Increasing Rates of Gross Nitrogen Mineralization in Diversified Midwestern Cropping Systems

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Introduction

Gross N mineralization is the total amount of nitrogen transformed by microbes from labile soil organic N (SOM-N) to NH₄⁺. Agroecosystems that achieve increased rates of gross N mineralization could potentially:
- Supply sufficient N to meet crop demand without depending on large fertilizer inputs and associated pools of inorganic N (NO₃⁻ and NH₄⁺).
- Reduce N losses to the environment by reducing large inorganic N pools.

Conceptual Model

Gross N mineralization rates should be greater in agroecosystems with large labile SOM pools, which can be favored by high organic matter inputs, such as manure and legumes. Additionally, crop yields could be increased in systems with high gross N mineralization as N availability would be more stable.

Low Gross N Mineralization

Nitrogen Fertilizer

Crop

Nitrogen Fertilizer

Crop

Labile SOM-N

NO₃⁻

Leaching

NH₄⁺/NH₃

High Gross N Mineralization

Data from the Marsden Farm cropping systems experiment in Iowa supports the conceptual model:
- Inorganic N pool size is greater in simple rotations than diverse rotations with manure and legumes.
- Despite smaller N pool size, corn yields are higher in more diverse rotations.

Study Objective

We tested the gross N cycling rates conceptual model by examining the relationship between manure application, particulate organic matter N, and gross N mineralization rates.

Measurements were taken on soil samples from three long-term cropping systems experiments in Iowa (Marsden), Minnesota (VICMS), and Wisconsin (WisCST). Cropping systems in each experiment vary in diversity and N fertility sources. Soil samples were taken from corn plots in fall 2012, 0-20 cm depth.

Results

Hypothesis 1: POM-N concentrations will be higher in agroecosystems with greater organic N inputs.

Hypothesis 2: Gross N mineralization will be higher in agroecosystems with large POM-N concentrations.

Hypothesis 3: Gross N mineralization will be higher in agroecosystems with greater organic N inputs.

POM-N concentrations were greater with increasing rates of manure N application (p=0.0001).

Gross N mineralization was greater when POM-N concentrations were larger (p=0.004).

Manure application was significantly positively correlated with gross N mineralization rate (p=0.02).

Conclusions

- Manure application increased POM-N, gross N mineralization was positively correlated with POM-N, therefore manure application may increase gross N mineralization rates.
- Cropping system management can have a large impact on POM-N concentrations and gross N mineralization rates.
- Agroecosystem design can improve supply of N to a growing crop through organic N inputs, which may reduce N losses to the environment.
- Future work will focus on further characterization of the relationship between labile SOM fractions and gross N mineralization in agroecosystems. Additionally, we will investigate how increased rates of gross N cycling can impact crop N availability and N losses to the environment.

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References


