Gross Ammonification in Corn is Influenced by Soil Organic Carbon and Nitrogen Management Strategy

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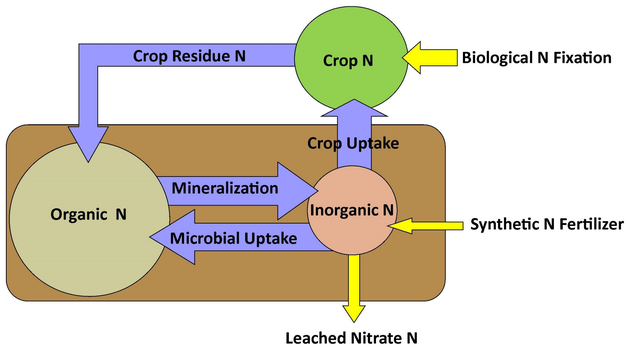
Introduction

- Nitrogen management strategies for annual grain cropping systems that can improve agricultural production efficiency and environmental quality are needed.
- Extended crop rotations with high organic matter inputs have been shown to increase crop yields while reducing N losses.
- Enhanced internal N cycling processes may reduce the need for large inorganic N pools and contribute to more efficient N management in extended crop rotations.



We explored the effect of N management strategies and soil organic C (SOC) on gross ammonification rates.

Methods

We used a long-term (12-year) cropping systems experiment in Iowa to compare a simple 2-year rotation with more diverse 3- and 4-year rotations. The diverse rotations receive N rich legume and manure inputs, while the simple rotation depends on relatively large inorganic N fertilizer applications.

2 year = corn-soy (C2)

3 year = corn-soy-oat/clover + manure (C3)

4 year = corn-soy-oat/alfalfa + manure (C4)

- Gross ammonification rate was measured by ^{15}N pool dilution.
- Soil organic C (SOC) was measured by combustion analysis.
- Measurements were made three times during the 2014 growing season at two soil depths (0-10 cm and 10-20 cm).

Results

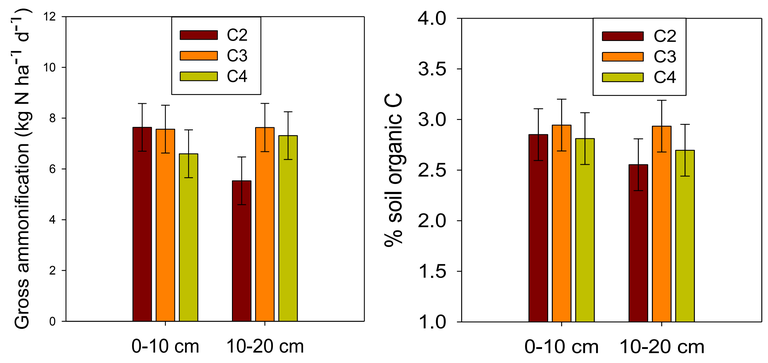


Figure 1. Cropping system effects on SOC and gross ammonification rate were observed in the 10-20 cm depth, but not the 0-10 cm depth.

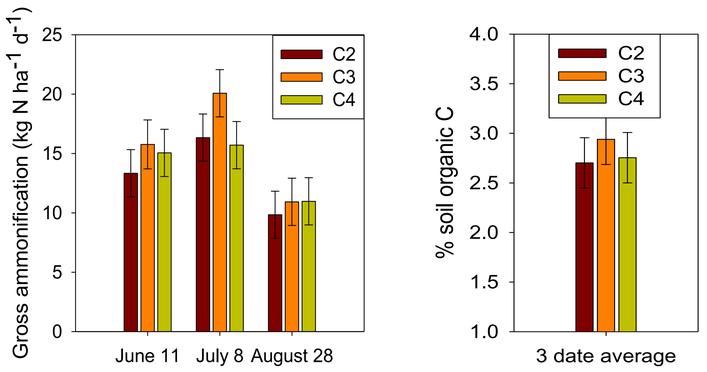


Figure 2. Gross ammonification rate but not SOC was significantly different across the three measurement events.

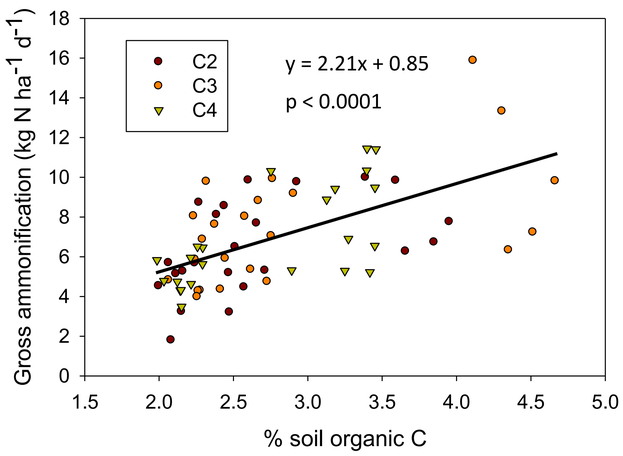


Figure 3. Soil organic C and gross ammonification rate were positively correlated across the cropping systems, depths, and dates.

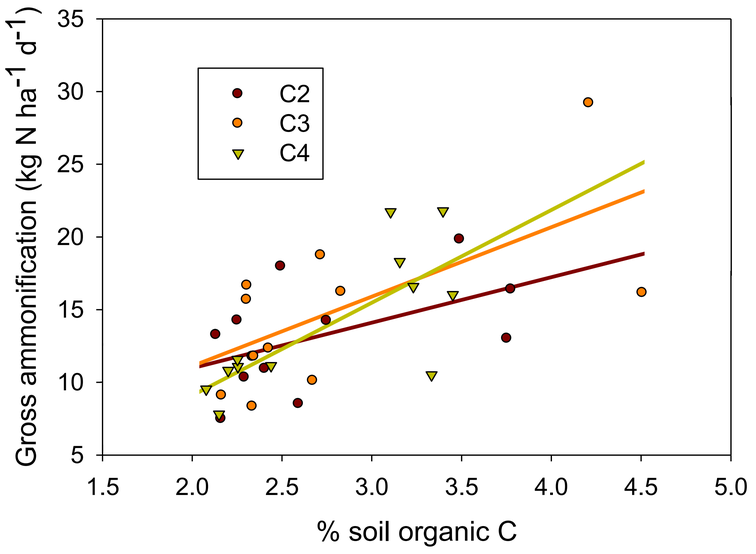


Figure 4. The diverse cropping systems had significantly greater regression slopes between SOC and total gross ammonification rate (0-20 cm) compared to the simple rotation, indicating a greater positive response of gross ammonification to increasing SOC levels in the diverse systems.

Conclusions

- Gross ammonification rate varied over a growing season with highest rates observed in early July.
- Gross ammonification is higher in soils with higher organic C.
- Gross ammonification was greater under diverse crop rotations in soils with higher organic C.
- Small differences in daily gross ammonification (e.g. 1 kg N ha^{-1} d^{-1}) could generate large differences in cumulative gross ammonification (e.g. > 60 kg N ha^{-1}) if the differences are consistent over a 2 month growing season.
- Nitrogen management strategies focused on increasing organic C can enhance internal N cycling rates, which could reduce dependence on exogenous N fertilizer inputs.
- Future research efforts should continue to explore cropping system impacts on internal N cycling dynamics, including the fate of newly produced ammonium.

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