IMPACTS OF CATTLE ON COTTON IN A BAHIAGRASS/PEANUT/COTTON ROTATION

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Abstract

Agricultural production systems have become more specialized over the last half century all over the U.S. This specialization has had several negative economic, biological, and environmental impacts. Integrating livestock into row crop operations has the potential to reverse the current trends and change the economic and environmental face of agriculture in the Southeast and the U.S. making farms more sustainable with less financial risk to the operation. Currently, some row crop farmers will use row crop land to contract graze winter stocker cattle. However, short season annual grazing has not shown the promise that integrating perennial grasses into row crop systems has using the same land base. Due to the complex nature of these types of studies, components of the perennial grass/livestock/row crop systems in humid environments are slow to be initiated. Our research integrating perennial grasses with row crops on the same land base is the most viable system that we have found for economical, biological, and environmental stewardship. This study begins to address the integrated system and cattle impacts on cotton and peanuts and related soil properties. Cattle traffic on winter grazing following bahiagrass-peanut resulted in higher soil surface (top 15 cm) compaction and bulk density. However, deep soil profile moisture (40-80 cm deep) was higher on the following cotton crop for areas with cattle traffic than the non grazed areas. No differences were noted in plant height or node number. Cotton yield, boll number, or boll size were not impacted by cattle traffic from winter grazing. Petiole nitrate nitrogen in cotton was higher throughout the bloom-maturity period on grazed areas thought to be due to N cycling with cattle.

Introduction

Farming has changed dramatically since the early 1950's. This was the period of transition from manual labor and horses to tractors and other mechanized equipment. Farms were more diverse prior to 1950's with cattle, hogs, horses, smaller acreage, and most commodities were sold locally or used on farm (Sulc and Tracy, 2007). Nutrients were often recycled on farms with manure or low rates of low analysis fertilizers being the norm (Dimitri et al., 2005). Since 1950, with a trend toward specialized crops, farm size has increased, the number of farms has declined, agricultural markets have become more international in scope, producers rely more on high analysis mineral fertilizers with no livestock to recycle nutrients, and government payments underpin commodity prices. Dimitri et al., 2005 reported a decrease in the number of commodities produced on farms from an average of five per farm in 1990 to less than two in 2002.

Rise in international commodity markets, high prices, and mechanization resulted in the use of short term rotations, annual cropping systems and the loss of livestock and diversification on farms in many parts of the U.S. The high prices for soybeans in the early 1970's were economically successful but took a lot of livestock out of the Southeast with fences being torn down to make room for larger equipment and larger fields. During this period there was dramatic growth in farm output on U.S. farms. When soybean prices fell in the 1980's about 80% of the row crops land was rented. Growers compensated for lower prices by renting more land and were not interested in building fences on landlord's farms to bring livestock back or diversify in other ways. As prices for soybeans and corn continued to decline growers looked to other row crops to fill in the gap. In the Southeast, corn and soybean were replaced with cotton and peanut based on price and crop insurance potential if crops failed. From the late 1990's to 2006, row crops were only marginally profitable even with high yields. This led to more growers leaving the business and other farmers using larger equipment. This short term rotation of annual crops has led to negative impacts to the environmental including: loss of soil organic matter (Kefyalew, et al., 2007); degradation of soil physical characteristics and increased soil erosion (Bullock, 1992, Karlen, et al., 1994b); surface and groundwater contamination (Karlen, et al., 1994b); an increase of pests, nematodes, diseases, weeds, insects, etc. (Katsvairo, et al., 2006); and an increase in greenhouse gasses (Lal et al., 1999). One method of alleviating many of the problems is integration of perennial grasses and livestock with row crops on the same land base. Pastures and livestock integrated with row crops has had limited attention by researchers in the U.S. In Florida, continuous cropping systems using conservation tillage techniques, has been compared to row crop/pasture rotations and have been shown to be more economically and climatically buffered due to their higher diversity, and were more environmentally sustainable since fuel and pesticide usage was 50% lower. Soil organic matter content has been shown to increase about 0.1% per year with perennial grasses/row crops as compared to simple annual crop rotations using conservation tillage.

Our objectives were to determine the impact of cattle traffic on soil properties and the cotton crop when grown in a livestock/perennial grass/row crop system using conservation tillage techniques and winter covers either grazed or not grazed.

Materials and Methods

A large scale rotation project of 2 years of bahiagrass followed by peanut/winter grazing and then cotton/winter grazing was initiated to determine the impacts of cattle traffic from a cow/calf operation on the following cotton crop. Crops grown in each of the quadrants in the rotation were bahiagrass-bahiagrass-peanut-cotton (B-B-P-C). Winter grazing is planted after both cotton and peanut. The study is under a 139 acre variable rate center pivot irrigation system with dry corners amounting to 40 acres in each quadrant. Three large exclusion areas, 16X16 meters square, were fenced off in the rotation scheme where cattle traffic was never allowed in the areas of bahiagrass, or winter grazing behind cotton or peanut. However, other normal agricultural operations such as cutting hay, winter grazing, or row crop planting were allowed and fences taken down for these operations. All crops were planted with no-till or conservation tillage methods. Areas outside exclusion cages were designated for similar measurements as within the cages. Plots were mapped with GPS coordinates so that fences could be erected in the same location after each crop sequence. Soil resistance measurements were made with a had held recording penetrometer and soil samples taken at different depths from the 3 exclusion cages for bulk density and soil moisture measurements. Likewise, plant height and node numbers, leaf chlorophyll and petiole nitrate nitrogen measurements were taken during the growing season on cotton plants. Final yield, boll number and size, and turnout measurements were taken on the cotton at harvest.

Results and Discussion

In 2007, cattle on winter grazing after peanut had increased soil resistance in the top 100-150 mm indicating surface compaction from the cow/calf operation (Fig. 1). However, this made little difference on the winter grazing (oats) since they were well established before cattle were allowed to graze the area. Oats were almost 12 inches tall prior to allowing animals accessing the winter grazing.

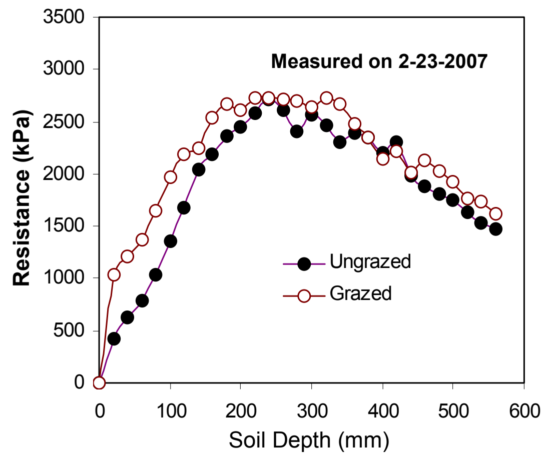

Figure 1. Cattle traffic effects on soil resistance. Each data point is the mean of 30 measurements from 3 replications.

After cotton was planted both bulk density and soil profile moisture were measured throughout the growing season. Soil bulk density was impacted in the from the cattle traffic on the winter grazing but only in the top 6 cm (Fig. 2). There was no apparent difference in the soil bulk density below that level. However, one of the cages was in an area that had higher organic matter and there was less soil compaction at that location whether grazed or ungrazed.

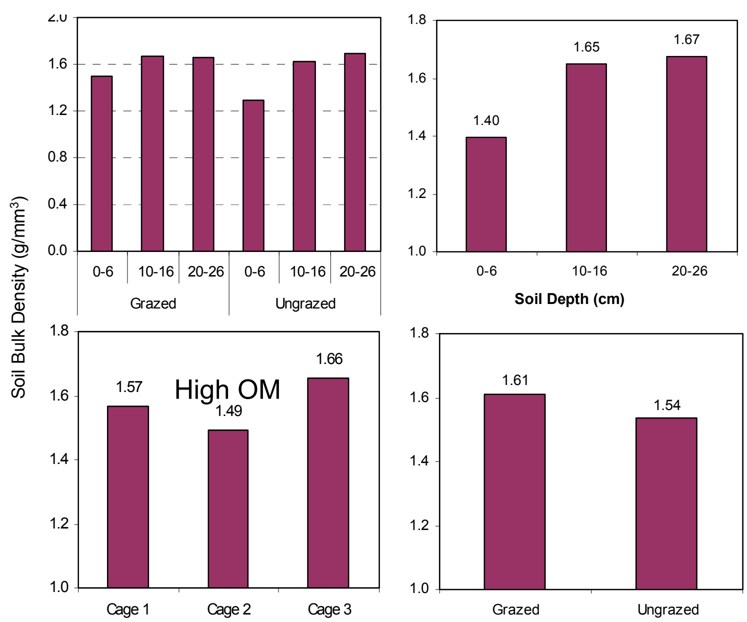

Figure 2. Soil Bulk Density in Cotton at Marianna after grazing or no grazing-2007

We have found that we are increasing OM by about .1% per year. Soil moisture was highest in the winter grazing prior to cotton planting in the top 6 cm of soil where OM is highest (Fig. 3). There was no difference between the grazed and non grazed areas to a depth of 30 cm. However, the cage with high OM showed much higher soil moisture on the small grain prior to planting cotton.

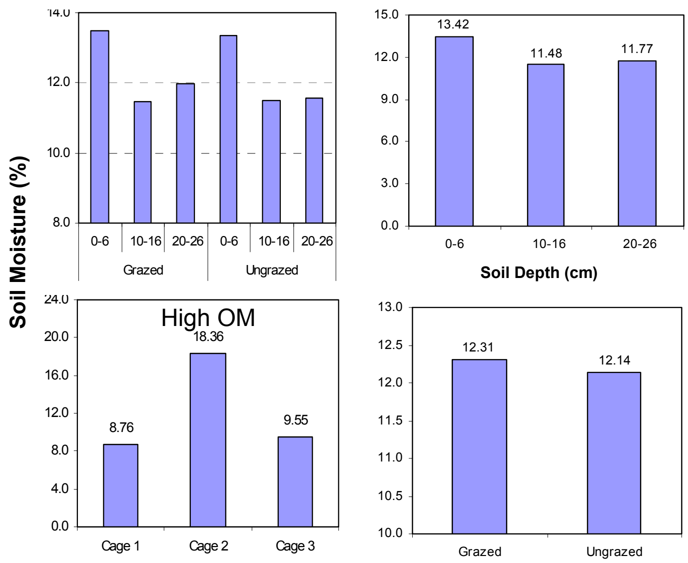

Figure 3. Soil moisture in winter grazing prior to planting cotton at Marianna in 2007

After cotton was planted, soil moisture was measured 4 times during the growing season. There was essentially no difference in soil moisture down to a depth of 0.6 m but the grazed area had higher soil moisture down to 1 m (Fig. 4). This indicates that cattle traffic had no negative impact on water infiltration and that actually there was a positive benefit to deep soil profile moisture when cattle grazed the winter grazing.

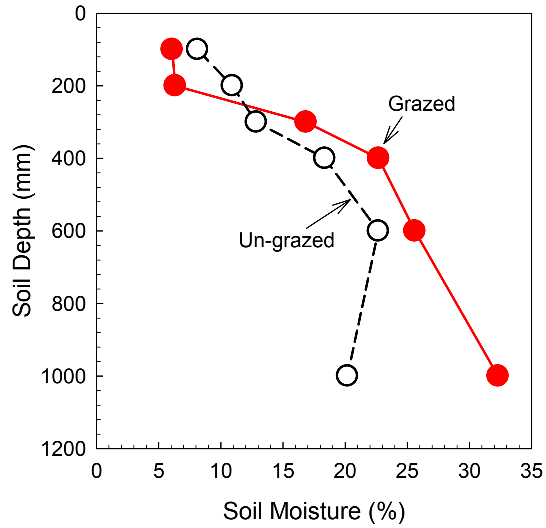

Figure 4. Soil moisture profile during the cotton growing season

Cotton height and node numbers were not impacted by cattle traffic (Fig. 5). There was a slight tendency for higher growth later in the season where small grain had been grazed prior to cotton being planted.

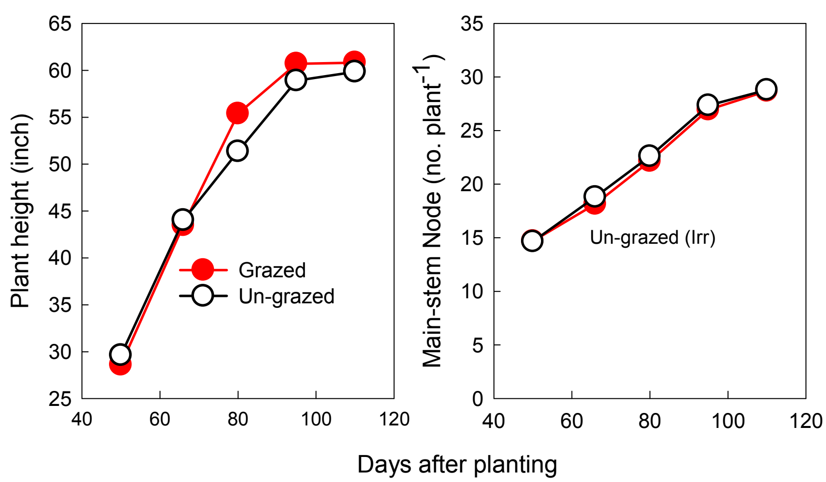

Figure 5. Cotton plant height and node numbers per plant from bloom to maturity with and without cattle trampling effects.

This may be explained by higher nitrate nitrogen found in cotton petioles as the cotton plants began to bloom and lasting until maturity (Fig. 6). The SPAD meter did not pick up higher chlorophyll readings but nitrate levels in the petioles increased throughout the season and this is attributed to N cycling from cattle manure as they grazed on the small grain.

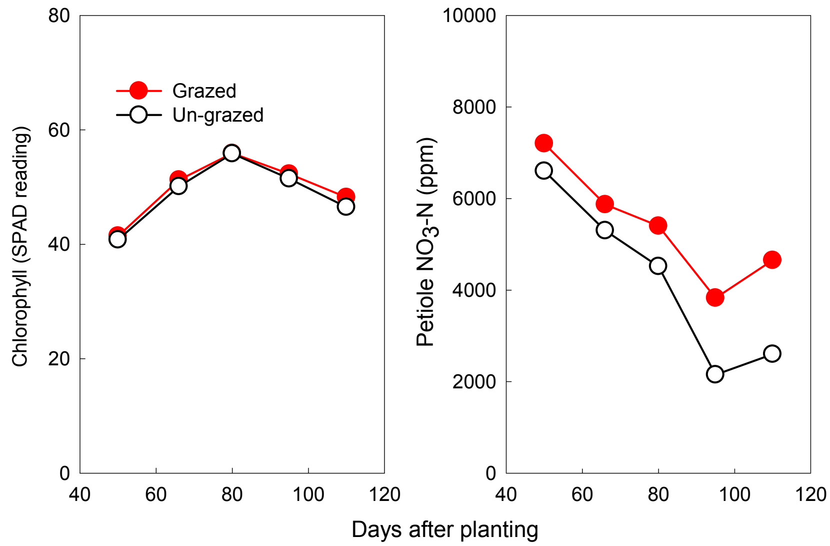

Figure 6. Cotton leaf chlorophyll and petiole NO_3-N during squaring through maturity with and without cattle traffic impacts at Marianna in 2007

The same rate of N was applied to small grains in and out of the exclusion cages but cattle kept nitrogen available more available to cotton plants. There was not a difference in boll numbers, boll size of lint yield of cotton and only turnout was significantly lower in the grazed areas (Table 1). However, there was a trend for higher yield where cattle grazed prior to planting cotton. This may be due to a nitrogen response. Yields were very acceptable whether cattle grazed the area or not.

Table 1. Lint yield and yield components for non-irrigated cotton in areas either grazed or not grazed in Marianna in 2007

Treat	Lint yield (kg/ha)	Boll size (g/boll)	Bolls (no./m2)	Turnout (%)
Grazed	1651 a	4.50 a	84.9 a	43.3 b
Un-grazed	1476 a	4.16 a	80.2 a	44.5 a
Difference	175	0.34	4.9	-1.2

Conclusion

Bahiagrass in rotation with row crops has enhanced the economical, biological and environmental aspects of the conservation farming system as compared to the standard peanut/cotton rotation using cover crops and conservation tillage. When cattle were added to the system, cattle traffic compacted the top 10 cm of the soil surface resulting in higher bulk density in the surface. Soils with higher OM did not compact as readily as those with lower OM content. We have shown that perennial grass has a positive impact on water infiltration, lowered soil mechanical resistance, increased LAI and plant biomass, and increased deep soil moisture. Cattle grazing appeared to enhance the deep soil moisture below about 30 cm down to a meter deep. Cattle often have a positive impact on farm economics by utilizing forages or crop residue during the off season. With this study comparing cotton after peanut after bahiagrass, where the winter cover was grazed or not grazed, we found no difference in cotton height, node numbers, or SPAD meter readings but did find an increase in petiole nitrate nitrogen from bloom until maturity. Even though increased nitrates were noted throughout the year, boll number, boll size, or lint yields were not significantly greater. However, there was a tendency for yields to be greater after cattle grazed the area as compared to areas not grazed. Future research will continue to focus on nitrogen cycling and impacts on other parts of the system.

Acknowledgement

Special thanks go to Brian Kidd, Ricky Beasley, and Maynard Douglas for assistance in the studies. This research was supported in part by cooperative research agreements with Cotton Incorporated, USDA/ARS, and Northwest Florida Water Management District

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