Effect of Long-Term (35 years) No-Till and Conventional Tillage Systems on Soil Quality

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Introduction

- No tillage (NT) systems are more beneficial in improving soil organic carbon and reducing carbon mineralization (C-min) as well as carbon-dioxide (CO_2) emission compared to conventional tillage (CT) systems (Wright and Hons 2005; Kushwah et al. 2016).
- The existing reports are inconsistent because of differences in soil type and climate (Al-Kaisi and Yin 2005).
- The goal of this study was to understand the impact of tillage regimes on soil quality in a semi-arid climate in Eastern Texas.

Hypothesis

Residue management and minimal soil disturbance in the NT system improve soil quality and minimize CO_2 emissions compared to the CT system.

Objective

Determine the impact of long-term NT and CT systems on soil organic carbon, C-min and CO_2 emissions.

Materials and Methods

- A long-term tillage experiment was initiated in 1982 in College Station, TX with 2 treatments (CT and NT) and 4 replications in a randomized complete block design.
- The plots have been planted each year with sorghum as a monocrop in 1-m wide rows.
- Observations on soil organic carbon, C-min and CO_2 emission were carried out after crop harvest in 2016.
- Soil organic carbon content was determined at 0-5, 5-10 and 10-20 cm depths using the combustion method (McGeehan et al. 1988).
- A laboratory incubation study (Figure 1) was conducted to quantify the rate of C-min for a 21-day period.
- An in-situ low cost methodology was developed based on (Anderson 1982) for measuring CO_2 emissions under field conditions after harvest (Figure 2).
- ANOVA was carried out using PROC GLM (SAS 9.4)

Figure 1. Experimental setup for estimating C-mineralization in soil

Figure 2. Home-made setup for CO_2 measurement

Results and Discussion

- At 0-5 cm depth, the NT system had higher cumulative C-min rates and organic carbon levels compared to the CT system (Figures 3, 6).
- However, at 5-10 cm depth, cumulative C-min and CO_2 emission were higher in the CT system compared to the NT system (Figures 4, 5).
- Retention of quality crop residues, enhanced activity of soil microorganisms and minimal soil disturbance are likely responsible for the higher C-min, organic carbon content and lower CO_2 emission observed in the NT system.
- Soil inversion in the CT system may likely have led to an increase in C-min at 5-10 cm.
- In-situ measurement of CO_2 emission using the titration method appears to be reliable, but the static nature of the chamber may lead to an under- estimation of actual CO_2 emission levels.

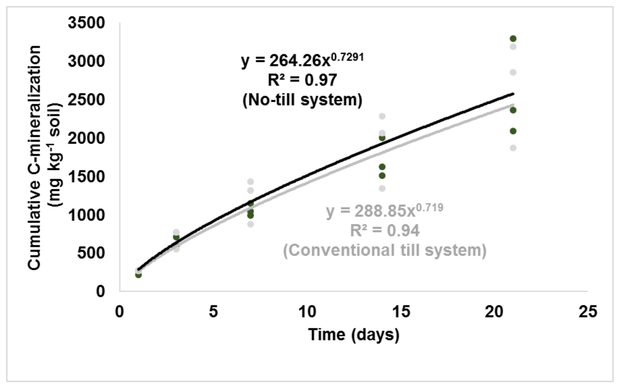

Figure 3. Cumulative C-mineralization rates at 0-5 cm depth

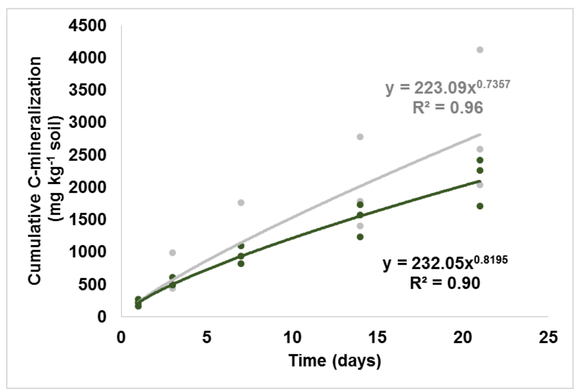

Figure 4. Cumulative C-mineralization rates at 5-10 cm depth

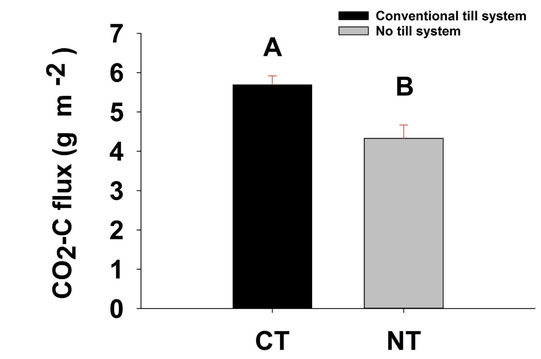

Figure 5. Effect of tillage systems on CO_2 emission

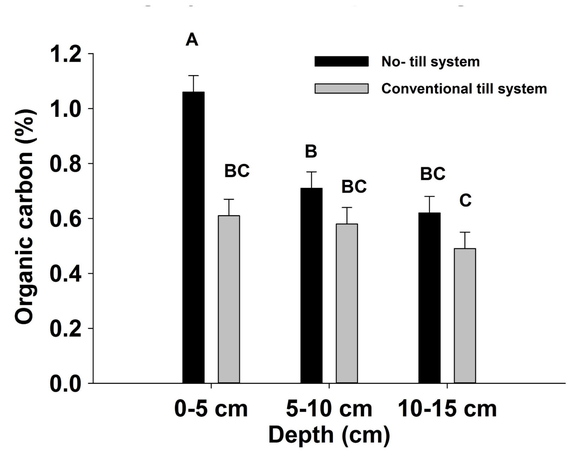

Figure 6. Effect of tillage systems on soil organic carbon (%) content

Conclusion

- The NT system had a positive impact on carbon-mineralization and CO_2-C flux.
- The NT system is more beneficial and sustainable compared to the CT system in terms of soil quality improvement.
- The titration method is cost-effective and can be an alternative to high cost modern observation systems.

References

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