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INFLUENCE OF CONSERVATION TILLAGE AND COVER CROPS ON SOIL MOISTURE AND LEAF COTTON TEMPERATURE

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Abstract

Soil compaction can reduce cotton yields by restricting root development necessary for nutrient and water uptake. This condition can be partially avoided by maintaining or improving soil organic matter content. Many soils in central Alabama have hard pans within the top 12 inches of soil, intensified by low organic matter contents. A field experiment was started in fall 2003 to evaluate a factorial treatment combination of conservation tillage systems (no tillage, fall paratill, spring paratill, and spring strip tillage) and winter cover crops (no cover, rye, and wheat) that might increase organic matter content and soil moisture availability, reduce soil compaction, while improving cotton profitability. Soil moisture was monitored to a depth of 12 inches every 15 minutes during the growing season. Cotton leaf temperature was determined in the uppermost fully extended leaf with an infra-red thermometer five times during the fruiting period. First year results show that cover crops increased soil moisture content and reduced leaf temperature, which translated into increased lint yields when compared with the no cover treatment.

Introduction

Soil compaction can reduce cotton (*Gossypium hirsutum* L.) yields by restricting root development. A healthy root system is necessary for adequate nutrient and water uptake. Compaction can be partially avoided by maintaining or improving soil organic matter content. A survey of cotton fields conducted by Kuykendall et al. (2002) in 2001 found that many fields in central Alabama had soil compaction problems. Many of these soils had hard pans within the top 12 inches. These traffic pans are most likely created by tillage operations, and are generally located at the bottom of the plow layer. These hard pan layers reduce the downward flow of water and limit root growth. During this survey, it was also noted that soils with frequent compaction problems usually had low organic matter contents. Soil organic matter improves soil physical properties, such as infiltration, structure, water retention and others.

Winter cover crops can be used to increase soil organic matter. Cover crops, such as rye (*Secale cereale* L.) and wheat (*Triticum aestivum* L.), can be sown in the Fall and terminated 2 to 3 weeks prior to planting cotton. Biomass produced by the cover crop during the winter months is usually rolled down to form a mat and left on the soil surface. This mat protects the soil from water and wind erosion, and increases soil organic matter content as it decomposes. Cover crops can also increase water infiltration since it reduces soil crust formation and decomposing roots create channels where water can infiltrate. However, for organic matter to accumulate, the soil must not be disturbed. For this reason, some kind of non-inversion tillage is needed to minimize disturbance of surface soil while breaking up hard pans below ground.

The objective of this study is to evaluate a combination of conservation tillage systems and winter cover crops to increase organic matter content, soil moisture availability and reduce soil compaction, while improving cotton profitability.

Materials and Methods

A field experiment was started in fall 2003 at the Prattville Agricultural Research Unit of the Alabama Agricultural Experiment Station (AAES) in Prattville, AL. A factorial treatment combination of conservation tillage systems (no-till, fall paratill, spring paratill, and spring strip-till) and winter cover crops (no cover, rye, and wheat) was established on a Lucedale fine sandy loam soil (fine-loamy, siliceous, thermic Arenic Paleudult). Cover crops were planted on Nov. 23, 2003 at a seeding rate of 1.5 bu/ac. The cover crops were terminated 3 weeks prior to cotton planting and a roller was used to lay down the cover reside to facilitate planting. Cotton (Stoneville 5242 BR) was planted May 11, 2004. Applied fertilizer included 30 lb N/ac to both cover crops and 90 lb N/ac to cotton.

Soil moisture was monitored every 15 minutes between 12 and 16 inches of depth in-row below the soil surface during the growing season. Cotton leaf temperature was determined in the uppermost fully extended leaf with an infra-red thermometer five times during the fruiting period.

Results

Cover crops had approximately 20 weeks for growing during the winter months. Rye produced considerable more biomass than wheat (Table 1). It appears that the greater biomass production had an impact on soil moisture availability and cotton leaf temperature. Although the growing season was not a dry one, the additional moisture and other benefits of the cover crops increased cotton yield.

Table 1. Biomass produced by winter cover crops.

Cover Crop	Biomass
	--- lb/ac ---
None	n/a
Rye	4,607
Wheat	3,287

Soil water content was lower during most of the growing season in the no-till plots, when compared to fall paratill and spring strip-till (Fig. 1). This may be attributed to less infiltration associated with a lack of below ground disruption in the no-till plots. Soil moisture was lowest for the spring paratill treatment. There is some evidence that a slot is created in the ground after paratilling. This slot can remain intact for a considerable period of time, causing water to preferentially infiltrate into the ground. Because of the location of the soil moisture sensor in relation to the paratill slot, rainfall water was able to infiltrate by-passing the sensor. The problem was not observed with the fall paratill because some reconsolidation of the soil profile probably occurred during the winter.

Winter cover crop had a significant effect on soil water content (Fig. 1). Soil moisture in plots with rye or wheat as a winter cover was about 5% greater than in those with no winter cover. This increase in soil water content helped improve cotton lint yields. Greater differences in yield could be expected in drier years.

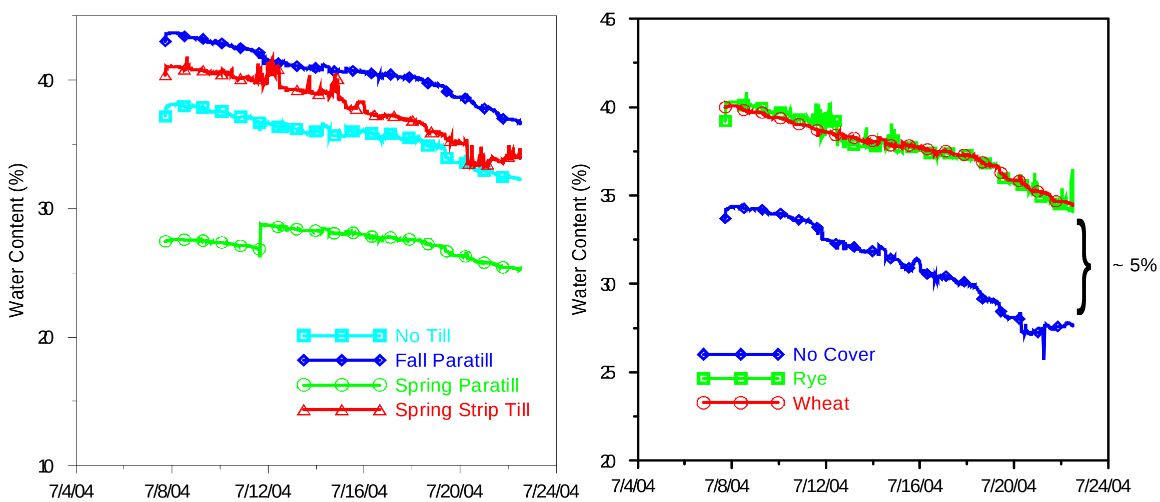

Figure 1. Soil water content as affected by cover crop and tillage treatments (main effects).

Temperature of the uppermost fully extended leaf served as an indicator of plant water stress, with higher temperatures indicating more stress than lower temperatures (Fig. 2). Similar to soil water content, there were no major differences in leaf temperature between tillage treatments. However, leaf temperatures were lower most of the time from cotton plants growing in cover crop residue, especially rye.

There were no significant differences in lint yield between tillage treatments (Fig. 3). However, there was a slight increase in yield with the paratill. Winter cover crop had a significant effect on lint yield, with rye producing the greatest yields. Wheat also increased yield, but not as much as rye. This could be attributed to the larger amount of biomass produced by the rye.

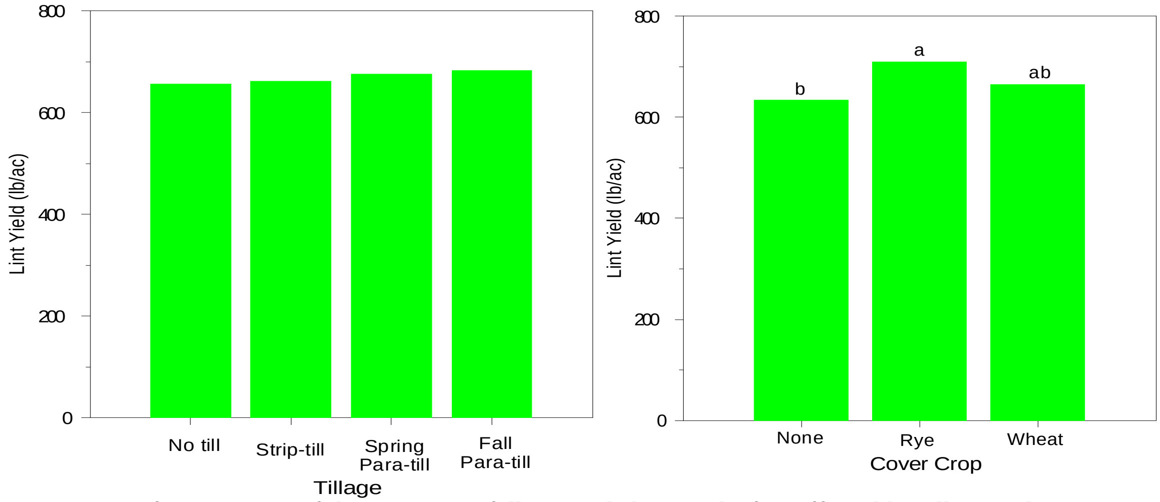

Figure 2. Leaf temperature of the uppermost fully extended cotton leaf as affected by tillage and cover crop treatments (main effects).

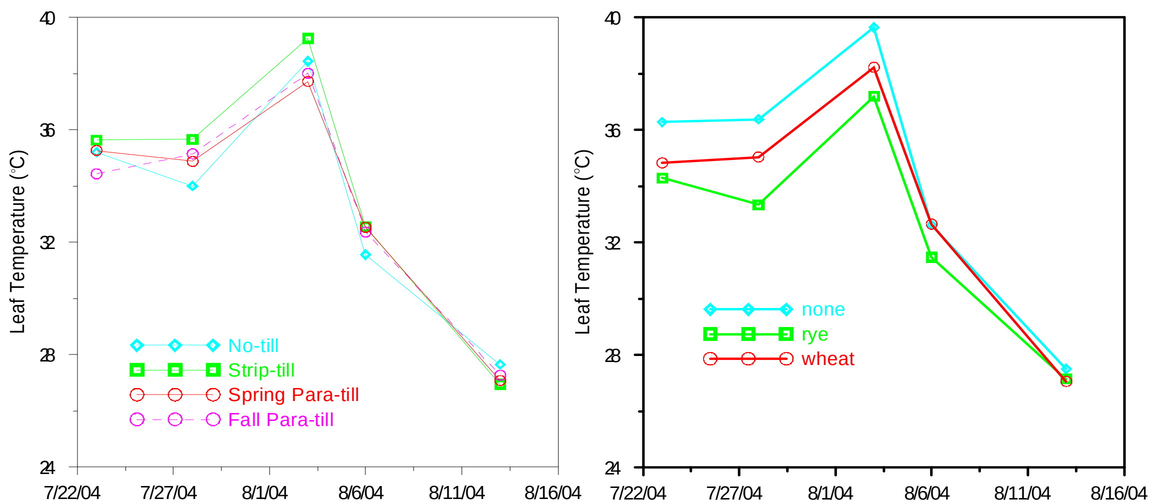

Figure 3. Cotton lint yields as affected by tillage and cover crop treatments during the 2004 season (main effects).

Conclusions

Preliminary results of this work (first year data) show that tillage did not seem to have an effect on lint yield or leaf temperature. However, cover crops increased soil moisture content and decreased leaf temperature. Both cover crops increased lint yields, with this increase being significant with rye. Data from future years of this experiment should help explain in more detail the effect of these tillage and cover crop practices, and determine if they are beneficial for these compaction susceptible soils.

References

Kuykendall, L., R.R. Beauchamp, and C.C. Mitchell. 2002. Changes in central Alabama cotton soil management, 1991and 2001. Beltwide Cotton Conference 2002, Atlanta, Georgia.

Disclaimer

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