NITROGEN MINERALIZATION FROM CLOVER LEAVES - SOIL TYPE AND LOW TEMPERATURE

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Objectives

Knowledge for improving prediction of N and C mineralization after incorporation of green manure => better management of green manure under cold climate conditions

Hypotheses

- The ratio of net mineralized N to mineralized C from plant residue is:
  - larger at low than at higher temperature
  - not affected by soil type
- Substantial N mineralization from green manure residues occurs even at 0 °C

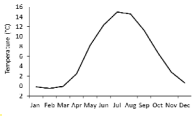
Material

Dry clover leaves (C/N ratio of 9.8) sorted out from a grass – clover mixture, field labelled with ^{13}C.

Two soil types from nearby location with similar cultivation history and climate. Soils were pre-incubated at about 15°C, and acclimated to final temperature for 3 days.

Soil type	*Sand (%)*	*Clay (%)*	*pH*	*Total C (%)*	*C/N*
Silty clay loam[1]	3	27	6.0	4.45	11.4
Sandy loam[2]	51	6	6.2	1.30	11.8

1): Kvithamar(63°29 N, 10°52 E); 2): Værnes (63°27 N, 10°57 E)



Average monthly soil temperature at 10 cm depth for the years 2006–2013

Methods

Two incubation experiments (simultaneous)
Temperature 0, 4, 8.5 and 15°C
Soil only or soil + clover leaves (4g/kg dry soil)

Exp. 1) N mineralization - NH_4-N and **NO_3-N**
4 replicates
Destructive sampling on day 0, 3, 8, 15, 30, 52, 80

Exp. 2) C mineralization
airtight chambers with **CO_2** trap
3 replicates
Sampling on day 0, 3, 8, 15, 30, 52, 80, 134, 142

Kept aerobic by monitoring and adding O2 .
Moisture slighthy below field capacity.

C decay rates calculated when first order mineralization could be identified analytically.

For leaves:
- - N mineralization estimated by the **difference method:**
  $N_{leaves} = N_{soil\ with\ leaves} - N_{soil\ only}$
- - C mineralization estimated both by **difference** and **13C method**.

Results

Nitrogen net mineralization

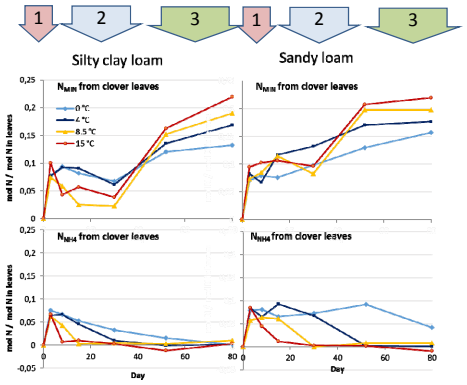


Fig. 1.Effect of clover leaves incorporation on net mineral N and ammonium-N in two contrasting soils (corresponding N amounts in pure soils were subtracted), kept at constant temperature.

1. Rapid mineralization. Mainly as NH_4. Not affected by temperature

2. Immobilization in the clay soil, stronger at higher temperature. Slow mineralization in the sandy soil, unclear effect of temperature. Slower nitrification at lower temperatures.

3. Net mineralization, positive effect of temperature On day 80 net N_{MIN} about the same in both soils

Carbon net mineralization

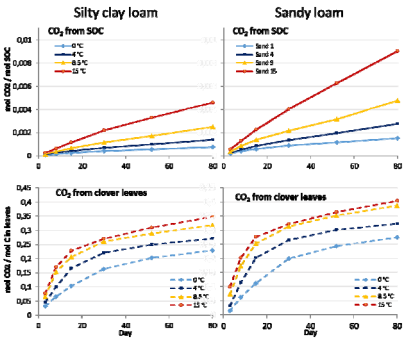


***Fig. 2**. Accumulated CO_2 from pure soil or from clover leaves*. SOC mineralized twice as fast in the sandy loam as in the clay loam.*
**: difference method*

N/C ratio of mineralized products

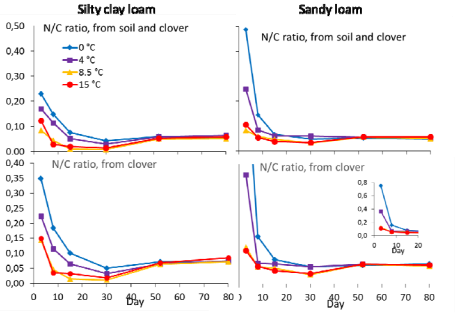


Fig. 4. Ratio of net mineralised N / accumulated CO_2 (mg/mg), from soil incubated alone (above) and from additional mineralization by leaves (below).
For leaves N is calculated by the difference method, while C by the ^{13}C method. Using the difference method for both does not substantially modify the results

…. and Conclusions

During the 80 days of incubation the total **N mineralization** from soil only was small (data not shown). Incorporation of clover leaves resulted in net mineralization with three distinct phases (Fig. 1 1 2 3).

During 2 **higher temperature increased immobilization** in the **silty clay loam** and had somewhat similar tendencies in the sandy loam. During this phase lasting about 50 days, the net **N_{MIN} available** to crop or other biogeochemical processes was **larger in the sandy soil**, particularly around 8°C, which is about the average soil temperature in May, that is around or soon after spring ploughing and sowing.

N mineralization was substantial even at 0°C.

C mineralization of **soil organic carbon** (SOC) and of clover **leaves** increased with tempe-rapture (Fig. 2,3). Mineralisation of SOC and also of leaves was **slower in the clay loam** (Fig.2). This soil type effect was stronger on SOC than on leaves mineralization

C mineralization responded **similarly to temperature changes** (Fig. 3) in both soils.

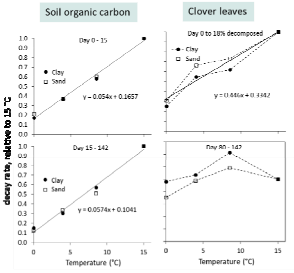


***Fig. 3**. Effect of temperature on the decay rate (net mineralized C/substrate C)** of SOC in pure soil and of leaves. For SOC, 1st order decay rates could be estimated both in early and late period , while for leaves this was possible only in the early period (not shown).*
***^{13}C method. Comparison with the difference method shows a priming effect (increased mineralization of SOC in presence of leaves). However, essentially the response to temperature and soil type was similar whether priming was considered explicitly or not.*

N/C, the ratio of net mineralized N to mineralized C was (Fig. 4):
- From clover leaves, **larger at lower than at higher temperature**, but only up to 50 days after incubation start.
  Affected by soil type, **larger in the sandy soil** than in the clayey soil.
- It was so also for the soil incubated alone.

This suggests that low temperature has stronger negative effect of on the microbial growth yield than on the microbial respiration – affecting the stoichiometry of the decomposition products

This effect should be studied directly and explicitly included in models for short term dynamics of N cycling, including leaching, denitrification and uptake by crops

References

Frøseth R B, Bleken M A. 2015. Effect of low temperature and soil type on the decomposition rate of soil organic carbon and clover leaves, and related priming effect. Soil Biology and Biochemistry. 80: 156–166.

Frøseth R B, Thorup-Kristensen K, Hansen S, Bleken M A. Mineralization of clover leaves at low temperatures in contrasting soil types. Submitted.

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