III. Weed Management

Herbicide Resistance Field Studies

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Each test sites in Limestone and Cherokee counties were treated and rated for control of horseweed and other winter weeds. All residual treatments (Table 1) did an excellent in job of inhibiting horseweed emergence at each site.

The fall foliar treatments produced surprising results. Ratings of the fall foliar treatments on December 11th indicated that all treatments, including Roundup alone, effectively controlled all emerged marestail plants (Table 2). Why Roundup alone controlled the glyphosate resistant horseweed at this stage will need further investigation. The fall foliar treatments containing Dicamba and Sharpen herbicide also produced excellent residual control of marestail through mid-March. The fall Roundup alone treatment had emerging marestail appearing in early to mid-February.

The spring herbicide results are also reported in Table 2. Results indicate that Roundup was no longer controlling any marestail plants. Dicamba control of marestail was also decreasing to about 96% with rating of the 8 and 16 ounces treatments on April 8th. These ratings are most likely high due to the fact that many of the horseweeds were twisted but still survived the application. The late April test (rated on May 8th) showed a very sharp decrease in marestail control (20-35%) with dicamba treatments. Only the Sharpen and Roundup treatment still provided 100 percent control of marestail.

This preliminary data supports the theory that marestail control problems using dicamba herbicide could be related to marestail size. Increasing dicamba rates only marginally increased marestail control. In this study marestail plants six inches or taller were not effectively controlled by dicamba treatments. Why the Roundup treatment controlled glyphosate-resistant marestail in December is still puzzling and will be further investigated. Sharpen appears to be a good herbicide with foliar and residual activity on marestail. Farmers will need to apply Sharpen herbicide according to label restriction on rates and timing of Sharpen application on various crops and soil types.

Table 1.
Residual and Foliar Herbicide Treatments Applied at Tennessee Valley Test Site, 2012-2013.

Residual[1]	Rate (oz/ac)	Foliar 2	Rate (oz/ac)
Valor	2.0	RPMax3	29
Zidua	2.0	Dicamba	8
Leadoff	1.0	Dicamba	16
Sharpen	2.0	RPMax + Dicamba	29 + 8
Fierce	3.0	RPMax + Dicamba	29 + 16
		RPMax + Sharpen	29 + 2

[1] Application made on November 26th. Emerged weeds controlled with 1 pt/A Grammoxone + 2 oz/A Sharpen.
[2] Application made on November 26th, March 26th and April 23rd. 3 RPMax = Roundup PowerMax.

Table 2.
Marestail control ratings made two weeks after application, Tenn. Valley Station, 2012-2013

Treatments	Rate (oz/ac)	12/11	4/8	5/8
RPMax[1]	29	100	0	0
Dicamba	8	100	96	20
Dicamba	16	100	96	35
RPMax + Dicamba	29 + 8	100	99	10
RPMax + Dicamba	29 + 16	100	100	15
RPMax +Sharpen	29 + 2	100	100	100

[1] Indicates Roundup PowerMax

Greenhouse Resistance Verification Studies

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Preface: The following research was conducted to determine if common ragweed and horseweed populations collected in Alabama were glyphosate and dicamba resistant, respectively. Each weed species will be discussed separately below. This information will be presented at the annual meeting of the Southern Weed Science Society in January 2014 in Birmingham, AL. Following this, the research will be submitted for publication in the journal Weed Technology. The Alabama Cotton Commission will be acknowledged as the primary funding source for this research. All the stated goals of the proposal have been fulfilled. This document should therefore be considered the final report.

Part I
Evaluation of Suspected Common Ragweed Resistance to Glyphosate

Introduction: Glyphosate resistant common ragweed (Ambrosia artemisiifolia) was first reported in Arkansas and Missouri in 2004 and has since been reported across the mid-west from the Dakotas to Pennsylvania. The mechanism of resistance is not fully understood but both target site mutation and reduced absorption and translocation mechanisms do not appear responsible. Common ragweed with suspected glyphosate resistance was collected in Madison County, AL in April 2012. The objective of this research was to evaluate common ragweed populations collected from Madison County for glyphosate resistance and compare their tolerance level to a known susceptible population.

Methods: Common ragweed was collected from the suspect glyphosate resistant population, which was named 'original field,' and transplanted in the greenhouse. Glyphosate was applied at 1.12 kg ae ha-1 to the transplants, and seed from plants with the quickest recovery were collected for a population named 'suspected one' (S1). Common ragweed from a different field in Madison County was also collected, and this population was named 'barn field.' Lastly, common ragweed seed was purchased from Azlin Seed Service (Leland, Mississippi) and used for a glyphosate-susceptible population named 'common.' Populations used for tolerance determination were established from seed in 10 centimeters2 pots with soil collected from a Wickham sandy loam (pH 6.3; 1.7 percent organic matter). Two maturity levels were evaluated. The 'small' stage characterized by 2 to 4 mature nodes above the cotyledons, 4 to 7 centimeters in height, and averaged 5 cm in width. The 'large' stage had > 6 nodes mature above the cotyledons and averaged 15 centimeters in height and 12 centimeters in width.

Glyphosate tolerance was evaluated using rate response studies in the greenhouse with conditions suited for common ragweed growth. Treatments included 0, 0.14, 0.28, 0.56, 1.12, 2.24, 4.5, 9.0, 18.0, and 36.0 kg ae ha-1 1 (0, 0.125, 0.25, 0.5, 1.0, 2.0, 4.0, 8.0, 16.0, and 32.0 lb ae/a) glyphosate (Roundup ProMax®; Monsanto Co., St. Louis MO) applied at 280 L ha-1. Irrigation was withheld for 24 hours after treatment. Three replications per treatment were applied and the experiment was repeated in time. Data were collected 28 days after treatment and included percent visual control on a 0 to 100 scale where 0 corresponds to no injury and 100 corresponds to plant necrosis and above ground biomass (fresh weight). Mass data were transformed to a percent reduction relative to the nontreated mean for analysis. ANOVA indicated that maturity level was a significant factor, so subsequent analysis was conducted separately for each level. Nonlinear regression analysis was conducted using Prism® (GraphPad Software, La Jolla, CA) with the four parameter log-logistic model. I50 values (glyphosate rate resulting in 50 percent visual control or fresh weight reduction) were compared between populations using 95 percent confidence intervals.

Common Ragweed Results: Visual control data for the small growth stage was not able to separate populations' glyphosate tolerance. However, data from the large growth stage indicate that original field, barn field, and S1 were 24, 17, 12 times more tolerant to glyphosate than the common (susceptible) population, respectively. Fresh weight reduction data from the small growth stage indicate that original field and barn field were 3 to 4 times more tolerant than the common (susceptible) population; the S1 population had a similar tolerance to all other populations. Fresh weight reduction data from the large growth stage indicate that original field and barn field were approximately 3.4 and 7.9 times as tolerant to glyphosate as the common (susceptible population), respectively, while S1 and common were similar in tolerance. Previous reports of glyphosate resistance report a 10- to 21-fold tolerance increase. These results indicate that glyphosate resistant common ragweed does exist in Madison County, AL, with a 3.4 to 24 fold increase in tolerance.

I50 values were calculated to determine the glyphosate concentration needed to kill or control 50 percent of the weed population. On average, original field and barn field had I50 values of 1.1 and 0.71 kg ae ha-1 (1.0 and 0.63 pounds ae/acre) while the large growth stage had I50 values of 4.8 and 1.8 kg ae ha-1 (4.3 and 1.61 pounds ae/acre) as estimated by visual and mass reduction data types, respectively. Therefore, as is known with other glyphosate resistant weeds, the level of glyphosate resistance is dependent on size with smaller weeds able to be controlled and larger weeds being more resistant. Will earlier application timing will not completely negate glyphosate resistance, it certainly will increase the chances of control.

Evaluating PRE herbicide GPA Application Volume for Pigweed Control in Reduced-Tillage Cotton

A. Price, K. Balkcom, M. Patterson and C.D. Monks

Objective: To optimize weed management components for an integrated glyphosate-resistant Palmer amaranth management program.

Results: The following tables provide result details. In general, increasing application volume did not increase pigweed or other weed control in 2012 or 2013. These results reveal that in high residue conservation tillage systems, producers are realizing predictable weed control within the row and the row middles regardless of the range of typically utilized spray GPAs.

Table 1.*
Agronomic Response of Cotton to GPA[1] and Pre-Emergence Herbicide, Wiregrass 2012

GPA	Population (plants/Ha)	Seed Cotton Yield (kg/Ha)
None	39467	1716
10	60994	2921
15	64582	3269
20	66974	3355
25	57406	2758
30	59200	3106
60	52024	1998
Herbicide		
None	39467	1716
Prowl	54018	2751
Reflex	66376	3052

*All averages were obtained using the GLM Least Squares Means procedure in SAS.
[1]Gallons per acre of H_2O carrier.

Table 2.
**Early1 In-Row and Row-Middle Weed Response to GPA[2] and Pre-Emergence Herbicide Wiregrass 2012*

GPA	Weed Control (%)									
	In-Row					Row-Middle				
	Palmer Pigweed	Crabgrass	Coffee Senna	Yellow Nutsedge	Morning Glory	Palmer Pigweed	Crabgrass	Coffee Senna	Yellow Nutsedge	Morning Glory
None	0	0	0	0	0	0	0	0	0	0
10	98	85	0	96	0	98	72	0	92	0
15	98	89	0	67	0	98	77	0	68	0
20	98	91	0	89	0	98	87	0	80	0
25	99	91	0	96	0	99	82	0	96	0
30	99	89	0	96	0	99	81	0	98	0
60	98	79	0	81	0	96	66	0	81	0
Herbicide										
None	0	0	0	0	0	0	0	0	0	0
Prowl	98	92	0	89	0	97	91	0	91	0
Reflex	99	82	0	86	0	99	64	0	81	0

[*]All averages were obtained using the GLM Least Squares Means procedure in SAS.
[1]Weed ratings were taken before the first post-emergence herbicide application on 5/30/2012.
[2]Gallons per acre of H2O carrier.

Table 1.
[*]Agronomic Response of Cotton to GPA1 and Pre-Emergence Herbicide E.V. Smith 2013

GPA	Population (plants/Ha)	Seed Cotton Yield (kg/Ha)
10	89099	4452
15	103451	4252
20	99265	4334
25	98069	4591
30	104049	4554
60	103451	4466
Herbicide		
Prowl H_2O[2]	95877	4233
Reflex[3]	103252	4651
Non-treated[4]	100461	2905

[*]All averages were obtained using the GLM Least Squares Means procedure in SAS.
[1]Gallons per acre of H_2O carrier.
[2]Prowl H_2O (0.75 lbs a.i./A) was applied pre-emergence (at planting).
[3]Reflex (1 pt/A) was applied pre-emergence (at planting).
[4]No pre-emergence herbicide was applied.

Table 2.
**In-Row and Row-Middle Weed Response1 to GPA2 and Pre-Emergence Herbicide*
E.V. Smith 2013

GPA	Weed Control (%)							
	In-Row				Row-Middle			
	Smooth Pig-weed	Crab-grass	Pitted Morn-ing Glory	Yellow Nut-sedge	Smooth Pig-weed	Crab-grass	Pitted Morning Glory	Yellow Nutsedge
10	99	99	98	99	99	98	93	98
15	99	99	99	99	99	99	88	96
20	99	99	97	99	99	99	73	98
25	99	99	96	98	99	99	86	99
30	99	99	99	99	99	99	97	98
60	99	98	99	99	99	98	96	99
Herbicide								
Prowl H_20[3]	99	99	99	99	99	99	93	98
Reflex[4]	99	99	97	99	99	98	85	98
Non-treated[5]	33	33	61	28	97	93	33	92

[*]All averages were obtained using the GLM Least Squares Means procedure in SAS.
[1]Weed ratings were taken before the first post-emergence herbicide application.
[2]Gallons per acre of H_2O carrier.
[3]Prowl H_2O (0.75 lbs a.i./A) was applied pre-emergence (at planting).
[4]Reflex (1 pt/A) was applied pre-emergence (at planting).
[5]No pre-emergence herbicide was applied.

Wide vs. Narrow Strip Tillage for Pigweed Control in Reduced-Tillage Cotton

A. Price, K. Balkcom, M. Patterson and C. D. Monks

Location: Wiregrass Research and Extension Center.

Objective: To optimize weed management components for an integrated glyphosate-resistant Palmer amaranth management program.

Progress: The cover crop was established in the experimental areas in fall 2012 and cotton established in 2013. The following table provides result details for the initial year of research. In general, narrow tillage width disturbance increased weed control in high residue systems while wide tillage width provided higher control in low residue systems. Averaged over tillage width and residue level, cover crops provided substantial levels of weed control compared to soil-applied herbicides.

Table 1.
Weed Response to Tillage Width, Cover Crop Residue Level and Weed Control Methods in Cotton E.V. Smith 2013

	Weed Control (%)							
	In-Row				Row-Middle			
	Pigweed	Crab-grass	Pitted Morn-ing Glory	Sickle-pod	Pigweed	Crab-grass	Pitted Morning Glory	Sicklepod
Tillage Width								
Narrow[1]	76	71	69	65	67	50	50	57a
Wide[2]	61	65	70	55	48	35	32	33b
LSD (0.05)	22.4	21.9	18.7	21.1	25.0	23.4	21.2	22.0
Residue Level								
Low[3]	66	60	57b	48b	33b	27b	16b	17b
High[4]	70	76	83a	71a	81a	58a	67a	73a
LSD (0.05)	22.4	21.9	18.7	21.1	25.0	23.4	21.2	22.0
Weed Control								
Non-treated[5]	23b	23b	27b	19b	47b	17b	24b	26b
Pre (banded)[6]	82a	83a	89a	77a	43b	30b	36b	47ba
Pre (broad-cast)[7]	99a	98a	93a	84a	82a	81a	64a	62a
LSD (0.05)	27.4	26.8	22.9	25.8	30.6	28.6	25.9	26.9

[1]A 4-row KMC subsoiler was used in the plots.
[2]A 4-row KMC strip till with wavy coulters and a rolling basket was used in the plots.
[3]Rye was terminated early, so there was very little or no residue left on the plots.
[4]Rye was left growing until spring when it was then rolled flat prior to planting.
[5]No herbicide was used.
[6]Prowl H2O (29 oz/A) + Reflex (16 oz/A) was banded over the row in 8” strips after planting.
[7]Prowl H2O (29 oz/A) + Reflex (16 oz/A) was broadcasted over the plot after planting.

Table 2.
Agronomic Response of Cotton to Tillage Width, Cover Crop Residue Level, and Weed Control Methods in Cotton – E.V. Smith 2013

	Agronomics	
	Population (plants/ha)	**Seed Cotton Yield (kg/ha)**
Tillage Width		
Narrow[1]	109231	4710
Wide[2]	110029	5035
LSD (0.05)	7831.4	429.6
Residue Level		
Low[3]	108434	4805
High[4]	110826	4940
LSD (0.05)	7831.4	429.6
Weed Control		
Non-treated[5]	110029	4647
Pre (banded)[6]	110029	4970
Pre (broadcast)[7]	108833	5000
LSD (0.05)	9591.4	526.2

[1]A 4-row KMC subsoiler was used in the plots.
[2]A 4-row KMC strip till with wavy coulters and a rolling basket was used in the plots.
[3]Rye was terminated early, so there was very little or no residue left on the plots.
[4]Rye was left growing until spring when it was then rolled flat prior to planting.
[5]No herbicide was used.
[6]Prowl H2O (29 oz/A) + Reflex (16 oz/A) was banded over the row in 8” strips after planting.
[7]Prowl H2O (29 oz/A) + Reflex (16 oz/A) was broadcasted over the plot after planting.