LONG-TERM TILLAGE SYSTEM EFFECTS ON CHEMICAL SOIL QUALITY INDICATORS IN THE SOUTHEASTERN COASTAL PLAIN

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INTERPRETIVE SUMMARY

Research Question

Long-term experiments are needed to generate reliable information on how different management cropping systems may impact soil quality. However, only a few experiments have been conducted under the warm climatic conditions and sandy soils of the southeastern USA. This research was undertaken to determine the effect of four tillage systems on soil quality chemical indicators on two Coastal Plain soils after 17 years.

Literature Summary

Changes in soil quality are normally observed after adoption of conservation tillage. Higher levels of soil organic matter have been observed with conservation than conventional tillage systems, but the accumulation of organic matter normally occurs only in the top few inches of soil. Profile-stratification patterns exist in conservation tillage systems where low-mobility nutrients accumulate in the soil surface. Surface soil acidification may also occur in these systems when large amounts of N are applied without adequate lime. These soil changes are documented from studies conducted in temperate climatic conditions; however, few studies have been conducted under warm climatic conditions on fine sandy soils such as those in the Southeast Coastal Plain.

Study Description

Two tillage experiments were conducted for 17 years (since 1981) in the Coastal Plain region of Southwestern Alabama. The experimental design at both locations was a randomized complete block with four replications. Treatments consisted of four tillage systems applied prior to planting the winter crop each year. Tillage treatments were: no tillage, disk, chisel plow, and moldboard plow. Various summer crops were double cropped behind the winter crop using no-tillage. In the fall of 1997, soil cores were collected and bulked by depth (0-1, 1-3, 3-6, 6-9, and 9-12 inches). Soil pH, organic matter, total N, P, Mn, and Zn were assessed.

Applied Questions

Can conservation tillage maintain higher soil carbon content than conventional tillage under warm climatic conditions for coarse-textured soils?

Clear differences among tillage treatments were observed for soil carbon in the first few inches of soil. The accumulation of soil carbon was inversely related to the level of soil disturbance (no-tillage> disk> chisel plow> moldboard plow). No tillage had twice the carbon compared with the moldboard plow treatment in the top 3 inches of both soils.

Is soil acidification affected by the intensity of tillage?

No difference in pH among tillage treatments was observed on the Benndale soil (very fine sandy soil with about 10% clay content), and pH was within acceptable limits. This indicates that surface lime application can control pH in soil with low clay content. Surface lime applications resulted in a drop in pH below the 6-inch depth in the Lucedale soil (fine sandy soil with about 22% clay content).

Was there accumulation of P (an element with low mobility) near the soil surface in no tillage, disk, and chisel plow treatments?

The commonly reported accumulation of P at the soil surface did not occur with no tillage. In fact, higher values of P with depth were observed under no tillage, disk, and chisel plow compared with moldboard plow for the Benndale soil. This suggests P movement through physical, chemical, or biological processes in this soil. The Lucedale soil exhibited no accumulation of P with depth, but no tillage had greater P values compared with moldboard plow down to 9 inches, suggesting some mobility of P in this soil.

Was there a relationship between changes in soil organic matter and other soil chemical properties?

There was a close relationship between soil organic carbon and total N, effective CEC, Zn, and Mn availability. In some cases, the combination of soil carbon and pH helped predict variation in some soil chemical properties. These results confirm the importance of these chemical parameters as key indicators of soil quality.

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