Ammonia-oxidizing microbial community dynamics under different mineral and fertilization management

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Introduction:

Soil nitrification is of critical value to soils and environment. This microbial mediated process may result in instability of the nitrogen supply to plants because nitrate is easily removed from soils by denitrification and leaching.

High level nitrification is cause of concern for environmental impacts such as soil acidification, depletion of buffering capacity, surface runoff and release of greenhouse gases to the atmosphere.

Rates of nitrification in soils are usually highly variable, depending on the nitrifying populations (density and diversity) and rely on various factors such as soil type, pH, moisture content substrate concentration, and mineral management etc [1] .

Objective :

The overall experimental objective of this work is to compare how mineral materials and fertilization management relate to microbial nitrifier diversity of soils used for land reclamation.

Material and Methods:

Soil samples were collected in August 2013 from reclamation area RA1 located 40km north of Fort McMurray Alberta, Canada. Soil cores 10 cm collected from sampling points 50 meter apart, from peat mineral mix cover and LFH forest floor cover soil. These mineral material are either fertilized or have un-fertilized mineral cover. Fig 1 depict field sites, managed since 2011 with an average cover soil placement of 40cm for peat mineral mix and 47 cm LFH cover. Fertilizer blend (22.9-9.1-9.1-9.1) are applied at a rate of 100kg N/ ha to fertilized soil covers. Undisturbed native boreal forest floor soils were also collected around sampling area.

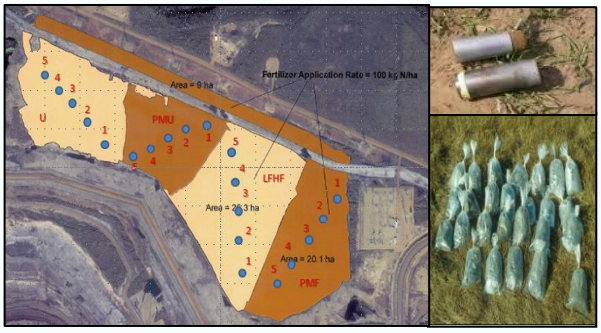

Fig 1. Field sites at Fort McMurray, Alberta under experimental study

Soil sample sieved and freeze dried and stored at -80 ºC for molecular analysis. Soil profiling carried out from ALS environment Saskatoon, Canada.

Molecular analysis on each sample point was carried out using isolation of total genomic soil DNA content, Polymerase chain reaction was carried on two functional target bacterial and archaeal gene biomarker, to amplify subunit A of ammonia monoxygenase gene with GC linked primers. The subsequent product are analysed on Denaturing Gradient Gel Electrophoresis . DGGE data analysed based on band peak intensity and presence and absence data. Ordination of data by multidimensinal Scaling (MDS) was carried-out using XLSTAT 2010 software (Addinsoft SARL, France). Shannon diversity index calculated based on band peak intensity data using formula
$H' = -\Sigma pi \ln(pi)$ [2] .

Results and Discussion:

Total nitrogen, ammonium and organic matter content in undisturbed native forest soils might relate to low rate of associated mineralization/ activity in forest soils and unfertilized forest floor LFH cover Table 1.

The tested biomarkers used have selective structure and diversity (index) of ammonia-oxidizing microflora under the source mineral and fertilization management Fig 2, and 3

Table 1. Soil Physicochemical profiling data

	Undisturbed Native Forest soil LFH	Peat Fertilized Soil Cover	Peat Un-Fertilized Soil Cover	LFH Fertilized Soil Cover	LFH Un-Fertilized Soil Cover
Soil Texture	Loam	Loam	Loam	Loam	Loam
pH	5.1	6.5	6.6	6.4	6.6
% Moisture	27.2	26.9	25.0	17.0	14.2
% Organic matter	3.1	10.9	7.4	4.4	3.7
% Nitrogen	0.079	0.311	0.206	0.127	0.103
Ammonium available mg/Kg	2.7	10.4	8.1	5.8	4.8
Phosphate mg/Kg	11	7.2	5.7	8.3	9.3
Potassium mg/Kg	4.4	16.8	24.9	24.1	16.4

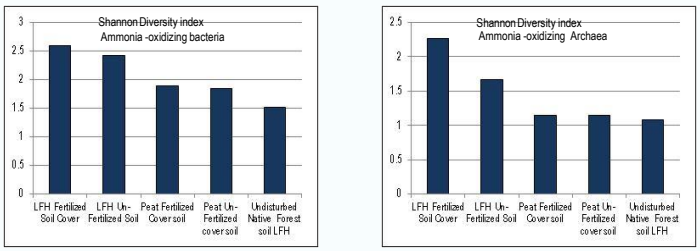

Fig 2 . Shannon diversity index
a . Ammonia-oxidizing bacteria b. Ammonia-oxidizing Archaebacteria

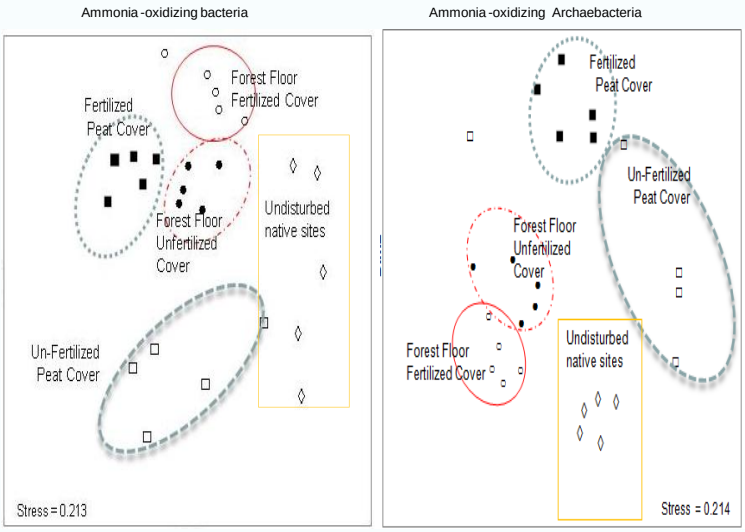

Fig 3. MDS analysis comparing microbial community structure of soils under different management to undisturbed native sites

Conclusion: Typical to Boreal forest floor LFH and abundant peat material used in land reclamation under mineral/ fertilization management might relate linking microbial abundance/ diversity and potential nitrification of soils and is currently being tested.

Reference: 1. Krave, A.S., Straalan, N.M. van., Verseveld, H.W. van Potential nitrification and factors influencing nitrification in pine forest and agricultural soils in Central Java, Indonesia. Pedobiologia **46**: 573–594 (2002)

Acknowledgements: This work is funded by Natural Sciences and Engineering Research Council under Forward III grant. The author would like to acknowledge forward group management and industrial partner for their support.