Beech Research Group

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German Research Foundation (DFG) - Research Unit 788

Competitive Mechanisms of Water and Nitrogen Partitioning

in Beech-Dominated Deciduous Forests

P5: Quantification of Soil Microbiological N-Turnover Processes for the Characterization of N-Partitioning between Soil Microbiology and Vegetation

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In order to improve our understanding about competition for N and partitioning, it is necessary to study the dynamics of central key biotic and abiotic processes that produce and consume N within an ecosystem and to follow the short and long term fate of N within an ecosystem.

P5 Processes and parameters

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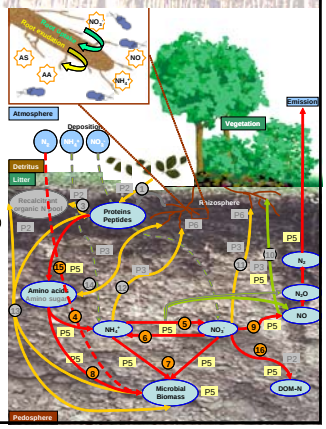
Processes:

- Ammonification 4
- Nitrification 5
- Microbial N-immobilization 7
- Uptake of amino acids by microorganisms 8
- Denitrification 9
- N_2-fixation 15
- Dissimilatory nitrate reduction to ammonium 6
- Abiotic nitrate immobilization 16

Parameters:

- Soil microbial biomass
- Soil DIN/DON-concentrations



P5 Aims of the project (1)

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- Quantification of competition for N between microbial N turnover processes involved in consumption/production/provision of N and plants and the resulting partitioning of N (field studies)
  - Identification of temporal patterns of N-competition
  - Identification of the effect of different vegetation components on N-competition
- Characterization of the competitive strength of microbial N-turnover processes under changing (studies under controlled conditions)
  - Water availability
  - C-availability
  - Vegetation component
- Determination of significance of contribution to N-competition
  - dissimilatory nitrate reduction to ammonium as a potential component in NO_3^- retention and biotic NO_3^- consumption processes
  - abiotic nitrate immobilization as a potential competitive mechanism for biotic nitrate consumption
  - N_2 fixation

P5 Aims of the project (2)

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- Identification of the effect of litter quality (leaf vs. root litter) on competition for N
- Identification of the importance of microorganisms vs. plant compartments and soil for short and long term partitioning of N
- Provision of algorithms of microbial N-uptake kinetics for implementation into process oriented models simulating present and prognosis of future competition for N between soil microorganisms and plants.

P5 Working program and methods (1)

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Integrated research approach comprising field studies and experiments under controlled conditions on microcosms in phytotrons and greenhouses.

Quantification of key microbial N-turnover processes and parameters under in-situ conditions at the research site near Tuttlingen

- gross ammonification, gross nitrification (^{15}N isotope pool dilution technique)
- NH_4^+/NO_3^- immobilization (^{15}N technique / ^{15}N tracer)
- Denitrification (Soil core method)
- Soil microbial biomass (Fumigation extraction (FE) method)

Experimental manipulations:

- Removal of natural regeneration, understorey vegetation, natural regeneration + understorey vegetation
- Girdling of stems
- Application of ^{15}N labelled leaf litter
- Application of $^{15}NH_4^+/^{14}NO_3^-$, $^{14}NH_4^+/^{15}NO_3^-$ and $^{15}N/^{13}C$ labelled amino acids

Quantification of additional N-turnover processes for determination of their significance in contributing to N-competition

- Dissimilatory nitrate reduction to NH_4^+ ($^{15}NO_3^-$ tracer)
- Abiotic nitrate immobilization ($^{15}NO_3^-$ tracer + Fumigation Extraction)
- N_2 fixation (Acetylene reduction assay)

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Working program and methods (2)

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Quantification of key microbial N-turnover processes and parameters under controlled conditions on microcosms in greenhouses and phytotrons at the GSF in Munich

- gross ammonification, gross nitrification (^{15}N isotope pool dilution technique)
- NH_4^+/NO_3^- immobilization (^{15}N technique / ^{15}N tracer)
- Denitrification (Soil core method)
- Soil microbial biomass (Fumigation extraction (FE) method)

Experimental manipulations:

- ± Water availability
- ± Girdling of stems
- ± Additional C-source

Experimental manipulations in greenhouses at University of Freiburg with determiniaton of soil microbial biomass only

- Application of ^{15}N labelled beech leaf litter (Fumigation extraction (FE) method)
- Application of ^{15}N labelled root litter (Fumigation extraction (FE) method)

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Results

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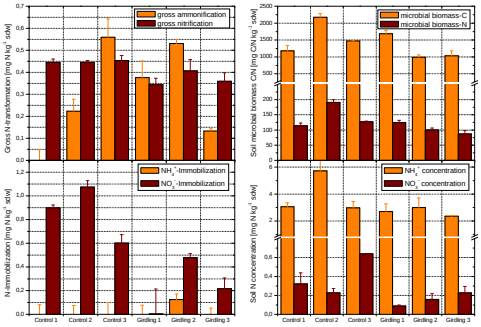
Girdling experiment
Sampling October 2006



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Results

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Girdling experiment
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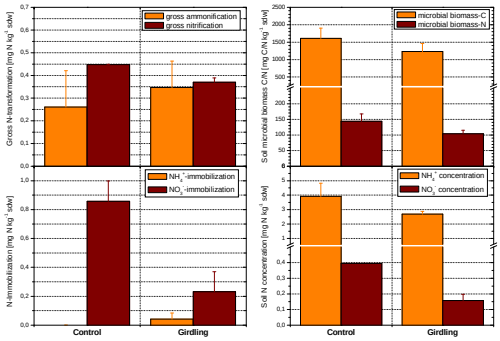

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Summary

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Preliminary effects of girdling after first sampling:

- Reduction in gross nitrification rates
- Reduced soil NH_4^+ and NO_3^- concentrations
- Reduction in NO_3^- immobilization
- Reduction in soil microbial biomass-C and -N

- No change in gross ammonification rates
- No change in NH_4^+ immobilization

These preliminary results are sound and plausible but need to be confirmed by results from future samplings

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