Temporal Changes in Greenhouse Gas Fluxes and Related Soil Properties Under Long-Term Tillage Systems

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Background

- Intensive tillage disturbs soil and makes soil organic matter more susceptible to oxidation and microbial degradation, ultimately leading to increased greenhouse gas (GHG) emissions—particularly CO_2-C.
- Research suggests that tillage can increase GHG fluxes (Reicosky, 1997).
- Cover crops (CCs) can also affect GHG fluxes, depending on management (Blanco-Canqui et al., 2015).
- Limited research has been conducted to evaluate the impact of tillage on GHG emissions and related properties from a temporal perspective.

Objective

To evaluate the temporal impacts of six tillage systems [(chisel, plow, double disk, double disk with CC, no till (NT), and no till with CC (NTCC)], under corn-soybean rotation on CO_2-C fluxes and related soil properties

Methods

- We conducted this study in an experiment on a silty clay loam at Rogers Memorial Farm near Lincoln, NE established in 1981 (Fig. 1).
- Cereal rye CC was planted in early November and terminated in mid- to late April.
- Tillage occurred in late fall (November) and mid- to late spring (April).
- The GHG fluxes and soil properties were determined in 2016 and 2017.
- Gas sampling was conducted in the field using a steel anchor and lid with samples collected every 10 min and analyzed on gas chromatograph (Fig. 2).
- Particulate organic matter (POM) was determined by loss of ignition after soil samples were air dried, shaken, and sieved with 0.5 mm (designated coarse POM or cPOM) and 53 µm (designated fine POM or fPOM) sieves (Fig. 3-4).

Results

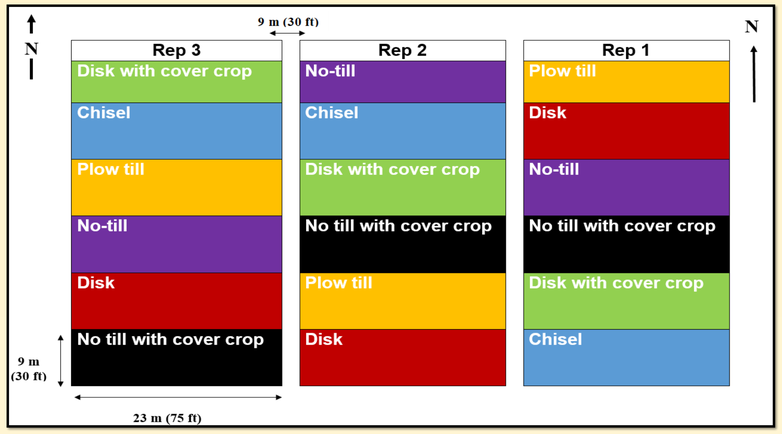

Fig. 1. Experiment layout under corn-soybean rotation established in 1981.

Fig. 2. Gas chamber used to collect gas samples

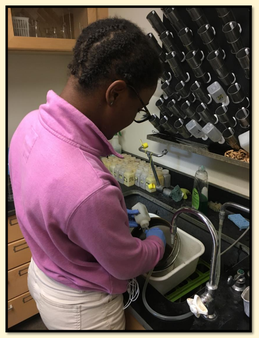

Fig. 3. Ivori collecting POM data

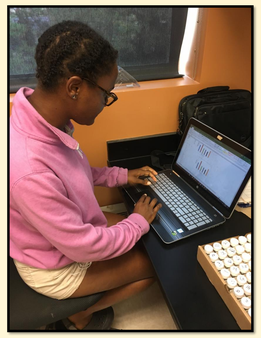

Fig. 4. Ivori entering data

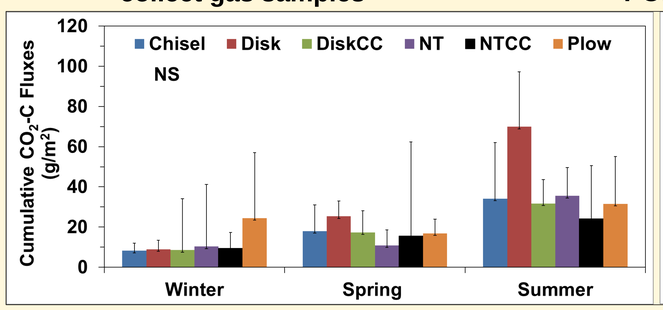

Fig. 5. Seasonal (Winter, Spring, Summer) mean cumulative CO_2-C fluxes. Error bars are standard deviation. NS=non-significant

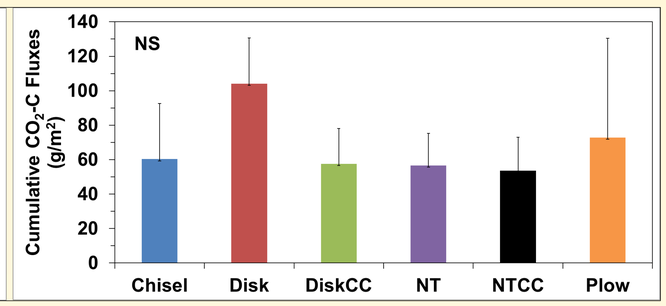

Fig. 6. Mean cumulative CO_2-C flux by tillage treatment from November 1, 2016 to June 28, 2017 in long-term tillage study. Error bars are standard deviation. NS=non-significant

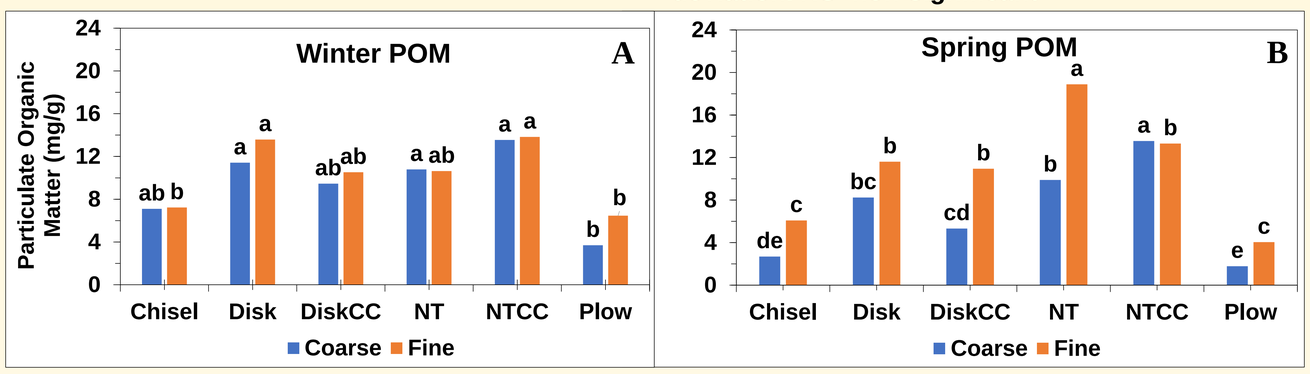

Fig. 7. Particulate organic matter measured in winter (A) and spring (B) in the long-term tillage study. Coarse is POM >0.5 mm and fine is POM between 0.5 mm and 53 µm. Different letters above bars within a POM size-class denote statistical differences between treatments at p <0.05.

Discussion

- CO_2-C fluxes varied seasonally, as shown in Figure 5, increasing to the greatest extent in summer, but tillage did not increase CO_2-C fluxes in those seasons (fall and spring; data not shown).
- Cumulative CO_2-C fluxes from November 1, 2016 through June 28, 2017 were unaffected by tillage treatments (Fig. 6).
- The cPOM and fPOM concentrations in winter were lowest in plow (Fig. 7A-B).
- The cPOM and fPOM concentrations in spring were lowest under chisel and plow compared to other treatments and tended to be greater under Disk, DiskCC, NT or NTCC (Fig. 7A-B) compared to plow due to destruction of soil aggregates and oxidation of soil organic C.
- In a similar study, cPOM and fPOM concentrations were lower in plow, chisel and disk compared to NT (Kibet et al., 2016).

Conclusion

- Cumulative CO_2-C fluxes were the greatest in summer.
- Plow tillage decreased cPOM and fPOM concentrations compared with NT.
- The reduction in POM concentrations with plow or chisel tillage may lead to reductions in soil organic matter concentration compared with NT.

References

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