Nitrogen Mineralization Indicators Reveal Gross N Mineralization is Related to Different Factors than Potential Net N Mineralization

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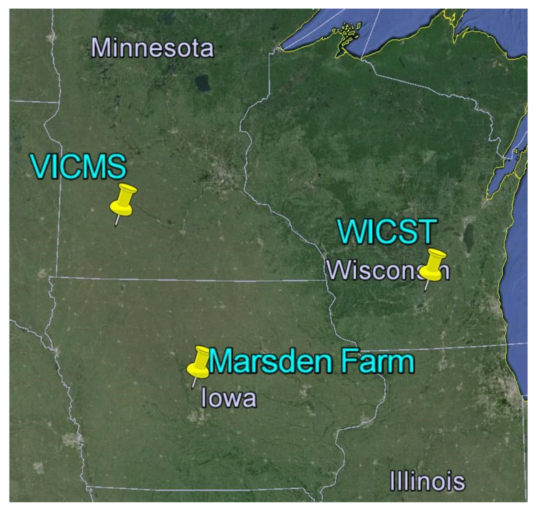
Introduction

- Mineralization of nitrogen plays an important role in assessments of soil health, as inorganic N is both necessary for crop nutrition and a possible source of pollution. M
- Recent evidence suggests that net N mineralization does not fully represent plant available N, and gross N mineralization may better indicate potential plant N availability.
- Much research has focused on predicting net N mineralization in agricultural systems. In contrast, gross N mineralization is relatively poorly understood, and it remains unknown if predictors of net N mineralization can also predict gross N mineralization.
- We tested the hypothesis that gross N mineralization is best predicted by soil organic matter (SOM) properties different from those that predict potential net N mineralization.
- Additionally, we examined the ability of N mineralization predictors to perform across diverse soil types and agricultural management strategies.

Methods

- We utilized agricultural soils from 6 cropping systems experiments in the Midwest US and Israel.



- Treatments within each site were classified as organic (amended with organic materials) or inorganic (not amended with organic materials).
- Gross N mineralization was measured with the ^{15}N pool dilution method and potential net N mineralization was measured with a 7-day anaerobic incubation.

- Measured predictors of N mineralization included various soil organic matter (SOM) properties (Table 1).
- Multiple linear regression (MLR) techniques were utilized to simultaneously account for multiple sources of variation and thus improve predictions. MLR models were selected using a cross validation technique and AIC selection criteria.

Predictors†	Gross N mineralization	Potential net N mineralization
POM C	**0.66***	**0.43***
Cold water HIX	**0.66***	0.02
Cold water HIX_{Ohno}	**0.64***	0.04
Hot water OC:ON	**-0.60***	-0.38
Hot water NO_3^-	**0.59***	**0.59***
Non-POM C	**0.58***	0.23
Cold water NO_3^-	**0.58***	**0.54***
Hot water ON	**0.57***	**0.69***
Cold water total N	**0.56***	**0.61***
Hot water total N	**0.56***	**0.75***
Hot + cold water ON	**0.56***	**0.72***
POM C/TotalC	**0.53***	0.05
Hot water HIX	**0.53***	0.17
Hot + cold water OC	**0.52***	**0.66***
Hot water HIX_{Ohno}	**0.52***	0.09
Cold water OC	**0.49***	0.39
Hot + cold water OC:ON	**-0.47***	-0.4
Hot water OC	**0.45***	**0.64***
POM N	**0.43***	0.36
POM N/Total N	**0.42***	0.09
Non-POM C:N	**0.41***	-0.05
CO_2 burst 0-7 day/Total C	0.34	0.1
Cold water fluorescence index	0.34	0.25
CO_2 burst 4-7 day	0.23	**0.66***
Cold water ON	0.22	**0.49***
Cold water freshness index	0.14	0.32
Hot water FI	0.09	0.24
CO_2 burst 0-7 day	0.08	**0.62***
Cold water NH_4^+	0.06	0.21
POM C:N	-0.01	-0.09
CO_2 burst 0-3 day	-0.02	**0.55***
Cold water OC:ON	-0.09	-0.2
Non-POM N	-0.12	0.13
Hot water NH_4^+	-0.12	0.2
Total N	-0.14	0.16
Total C	-0.16	0.16
Hot water freshness index	-0.24	0.13
Total C:N	-0.25	-0.02

† POM = particulate organic matter, HIX = humification index, HIX_{Ohno} = modified humification index, FI=fluorescence index

** significant at α level of 0.0013

Table 1. Many SOM properties were positively correlated with gross and potential net N mineralization across all soils and management types. Of the 32 measured SOM characteristics, 9 were significantly correlated with both gross and net N mineralization, 12 were correlated with only gross N mineralization, and 4 were correlated with only net N mineralization.

Results

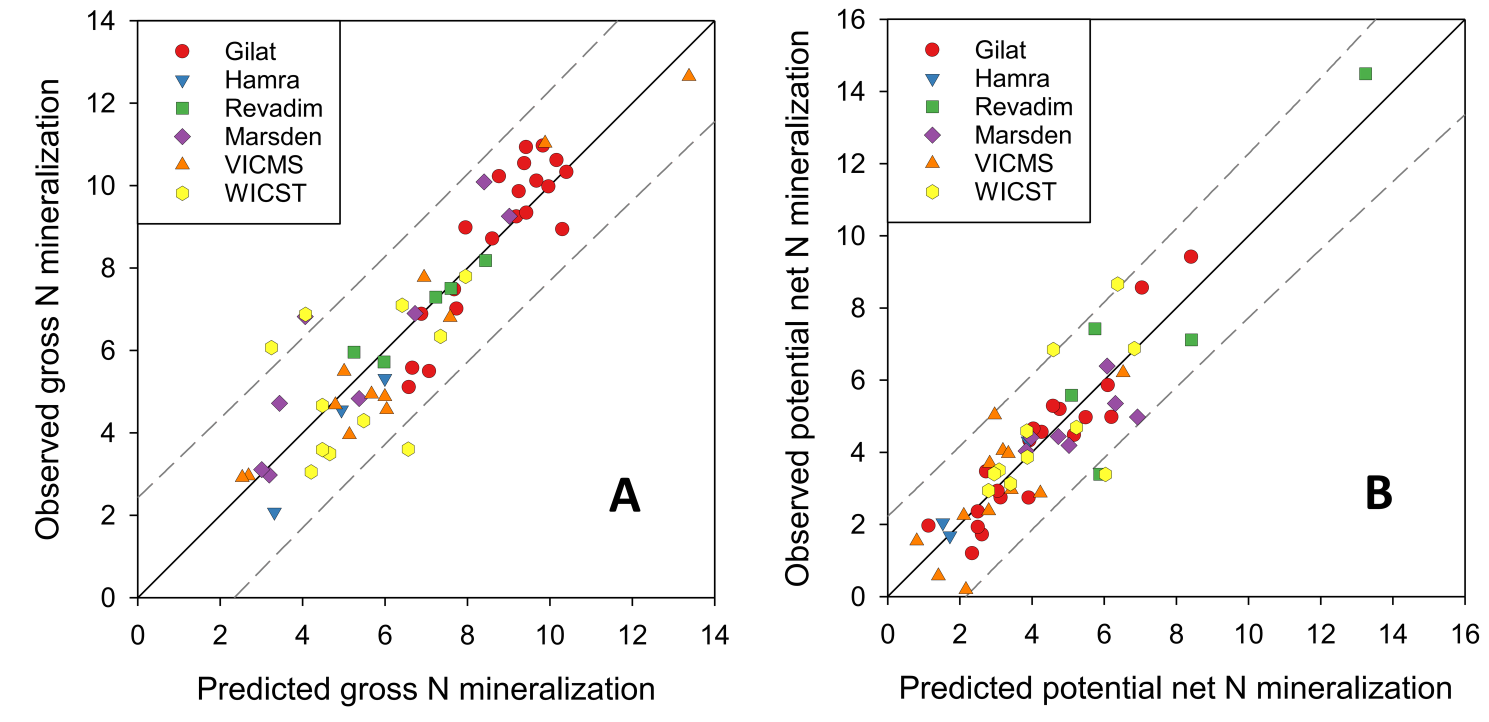


Figure 2. Gross N mineralization (A.) and potential net N mineralization (B.) MLR predictions were closely correlated with observations (R^2 = 0.82 for gross N mineralization and R^2=0.80 for potential net N mineralization). Predictors selected for the gross N mineralization model were: Non-POM C, cold water organic N, hot water NO_3^-, hot + cold water organic C, and cold water HIX. Predictors selected for net N mineralization were: Normalized POM-N, Non-POM N, cold water total N, hot water organic C, hot water total N, and hot water NH_4^+. Solid lines are 1:1 regression lines, and dashed lines are 95% prediction intervals. Units are mg N kg^{-1} soil d^{-1}.

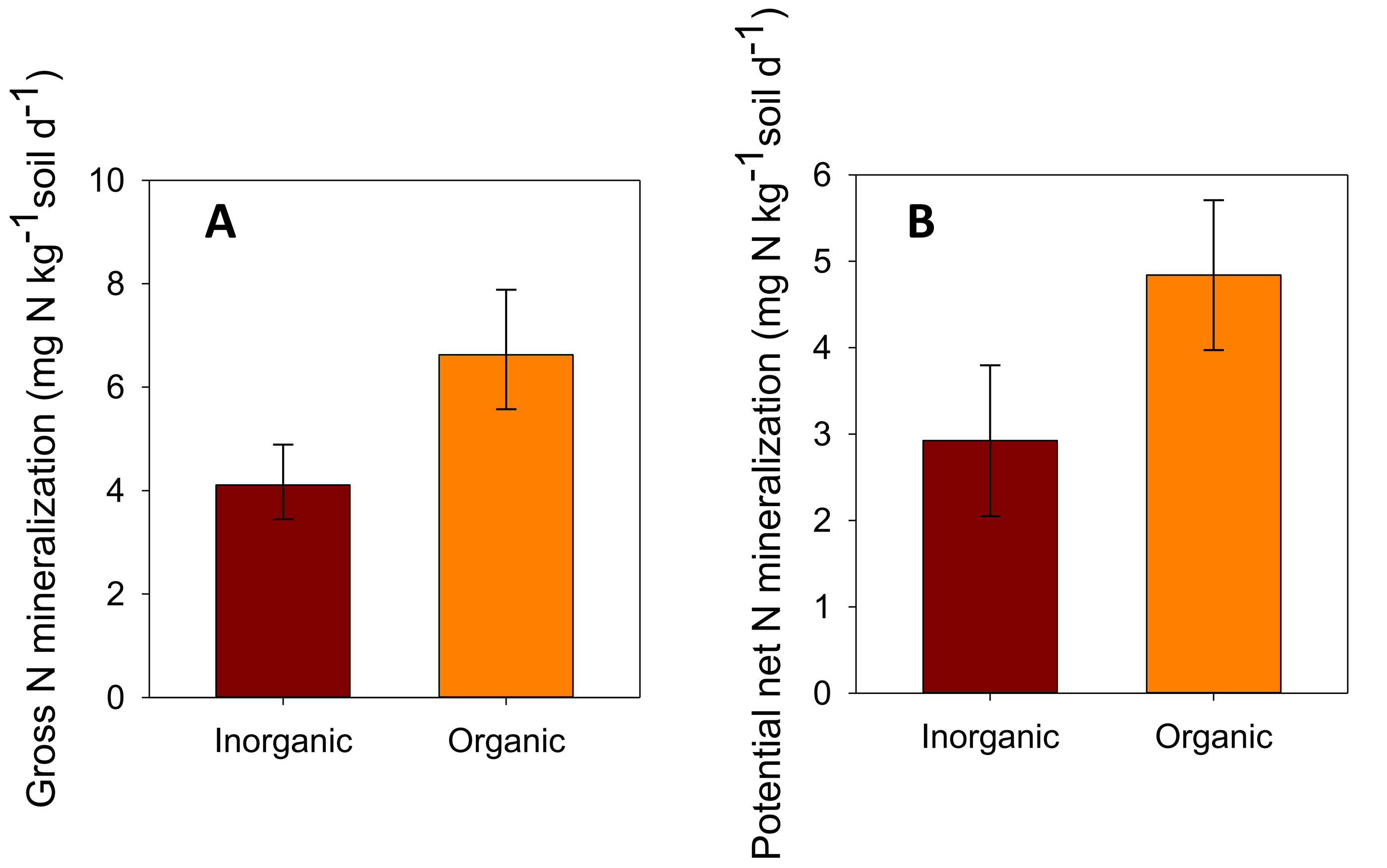


Figure 2. N mineralization was greater with organic fertility management than with inorganic fertility management for both gross N mineralization (A., p=0.002) and potential net N mineralization (B., p=0.004). Error bars are 95% CI.

Conclusions

- Gross and potential net N mineralization had distinct relationships with several SOM characteristics.
- Predictor combinations selected by MLR were distinct for gross and potential net N mineralization, yet R^2 > 0.8 was achieved for both.
- MLR predictions were consistently accurate across a wide diversity of soil types and agricultural management regimes, suggesting MLR could be useful for universal assessments of soil health.
- Organic amendments increased both gross and potential net N mineralization across diverse soils. Organic amendments may be considered universally beneficial for increasing N mineralization.
- Future research should investigate the utility of MLR predictions in additional ecosystems, and how the predictions of gross and net N mineralization can be related to plant N uptake.

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