Effect of moisture content of horticultural peats on denitrification

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Introduction

Denitrification is a four-reaction process through which nitrate (NO_3^-) is converted to nitrite (NO_2), nitric oxide (NO), nitrous oxide (N_2O) and molecular nitrogen (N_2) by facultative anaerobic microorganisms that use organic compounds as electron donor and nitrogen oxides (ion and gaseous form) as terminal electron acceptor[1].

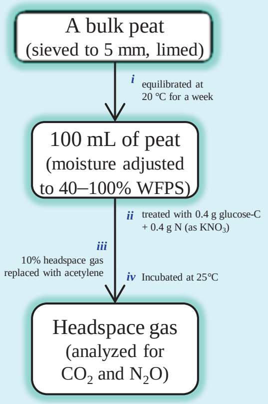
Measuring denitrification has paramount importance, as the gas produced (N_2O) is a potent greenhouse gas that contributes to global warming. Information on the rates of denitrification from horticultural growing media is, however, rare in literature. In this study, the effects of moisture contents on denitrification were investigated using moderately decomposed (H4–H5) *oligotrophic*, *mesotrophic*, *eutrophic* and *transitional* peat types.

Materials and Methods

...all peats contained remnants of *Sphagnum*, *Carex*, *Bryales*, secondary compounds (clamps) and woody plants (mixture) but they differed in proportions

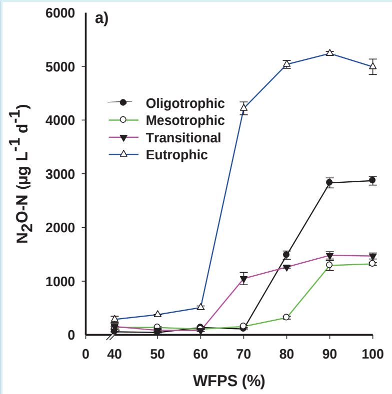
Botanical composition	Peat-forming environment[2]			
	O	**M**	**T**	**E**
Sphagnum	50	35	60	40
Carex	15	15	20	30
Bryales	15	10	5	10
Clumps	10	30	10	10
Mixture	10	10	5	10

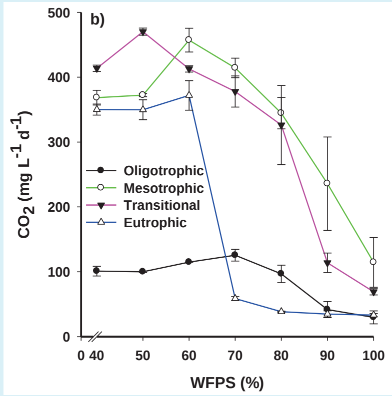
The oligotrophic (**O**) peat was obtained from ombrotrophic bog (Pütte 27, Estonia) that entirely depended on precipitation for its nutrient source whereas the mesotrophic (**M**) and eutrophic (**E**) peats were obtained from fens (Vechta, Germany and Kikilla, Finland, respectively) that received minerals from precipitation, ground and surface water. The transitional (**T**) peat was obtained from the intermediate mire (the mesotrophic to ombrotrophic interval, Osnabrück, Germany) where neither the precipitation nor surface and ground water dominates the nutrient balance.



... procedures followed to incubate peat samples at different water filled pore space (WFPS) using the acetylene inhibition techniques[3].

Results





- ✓ *N_2O emission was low below 60% WFPS,*
- ✓ *N_2O increases at 70% for eutrophic and transitional peats by 13 and 16 fold, respectively,*
- ✓ *N_2O in oligo- and meso-trophic peats increased considerably at 80% WFPS.*
- ✓ *evolution of CO_2 increased at lower WFPS and dropped significantly at higher WFPS,*
- ✓ *at higher WFPS, the peats pattern for CO_2 was opposite to N_2O,*
- ✓ *the CO_2 at 100% WFPS was 3–10 times lower than the respective peak.*

…the tested peat samples differed significantly ($p < 0.05$) in their dry bulk densities, air volumes, water volumes, organic matter, total C, and N contents but they were statistically at par for total pore space and pH.

Parameter	**O**	**M**	**T**	**E**
Dry bulk density (g L^{-1})	89 ± 0.7b	109 ± 1.3a	80 ± 1.8c	76 ± 2.6c
Total pore space (%)	93.7 ± 1.2a	92.6 ± 0.3a	94.4 ± 0.9a	94.7 ± 1.1a
Air volume (% v/v)	13.9 ± 1.2b	10.5 ± 2.3c	21.4 ± 1.5a	14.4 ± 1.2b
Water volume (% v/v)	79.8 ± 1.1a	82.1 ± 2.1a	73.0 ± 1.5b	80.5 ± 1.1a
Organic matter (%)	95.9 ± 0.2a	95.8 ± 0.0a	96.8 ± 0.4a	94.4 ± 0.2b
pH (after liming)	6.2 ± 0.12a	6.5 ± 0.04a	6.1 ± 0.13a	5.9 ± 0.24a
pH (before liming)	4.8 ± 0.05a	4.3 ± 0.01a	4.5 ± 0.01a	4.6 ± 0.01a
Total carbon (%)	48.9 ± 0.1a	48.8 ± 0.2a	50.5 ± 0.0a	46.9 ± 0.1b
Total nitrogen (%)	1.04 ± 0.1a	1.02 ± 0.1a	0.90 ± 0.0b	0.87 ± 0.1b
Total-C/total-N	46.9 ± 0.2b	47.7 ± 0.2b	56.1 ± 0.0a	53.7 ± 0.3a

Mean ± standard deviation ($n = 3$)

Discussion and Conclusion

- ✓ the rates of (N_2O+N_2)-N at 40 or 50% WFPS were statistically similar ($p > 0.05$) between peat types. However, emissions at these relatively drier WFPS confirmed the existence of anaerobic microsites in the samples to favor denitrification activity,
- ✓ 60% WFPS (i.e., corresponding water volumes of 56.2–56.8 % v/v) were considered to be critical threshold limits in the tested peat samples, above which denitrification increased (but at different rates) with increasing water contents,

Overall, emissions of (N_2O+N_2)-N from the *eutrophic* and *transitional* peats were started at lower WFPS compared to the *oligotrophic* and *mesotrophic* peats to suggest that the tested peats should be irrigated differently so as to minimize gaseous N losses during crop cultivation.

References

[1]Davidson et al. (1993). Processes regulating soil emissions of nitric oxide and nitrous oxide in a seasonally dry tropical forest. Ecology 74:130–139.
[2]Stewart RE, Kantrud HA (1971). Classification of natural ponds and lakes in the glaciated Prairie Region. Resource Publication No. 92, U.S. Fish and Wildlife Service, Washington DC.
[3]Yoshinari et al. (1977). Acetylene inhibition of nitrous oxide reduction and measurement of denitrification and nitrogen fixation in soil. Soil Biol Biochem 9:177–183.

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