PALMER AMARANTH CONTROL AS AFFECTED BY HERBICIDE, METHOD OF APPLICATION, AND WINTER COVER CROP

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Introduction

Cotton production in the southeastern US exceeds 2.1 million acres a year, with an estimated farm gate value greater than $700 million. Cotton production since 2000 has remained relatively constant in the region. Cotton that incorporates biotechnology (glyphosate or glufosinate resistant, Bt and Bt 2) into the production scheme continues to increase. Since its introduction in 1997, glyphosate-tolerant cotton has been rapidly adopted by growers across the southeast; greater than 89% of the hectarage was planted to these cultivars in 2005. Glyphosate-tolerant cotton allowed growers to reduce or eliminate soil-applied herbicides, abandon cultivation, and transition to conservation tillage, which promotes soil conservation and compliance with government regulation. Approximately 50% of the cotton in Georgia was produced using either no-tillage or strip-tillage techniques by 2005. With the elimination of cultivation as a control tactic in conservation tillage systems, herbicides were the primary, and sometimes only, method used for weed control. Glyphosate was applied two to four times per season on most fields and may have been the only herbicide used in any year given its efficacy against a broad spectrum of annual and perennial grass and broadleaf weeds. In Georgia, 93% of the cotton hectares received at least one glyphosate application in 2005. In 2004, glyphosate-resistant Palmer amaranth was discovered in Georgia; resistant populations are widely distributed across the cotton producing regions of the southeastern and mid-southern US. Additionally, acetolactate synthesis (ALS) resistant Palmer amaranth is also wide spread. Palmer amaranth biotypes with multiple resistance to ALS herbicides and glyphosate now occur in this region.

The use of multiple herbicide modes of action in weed management systems is now required for successful cotton production. Residual herbicides applied PRE for Palmer amaranth control include pendimethalin (Prowl 3EC) and fomesafen (Reflex), while *S*-metolachlor (Dual Magnum) is POST applied to cotton weeds prior to emergence. Growers seeking ways to reduce input costs can impregnate fertilizer with pendimethalin and other herbicides. The simultaneous application of herbicides with fertilizer saves time and labor, reduces soil compaction by eliminating field operations, and reduces application costs.

Early season Palmer amaranth control is essential as cotton becomes established more slowly than other crops (i.e. soybeans, corn). Cover crops, such as rye, can suppress weeds both chemically (through demonstrated allelopathy) and physically (impeding germination and emergence). Combining herbicide-fertilizer impregnation with strip-tillage techniques may improve early season weed control and assist farmers with viably economic cotton production. Weed control effectiveness of cover crops along with herbicide application using fertilizers were studied in a heavily infested glyphosate-resistant Palmer amaranth field. The main goal was to determine if the herbicides provided residual weed control in each tillage system and cover crop combination, and if crop safety can be improved (i.e. prevent seedling cotton injury from *S*-metolachlor and fomesafen by using fertilizer as a carrier).

Materials and Methods

Studies were conducted in Macon County, GA in a glyphosate-resistant Palmer amaranth infested field in 2008 and 2009. Main plot tillage methods were (1) conventional rip, hip, and bed, (2) wheat cover crop that was spring rolled followed by strip-tillage cotton planting, or (3) rye cover crop that was rolled and followed by strip-tillage planting. Subplots were herbicide and method of application. Herbicides were pendimethalin, *S*-metolachlor, and fomesafen. Methods of application were impregnated on fertilizer (250 lb/ac) or spray applied with water (15 gal/ac). Trials were initiated with November planting of cover crops (wheat and rye). Cover crops were destroyed by herbicide treatment in early April each year followed by planting of glufosinate-resistant cotton and PRE and POST herbicide treatments. The experiment was a 3 by 8 by 2 factorial in a randomized complete block design with 4 replications (Table 1). Plots were two rows by 25 feet long in Tifton, and two rows by 30 feet long in Plains. Standard agronomic practices were conducted including conventional tillage along with fertility, and pest control recommendations (other than weeds) by the University of Georgia Extension Service.

Applications of herbicides began at planting and to 3 leaf (3LF) stage of cotton. A POST treatment of glufosinate was applied at the 3LF stage of growth to all plots to determine how long the residual herbicide would control Palmer amaranth in combination with the cover crops. Herbicides were applied by tractor or backpack pressurized by compressed air or CO_2 delivering 15 gal/ac, or by a Gandy fertilizer applicator. A non herbicide-treated control was included for comparison.

Visual estimates of crop tolerance and weed control (on a scale of 0 to 100%, where 0% = no injury or weed control and 100% = cotton death or complete weed control) were estimated throughout the growing season. For Palmer amaranth stand counts, two counts were taken on 1-ft^2 sections of each plot every 7 days after planting to determine emergence. Five cotton stand counts were taken during the course of the study. Data was subjected analysis of variance appropriate for a randomized complete block design for a factorial arrangement of treatments.

Results and Discussion

Data are presented separately by year for the analysis of variance (Table 2). The two-way interactions between cover crops and application method were not significant for any variable, except for Palmer amaranth control in 2009. The two-way interactions between cover crops by herbicides and herbicides by application method varied by biological measure.

Cotton injury was similar for spray and fertilizer impregnation treatments, with greater injury observed in 2008 than in 2009. PRE *S*-metolachlor injury was unacceptable in 2008; fertilizer application did not prevent cotton injury from occurring. Spray and fertilizer impregnation of *S*-metolachlor are therefore not advised and not registered for PRE application in cotton.

Fomesafen PRE provided good to excellent Palmer amaranth control as compared to the nontreated in all systems. Palmer amaranth populations were greater in 2009 than 2008, likely due to optimal moisture conditions in 2009. Palmer amaranth populations were reduced by rye cover much more effectively than wheat cover crop due, in part, to density of the surface material. Rye averaged 4,200 lb/ac dry biomass while wheat averaged 1,000 lb/ac. Palmer amaranth was controlled more effectively by a combination of fomesafen and rye in 2008 and 2009.

In conclusion, Rye cover reduced Palmer amaranth density and provided extended control as compared to wheat and the nontreated control. Fomesafen provided residual control of Palmer amaranth as either a spray or fertilizer impregnated application. PRE applied S-metolachlor using a fertilizer impregnation did not reduce cotton injury as compared to the spray application. The PRE combination of pendimethalin plus fomesafen provided maximum early season control by mixing two different herbicide modes of action: DNA plus PPO, respectively. PRE herbicide applications must be followed by POST application of glufosinate in order to provide adequate season long control in cotton as this Palmer amaranth is glyphosate resistant.

Table 1. Cover crop, herbicides, and method of application for Palmer amaranth study.

Cover crops			
	Wheat		
	Rye		
	Conventional tillage		
Herbicide treatment		Rate	Application timing
		—lb ai/ac—	————
	Pendimethalin	1.5	PRE
	S-metolachlor	1.25	PRE
	Fomesafen	0.25	PRE
	Pendimethalin + *S*-metolachlor	1.5 + 1.25	PRE
	Pendimethalin + fomesafen	1.5 + 0.25	PRE
	Fomesafen + *S*-metolachlor	0.25 + 1.25	PRE
	S-metolachlor	1.25	POST
	Nontreated		
Application method			
	Spray		
	Fertilizer impregnation		

Table 2. Analysis of variance for cotton response, Palmer amaranth control as affected by cover crop, herbicide, method of application, and interactions[a].

	Cotton injury (36 DAP)		AMAPA Control (18 DAP)		AMAPA Control (36 DAP)		AMAPA Density (22 DAP)		AMAPA Density (36 DAP)	
Variable	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Cover	<0.0001	0.09	<0.0001	0.56	<0.0001	0.0006	<0.0001	0.12	<0.0001	
Herbicide	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Application	0.24	<0.0001	0.007	0.31	<0.0001	<0.0001	0.34	0.56	0.28	0.008
Cover x herbicide	0.09	0.06	0.01	0.17	0.19	0.008	0.001	0.62	0.03	0.36
Cover x application	0.47	0.69	0.53	0.51	0.94	0.01	0.93	0.87	0.13	0.65
Herbicide x application	<0.0001	0.84	0.009	0.34	0.02	0.13	0.53	0.03	0.007	0.19

[a]ANOVA for 3 by 8 by 2 factorial arrangement of treatments, $P \leq 0.05$