Showing Farmers the Difference: Measuring Soil Quality in Conservation Tillage and Conventional Fields Using the NRCS Soil Quality Test Kit

J.W. Gaskin[1], J. E. Dean[2], R.E. Byrd[1]

[1]Biological & Agricultural Engineering Dept. University of Georgia, Athens, GA 30602.USA.

[2]Natural Resource Conservation Service, Athens, GA 30601. USA.

Corresponding author's e-mail: jgaskin@engr.uga.edu

ABSTRACT

Although many farmers have reported noticeable differences in their fields and soils after several years of conservation tillage, there is little on-farm data available in Georgia comparing soil quality in fields under conservation vs. conventional tillage. The Georgia Soil Management Team was formed in 1999 to help educate farmers and agricultural professionals on soil quality. This group has used the NRCS Soil Quality Test Kit to begin to gather this type of data and make it accessible to farmers. We have collected data for three years in seven Georgia counties with the Test Kit measuring infiltration, bulk density, and water stable aggregates, and also sending soil samples to the Soil, Plant, and Water Laboratory at the University of Georgia for carbon and routine nutrient analysis. The data reflect a range of surface soil textures, years in conservation tillage, and conservation tillage practices. Generally, the conservation tillage fields have higher percent carbon, water stable aggregates and infiltration rates than comparable conventional fields. These data have been presented and discussed at several Georgia Conservation Tillage Alliance Meetings and other educational settings. We hope to gather more data over the next several years in order to continue the development of this on-farm database, which can benefit growers and educators alike.

KEYWORDS

Soil management, water infiltration, bulk density, soil structure

INTRODUCTION

Farmers who have used conservation tillage practices for several years often report improvements in soil tilth, reduced crusting, and decreased runoff, all of which can result in improved crop quality and production. This anecdotal information is often discussed in Conservation Tillage Alliance Meetings where growers gather to learn from each other's experiences, but there is little on-farm data on soil characteristics to validate the growers' reports. Although there is a large body of research data available on the effects of conservation tillage on soil characteristics, information from a nearby county or farm is sometimes more effective in illustrating the benefits.

The Georgia Soil Management Team was formed in 1999 to help educate farmers and agricultural professionals about the importance of soil quality. This group has used the NRCS Soil Quality Test Kit to compare selected soil quality characteristics in fields with similar soils using either conservation or conventional tillage. We hoped to develop a database that would show farmers the differences in soil quality under different management systems and over time. We also hoped the Soil Quality Test Kit would be used by other groups such as 4-H students.

METHODS

Information for the database has been gathered since 1999 by visiting a Georgia county or group of counties in the late fall or early winter after harvest and before planting preparation. The County Extension Agent and/or the NRCS conservationist was contacted and asked to recommend farmers using conservation tillage who might want to participate. Once a farmer's field was selected, County Soil Survey maps were used to identify the dominant soil series. A nearby farm with soils in the same soil map unit using conventional tillage was also sampled for comparison. For example, if we selected a strip till cotton field in Coffee County, we would use the Coffee County Soil Survey to determine the mapped soil series in the field and find a nearby conventional cotton field with the same surface soil texture and with the same soil series mapped as a contrast-

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ing management for that soil series. Farm field locations were noted on road maps so the site could be revisited.

Once a field was selected, we looked for a representative area with about a 50-foot radius in the field with similar surface soil texture, slope, and growth characteristics. All the subsampling and replicate sampling were conducted within that radius. Subsampling sites were randomly selected within the sampling area..

A subset of parameters was selected to evaluate the various aspects of soil quality. Bulk density and infiltration were measured as an indicator of the physical component of soil quality. Routine soil nutrient analysis for pH and available Ca, K, Mg, Mn, P, and Zn, as well as percent C were analyzed as indicators of chemical soil quality. Water stable aggregates were run as an indicator of biological activity.

Bulk density was measured using the ring method in the NRCS Soil Quality Test Kit Guide (NRCS, 1999). Four bulk density samples were collected in each field's sampling area: two samples collected in-row, two samples in the middles, and an average bulk density calculated for the area. Infiltration was measured using the NRCS Soil Quality Test Kit Guide twice in-row and twice in the middles, and an average was calculated (NRCS, 1999). The procedure was performed twice in each ring to obtain both a dry and wet infiltration rate. The wet infiltration is reported in the database.

Composite soil samples (six or more subsamples) were collected from the soil surface (0-6 in) for routine soil analysis at the University of Georgia's Soil, Plant, and Water Laboratory. Soil test P, Ca, K, Mg, Mn, and Zn were extracted with Mehlich I solution (AOAC Method 968.08, Cunniff,1996) and analyzed on an emission ICP by EPA 200.7 (USEPA, 1994). A composite soil sample was also collected from the surface (0 - 0.5 in) for carbon analysis. Total soil carbon was analyzed on a LECO analyzer (Nelson and Sommers, 1996). This was converted to percent organic matter using a 1.724 multiplier. Soil pH was determined on a 2.5:1 soil/water paste (Thomas, 1996).

Water stable aggregates were determined using the NRCS Soil Quality Test Kit method. Four subsamples were collected from the soil surface (0-6 inches) and an average percentage calculated for the area.

RESULTS

A total of 21 fields from seven counties in Georgia have been sampled since the fall of 1999. The counties from which we have data are Brooks, Coffee, Houston, Jenkins, Macon, Randolph, and Tift. Soil series mapped on the sites were Cowarts/Carnegie, Faceville, Norfolk, Orangeburg, Pelham, and Tifton. Most of the fields had a sandy or loamy sand texture in the soil surface.

Cotton was grown during the previous growing season in most fields, but several had strip till peanuts. The number of years a field had been in conservation tillage ranged from one to 18. Because conservation tillage is a growing practice in Georgia, a higher number of fields sampled had only been in conservation tillage for one to three years (Fig. 1). We also found differences in what was considered conservation tillage in several counties. Most of the growers whose fields we sampled had converted to a conservation tillage system, which included strip tilled cotton into a winter cover crop, usually rye (CTS - 8 fields). There was a group of growers who strip tilled cotton or peanuts into a winter cover, but harrowed the fields before the winter cover was planted (CT/FT - 7 fields).

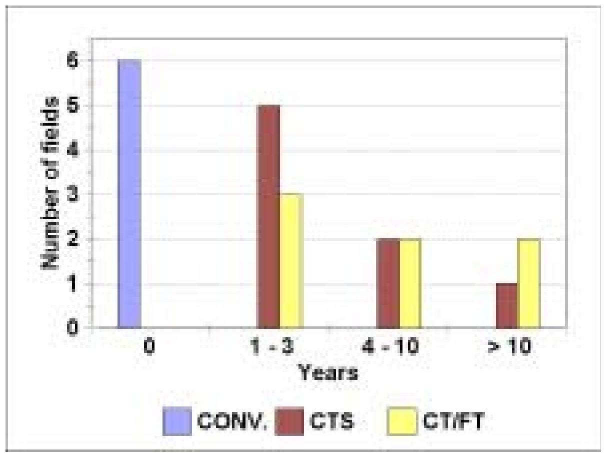

Fig.1. Distribution of the fields sampled for the soil quality database by years in conservation tillage. Consevation tillage with winter cover crop (CTS), summer strip-till/ fall tillage (CT/FT), or conventional tillage (CONV).

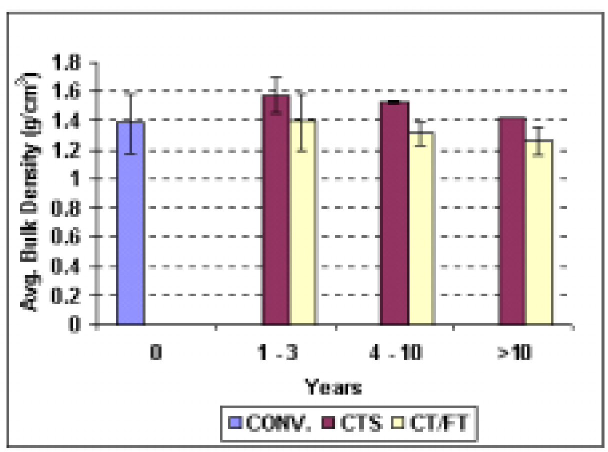

Fig. 2. Average bulk densities measured with the NRCS Soil Quality Test Kit in conventional (CONV), conservation tillage with winter cover (CTS) and summer strip-till/ fall tillage (CT/FT).

Bulk density in the soil surface of the CTS or CT/FT fields is similar to that of the CONV, though there may be a trend of decreasing bulk density with time in conservation tillage (Fig. 2).

We present infiltration as the number of minutes required for one inch of water to move into the soil (Fig. 3). This measurement illustrates to the farmer that water is unlikely to puddle in the CTS fields. All these measurements were taken in the late fall and early winter. Due to the extended drought conditions, most soils were very dry. Only one measurement (CTS 4-10 years group) was taken under wet conditions.

As expected, the variability of this measurement was very high (Fig. 3). However, the time to infiltrate one inch of water tended to decrease with the number of years in CTS or CT/FT. The relatively high average for the CTS 4-10 years group is due to longer infiltration times in the middles of the one field measured under wet conditions. In some cases, water infiltrated very quickly in the CONV. system; however, these measurements were made after the field had been harrowed and no rainfall had occurred. After rainfall, these fields would typically have a crust which would decrease infiltration.

Organic matter in the top 0.5 inch of the soil ranges from less than 1% to over 3.5 % (Fig. 4). The fields in the CTS generally had higher soil organic matter than CONV, but the average for CTS is lower than for CT/FT. The lower average for CTS is probably due to the fact we have more fields in this group that have used conservation tillage for one to three years, and these fields are just beginning to rebuild soil organic matter. In the few samples that we have, we see an increase in water stable aggregates with the amount of time in CTS while the CT/FT appears to hold steady (Fig 5).

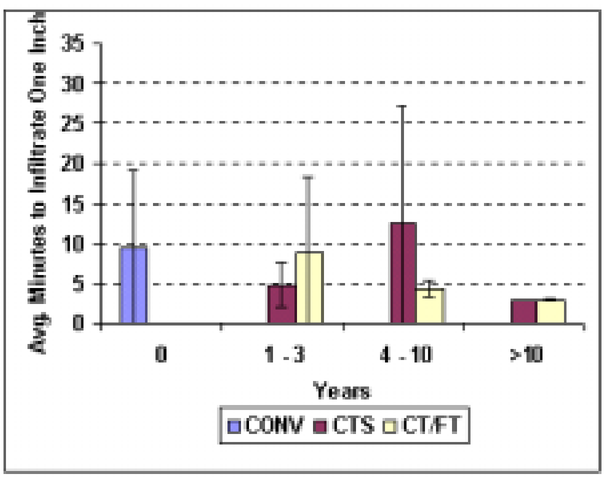

Fig. 3. Average amount of time it takes for one inch of water to infiltrate the soil measured with the NRCS Soil Quality Test Kit in conventional (CONV), conservation tillage with winter cover (CTS) and summer strip-till/ fall tillage (CT/FT).

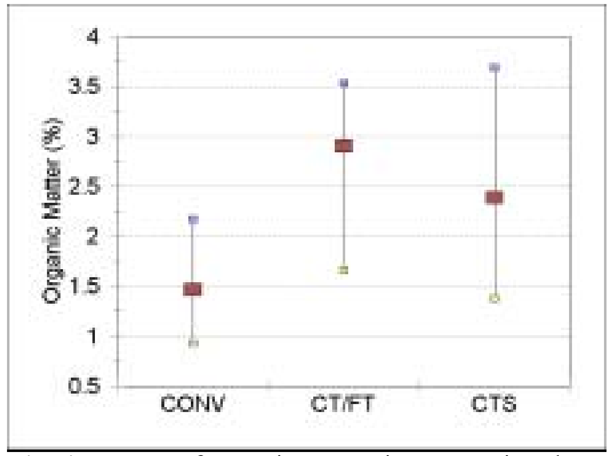

Fig. 4. Range of organic matter in conventional (CONV), conservation tillage with winter cover (CTS) and summer strip-till/ fall tillage (CT/FT).

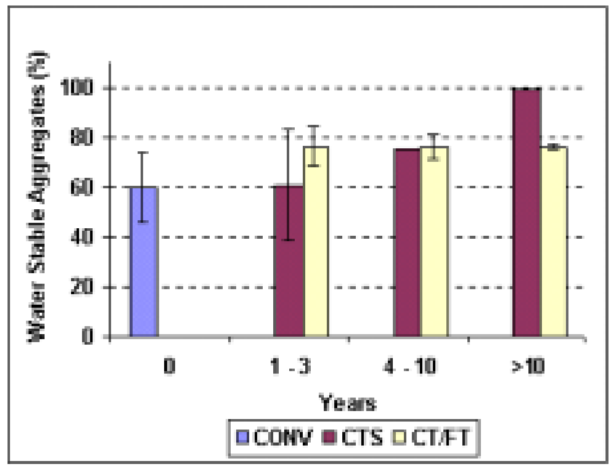

Fig. 5. Average water stable aggregates measured with the NRCS Soil Quality Test Kit in conventional (CONV), conservation tillage with winter cover (CTS) and summer strip-till/ fall tillage (CT/FT).

DISCUSSION

The information has been shared with over 400 farmers and 190 agricultural professionals at such meetings as the Georgia Conservation Tillage Alliance annual meeting, the Southern Sustainable Agriculture Research and Education Professional Development Program / Southern Sustainable Agriculture Work Group Annual Meeting, Conservation Tillage Workshops, and the National Association of County Agricultural Agents National Meeting. Growers have been very interested in the results from their farm and how they compare to other farms using conventional tillage. The process has helped increase farmer awareness about soil quality and how it may relate to changes they are experiencing in their fields.

The Soil Quality Test Kit has also been used with the Coffee County 4-H group. Middle and high school students measured various soil quality parameters in conservation tillage fields and compared the results to conventional tillage fields. Students presented their results and why their variable would be important to the group.

The data has been used as a springboard to discuss the link between soil quality and water quality, and to discuss how improvements in infiltration and soil water storage with increases in soil quality helps make better use of rainfall and more efficient use of irrigation water resources. Education on these issues are becoming more critical in Georgia as the state policies are beginning to address the fact that water is becoming a scarce resource. We hope to continue collecting data every fall and return to the fields we have measured after about four years to see if we can document trends.

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