop Situation Podcast (August 8, 2018)
15. A look back at DREC. Mississippi Crop Situation Podcast (August 1, 2018)
16. Soybean: July 24 2018. Mississippi Crop Situation Podcast (July 24, 2018)
17. Young Farmers and Ranchers Program: recorded July 18. Mississippi Crop Situation Podcast (July 23, 2018)

Technical Meetings/Training Sessions (26):

1. Leflore County Grower Meeting – Weed management in Mississippi row crops; Greenwood, MS (February 26, 2019)
2. Tunica County Grower Meeting – Weed management in Mississippi row crops; Tunica, MS (February 21, 2019)
3. Coahoma County Grower Meeting – Weed management in Mississippi row crops; Clarksdale, MS (February 21, 2019)
4. Humphreys County Grower Meeting – Weed management in Mississippi row crops; Belzoni, MS (February 19, 2019)
5. Yazoo County Grower Meeting – Weed management in Mississippi row crops; Yazoo City, MS (February 19, 2019)
6. Calhoun County Grower Meeting – Weed management in Mississippi row crops; Pittsboro, MS (January 28, 2019)
7. Pontotoc County Grower Meeting – Weed management in Mississippi row crops; Pontotoc, MS (January 28, 2019)
8. Washington County Grower Meeting – Weed management in Mississippi row crops; Hollandale, MS (January 15, 2019)
9. Madison County Grower Meeting – Weed management in Mississippi row crops; Canton, MS (January 14, 2019)
10. Hinds County Grower Meeting – Weed management in Mississippi row crops; Raymond, MS (January 14, 2019)
11. Tri State Soybean Forum – Targeting Palmer amaranth with residual herbicides; Stoneville, MS (January 4, 2019)
12. Mississippi Row Crop Short Course – Herbicide application timing: effect on weed control; Starkville, MS (December 3, 2018)

13. Mississippi State University Extension Dicamba Applicator Training – Auxin applicator training; Cleveland, MS (March 6, 2019
14. Mississippi State University Extension Dicamba Applicator Training – Auxin applicator training; Clarksdale, MS (March 6, 2019
15. Mississippi State University Extension Dicamba Applicator Training – Auxin applicator training; Clarksdale, MS (March 6, 2019
16. Mississippi State University Extension Dicamba Applicator Training – Auxin applicator training; Tunica, MS (March 6, 2019
17. Mississippi State University Extension Dicamba Applicator Training – Auxin applicator training; Raymond, MS (March 5, 2019
18. Mississippi State University Extension Dicamba Applicator Training – Auxin applicator training; Greenwood, MS (March 4, 2019
19. Mississippi State University Extension Dicamba Applicator Training – Auxin applicator training; Yazoo City, MS (March 4, 2019
20. Mississippi State University Extension Dicamba Applicator Training – Auxin applicator training; Stoneville, MS (March 4, 2019
21. National Conservations Systems Cotton and Rice Conference – Weed management in Mississippi soybean; Baton Rouge, LA (February 1, 2019)
22. National Conservations Systems Cotton and Rice Conference – Weed management in Mississippi soybean; Baton Rouge, LA (January 31, 2019)
23. BASF Herbicide Meeting – Weed control for row crops in the midsouthern U.S.; Tampa, FL (January 23, 2019)
24. Mississippi Agricultural Consultants' Association Research Exchange – Mississippi weed control update; Stoneville, MS (September 14, 2018)
25. Mississippi Agriculture Industries Council Certified Crop Advisor Training – Weed control issues in Mississippi row crops; Orange Beach, AL (July 24, 2018)
26. Mississippi State University Extension Service Scout School – Weed identification in Mississippi crops; Verona, MS (May 31, 2018)