Soil Moisture and Cotton Leaf Temperature in Conservation Systems

Francisco J. Arriaga, Kipling S. Balkcom, and Randy Raper
USDA-ARS, National Soil Dynamics Laboratory
411 S. Donahue Drive, Auburn AL 36832
farriaga@ars.usda.gov

Abstract

Cotton (*Gossypium hirsutum* L.) yields are typically reduced by soil compaction due to reduced root development. Soil compaction is usually a concern in soils with low soil organic matter content. A survey conducted in 2002 revealed that many soils in central Alabama have hard pans within the top 12 inches of soil, and these soils also had low organic matter contents. In the fall 2003 a field experiment was started to determine the potential of conservation tillage systems (no tillage, fall paratill, spring paratill, and spring strip tillage) and winter cover crops (no cover, rye, and wheat) to reduce soil compaction, increase soil organic matter content and moisture availability. Soil moisture was monitored continuously during the growing season to a depth of 12 inches. An infrared thermometer was used to determine cotton leaf temperature of the uppermost fully extended leaf during the fruiting period. Cover crops increased soil moisture contents, reduced leaf temperature, and increased lint yields when compared to the no cover treatment.

Summary

Cotton yields can be depressed by soil compaction. Compaction restricts root development, reducing the ability of plants to obtain nutrients and uptake water. Soil organic matter can help reduce compaction. Many fields in central Alabama have soil compaction problems, with hard pans present in the top 12 inches. In all likelihood, these are trafficpans created by tillage operations since they are typically located at the bottom of the plow layer. Nevertheless, these layers usually affect water movement and limit root growth. Soils in this region of Alabama with compaction problems frequently have low organic matter contents.

Soil organic matter content can be increased with the use of winter cover crops, such as rye (*Secale cereale* L.) and wheat (*Triticum aestivum* L.). The cover crop is usually rolled in the spring to form a mat and left on the soil surface. This plant residue protects the soil from erosion and increases soil organic matter content as it decomposes. Increases in organic matter will improve soil physical properties over time. Water infiltration can also increase since cover crops reduce soil surface crusting. Also, decomposing roots create channels into which water can infiltrate. Further, non-inversion tillage systems can reduce soil surface disturbances while promoting organic matter accumulation and eliminate below-ground hard pans. Therefore, 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 production.

The study was initiated in fall 2003 at the Prattville Agricultural Research Unit of the Alabama Agricultural Experiment Station (AAES) in Prattville, AL. The soil at the site is a Lucedale fine sandy loam soil (fine-loamy, siliceous, thermic Arenic Paleudult). A factorial treatment arrangement with four conservation tillage systems (no-till, fall paratill, spring paratill, and spring strip-till) and three winter cover crops (no cover, rye, and wheat) was established. All cover crops were planted on 23 Nov. 2003 at a seeding rate of 1.5 bu/ac. Three weeks prior to planting, the cover crops were chemically terminated and rolled to facilitate planting operations. Cotton was planted on 11 May 2004. Soil moisture was monitored in-row during the growing season between 12- and 16-in of depth. An infrared thermometer was used to determine cotton leaf temperature of the uppermost fully extended leaf five times during the fruiting period. Temperature of the uppermost fully extended leaf can serve as an indicator of plant water stress, with higher temperatures indicating more stress than lower temperatures

Biomass production was greater with rye (4,607 lb/ac) than wheat (3,287 lb/ac). However, both cover crops increased soil moisture about 5% during most of the growing season when compared to the no cover treatment. Additionally, leaf temperatures were reduced with cover crops, with the lowest temperatures recorded in the rye, followed by wheat. Lint yields were significantly affected by the winter cover crops, with rye (709 lb/ac) producing the greatest yields followed by wheat (665 lb/ac). However, greater differences in yield due to cover crop use could be expected in drier years.

Soil water content in the no-till treatment was lower for most of the season when compared to fall paratill and spring strip-till. Below-ground soil disruptions usually aids infiltration and soil water redistribution compared to no-till, especially in soils with hard pans. However, soil moisture was lowest for the spring paratill treatment, but this was most likely caused by the location of the moisture sensor and time of tillage. After paratilling, a slot is created which can remain intact for a considerable period of time. This slot can create preferential water movement. The location of the soil moisture sensor in relation to the paratill slot allowed rainfall water to move into the soil bypassing the sensor. This was not observed with the fall paratill because some reconsolidation of the soil profile probably occurred during the winter. This is supported by yield data, since there were no significant differences in lint yield between tillage treatments (655, 662, 676, and 683 lb/ac, for no-till, strip till, spring paratill, and fall paratill, respectively). Additionally, there were no major differences in cotton leaf temperature among the four tillage treatments.

First-year data showed no effect of tillage on leaf temperature and lint yield. However, rye and wheat increased soil moisture content and decreased leaf temperature. These translated to increased lint yields, with the increase being significant with rye. As work continues on this study, future data should help determine which tillage and cover crop practices are beneficial for these degraded soils.