Increasing Farm Sustainability through the Use of Cover Crops for Weed Suppression in Non-Transgenic Conventional Cotton

Final Report for OS04-020

Project Type: On-Farm Research
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Region: Southern
State: Georgia
Principal Investigator:

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Project Information

Abstract:

The project spans a two year growing season in Hawkinsville, Georgia. In both years the cooperating farmers were asked to plant Black Oats as a cover crop in a conservation tillage system for the purposes of controlling weeds. Three farms were used in the research with each farm having two treatments each and one farm having three treatments. Two farms had treatments where herbicide was applied at a standard rate and timing to control weeds and one treatment where herbicide was applied at a level that would be determined to be economically detrimental to the farmer. One of these farms also had a control treatment where no herbicide was applied. These farms planted a conventional non-transgenic variety cotton. The third farm planted a genetically modified cotton seed and had the same herbicide treatments as the other two farms. During the growing season, weed populations were monitored in each plot. At harvest samples from each plot was collected and analyzed for typical cotton parameters. Analysis of the weed populations across the two years indicated there were treatments that had significant increases or decreases in weed populations that was independent of the treatment. In all treatments except one, the average wed population was less than 3500 weeds per acre. The plots where conservation tillage had been used for 10 plus years had average weed populations of less than 1000 per acre except one treatment where the grass covered the entire plot from planting. The plots where genetically modified cotton was planted had the least number of weeds per acre, but were not significantly different from that of the ten plus year conservation tillage plots with conventional cotton planted. Lint yield from the conventional cotton on ten plus year conservation tillage land verses modified cotton on conservation tillage land showed no significant difference across the two years. However, there was a difference between treatments when the two year average was compared. A complete economic analysis was not conducted, but based on the yield of each plot and the input cost, the use of conventional cotton seed would be more economical than the use of genetically modified seed. However, prior to planting the test plots for a third

year, the conventional seed provider stated that the supply of seed was very limited thereby leading to only one test plot being planted.

Tables, figures or graphs mentioned in this report are on file in the Southern SARE office.
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Introduction

Increasing sustainability of farm operations will require that natural means of weed suppression be incorporated into the farming operation. One alternative is the proper use of cover crops. Cover crops not only supply nutrients (e.g. legumes fix nitrogen and cereal crops recycle nutrients), but also break pest cycles, provide needed soil organic matter, increase available water, and help suppress weeds. Proper use of cover crops may not totally eliminate the use of chemicals, but any reductions will lower the overhead and maintenance cost incurred by the farmer. Prior to transgenic varieties, the difficulty of handling high residue restricted farmers from using cover crops to control weeds and build soil ecosystems. However, improvements in planting equipment now allows the farmer to successfully incorporate high residue cover crops into their farming operation. Additionally, many farmers believe that conventional cotton produces better quality lint over than that of transgenic varieties. Data shows that since the inception of RR cotton, most characteristics used to measure the quality of cotton have been in a range that reduces the price that a farmer can receive for a bale of cotton (Steve Brown, 2003). Drought conditions since the introduction of transgenic varieties may have stressed the cotton thereby lowering the quality of transgenic varieties. This point further increases the need to use a conventional variety of cotton with high residue producing cover crops. If the quality of conventional and transgenic cotton varieties are similar in non-drought years, the use of conventional cotton with cover crops as the means of weed suppression would allow the farmer to be a better environmental steward and potentially be more profitable.

Transgenic cotton including the Round-Up (RR) varieties first appeared in 1997 and now occupies approximately 90% of the cotton planted in Georgia and the other southern states. Within Georgia alone reduced tillage systems are used on approximately 600,000 acres. There is concern that continued reliance on RR cotton will create weed species with resistance to glyphosate (actual Round-Up chemical). Resistant weed species may require potentially more toxic herbicides to be used or growers will have to revert back to using plowing methods as a means of weed control. Either method of weed control will be detrimental in making these southern farms sustainable systems. Therefore the farmer needs an alternative method of weed control other than transgenic cotton varieties which relies or encourages over use of glyphosate.

Project Objectives:

To demonstrate if a Black Oats cover crop can be used and how effective the cover is in suppressing weed pressure in a conservation tillage system. Additionally the research will compare yield and quality differences in non-GMO modified and GMO cotton.

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Research

Materials and methods:

The research objective as stated above was to use Black Oats as a cover crop to suppress weed pressure in conservation tillage systems. The plots were divided into seven treatments across three farms as shown in Figure 1. To complete the objective stated above, the project was divided into three different parts: 1) planting and analyzing the cover crop biomass, 2) monitoring and measuring weed populations in the treatments, and 3) harvest and compare yields from each treatment.

The project spans a two year growing season in Hawkinsville, Georgia. In both years the cooperating farmers were asked to plant Black Oats as a cover crop in a

conservation tillage system for the purposes of controlling weeds. Three farms were used in the research with each farm having two treatments each and one farm having three treatments. Two farms had treatments where herbicide was applied at a standard rate and timing to control weeds and one treatment where herbicide was applied at a level that would be determined to be economically detrimental to the farmer. One of these farms also had a control treatment where no herbicide was applied. These farms planted a conventional non-transgenic variety cotton. The third farm planted a genetically modified cotton seed and had the same herbicide treatments as the other two farms. During the growing season, weed populations were monitored in each plot. At harvest samples from each plot was collected and analyzed for typical cotton parameters. Analysis of the weed populations across the two years indicated there were treatments that had significant increases or decreases in weed populations that was independent of the treatment. In all treatments except one, the average wed population was less than 3500 weeds per acre. The plots where conservation tillage had been used for 10 plus years had average weed populations of less than 1000 per acre except one treatment where the grass covered the entire plot from planting. The plots where genetically modified cotton was planted had the least number of weeds per acre, but were not significantly different from that of the ten plus year conservation tillage plots with conventional cotton planted. Lint yield from the conventional cotton on ten plus year conservation tillage land verses modified cotton on conservation tillage land showed no significant difference across the two years. However, there was a difference between treatments when the two year average was compared. A complete economic analysis was not conducted, but based on the yield of each plot and the input cost, the use of conventional cotton seed would be more economical than the use of genetically modified seed. However, prior to planting the test plots for a third year, the conventional seed provider stated that the supply of seed was very limited thereby leading to only one test plot being planted.

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Planting and analysis of cover crop:
The black oats were planted as soon after the previous commercial crop was harvested as possible. This was in the middle to late November in both study years. The oats were planted at a rate of approximately 1 bushel per acre across all treatments. No irrigation was used to establish the stand in that there was ample moisture both years to get a good stand of oats. Nitrogen fertilizer was used in the second growing season to try and increase the cover crop biomass. Prior to planting the commercial crop, random samples of the cover crop was collected and analyzed for total biomass on a dry bases.

Monitoring and measuring weed biomass:
Monitoring and measuring weed biomass was facilitated by dividing each treatment into three sections to be used as replications of the treatment. Weed populations were measured every other week from planting to either harvest or a point where the farmer decided that no yield was possible. To ensure that sample collection was not biased due to the amount of weeds, a random grid was established prior to the first sampling date and was maintained through out the growing season. To better accomplish this each replication within each treatment was divided into 10 blocks and 9 sections within each block. A block and section design is shown on the data sheet located in the appendix to this report along with a copy of the random number generator results used for sampling. The weeds were sampled by locating the randomly selected Block and Section, standing at the corner of the section and

tossing a 1/10th square meter square into the section. The number of weeds were then counted and noted on the data sheet. This was repeated in all selected Blocks and Sections. The same random numbers were used for all treatments for a given date. The data was then entered into a spreadsheet fro better data management and analysis. If the 1/10th square meter waas completely filled with a weed a value of 50 was entered, otherwise the number of weeds was entered based on the number of stems not vines.

Harvest and compare yields from each treatment:
During harvest of the cotton, the replications were harvested separately, weighted and a sample collected for quality analysis. The weights were measured through the use of scales placed under the wheels and tongue of a boll buggy. The analysis consisted of the standard tests (i.e. Gin turnout, mic, elongation, strength, uniformity, length, rd, b, and color grade). These values were entered into a spreadsheet and analyzed for differences. Results can be seen in the Results and Discussion Section below.

Research results and discussion:

Results

Planting and analysis of cover crop:
Biomass collected from each treatment varied from a low of 7400 kg ha-1 to 35900 kg ha-1. This low and high was located on the same field in different treatments. The data collected from the treatments can be seen in Table 1.

As can be seen in the data, there is no pattern to the amount of biomass produced across treatments. The amount of cover crop biomass can be related to the climate and during both growing seasons there were hard cold snaps that may have effected the growth of the oats. It was also observed from the measurements and comparison to the rye (see Table 1) the oats did not grow as well. This could be the natural growth pattern for oats in this climate or we may have had two bad growing seasons. From this research, it would be suggested that rye be used based on the biomass samples collected from the same farm as treatment 4 and 5. Another note is that rye is currently cheaper than the oats and from this research produces more biomass at time of commercial crop planting.

Table 1: Cover Crop Biomass collected from treatment plots.

Treatment:	2005 Biomass (kg ha-1)	2006 Biomass (kg ha-1)
T1	15400	5800
T2	16600	15800
T3	14200	9300
T4	10300	19000
T5	8300	24300
T6	35900	26000
T7	7400	27000

Monitoring and measuring weed biomass:
The weed population varied from treatment to treatment with a significant difference in only one treatment across years. This treatment was the no-herbicide treatment on the farm that had been using the conservation tillage system for ten plus years. In the first year of the study, the number of weeds was no different from that of the farm using round-up ready cotton, but was significantly different from the farm that had only been using conservation tillage with weeds as a cover crop. The weeds that were present in the first year on the T4 and T5 farm was mainly pigweed

with some morning glory and grass. In the second year, the treatment 5 plot, the grass formed a complete mat even prior to the cotton emerging. I was the decision of the farmer, county agent and the project director to just watch the plot to see how quickly the grass would grow. After a couple of weeks, the farmer noted that he had not seen that type grass in his fields before and was wondering if the problem steamed from the oat seeds or if the grass was there previously and just had not emerged. Therefore, in can be seen in Figure 2 that the number of weeds is shown as 500 per m2 in T4, but most of that was grass that covered the whole sampling area and the 50 per 1/10th square meter was noted so as to not overpower the other data on the graph. Likewise, on T1, T2 and T3 for both years the weeds were hard to control and a majority of the weeds were pigweed. The farmer in year one mowed the plots once he decided he has lost the complete crop and in the second year, we stopped the test at a point that he determined the amount of pigweed specifically had reached a point that the yield from any one of the plots would be less than the cost of harvesting the cotton, so he again mowed the plots prior to us knowing he had mowed them.

Overall, the T1, T2 and T3 plots that had winter weeds as a cover crop prior to planting a commercial crop, even with the addition of black oats for two years, were hard to manage and ultimately resulted in the test being so overcome with weeds that the harvest would have cost more than the return from the sale of the cotton. The major weed in both years in the control, no herbicide use and a threshold application was pigweed with some morning glory and grasses. With the reduced herbicide application, the soil was system was not able to suppress the weeds and some of the pigweed reached heights of at least 6 feet and had diameters at the soil surface of approximately 3 inches. This made it impossible for the cotton to grow and the cotton picker to pass through the plots. In T4 and T5, the continual use of conservation tillage with high biomass at time of planting appears to have had some impact on the suppression of weeds. The fact that in the second year of T4 the grass overtook the plots can not be explained by the research team (Figure 3). However, T5 performed as well as T6 and T7, which used a cover crop and round-up ready cotton seed, on suppressing the weed population.

Figure 2. Weed population per square meter in given treatment.

Figure 3. Weeds in Treatment 4 (2006). The cotton plants that did germinate were quickly taken over by the weeds 9mainly grass) and the plots were mowed shortly after this picture was taken.

Harvest and compare yields from each treatment:
The average lint yields from each treatment can be seen in Figure 4. As can be seen, the regular use of herbicides on T5 helped the plants yield more than T4. Both treatments were planted on land that had been in conservation tillage for ten plus years and the use of herbicides, the older chemistry in this case, has a significant difference on the yield. These chemicals allow the planting of a convention non-transgenic cotton, but still requires a regular spray pattern. It was also suggested by the County Extension Agent and co-project director that the use of a pre-emergence herbicide can have large benefits on controlling and suppressing weeds, thereby reducing the amount of herbicides needed in the growing season. The lint yield in the conventional cotton was not significantly different from that of the genetically modified cotton.
This equal or greater lint yield is good for the farmer in that the yield is just as high, the cost of the herbicide may not be different, but the seed for the genetically modified seed at the time this was written was as high as 5 times more per bag than the conventional seed. This would lead to potentially being a larger profit or less out of pocket costs for the farmer. However, our cooperating seed dealer stated that the

amount of conventional seed was low to non-existent in 2007 and is expected to be that way in the future.

Figure 4. Cover crop biomass collected from treatment plots prior to planting. Values are presented in kg m-2.

Participation Summary

Educational & Outreach Activities

PARTICIPATION SUMMARY:

Education/outreach description:

Outreach as related to this research has been to sponsor 10 farmers to attend the annual Conservation Tillage Conference as well as helping sponsor the conference itself. One field day has also been conducted to share the results of the first years data and a second field day will be scheduled with the county extension agent and project co-director.
Publications from this research should consist of at least one poster to be presented at the annual Georgia County Agents meeting and a research paper. There may also be a presentation at the annual conservation tillage conference and some newsletter articles.

Project Outcomes

Project outcomes:

The impacts of this research could potentially prove to be valuable in providing the farmer with a less costly seed while providing an equal or comparable yield as compared to genetically modified cotton seed. However, as stated above the supply of conventional seed is scarce thereby making the information gained from this research less important. One potential advantage and impact to the results of this research is that there will be some answers to questions if conventional cotton is put back into production due to the emerging resistance of pigweed to glyphosate. This problem is not wide spread, but if it becomes more of a problem the use of conventional cotton may become more widely accepted and the results of this research could be very important and will have a wide spread impact.

Farmer Adoption

Farmers involved in the research and those in the surrounding area were interested in the use of conventional cotton, but with the limited supply of cotton seeds they will not be able to use this in the near future. However, if conventional seed production is increased in the future, they may and would be expected to seriously consider the use of these seeds. Concerning the oats, with the current cost of the seed and the poor performance we saw in this research, it is not expected that farmers will widely adopt the use of the oats seed for cover since rye provides a higher biomass at less cost, thereby making the system more sustainable.

Recommendations:

Areas needing additional study

Additional Study

If conventional seed were available, then I think this research could be and should be repeated with rye cover crop and perform a more extensive cost analysis on the system. Other research that should be studied is the use of a residual pre-emergence herbicide in conjunction with a high biomass cover crop.