ECONOMIC ANALYSIS OF HEAVY RYE COVER CROP TO CONTROL GLYPHOSATE-RESISTANT PALMER AMARANTH IN COTTON

W. Don Shurley[1], Stanley Culpepper[2], Amanda Smith[1], and Bob Nichols[3]
1/ Department of Agricultural and Applied Economics, University of Georgia
2/ Department of Crop and Soil Sciences, University of Georgia
3/ Cotton Incorporated, Cary, NC

Abstract

Glyphosate-resistant Palmer amaranth has caused many growers to abandon conservation tillage and revert back to tillage and cultivation along with herbicides. The objective of this study was to determine the agronomic feasibility and resulting profitability of utilizing a very heavy cover crop (heavy biomass) to control glyphosate resistant Palmer amaranth in a conservation tillage system planting a Roundup-Ready Flex® variety. This research was conducted at seven locations over a two-year period (2012 and 2013). Three heavy rye cover crop systems were compared to strip-till production with no cover crop. There was no difference in cotton yield between having no cover crop and the three rye cover crop treatments. The highest net return was achieved when not having a cover crop. This was due to much higher costs with the cover crop systems. The heavy rye cover did provide savings in herbicide expense, but these savings were more than offset by other costs. Future research could address methods to reduce the costs associated with cover crop systems such as various cotton herbicide programs, varying seeding rates on the cover crop, and various types of cover crop. Future research could also include any cotton fiber quality differences between no cover crop and having a cover crop.

Introduction

Effective weed management is one of many critical components of profitable cotton production. However, herbicide resistance, if present, represents a significant threat to successful weed control and profitability. Approximately 92 percent of Georgia cotton acreage is planted to Roundup-Ready varieties (Shurley). Since 2004, Palmer amaranth resistant to glyphosate has spread and now been confirmed in nearly every agronomic (row crop producing) county in the state. Glyphosate-resistant Palmer amaranth is the dominant issue in Georgia cotton production and row crop production in general.

University of Georgia Extension has developed herbicide programs for both Roundup-Ready® and LibertyLink® varieties in both conventional and conservation tillage systems (Culpepper). These programs (recommendations) are diverse in mode of action; they reduce the reliance on a single mode of action (glyphosate), and also integrate other cultural practices such as hand-weeding, tillage, cover crops, crop rotation, etc. Herbicide programs are improving and becoming more effective. Georgia cotton growers are becoming more successful at controlling the growth and spread of glyphosate-resistant Palmer amaranth.

One of the greatest challenges for cotton production when glyphosate resistance is present is making sure no Palmer amaranth is emerged at planting time. Beyond that, early season control is also critical. Glyphosate-resistant Palmer amaranth has caused many growers to abandon conservation tillage and revert back to tillage and cultivation along with herbicides.

Objectives and Methodology

The objective of this study was to determine the agronomic feasibility and resulting profitability

of utilizing a very heavy cover crop (heavy biomass) to control glyphosate-resistant Palmer amaranth in a conservation tillage system planting a Roundup-Ready Flex® variety. A heavy cover crop reduces exposure to sunlight—both reducing amaranth germination and interfering with emergence and growth.

This research was conducted at seven locations over a two-year period (2012 and 2013). The research consisted of large on-farm plots—four treatments with each treatment replicated four times. The treatments were four cotton production systems defined as follows:

Solid seeded rye: Rye cover crop (planted with drill) with cotton planted into solid rye. All cotton herbicides were broadcast except for layby, which was directed.

Rye-free zone: Rye cover crop (planted with drill) but 12-inch strips left out where cotton was planted. All cotton herbicides were applied as with solid seeded rye.

Rye-free zone banded: Same as rye-free zone except cotton PPI herbicides were applied in an 8-inch band and PRE herbicides applied in a 12-inch band.

No cover crop: No rye cover crop. Strip-till cotton was planted into previous crop residue and fallow. All cotton herbicides were broadcast except for directed spray at layby.

These four treatments (production systems) were the same at all locations for both years. There were four locations in 2012 and three locations in 2013. The locations for 2012 were Macon County, Worth County, Colquitt County, and Berrien County. The 2013 locations were Macon County, the University of Georgia Ponder Farm (Tift County), and the Sunbelt Agricultural Exposition Farm (Colquitt County).

The following details the herbicides applied in each of the four treatments (Table 1). The programs were very similar except for the PPI application in the FZ banded treatment and the addition of 2,4-D in the no cover crop treatment. Otherwise, the materials used were the same in each treatment, but there were some slight differences in the rate (amount per acre) applied.

Table 1. Herbicides Applied in Each of Four Treatments, Four Locations 2012, Three Locations in 2013.

	Solid Rye	Rye w/ 12" FZ	FZ Banded[1]	No Cover
Burndown	Gramoxone + Valor	Gramoxone + Valor	Gramoxone + Valor	Gramoxone + Valor + 2,4-D
PPI			Prowl + Reflex	
PRE	Direx + Reflex + Gramoxone	Direx + Reflex + Gramoxone	Direx + Reflex	Direx + Reflex + Gramoxone
POST 1	Warrant + RUWM[2]	Warrant + RUWM[2]	Warrant + RUWM[2]	Warrant + RUWM[2]
POST 2	Dual + RUWM[2]	Dual + RUWM[2]	Dual + RUWM[2]	Dual + RUWM[2]
Layby Directed	Direx + MSMA	Direx + MSMA	Direx + MSMA	Direx + MSMA

1/ PPI applied in a 12-inch band, PRE applied in an 8-inch band
2/ Roundup Weather Max

Rye was planted at a rate of 90 pounds of seed per acre (for solid rye cover). The rye cover crop received 20 lbs/acre of nitrogen. Cotton following rye also received an additional 20

lbs/acre of nitrogen. Other than herbicides and associated application cost and nitrogen as prescribed, all other inputs and production practices were the same for each treatment.

The rye was allowed to grow very tall (7 to 8 feet in height). The rye was then sprayed (burndown) and "rolled"—using a roller pulled behind the tractor to lay/press the rye down to the ground. Planting was then done in the same direction as the rye was rolled.

Seedcotton yield per acre was determined by weighing the production from each replication of each treatment. Seedcotton was not ginned, so lint yield was estimated at 40 percent of seedcotton yield (a 40 percent gin turn-out). Lint was valued at the November 2012 and November 2013 average cash price for base grade (Color 41, Leaf 4, Staple 34) cotton for the 2012 and 2013 treatments respectively (USDA-AMS). Any fiber quality differences were not included in the analysis.

Results

Cotton Yields

In 2012, the study was conducted at four locations. At two of the four locations (Macon County and Berrien County), the cotton yield for all three cover crop treatments was higher and statistically significantly different than the no cover crop treatment (Figure 1). At the other two locations (Worth County and Colquitt County), yield was not significantly different among any of the treatments.

At all four locations in 2012, the rye cover crop treatments were equal to or higher than the no cover crop treatment. Although not statistically different, the solid rye treatment gave the highest yield at three locations and the no cover crop treatment had the highest yield at one location.

In 2013, the study was conducted at three locations (Figure 2). At Macon County, cotton yield for the solid rye cover crop treatment was lower and statistically different than the other three treatments. At both other locations, there was no statistical difference in yield among treatments. The no cover crop treatments had the highest yield at each location, but this difference was not statistically significant. Among the three cover crop treatments, the rye planted with the rye-free zone resulted in the highest cotton yield, but this difference in yield was not statistically significant.

Averaged over all seven locations over the two years, cotton yields were not statistically different across the four treatments (Figure 3). Numerically, the highest cotton yield was achieved with the rye-free zone (1,133 lbs/acre) and the lowest yield achieved with the rye-free zone banded (1,097 lbs/acre). But statistically, there was no difference in yield among the four treatments—the three cover crop treatments yielded just as well as no cover crop, and the three cover crop treatments yielded the same.

Herbicide Costs

Herbicide costs ranged from $60.22 per acre for the rye-free zone banded treatment to $79.75 per acre for the no cover crop treatment (Table 2). There was little difference in herbicide cost between the solid rye treatment and rye-free zone treatment. The free zone treatment with PPI and PRE herbicides banded, was approximately $12 per acre cheaper than the other two cover crop treatments. In the cost of herbicides, the three cover crop treatments ranged from roughly $7 to $19 per acre cheaper than having no cover crop.

Table 2. Average Herbicide Costs[1] per Acre for Each Treatment, 2012-2013

	Solid Rye	Rye w/ 12" FZ	FZ Banded	No Cover
Burndown	$11.43	$11.43	$10.05	$18.14
PPI			$3.57	
PRE	$17.48	$16.30	$2.73	$17.74
POST 1	$15.75	$15.75	$15.75	$15.75
POST 2	$16.37	$16.37	$16.37	$16.37
Layby Directed	$11.75	$11.75	$11.75	$11.75
Total Cost	**$72.78**	**$71.60**	**$60.22**	**$79.75**

1/ Includes crop oil in addition to herbicides shown in Table 1. Excludes costs of application.

Other Costs and Net Returns

In addition to the cost of herbicides, other costs that varied among the four treatments were seed cost for the rye cover crop, nitrogen on the cover crop and extra nitrogen on cotton following the cover crop, and the costs of application. Machinery and equipment costs were estimated and derived from UGA Extension estimates (Shurley and Smith). Application costs included the variable costs (fuel, repairs, and labor) of planting the rye cover crop, nitrogen application on rye, rolling the rye, and herbicide application unless herbicide was applied in tandem with another operation (like rolling or planting) already budgeted. Application cost also included the annual fixed costs (depreciation, interest, and insurance) on the roller since this is an additional investment required for the heavy rye cover crop system. All other machinery and equipment for both rye and cotton was assumed already owned and available, so annual fixed costs need not be considered.

Costs considered were only those that varied or would change as the result of having a cover versus not having a cover crop and that would change based on the three cover crop systems utilized. All other inputs and production practices were the same regardless of cover crop or no cover crop. Thus, those costs are irrelevant and need not be considered. Therefore, the Net Return is the net or residual above these variable treatment-related costs only.

Table 3. Average Per Acre Net Return for Each Treatment, 2012-2013

	Solid Rye	Rye w/ 12" FZ	FZ Banded	No Cover
Cotton Yield (lbs/acre)	1,103	1,133	1,097	1,101
Price ($/lb)	$0.721	$0.721	$0.721	$0.721
Income	**$795.06**	**$816.68**	**$790.73**	**$793.62**
Variable Costs				
-Rye Cover Crop (Seed)	$40.50	$27.00	$27.00	
-Additional Nitrogen	$26.51	$26.51	$26.51	
-Herbicides	$72.78	$71.60	$60.22	$79.75
-Application[1]	$38.92	$38.92	$43.47	$17.02
Total Variable Cost	**$178.71**	**$164.03**	**$157.20**	**$96.77**
Net Return	**$616.34**	**$652.65**	**$633.53**	**$696.85**

1/ Includes the variable costs (fuel, repairs, and labor) of planting the rye cover crop, nitrogen application on rye, rolling the rye, and herbicide applications. Also includes the annual fixed costs (depreciation, interest, and insurance) on the roller.

Total variable costs were lowest when having no cover crop (Table 3). Costs were highest for the solid rye cover crop. The rye-free zone (with herbicides broadcast) and rye-free zone with PPI and PRE banded, saved approximately $14 to $21 per acre compared to the solid rye cover crop system. Variable costs ranged from $96.77 per acre (no cover crop) to $178.71 per acre (solid rye cover crop). Compared to having no cover crop, the three cover crop treatments averaged approximately $70 per acre higher cost. Compared to having no cover crop, the least expensive of the three cover crop treatments was the rye-free zone with PPI and PRE banded—approximately $60 per acre higher than the no cover crop treatment.

Cotton yield was not statistically different among the four treatments although numerically, the rye-free zone treatment (with herbicides broadcast) had the highest yield. Fiber quality was not considered in this study, so the average price for cotton was the same for each treatment.

Net return was highest ($696.85 per acre) for cotton produced with no cover crop. This was due primarily to the difference in (lower) costs. Likewise, the lowest net return resulted from cotton produced with the solid (no rye-free zone) cover. Compared to having no cover crop, net return averaged approximately $63 per acre less for the three cover crop treatments. The rye-free zone with broadcast herbicides offered the highest net return among the three cover crop treatments—approximately $44 per acre less than having no cover crop.

Summary and Conclusions

Three heavy rye cover crop systems were compared to strip-till production with no cover crop. A heavy rye cover crop suppresses emergence and growth of weeds like Palmer amaranth. One objective of this research was to determine if a heavy rye cover crop could be a successful management practice for helping control glyphosate-resistant Palmer amaranth in conservation tillage.

Statistically, there was no difference in cotton yield between having no cover crop and the three rye cover crop treatments. The implication of this is that producing cotton behind a heavy rye cover crop can achieve yield consistent with having no cover crop—there was no yield loss due to having the heavy cover.

The highest net return was achieved when not having a cover crop. This was due to much higher costs with the cover crop systems. The three heavy rye cover crop treatments were less expensive in herbicide cost compared to strip-till production without a cover crop. The heavy rye cover did provide savings in herbicide expense, but these savings were more than offset by other costs such as application, cost of the cover crop, and additional nitrogen.

Assuming, on average, no difference in yield, the net return of a cover crop system compared to no cover crop will depend on cost. The herbicide programs for the three heavy rye cover crop treatments in this study and associated cost were very similar to strip-till cotton production with no cover crop. Even with the heavy cover crop and large amount of biomass to suppress emergence and growth of glyphosate-resistant Palmer amaranth, the use of herbicides and amounts applied were similar.

Future research could address methods to reduce the costs associated with cover crop systems such as various cotton herbicide programs, varying seeding rates on the cover crop, and various types of cover crop. Future research could also include any cotton fiber quality differences between no cover crop and having a cover crop.

Variable costs were approximately $70 per acre higher for the three rye cover crop treatments compared to having no cover crop. The least difference in cost was approximately $60 per acre. Compared to having no cover crop, net return averaged approximately $63 per acre less for the three cover crop treatments.

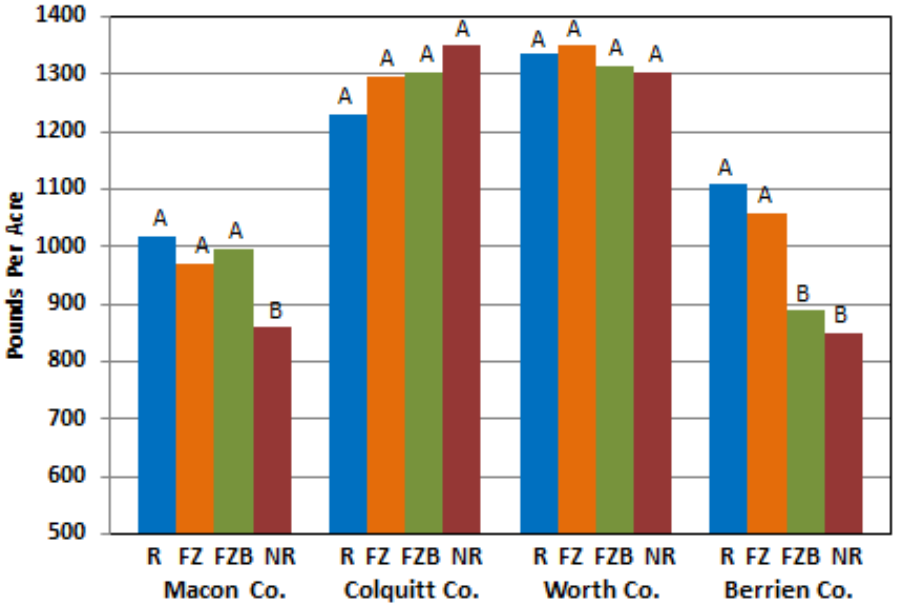

Figure 1. Cotton Yield For Each Treatment, by Location, 2012

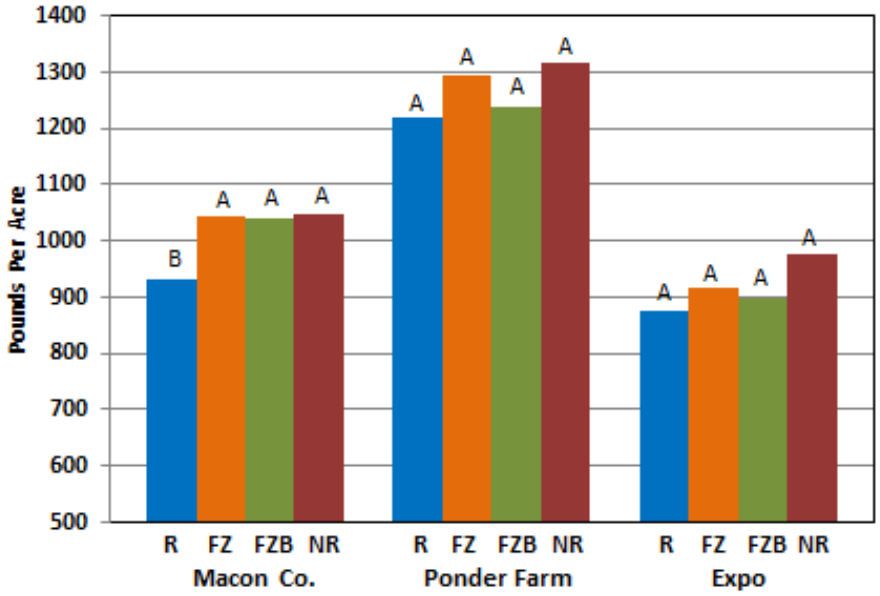

Figure 2. Cotton Yield For Each Treatment, by Location, 2013

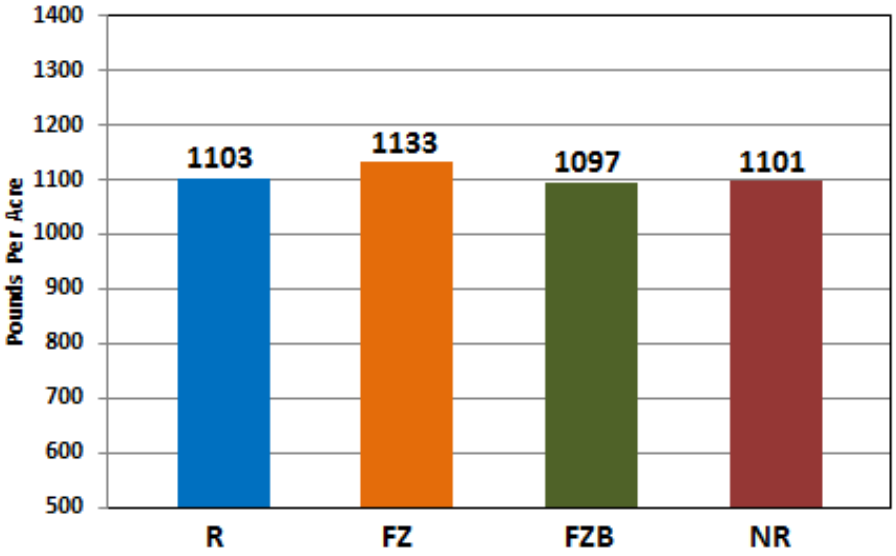

Figure 3. Average Cotton Yield By Treatment, 2012-2013

Acknowledgement

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References

Culpepper, A. S., Kichler, J., and York, A. C. (2013, February). University of Georgia programs for controlling Palmer amaranth in 2013 cotton (Circular 952). Athens, GA: University of Georgia Extension.

Shurley, D., Collins, G., and Whitaker, J. (2013, October 1). 2013 cotton varieties and technologies planted. *Georgia Cotton News.* Retrieved from http://www.ugacotton.com/2013/10/2013-cotton-varieties-and-technologies-planted-in-georgia/.

Shurley, D., and Smith, A. (2013, March). 2013 Georgia cotton costs and return budget estimates. *Georgia Cotton News.* Retrieved from http://www.ugacotton.com/budgets/.

USDA, AMS, Cotton and Tobacco Program. (2012, December). November 2012. *Cotton Price Statistics,* 94(4). Retrieved from http://search.ams.usda.gov/mndms/2012/12/CN20121204MCPS.PDF/.

USDA, AMS, Cotton and Tobacco Program. (2013, December). November 2013. *Cotton Price Statistics,* 95(4). Retrieved from http://search.ams.usda.gov/mndms/2013/12/CN20131204MCPS.PDF/.