



Current MITHE-SN Projects Metadata

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The impact of microbial activity and trace metal speciation in the rhizosphere on metal uptake by plants (Soils + Plants)

Objectives being Investigated

Understanding the processes that regulate the solubility of trace metals in soils, their uptake by plants and their transport towards waters bodies is a key societal challenge because this knowledge is vital to insure the sustained development of terrestrial and aquatic ecosystems and to prevent health hazards to humans. Due to its proximity to a site of elemental uptake by plants, the rhizosphere represents a critical component of all soil-plant systems and recent studies indicate that the extent of the functional role of the rhizosphere on the biogeochemical cycling of metals is much larger than the volume fraction it occupies in soils. In this context, our primary goal is to investigate the functional relationships existing trace metal speciation in the rhizosphere, microbial activity and the uptake of metal by edible plants. The scientific approach is based on a combination of field work, growth-chamber experiments and microscale investigations aimed at: 1) contrasting the microbiological properties and chemical speciation of metals between the rhizosphere and the bulk components of soils, 2) establishing the processes linking microbial activity to the liquid-phase speciation of trace metals and 3) quantifying the interactions between metal speciation in soils and their accumulation in edible plants. These relationships will be examined for selected edible plants and a range of urban soils by measuring the speciation of dissolved metals in soils, the microbial biomass and activity, and the solid phase fractionation of metals using Synchrotron-based techniques.

Study/Sampling Design

The study will be based on approaches including field work, growth chamber and laboratory experiments. The microbial biomass and activity will be measured in the rhizosphere and bulk materials of a variety of field samples to establish the nature and the magnitude of the contrast and to identify the soil properties associated with the observed differences. The characterization of microbial properties will involve the measurement of total microbial biomass C and N, active microbial biomass C, dehydrogenase, urease, arylsulfatase and phosphatase in soils.

Using field samples, microbial activity will be manipulated before conducting a series of growth experiments under controlled environments. The relationships between microbial activity, speciation and metal uptake will also be examined for selected plants in a range of urban gardens. Measurements will include microbial biomass and activity, the fractionation of solid phase metals (H₂O, salt, EDTA, acid) and the speciation of dissolved (ISE, polarography) trace metals in soils. Rhizon micro-lysimeters will be used to collect the soil solution of the rhizosphere first during growth experiments and subsequently under field conditions. The mass and the total concentration of trace elements (Cd, Cu, Ni, Pb and Zn) will be measured for the different plant parts (roots, shoots, leaves, fruits) at maturity. These analyses will be complemented by determining metal speciation along gradient covering the whole soil-root interface using Synchrotron-based techniques. Soil samples from the field and from growth experiments will then be used to produce microscale elemental maps and identified hotspots will be further examined to determine the in situ solid-phase speciation.

Number of projects providing material for study: 0

Location of Field Site(s)

Soils from forested sites in the Rouyn-Noranda area:

- Rouyn-Noranda, Québec, Canada (48° 14'N, 79° 01'W)

Soils from abandoned agricultural sites in the Monteregian area:

- Contrecoeur, Québec, Canada (45° 51'N, 73° 14'W)
- St-Constant, Québec, Canada (45° 22'N, 73° 34'W)
- St-Hubert, Québec, Canada (45° 31'N, 73° 25'W)
- Valleyfield, Québec, Canada (45°15'N, 74°08'W)

Soils from urban gardens in Montréal:

- Montréal, Québec, Canada (45° 30'N, 73° 33'W)

Human Studies

Outcome or Process Studied

--- none provided ---

Exposure Medium, and Metals/Substances Quantified

--- none provided ---

Biological Endpoint(s) Monitored

--- none provided ---

Biota Studied

Species

Lupinus albus cv Kiev

Populus tremuloïdes Michx

*Triticum aestivum*cv USU-Perigee

Metals, etc. Quantified

Cd, Cu, Ni, Pb and, Zn

Biological Endpoint(s)

Elemental concentrations in fine roots, fruits, leaves and shoots.

Physical Material(s) Studied

Medium/Media

Soil horizons, soil solutions and soil extracts

Metals, etc. Quantified

Al, Cd, Cu, Mn, Ni, Pb, Zn and

Ca, K, Mg, Na, pH and dissolved organic carbon (DOC)

Bibliographic References on-file with Secretariat: No

Data Available: No

Data Archived with MITHE-SN: No

Collaborators

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Metals in the Human Environment Strategic Network

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