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Higher molecular weight dissolved organic nitrogen turnover as affected by soil management history

BACKGROUND

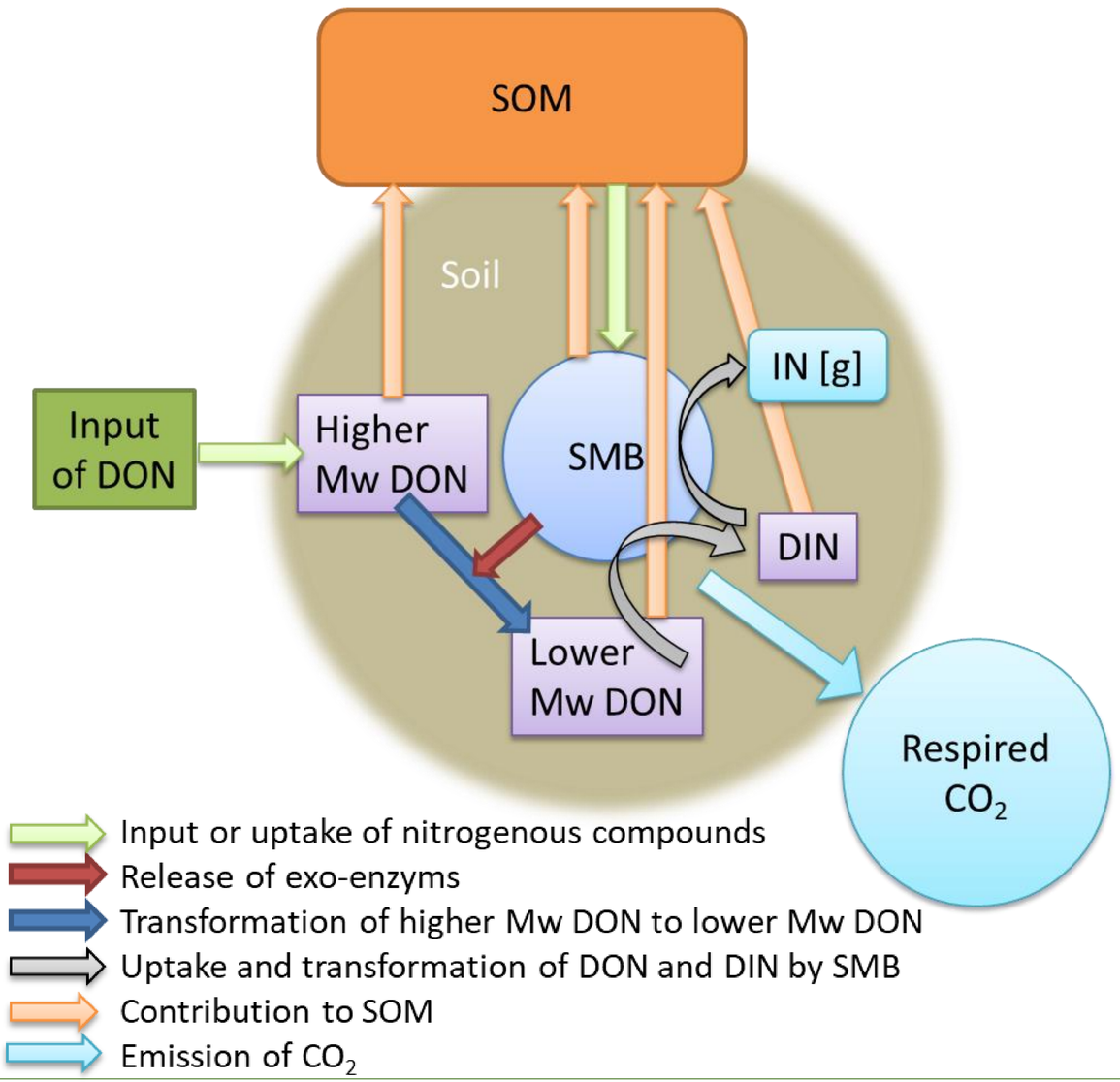
Dissolved organic nitrogen (DON) play an important role in short term soil N cycling. DON, as a collective term, refers to a diversity of organic N compounds which can operationally be grouped into higher molecular weight (Mw) DON (Mw > 1 kDa) and lower Mw DON (< 1 kDa). Higher Mw DON needs to undergo depolymerization (resulting in lower Mw DON) to become bioavailable. This is an exo-enzymatic process governed by the soil microbial biomass and plants. Since mineralization of lower Mw DON is relatively fast, from minutes to hours, the bottleneck in the turnover of soil ON lies in the higher Mw DON fraction, but there is a lack of knowledge on the turnover of different higher Mw size fractions.

OBJECTIVES

We studied the fate of two higher Mw DON fraction (1-10 kDa and >10 kDa) in three soils, with different liming histories since 1942.

HYPOTHESIS

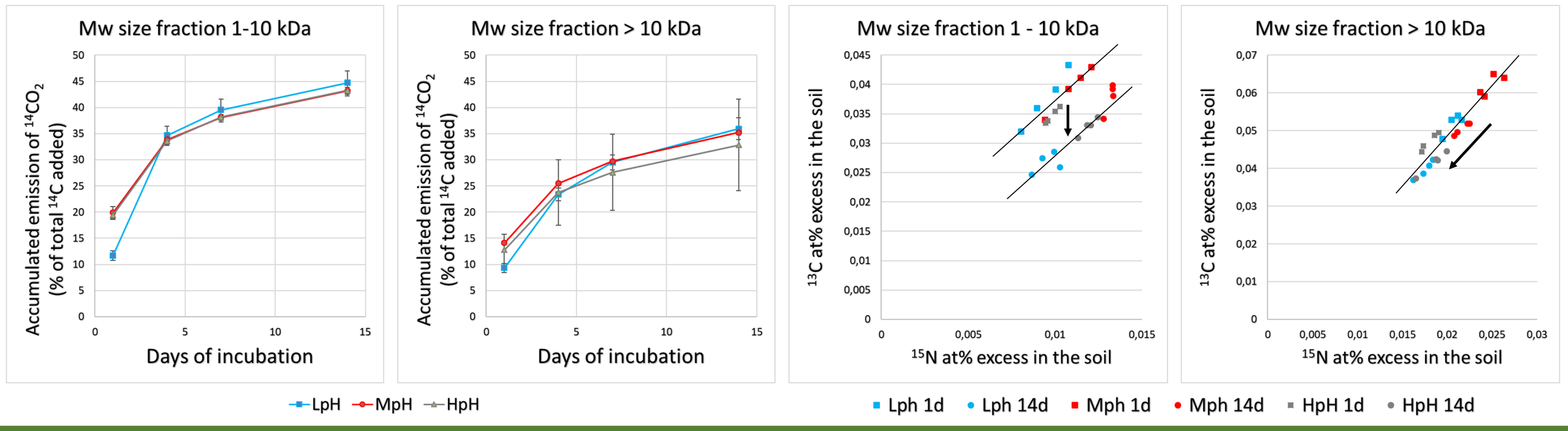
1. Differences in soil pH will affect the dominating microbial communities
2. At lower soil pH the turnover of higher Mw DON will be slower as compared to higher soil pH.



MATERIALS AND METHODS

Using micro-lysimeters, the turnover of two triple-labeled (^{15}N, ^{14}C and ^{13}C) higher Mw DON fractions were studied in a sandy soil with three distinct pH levels (Low (LpH) at 4.1, Medium (MpH) at 5.9, and High (HpH) at 7.6). The incubation experiment was initiated by adding a pulse of triple-labeled DON to the soil in the micro-lysimeters, whereafter the temporal development of respired $^{14}CO_2$ was measured. The experiment was terminated (at day 1 and 14) by washing the soil column with water and following the soil ^{13}C and ^{15}N depletion was among other analyzed.

RESULTS



DISCUSSION AND CONCLUSION

Across all three soil pH levels, the accumulated emission of $^{14}CO_2$ was higher for 1-10 kDa than for >10 kDa – meaning that the mineralization of the 1-10 kDa fraction was faster than the > 10 kDa fraction indicating that the bottleneck in the soil N cycle lies in ON above 10 kDa.

The ratio between ^{13}C and ^{15}N at% excess remaining in soil showed that for the 1-10 kDa DON fraction there was a downward shift from day 1 to day 14 indicating that in this Mw size fraction relatively more ^{13}C was leaving the system in mineral form (as CO_2), whereas ^{15}N was retained in the soil microbial biomass.
For the > 10 kDa DON fraction, the soil ^{13}C and ^{15}N enrichment decreased with time, but the ^{13}C to ^{15}N at% excess ration was constant over time indicating that that C and N was equally mineralized and incorporated in the soil microbial biomass.
NB: these are preliminary results, so the ^{13}C and ^{15}N at% excess ration can only be compared within each DON fraction and not across fractions.

Measurements of the ^{13}C and ^{15}N content in water samples will reveal whether N has left the system as $DIN_{[aq]}$ or $IN_{[g]}$, and PLFA-SIP on soil samples will elucidate to what extent labeled DON was incorporated in the microbial biomass or stayed intact in the soil.