Long term crop rotation and tillage effects on greenhouse gas emissions in Illinois, USA

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Introduction and Rationale

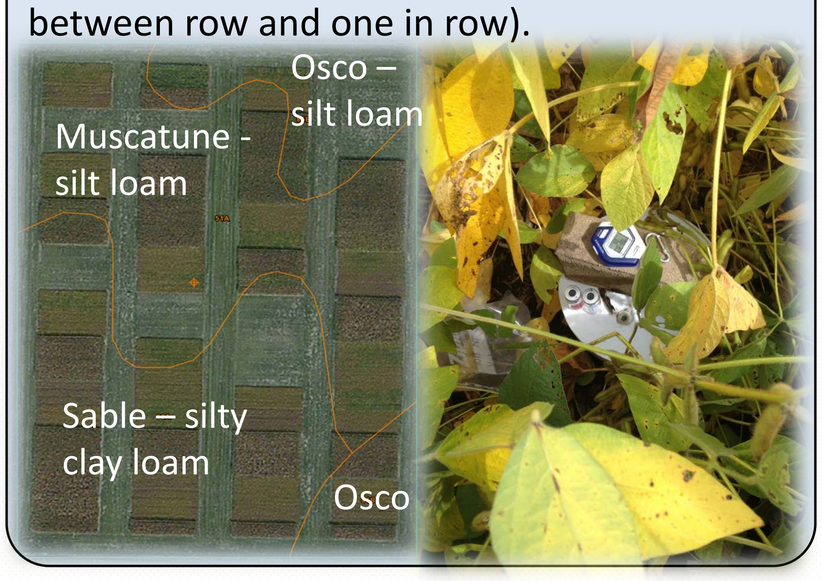
Global greenhouse gas (GHG) emissions are large due to land use change and fossil fuel combustion. A major contributor to atmospheric pollution, the global warming potential of N_2O per unit mass has been estimated to be about 320 times greater than that of CO_2 (Callander et al., 1995). Management practices within conventional row crop agriculture vary greatly, generating a wide range of effects on soil, crops and, thus, GHG emissions. Greater N_2O emissions have been reported in continuous corn compared to corn in rotation (Adviento-Borbe et al., 2007) and also under no-till compared to tilled systems (Venterea et al. 2005, Halvorson et al., 2008, Malhi et al., 2006).

Objectives

To determine the effect of rotations and tillage on GHG emissions (N_2O, CO_2, and CH_4) after 15 years of management.

Experimental Procedure

The study was conducted in Monmouth, IL. A split-plot of rotation and tillage in a RCBD with 4 reps established in 1996 was used to collect GHG data from spring 2012 to 2015. Main-plots consisted of continuous corn (CCC), corn-soybean (CS), corn-soybean-wheat (CSW) and continuous soybean (SSS); while sub-plots involved no-till (NT) or chisel tillage (CT). GHG (N_2O, CO_2, and CH_4) emissions were taken from 0.031 m^2 PVC chamber bases located in each plot of the study site (corn plots have one chamber between row and one in row).



Results and Discussion

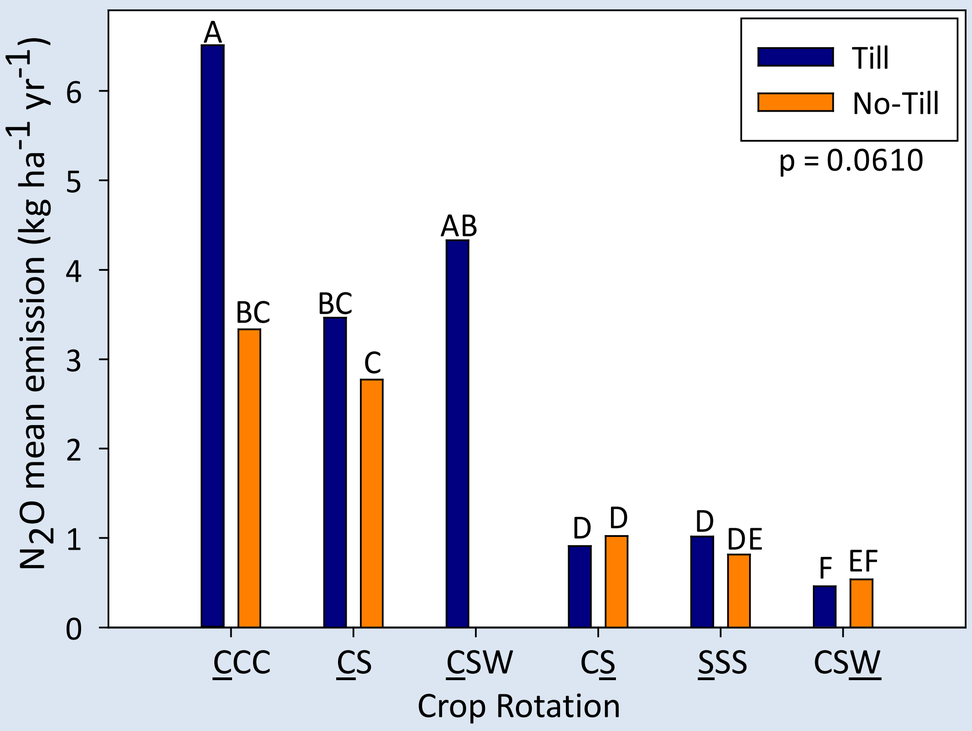


Figure 1. Interaction of tillage and crop/rotation on N_2O emissions. Data are back-transformed averages over three years at Monmouth, Illinois. Cumulative N_2O emissions were highest from corn, and tended to be higher with tillage than under no-till. CCC-T and CSW-T rotations had the highest N_2O emissions, followed by CS-T, CCC-NT, and CS-NT. Cumulative N_2O emissions from soybean were only about ¼ those from corn, and were unaffected by rotation or tillage. Wheat produced only about ½ as much N_2O emissions as soybean. Wheat added into the corn-soybean rotation decreases cropping system N_2O emissions and also plays a role in protecting soils (present over the winter).

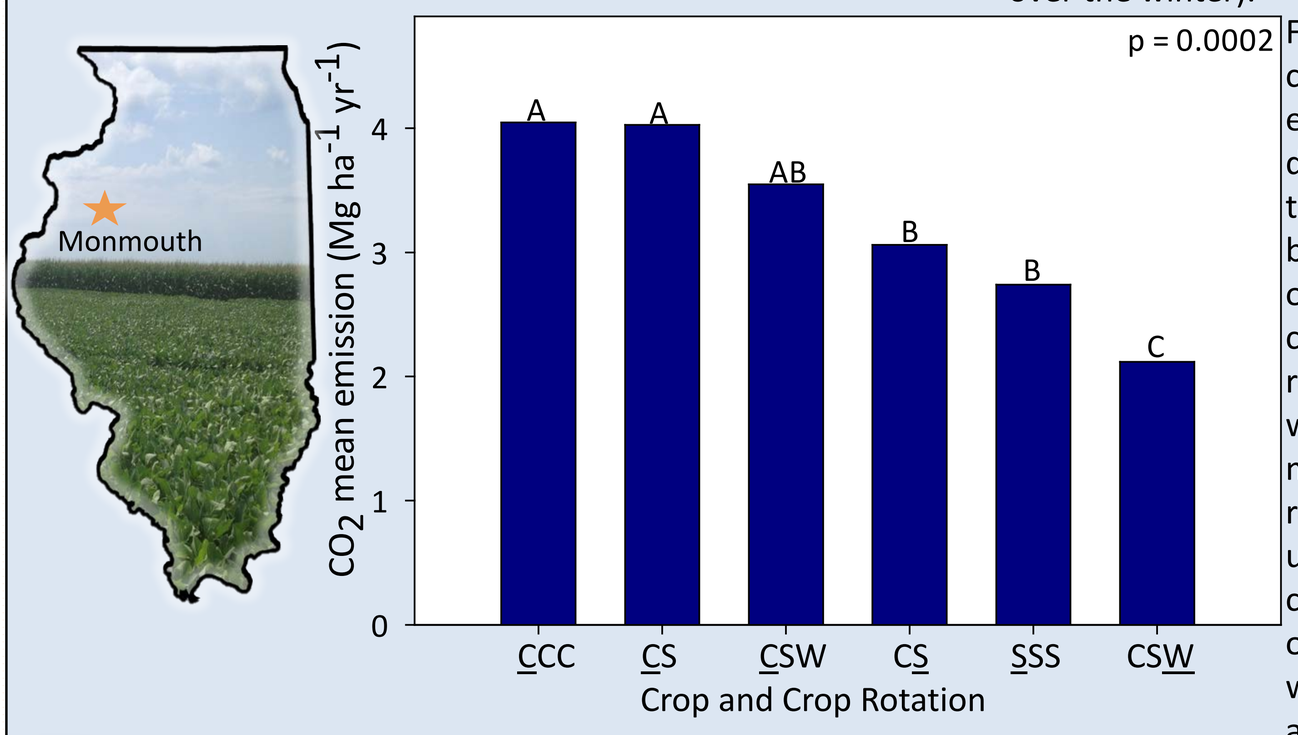


Figure 2. Effect of crop and crop rotation on CO_2 emissions. Except for CSW, data are averaged over tilled and no-till. Data are back-transformed averages over three years. Because corn produces much more residue than soybean or wheat, it is not clear why more CO_2 would be released during the season under the corn crop compared to when the other two crops (especially wheat that follows corn) are growing.

Conclusions and Recommendations

- Cumulative N_2O emissions averaged over three years were highest from the corn phase of the rotation compared to the soybean and/or wheat phase.
- Chisel tillage increased cumulative N_2O emissions only under CCC, but not in the other rotations.
- Cumulative CO_2 emissions where not affected by tillage options within rotations. Rotations with more corn had higher emissions during the corn phase than during the soybean or wheat phases.
- As we lower the number of corn years, GHG emissions are mitigated due to lower N fertilizer inputs.
- CH_4 emissions were not different among treatments or years

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