Effect Of Long-Term Conservation Tillage Rotations On Crop Yields And Soil Physical And Chemical Properties

DR. CHARLES BURMESTER

AUBURN, AL.

Introduction

A replicated cotton rotation experiment was established in 1979 and for the past 30 years has provided valuable information to farmers in the Tennessee Valley region in Northern Alabama. The comparison of continuous cotton production with one year rotations of corn, soybeans or wheat/double-cropped soybeans have been consistent since 1979. In 1988, two continuous no-till cotton plots and fall tillage (chisel) prior to planting a wheat cover crop were established. The two no-tillage plots consist of planting into old cotton stubble or into a wheat cover crop. In 1994 all plots except continuous cotton were changed to no-tillage, and the row spacing for cotton, corn and soybeans were reduce from 40 to a 30 inches.

Yield Results

It is important to note that this rotation test site, located on a Decatur silt loam soil, has developed no major disease or nematode problems during its 32 year history. Cotton yield responses to rotations were low (2-7%) during the first eight years of the study (Table 1). Cotton yield response to rotations increased slightly during the 1988-1994 time period. The biggest cotton yield increase (13%) was found in the wheat and double-cropped soybean rotation (Table 1). The no-till cotton yields during this period were disappointing, especially where cotton yields were reduced by 2% when planted into old cotton stubble (Table 1). The 1995-2005 time periods saw many changes in cotton production including Bt and Roundup Ready cotton development. Cotton yield response to rotations increased greatly this period (Table 1). All rotations except corn produced double digit increases in cotton yields (Table 1). These increases coincided with all the treatments except continuous cotton planted with conservation tillage. The 2006-2010 time periods contained two major drought years (2006-2007) that reduced cotton yield responses greatly. Even with these two non-responsive years, cotton yield increases averaged 12% when cotton was rotated with wheat and double cropped soybeans and 10% and 17%, respectively, when no-tilled into cotton stubble or a wheat cover. Cotton yields were also increased 16% when no-tilled into wheat following fall tillage. Cotton yields increased only 6% when rotated with corn during this period and cotton yields were reduced 3% when cotton followed soybeans (Table 1).

Soil Properties

During this cotton rotation experiment soil organic matter (SOM) was analyzed in the top 2.5 inches of the soil from key treatments in 1987, 1994, 2001. In 2010 SOM was sampled in the top 2 inches of the treatments. The 1987 sampling was before establishment of the two no-till treatments. The 1994 sampling was before all the rotations were switched to conservation tillage and the 2001 and 2010 sampling serve as baselines for SOM development (Table 2). Continuous cotton SOM increased very slightly from the 1.34% level found in 1987 to 1.53% SOM in 2010 (Table 2). Using conventional tillage the corn and soybean rotation did not significantly increase SOM at the 1987 or 1994 sampling (Table 2). In 1994 the no-till cotton treatments and wheat-double cropped soybean rotation significantly improved SOM in the top 3 inches (Table 2). Also in 2001,the largest increases in SOM reading were found in the no-till cotton treatments and the wheat double-cropped soybean rotation. In the 2010 sampling large increases in SOM was noted in all the rotations and all rotations increased SOM compared to the conventional tillage cotton (Table 2). Some of the increase in SOM in 2010 may be relates to a slightly shallower sampling depth of 2.0 inches versus 2.5 inches in previous years. The rotations including wheat almost doubled SOM levels from 2001-2010 (Table 2). The corn rotation increased SOM by over 1% and the cotton no-till into old cotton residue increased SOM by over 0.5% during this 9 year period (Table 2). The soybean rotation was not sampled for SOM at this depth in 2010. During the 2010 sampling SOM was measured on an existing pasture (over 20 years) on the same soil type. The SOM in the pasture measured about 5 times higher compared to continuous cotton and about 3 times higher than compared to the no-till wheat cover treatment. (Table 2).

Summary

In the last several years many Tennessee Valley area farmers in northern Alabama have switched from continuous cotton to rotations with wheat, corn and soybeans. Conservation tillage is also used by many farmers in this area. This data indicated large advantages to rotations and conservation tillage on these soils. This data indicates a direct relationship between cotton yield increases and increases in surface SOM. The rotations including wheat in the rotations appeared to build organic matter faster, resulting in consistently higher yields. Using conservation tillage and wheat in the rotations can lead to double digit cotton yield increases and large increases in SOM. Rotations with corn and soybeans increased cotton yields and SOM levels over time, but less than seen with wheat in the rotation.

In cotton fields with reniform nematode problems much higher yield response to using corn in the rotation would be expected. This rotation test indicates the positive cotton yield response to rotations and cropping systems that can result from building SOM over time. Δ

DR. CHARLES BURMESTER: Extension Agronomist, Auburn University

Table 1. ***Relative seed cotton yield responses to long term crop rotation/tillage systems at the Tennessee Valley Substation, 1980-2010.***

Rotation/Tillage System	1980-1987 %	1988-1994 %	1995-2005 %	2006-2010 %
Continuous Cotton[1]	100.00	100.00	100.00	100.00
Cotton/Soybean[2]	105.00	105.00	109.00	97.00
Cotton/Corn[2]	102.00	108.00	111.00	106.00
Cotton/Wheat-Soybean[2]	107.00	113.00	111.00	112.00
NT Cotton (stubble)[3]	-	98.00	110.00	110.00
NT Cotton (wheat)[3]	-	104.00	116.00	117.00
Cotton/Wheat-Chisel[4]	-	109.00	117.00	116.00

[1]continuous conventional tillage cotton since 1979.
[2]rotations established in 1979, converted from conventional to no-tillage in 1994.
[3]no-tillage into wheat cover crop or previous cotton stubble established in 1988.

Table 2. ***Surface soil organic matter (%) from long-term rotation/tillage experiment at the Tennessee Valley Substation, 1980-2010.***

Rotation/Tillage System	1987(2.5in)	1994(2.5in)	2001(2.5 in)	2010(2.0in)
Continuous Cotton[1]	1.34	1.48	1.41	1.53
Cotton/Soybean[2]	1.38	1.58	1.65	-
Cotton/Corn[2]	1.35	1.50	1.70	2.80
Cotton/Wheat-Soybean[2]	1.46	1.85	1.98	3.80
Cotton - No till stubble[3]	-	1.75	2.23	2.80
Cotton - No till wheat[3]	-	1.68	2.26	4.42
Pasture (>20 years)[4]	-	-	-	7.43

[1]continuous conventional tillage cotton since 1979.
[2]rotations established in 1979, converted from conventional to no-tillage in 1994.
[3]no-tillage into wheat cover crop or previous cotton stubble established in 1988.
[4]continuous pasture for more than 20 years.