Controls on denitrification in a riparian buffer strip in a small headwater catchment in south Belgium

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Introduction

Riparian buffer strips are managed for the enhancement of water quality throught control of non point source pollution. Denitrification in riparian buffer strips is thought to be the major process that reduces nitrate input in surface water. However denitrification is one of the least well quantified of the soil N cycle processes (Parkin, 1990). A better quantitative estimate of denitrification is required before management practices can be assessed. The major factors regulating denitrification are the availability of nitrogen oxides, the availability of organic carbon componds and decreased oxygen concentration (Knowles, 1996). Soil water content affects the process by limiting diffusion of nitrate as well as dissolved organic carbon (Luo *et al.*, 2000).

We investigated the soil organic carbon content and its influence on potential denitrification. A dissolved organic carbon fractionation was tested on soil water samples (Fujii *et al.*, 1998). Denitrification dynamics were studied according to two experiments testing the effect of conditionning a soil by waterlogging it with different initial conditions (Dendooven *et al.*, 1999).

Materials ans Methods

Site description and sampling

The Belgian part of the small Attert headwater catchment covers 7100 ha. One experimental crop site has been equipped with 19 soil water cup samplers distributed in 11 plots of 1 m² in a gridded area of about 30 ares. A 11 m wide buffer strip has been managed along a small tributary of the Attert river. The soil is a sandy silt with heavy clay by places. The soil was sampled from the 0-20 cm layer and sieved to pass 6.5 mm. 33 subsamples resulted in the replicate of the 11 initial plots. 15 additional samples were collected on a different scale to study the spatial variability of the process.

Measurements of denitrification rate in the laboratory

Following Dendooven's procedure (Dendooven *et al.*, 1999), the work involved two experiments. One anaerobic incubation to assess potential denitrifying activity and one conditionning of soil under waterlogged conditions to investigate how antecedent water regime of the soil affects denitrification. Table 1 presents a synthesis of all the treatments applied.

Experiment one : conditionning of soil under waterlogged conditions : 3 treatments

Soil amended with distilled water	*Soil amended with distilled water and 50 mg NO_3^- -N kg^{-1}*	*Soil amended with distilled water and 50 mg NO_3^- -N kg^{-1} plus 100 mg glucose C kg^{-1}*

Experiment two : anaerobic incubation to assess potential denitrifying activity : 4 treatments

7.5 g soil + 10 ml solution with 3.4 mM KNO_3	*7.5 g soil + 10 ml solution with 3.4 mM KNO_3 + C_2H_2 (10% v/v)*	*7.5 g soil + 10 ml solution with 3.4 mM KNO_3 and 0.44 mM chloramphenicol*	*7.5 g soil + 10 ml solution with 3.4 mM KNO_3 and 0.44 mM chloramphenicol + C_2H_2 (10% v/v)*

Table 1 : Experimental procedure of denitrification rate measurements in the laboratory

Each sample was then conditionned anaerobically during 72h. The headspace have been analysed for N_2O by gas chromatography.

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Measurements of organic carbon content

Soil water samples were collected in the field and filtered (0.45µm) to perform a 2-step fractionation and isolation of dissolved organic carbon. 1 l sample was fractionated on a 20 ml column of XAD-7 and XAD-4 Amberlite resins. The sample was run through the XAD-7 column and the effluent was collected. The XAD-7 effluent was then run through the XAD-4 column. The flow rate was 4 ml min^{-1} on each column. Both column were then eluated with 100 ml 0.1N NaOH at a rate of 2 ml min^{-1}. Dissolved organic carbon (DOC) content of effluents and eluates were analysed by two different methods : Dr. Lange kit test LCK383 and TOCmeter.

This fractionation allows to separate compounds with similar structures into the following categories : HPOA (hydrophobic acids), HPON (hydrophobic neutrals), HPIA (hydrophilic acids), HPIN (hydrophilic neutrals) and low molecular weight hydrophilic acids.

Preliminary results and discussion

As the measurements of potential denitrification are not successfully completed yet, our results are still uncomplete. Full comments on full results will be presented during the workshop.

Sampling of dissolved organic carbon took place once a week during fall 2000. As the samples were filtered on a 0.45 µm membrane, the total organic carbon measured is equal to dissolved organic carbon. Interest of fractionation is to give access to the measurements of hydrophilic and hydrophobic acids, including humic and fulvic acids. First results from the buffer strip show a variation between 9.2 and 20.6 mg of total mass of organic carbon in one liter of soil water (fig.1). These results are comparable to those obtained by McCarthy and Bremner, (McCarthy and Bremner, 1992) who tested the ability of organic C content of aqueous extract of surface soil to promote denitrification on subsoils. As organic C availablity in soil is recognized as one of the most important factors controlling denitrification, we should observe high variations in denitrification rates related to these variations in soil water dissolved organic carbon composition.

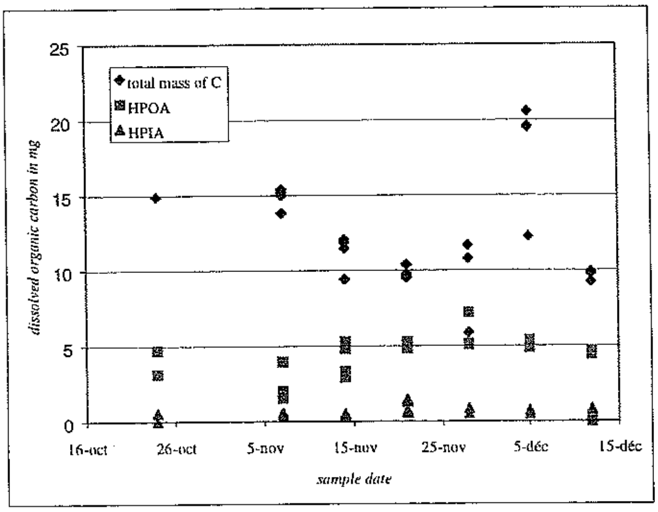

fig.1 : DOC content of soil water samples and their fractionation in hydrophobic acids (HPOA) and hydrophilic acids (HPIA). Humic and fulvic acids belong to the HPOA group.

Litterature cited

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