COMPARATIVE ANALYSIS OF CARBON AND NITROGEN MINERALIZATION IN DIVERSE FARMING SYSTEMS

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Research Question

How do different farming systems affect the health of the soil, as shown through the pools of labile carbon and nitrogen?

Palouse Conservation Field Station

- 12th year in five different farming systems
- ART: Agroecosystem Research Trials
  - NAT: Native Agroecosystem Trial
    - Idaho fescue and Bluebunch wheatgrass
  - OAT: Organic Agroecosystem Trial
    - **Spring Pea** as a green manure
  - PAT: Perennial Agroecosystem Trial
    - Alkar Tall Wheatgrass
  - No Till a (with legume)
    - Winter Wheat, **Garbonzo Beans,** Spring Wheat
  - No Till b (only cereals)
    - Winter Wheat, **Spring Barley**, Spring Wheat

Aerial View of ART at PCFS

Purpose

- 24-hour CO_2 burst
- Applicability to Farmers
  - Simply gauge the health of the soil
- Solvita Test (Haney et. al, 2008)

Hypothesis

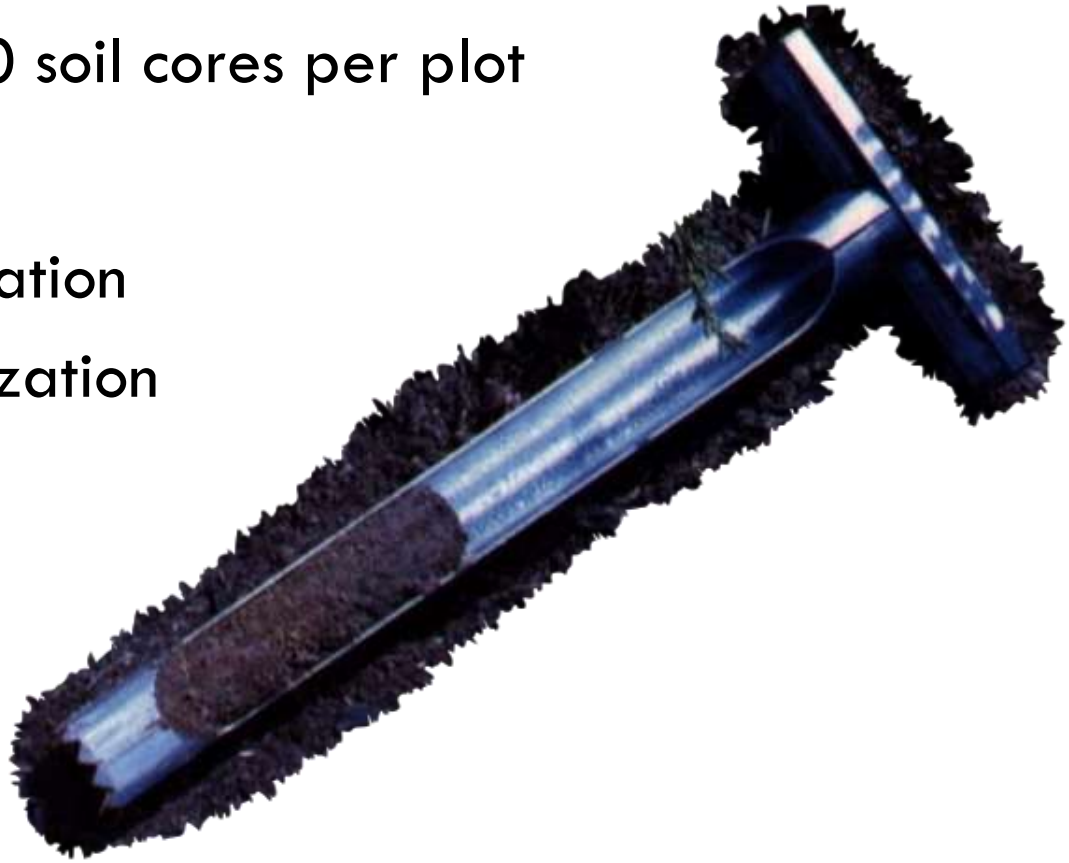
Carbon mineralization rates would be highest with "healthiest" soils:

- Native Prairie Grasses
- OAT
- PAT
- NTa (with legume)
- NTb (only cereals)

NAT > OAT > PAT > NTa = NTb

Methodology

- Field work:
  - 10-cm depth samples
  - Approximately 50 soil cores per plot
- Lab work:
  - Carbon Mineralization
  - Nitrogen Mineralization
  - Total Carbon
  - Total Nitrogen



Carbon Mineralization Incubations

Measurement of the respiration rates (CO_2) of the microbes in the soil

- Carbon dioxide reacts with alkali traps (10.0 mL 1M NaOH) to form CO_3^{2-}
- 24 day Incubation:

  Samples taken at days 1, 3, 7, 15, and 24

Titrations

$Na^+ + \mathbf{OH^-} + \mathbf{CO_2} \rightarrow Na^+ + \mathbf{CO_3^{2-}}$

$Ba^{2+} + CO_3^{2-} \rightarrow BaCO_3$ (solid)

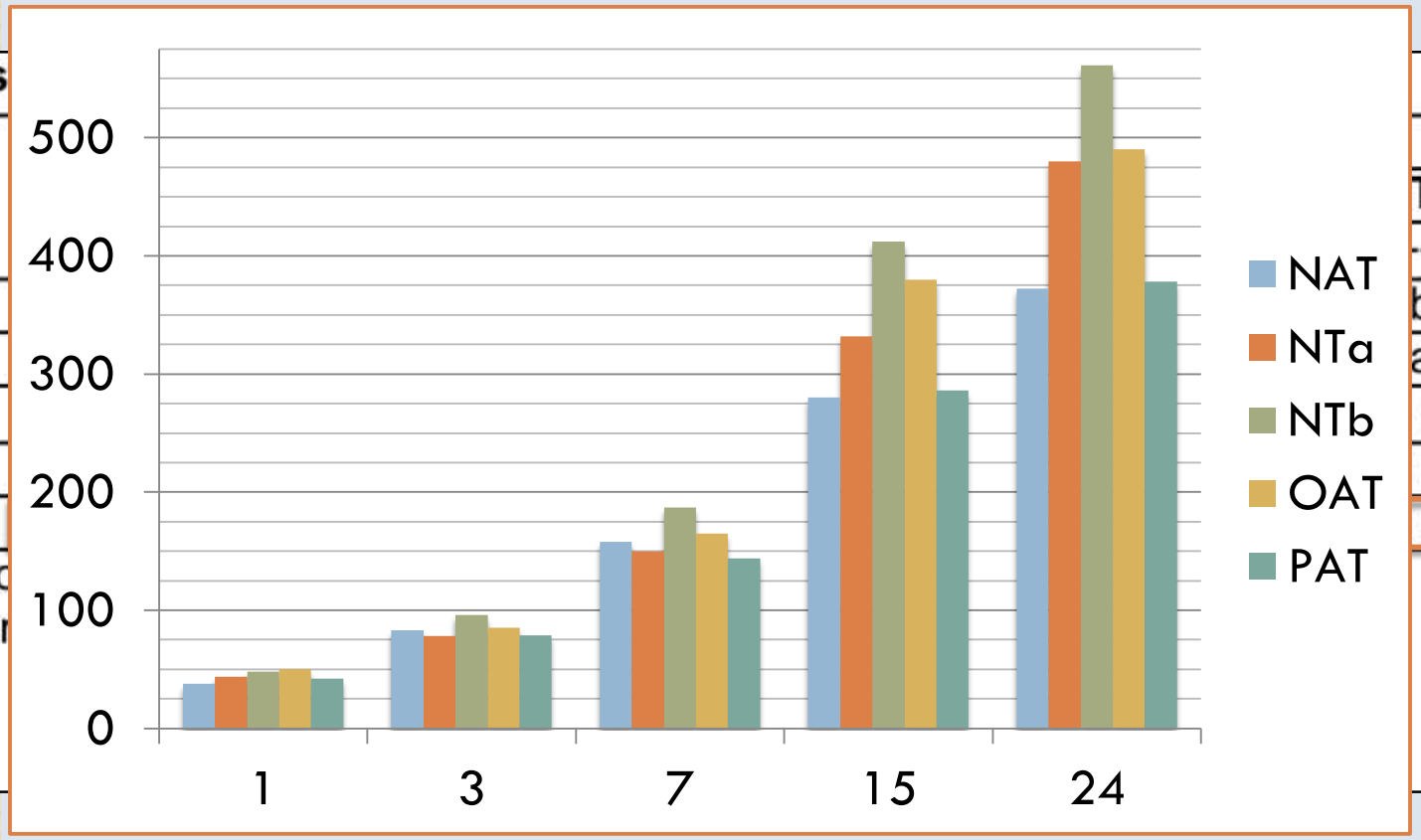
(Campbell et al., 1991; Franzluebbers et al., 2000; Haney et al., 2001)

Other Lab Work

- Nitrogen Mineralization measures the change nitrate (NO_3^-) and ammonium (NH_4^+) content of the soil (Liebig et al., 2004)
  - Analyzed at T_0 and days 1, 3, 7, 15 and 24
- Total Carbon (C) and Total Nitrogen (N) (Liebig et al., 2004)
  - Overall assessment of total soil C, N and their ratios among farming systems
  - Analyzed using dry combustion (TrueSpec)

Farming sys	
Time (days)	
1	
3	
7	
15	
24	

Values in a ro
multiple mean



T
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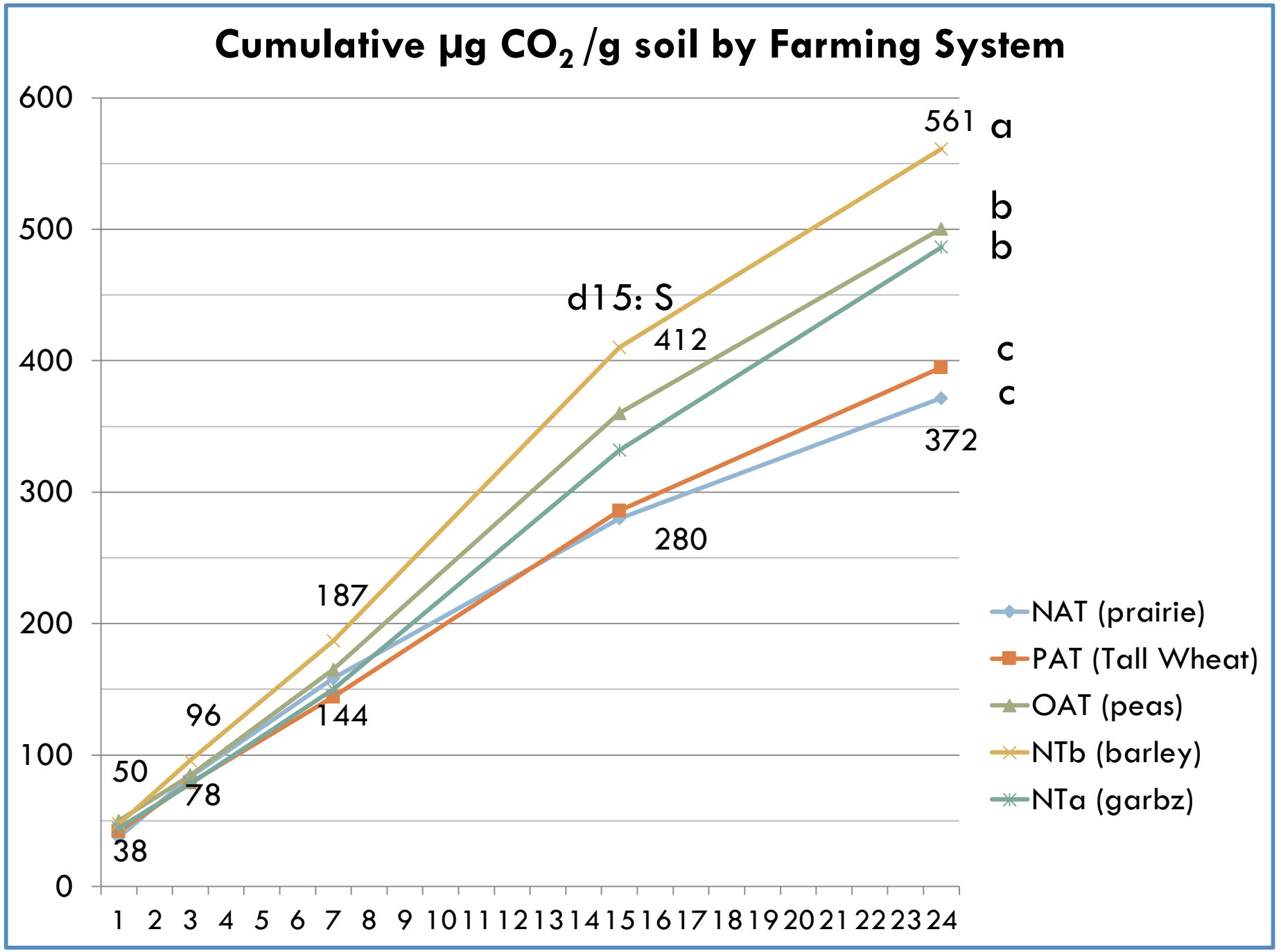
b
a
b
c
c

Results: Carbon Mineralization Incubations


Cumulative µg CO2 /g soil by Farming System
600
500
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
561
a
b
b
d15: S
412
c
c
372
280
187
96
144
50
78
38
NAT (prairie)
PAT (Tall Wheat)
OAT (peas)
NTb (barley)
NTa (garbz)

Next Steps

CO_2 Burst Predicting Nmin

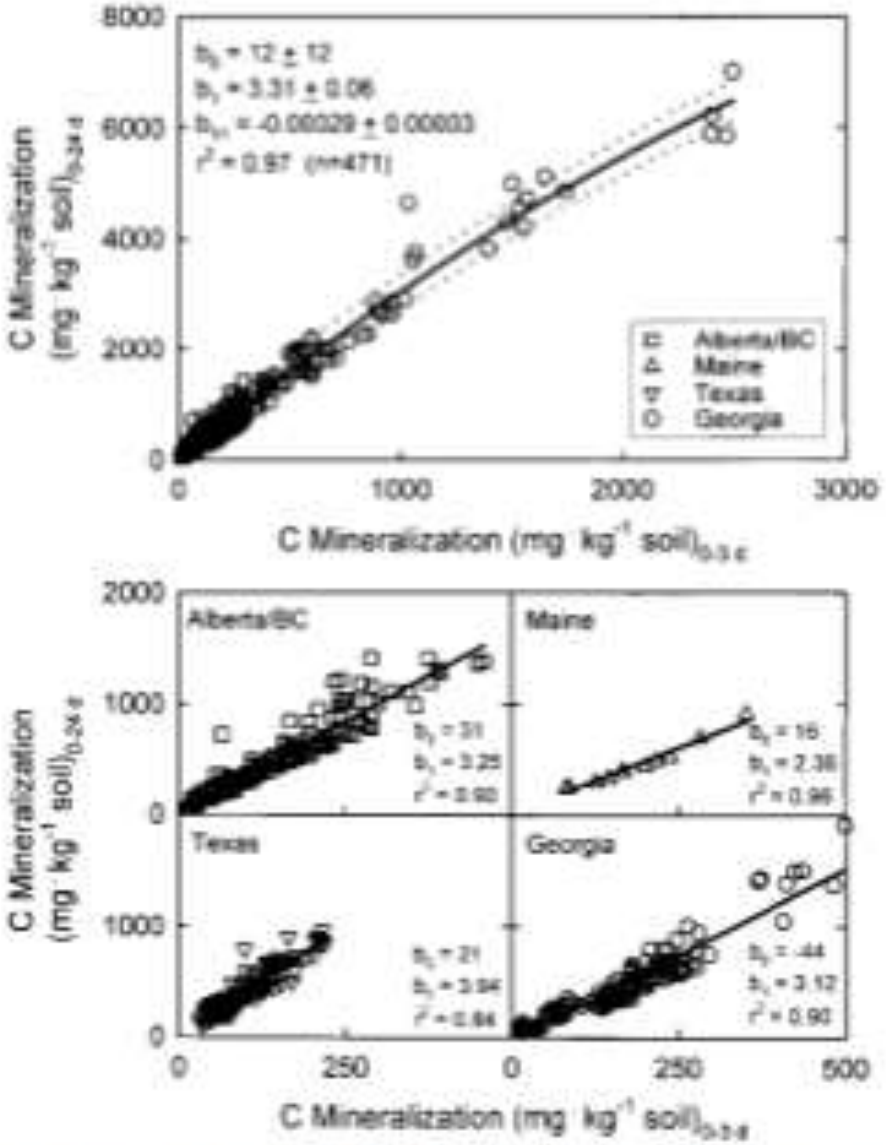


Fig. 3. Relationships of C mineralization during 0–3 d with C mineralization during 0–24 d in soils from Alberta–British Columbia, Maine, Texas, and Georgia. Lower panels are magnifications of the 0 to 500 mg kg^{-1} range in $CMIN_{0-14}$ for each of the four regions.

Franzluebbers et al., 2007

Summary and Conclusions

My Hypothesis: NAT > OAT > PAT > NTa = NTb

Actual Results: NTb > OAT = Nta > PAT = NAT

- Is is applicable to farmers?
  - General indicator of soil health
  - Not precise enough to measure differences in a mere 24 hr

Future Research:

Determine general range of carbon mineralization rates for public use

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