IMPACT OF CONSERVATION PRODUCTION PRACTICES ON SOIL MOISTURE AVAILABILITY IN ALLUVIAL SOILS

Gretchen F. Sassenrath
D. Ken Fisher
J. Ray Williford
USDA-ARS APTRU
Stoneville, MS 38776
Gretchen.Sassenrath@ars.usda.gov

Introduction

Conservation production practices have been shown to improve soil quality, and may increase cotton crop yield and quality. Reductions in tillage and incorporation of cover crops have the potential to improve soil nutrients and water availability, reducing the need for supplemental irrigation on sandy soils. Traditional high-intensity tillage methods are still the norm in the Mississippi Delta. While the region enjoys high levels of rainfall, increasing use of ground water for crop irrigation has begun to deplete the alluvial aquifer. We are interested in exploring the potential of conservation production practices to increase economic returns, in part by reducing fuel costs, and conserve ground water resources by reducing the need for supplemental irrigation. Two critical issues that we face are timely residue management and good germination of the cash crop.

The soils of the Lower Mississippi River Alluvial Flood Plain are nutrient rich, geographically young soils deposited during cyclical flooding and drying episodes, with an average thickness between 125 and 150 feet in depth. The soils within a given field may range from excessively drained silt loams and loamy sands of natural levees to the poorly drained silty clay loams and clays found chiefly in slack water areas. Minor differences in elevation can accentuate differences in soil drainage characteristics (Cox *et al.*, 2006), and result in distinct differences in soil properties. The clay soils hold moisture early in the year, decreasing soil temperature and impeding germination, and resulting in drastic variations in plant stand establishment. Alternatively, during particularly dry years added moisture in the wetter portions of fields can be beneficial to the crop. These differences in soil texture and topography, and the resultant variations in hydrologic properties, are primary determinants of crop yield (Iqbal *et al.*, 2005). The inherent within-field variability also creates management challenges to insure timely tillage, field preparation and planting, and contributes to spatial variability of crop growth and yield. Introducing conservation practices to these highly variable fields is a challenge, as the different soil types respond differently to tillage and cover crops. Conservation methods are compromised by early season rains that limit access to fields, increase soil water-logging, and decrease soil temperatures.

Farmers are under increasing pressure to reduce the impact of management practices on the environment. Although dryland agriculture has historically been profitable in the area, producers are becoming increasingly reliant on supplemental irrigation to ensure adequate yields and reduce risks of production. Increasing pressure on the alluvial aquifer and concerns for aquifer depletion have led to interest in alternative methods of improving profitability while minimizing environmental impact. However, no clear roadmap is available as to how to best implement cultural practices for optimal environmental benefit while maintaining profitability. The consequences of production practices on conservation of soil and water resources are also unknown for the alluvial soils. NRCS conservation program payments are based on the Soil Conditioning Index (SCI), which determines improvements in soil quality through three subfactors: organic matter (OM), field operations (FO), and erosion (ER) (NRCS, 1999). Changes in management practices do not result in a consistent change in SCI subfactors for all soils and environments (Zobeck *et al.*, 2007).

This research was undertaken to examine the impact of conservation production practices on cotton yield and quality. Differences in soil nutrients and water availability following different tillage practices and with incorporation of winter wheat cover crops into cotton production were measured to determine the impact of production practices on soil quality.

Materials and Methods

Cotton (*Gossypium hirsutum* cv. DPL 444BR) was planted in 32 rows x 30 m plots in the spring, with eight replications of each treatment. Conventional production practices included in-row subsoiling in the fall. Conservation plots were not subsoiled, and were planted with winter wheat cover crop in the fall. Cover crops were terminated with herbicide three weeks prior to planting the cash crop and rolled. Standard agricultural practices of fertilizer, insect and weed control were followed. Soil moisture was measured with Watermark soil moisture sensors[1] placed at 15 cm (6”) intervals in the rooting zone to a depth of 0.9 m (36”). Irrigation was supplied with an overhead sprinkler irrigation system, begun when the readily available soil moisture at 30 cm (12”) was depleted to -50 - -70 mbars, and continued at 5 day increments thereafter until the end of the season unless significant rainfall was received. Plots were harvested with a commercial cotton picker equipped with a sampling system for large plot harvests. Seed cotton was ginned on a 10-saw research gin. Standard cotton classing was performed at the USDA-Agricultural Marketing Service Classing Office in Dumas, AR.

Results and Discussion

Increased organic matter through use of cover crops has been shown to improve yields of the subsequent cash crop and reduce erosion from the soil surface (Raper *et al.*, 2000; Rhoton, 2000). However, soil organic matter is rapidly depleted under the typical environmental conditions in the Mississippi Delta. Even after three years under conservation management, soil organic matter changed very little (Figure 1). Conservation practices that included a winter wheat cover had only a very slight impact on SCI (Table 1). While the conservation production system showed a positive SCI, the slight improvement would only result in a $2.32 per acre per year payment (P. Rodrigue, NRCS, personal communication). While positive environmental benefits may occur in the long-term, a yield increase from implementation of conservation practices was not observed until the third year (Figure 2).

Conservation systems with high levels of cover crop residue are beneficial for sandy soils in part due to increased percolation of water into the soil profile (Raper *et al.*, 2000). After the cover crop is terminated, the crop residue acts as a mulch to reduce evaporation from the soil surface.

Research from our fields indicates that increases in soil moisture with cover crops may be more of a detriment in the Delta, especially early in the season. During the winter, the entire soil profile saturates with water due to the heavy winter rains, as measured by soil moisture sensors (data not shown). Prior to planting, the soil surface dries out more quickly in conventional plots due to increased evaporation than in conservation plots with cover crops. The reduced soil moisture in the conventional tilled plots results in a better seed bed, improved seed placement and soil contact, and better plant stand. The reduced soil moisture also helps increase seed bed temperatures, further enhancing germination. DeFelice *et al.* (2006) found that conservation systems resulted in a negative yield advantage for corn and soybeans on poorly drained soils. The need to increase surface drainage in the early spring may limit the use of cover crops in the Delta, further exacerbating efforts to increase the use of conservation tillage practices and limiting potential conservation incentive payments to farmers.

During the growing season, treatments with winter wheat cover crops were found to require more water than conventional plots (Figure 2). Yield in conservation plots responded to irrigation in two of the three years of the study. This is contrary to what was seen in other studies using rye as a cover crop (Balkcom et al., 2006). This may result from the lower biomass produced with winter wheat compared to rye, or the slow improvement in soil quality with implementation of conservation practices.

Conclusion

Adapting conservation practices for alluvial soils requires ingenuity in addressing early-season soil moisture levels that limit seed bed preparation, planting, and germination. Failure to establish a good plant stand reduces yield of the cash crop. Incentive payments made to farmers to encourage implementation of conservation production practices need to be examined for applicability to Delta soils and environment.

[1]Disclaimer

Mention of a trade name or proprietary product does not constitute an endorsement by the U.S. Department of Agriculture. Details of specific products are provided for information only, and do not imply approval of a product to the exclusion of others that may be available.

Acknowledgement

We would like to thank Dr. Paul Rodrigue for helpful discussions and assistance with SCI calculations.

Reference

Balkcom, k.s., Reeves, D.W., Shaw, J.N., Burmester, C.H., and Curtis, L.M. 2006. Cotton yield and fiber quality from irrigated tillage systems in the Tennessee Valley. Agronomy Journal. 98:596-602.

Cox, M.S., Gerard, P.D., Abshire, M.J. 2006. Selected soil properties' variability and their relationships with yield in three Mississippi fields. Soil Science. 171:541-551.

DeFelice, M.S., Carter, P.R., Mitchell, S.B. 2006. Influence of tillage on corn and soybean yield in the United States and Canada. Online. Crop Management doi:10.1094/CM-2006-0626-01-RS.

Iqbal, J., Read, J.J., Thomasson, A.J., Jenkins, J.N. 2005. Relationships between soil-landscape and dryland cotton lint yield. Soil Sci. Soc. Am. J. 69:872-882.

Natural Resources Conservation Service. 2002. Soil conditioning index for cropland management systems. *In:* NRCS National Agronomy Manual, Directive No. 190-V-NAM. Available online at: http://policy.nrcs.usda.gov/media/pdf/M_190_NAM.pdf.

Raper, R.L., D.W. Reeves, E.B. Schwab, C.H. Burmester. 2000. Reducing soil compaction of Tennessee Valley soils in conservation tillage systems. J. Cotton Sci. 4:84-90.

Rhoton, F.E. 2000. Influence of time on soil response to no-till practices. Soil Sci. Soc. Am. J. 64:700-709.

Zobeck, T.M., Crownover, J., Dollar, M., Van Pelt, R.S., Acosta-Martinez, V., Bronson, K.F., and Upchurch, D.R. 2007. Investigation of soil conditioning index values for southern high plains agroecosystems. Journal of Soil and Water Conservation. Nov – Dec., 2007.

Subfactor	Conventional tillage	Conservation Tillage, with cover crop
OM	-0.52	-0.29
FO	0.3	0.84
ER	-0.26	0.61
SCI	-0.14	0.34

Table 1. Calculated Soil Conditioning Index for two production systems on Dundee silty clay loam in Stoneville, MS after three years of treatment.

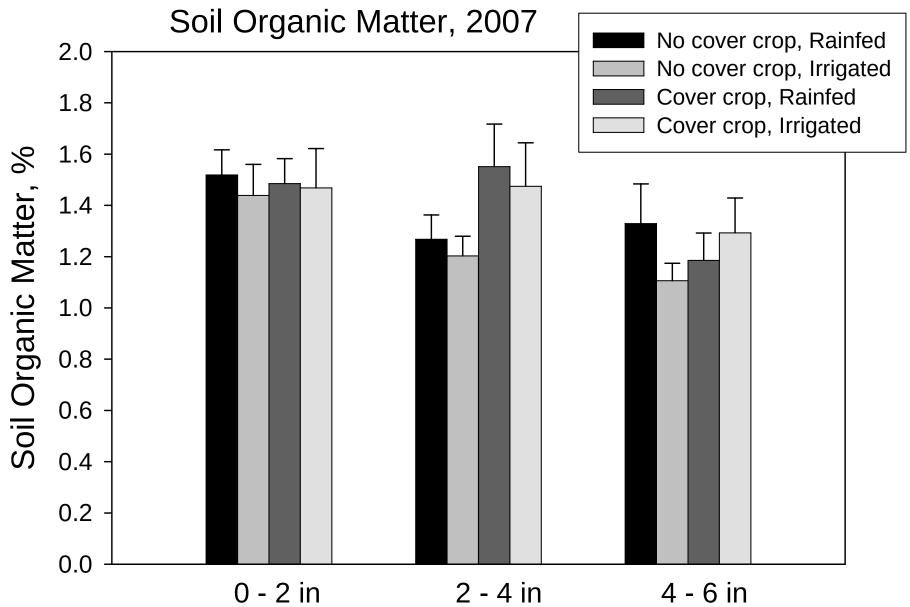

Figure 1. Changes in soil organic matter after three years under different production systems.

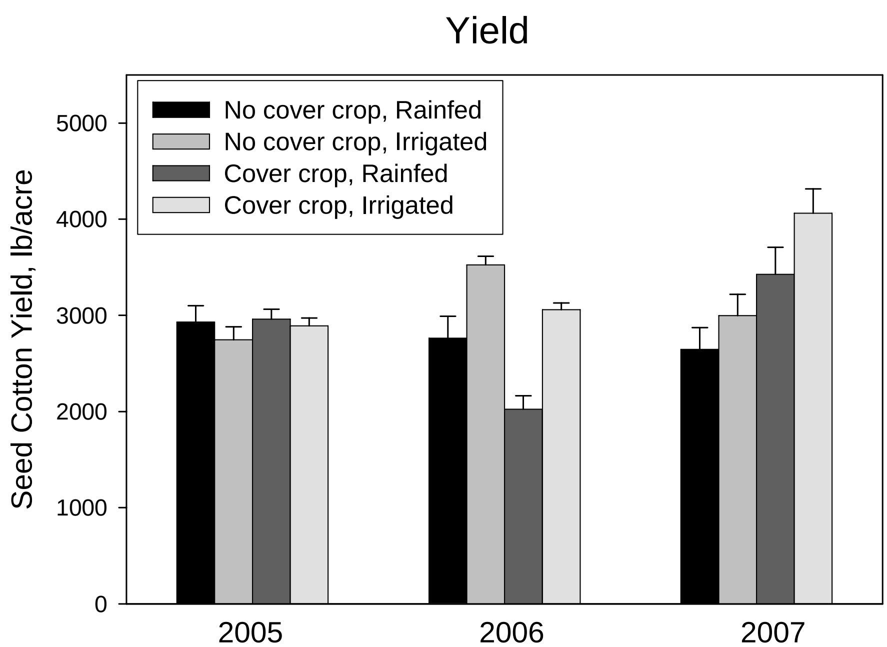

Figure 2. Impact of management practices and irrigation on cotton yield.