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COVER CROP EFFECTS ON LIMITED-IRRIGATION COTTON GROWN ON A COASTAL PLAIN SOIL

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Abstract

Conservation tillage is used in less than 30% of the cotton grown in Georgia. Although conservation tillage acreage has increased with the adoption of herbicide resistant varieties, use of cover crops is limited. The objective of this study was to evaluate the effects of tillage (strip-till vs. no-till) and cover crops [Austrian winter pea (*Pisum sativum* L. ssp. *arvense* (L.) Poir), balansa clover (*Trifolium michelianum* Savi), crimson clover (Trifolium incarnatum L.), hairy vetch (*Vicia villosa* Roth), oil seed radish (*Raphanus sativus* L.), black oat (*Avena strigosa* Schreb), and rye (*Secale cereale* L)] on cotton production. The study was conducted on a Bonifay fine sand near Waynesboro Georgia. Three years of the cover crop evaluation showed that rye provides a consistent and useful amount of cover on these droughty soils, which thereby helps to increase soil water availability and lower soil temperatures during the early period of cotton establishment. Black oats, Austrian winter pea, oilseed radish, and hairy vetch produced less biomass but provided adequate soil cover. Balansa clover and crimson clover did not grow well in these sandy soils. Strip tillage resulted in greater yields than no-till two out of the three years.

Introduction

Of the almost 1.5 million acres of cotton planted in Georgia in 2000 less than 25% was grown under conservation tillage (CTIC, 2002). Keeping residues on the soil surface through reduced tillage can help conserve soil water by reducing solar radiation and wind effects on evaporation and enhancing soil properties associated with infiltration. Strip tillage, in 10 to 16 inch wide strips ahead of planters, is a preferred conservation practice in Georgia cotton. Crop water use is more efficient in strip-tilled soil than in conventional tilled soil and the effect can increase cotton production up to 35% (Lascano et al., 1994) and water availability is usually increased with surface residue cover. During peak bloom, cotton uses 0.3 to 0.4 inches of water per day and an increase of 200 to 700 lb per acre can be obtained with application of irrigation on Coastal Plain soils (Gaucho et al., 1999). Hares and Novak (1992) found no difference in soil temperatures between conventional tillage soil and soil within strip-tillage strips during early spring.

Cover crops provide an effective means for protecting soils from erosive forces of wind and water. In the southeast, cover crops can also help restore soil organic matter levels and restore soil productivity. Response to cover crops in conservation tillage systems can be variable. Bauer and Busscher (1996) reported greater cotton yields with a rye cover crop than with legumes or fallow in conservation tillage but in conventional tillage yields were not different among cover treatments. These results indicate the site and management specific differences that can be obtained with conservation tillage and cover crop systems.

This research report presents results from an ongoing project designed to evaluate: 1) effects of seven cover crops and winter weeds on cotton grown with limited irrigation, 2) differences in response to cover crops between strip tillage and no-tillage and 3) effects of conservation management systems on changes in soil physical, chemical and biological properties.

Materials and Methods

Cover Crop and Tillage Evaluation

The study was initiated in fall of 1999 at the Central Savannah River Area Conservation Tillage Demonstration Farm near Waynesboro, GA on a Bonafay fine sand (1 to 3% slope). The experimental design was a split-plot randomized block with three replications of eight cover crop-tillage combinations. The cover crops rye, black oats, oilseed radish, crimson clover, hairy vetch, Austrian winter pea, and balansa clover are established each fall. An additional no-cover (winter weeds) treatment was added to the study in fall of 2000.

Cover crops are planted using a no-till grain drill (15 ft wide, 7 ½ inch rows) on plots 60 ft wide by 75 ft long. Plots were split for cotton planting which provides 12 rows (35 ft X 60 ft long) for each tillage treatment (strip till and no-till). Strip-tillage plots are planted with a 4-row (38") in-row chisel (16 inches) planter that produces a tilled strip 14 inches wide. The no-till plots are planted with a no-till planter without in-row chisel. Irrigation is applied through a center pivot system that spans the length of the study area. Irrigation is controlled manually.

In the spring 2 to 3 weeks before cotton planting, samples for cover crop biomass and percent soil cover are collected. Plant biomass is analyzed for C and N content. Nitrogen availability from the cover crop residues was estimated based on data from Schomberg and Cabrera (2001) and is estimated from the total biomass of the residue and the N concentration. Cotton plant counts are determined three to four weeks after planting. Cotton plant height and biomass are determined during the growing season and prior to harvest. Cotton yield is determined by mechanically picking each sub-plot. Soil temperature and water are measured during the growing season to evaluate residual cover crop effects. Soil C, total N, NO3 and NH4 by depth to 36 inches (0-1, 1-6, 6-12, 12-24, 24-36, inches) is determined each year.

Results and Discussion

Cover Crop Biomass

Differences in cover crop biomass were present due to year and cover crop type as well as a significant interaction effect. Average biomass production is presented in Figure 1. Rye consistently produced more biomass than the other cover crops. Black oat produced a similar amount of biomass as rye in 2000 but less biomass in 2001 and 2002. Balansa clover and crimson clover produced the least amounts of biomass averaging around 1000 lb ac^{-1}. These two clovers can produce significant amounts of biomass in the southeast but apparently are not well suited for these sandy soils. Hairy vetch, Austrian winter pea, and oil seed radish provided more biomass than crimson clover and balansa clover. Late planting in 2001 and 2002 probably reduced yields on the cover crops for those years, however dry weather also was a contributing factor to limited biomass production in the spring. The weed plot biomass was inadequate to produce greater than 30 % soil cover required for the definition of conservation tillage practices.

Cover Crop Nitrogen

Nitrogen content was greater in 2000 than in 2001 and 2002. Nitrogen contents of the cover crops averaged for the three years are presented in Figure 2. In 2000, residue N amount was greatest for hairy vetch followed by Austrian winter pea, black oat, and oil seed radish. In 2001 and 2002 the amount of N in the cover crops was reduced due to the lower biomass production. The two legumes Austrian winter pea and hairy vetch still produced more than 60 lb N ac^{-1} both years. The other cover crops contained very little N and would not contribute significantly to available N supply for cotton. Nitrogen from the legumes would be available earlier in the cotton-growing season compared to N from rye and black oat. Nitrogen available from Austrian winter pea and hairy vetch averaged around 40 lb ac for the two driest years which indicates that N applications following these two cover crops should be reduced to keep from over fertilizing and causing excessive rank growth. Adjustments for N applications following the other cover crops should be considered in years where significant biomass is produced.

Cotton Yields

Cotton lint yields are presented in Figure 3. Drought reduced yields in each year but were greater in 2000 and 2001 due to the limited amount of water available from irrigation. In both years the irrigation supply was depleted by early July. In 2002, a few rain events allowed watering into late July but the water supply was also depleted during 2002. Cotton yields (lint) were influenced by crop-by-year and tillage-by-year effects. The interaction between tillage and cover crop was not significant. In 2000, there were no significant effects of tillage or cover crops. When yields were averaged across all cover crops, yields were 52 lb ac^{-1} greater with strip tillage compared to no-tillage in 2001. Cotton yield following winter weeds (primarily red sorrel) were very low but because this treatment was added after the study began which placed the plots outside the effective radius of the irrigation rig. Again in 2002 strip tillage plots out yielded no-till plots (643 vs. 567 lb ac^{-1}).

Conclusions

At this point in the study we conclude that strip tillage on these soils results in greater yields. However additional costs associated with strip tillage may limit the profitability compared to no-till. Any of the cover crops except crimson clover and balansa clover could be used on these soils with good results. These two cover crops have not established well over the three years of this study. They appear to be poorly adapted to the droughty conditions that occur in these highly sandy soils. The best cover crop appears to be rye but the legumes hairy vetch and Austrian winter pea may be economically more attractive due to their ability to fix N even under limited water availability.

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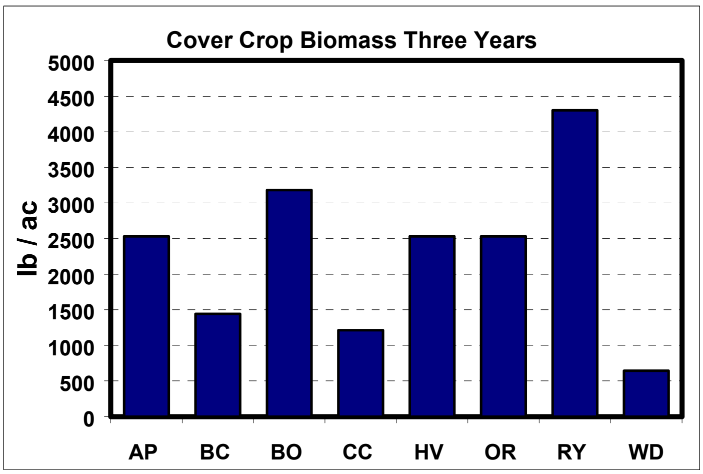

Figure 1. Three year average cover crop biomass production. Cover crops are AP- Austrian winter pea, BC- balansa clover, CC – crimson clover, HV – hairy vetch, OR – Oilseed radish, RY – rye, and WD – weeds (primarily red sorrel).

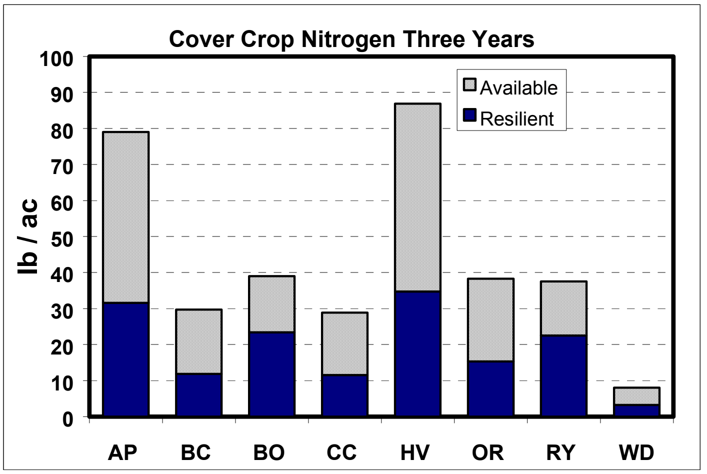

Figure 2. Three year average nitrogen content of cover crops. Cover crop abbreviations as in figure 1.

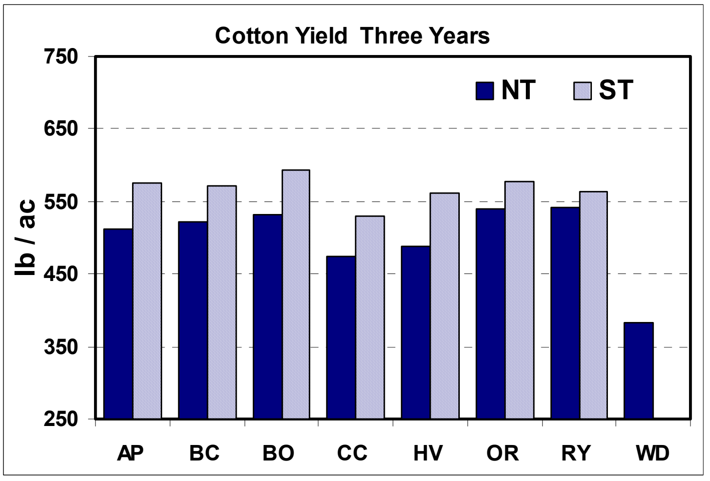

Figure 3. Three-year cotton yields following cover crops and managed using no-tillage (NT) or strip tillage (ST). Cover crop abbreviations as in figure 1.