Short term N_2O losses in urine patches: a ^{15}N labelling study

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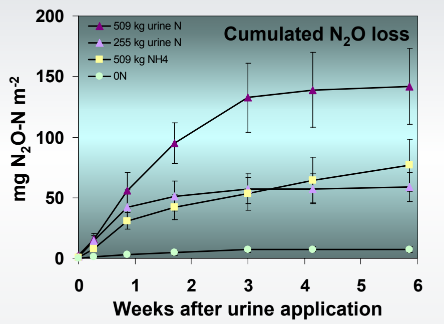
Background

Deposition of urine and dung by grazing animals is a strong source for N_2O production in grass pastures. Investigations have shown that at least 20% of the annual losses of N_2O from a grazed pasture may be associated with urine patches (Williams et al., 1999; Yamulki et al., 1998). In low-input systems, such patches may thus be extremely important for the N_2O formation. In this study ^{15}N labeling was used in order to quantitatively and qualitatively describe the production and emission of N_2O from simulated urine patches in a grass-clover pasture.

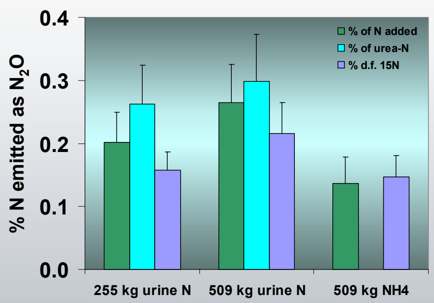
Experimental setup

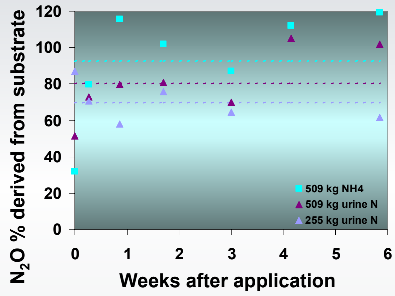
Intact soil columns confined by 30 cm diam. × 25 cm long PVC cylinders were excavated from a 2nd year organically managed grass-clover pasture (Danish Institute of Agricultural Sciences). Synthetic urine with ^{15}N labelled urea (5 atom % excess) was added at rates of 255 kg N ha^{-1} (LU) and 509 kg N ha^{-1} (HN) to the soil columns. The different N rates were achieved by changing the urea content. The experiment also included an untreated control (0N) and a treatment with pure NH_4Cl (509 kg N ha^{-1}) as a nitrogen control (HN). Nitrous oxide emissions were determined frequently over six weeks following the urine and nitrogen applications.



Nitrogen additions significantly increased the N_2O emissions. When N was added as urine the most N_2O emission occurred within the first 2-3 weeks. When N was added as NH_4^+ the increased N_2O emission persisted throughout the six week experimental period.

Based on total N applications, the percentage emitted as N_2O tended to be higher from urine compared with pure NH_4^+, and relatively more N_2O was emitted with high urine compared with low urine applications. Based solely on the urea-N content, the relative N_2O emission tended to be more equal among the two urine treatments, approximating 0.28%.





Concentrations of ^{15}N in N_2O from urine treated plots indicated that 70 % (LU) and 80 % (HU) of the N_2O originated from the labelled urea-fraction. The non-labelled N_2O possibly originated from other N-compounds in the urine (hippuric- and uric acids; allantoine; creatinine and NH_4Cl). But as these compounds constituted only 11% (HU) and 23% (LU) of total urine-N, soil N was likely also a source for N_2O. In the NH_4Cl treated soil, all N_2O (96%) was derived from the ^{15}N labelled NH_4^+-pool.

Conclusion

- emission of N_2O was greater when N was added as urine compared with mineral N, possibly due to the presence of organic carbon compounds in the urine fueling the N_2O production.
- an exchange of N between the applied substrate N-pool and the soil N-pool was observed following urine applications but not following application of NH_4Cl. This also indicates increased microbial activity in the urine soil, perhaps combined with stress-induced (pH increase form urea hydrolization) leaching of N from plant roots and microbial cell lysis.
- decreasing the urea content of the urine seemed to reduce the N_2O emission factor, suggesting dietary controls of urine N-composition as a N_2O mitigation option

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References

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