



Assessing quality and quantity of groundwater DOC in relation to plant export from different over-winter green-cover treatments in tillage farming systems

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The biogeochemistry of nitrogen is often connected to carbon and C/N dynamics. The dissolved organic carbon (DOC) electron donor availability can be related to groundwater denitrification (Buss, et al. 2005). Therefore groundwater nitrate attenuation processes are also frequently linked to carbon availability. In recent years the role of over-winter green cover in tillage farming has been studied extensively. Nevertheless further research on the biogeochemical effect of green cover on soil/sediment and groundwater quality is still needed. In particular plant roots are known to exude different types of organic compounds, but their role in groundwater quality has not been investigated in depth. According to Cannavo et al. (2004a,b), in addition to quantity, the quality of water-extractable soil organic matter (e.g. molecular size/weight) has also an important role for microbial activity.

In this study we investigate the effect of over-winter green-cover on potential DOC export to shallow groundwater (2 - 5 m below ground level), located on tillage land in Oak Park, Carlow, Ireland. The experiment includes three over-winter green-cover treatments: natural green-cover, mustard and no-cover (sprayed with herbicide following harvest); and is underlain by a sand and gravel aquifer. The site is equipped with 4 shallow piezometers per treatment (total no. of piezometers is 20, including treatments and surrounding piezometers). In addition to monitoring the quantity of DOC concentrations in shallow groundwater under different green cover treatments over time, an attempt was made to evaluate the quality of dissolved organic matter in shallow groundwater using Excitation Emission Fluorescence Matrix (EEFM) profiles obtained from analyses performed on a Varian Fluorescence Spectrophotometer of a single batch of samples (from all 20 installed piezometers in September 2009). To evaluate the quality of dissolved organic matter in shallow groundwater, computation of the humification index (HIX) was performed. Computation of HIX was adapted from the methodology described in Zsolnay (2003) and Cannavo et al. (2004b) using emission spectra from excitation at 245nm, and the HIX was expressed as the H/L ratio. H/L is defined as the ratio between the area of the higher and lower usable quarter of emission spectrum peak [i.e. H (352 - 382nm), L (450 - 480nm)], corresponding to the pools of high (H) and low (L) organic molecule sizes (Cannavo et al., 2004b).

Quantitatively the results showed generally low DOC values (< 3mg/L). However, the groundwater DOC concentrations under mustard-cover were higher if compared to two other treatments, which indicated possible mustard plant DOC export to shallow groundwater (Premrov et al., 2009). Qualitative analyses showed an EEFM profile pattern typical for water extractable organic matter. Mean HIX values were generally low (< 2), as expected for shallow groundwater, corresponding to small organic molecules. The HIX levels obtained in this study were also generally comparable to the low HIX values found by Cannavo (2004b) (e.g. HIX of c. 2 at 1- 2 m unsaturated zone depth). Despite slightly higher mean HIX values under mustard-cover, no clear trend was observed in the quality of dissolved organic matter in groundwater in relation to different green cover treatments: i.e. mean groundwater HIX value under mustard treatment (n=4 per treatment) was 1.84, std.err.= 0.19; while the mean value for natural regeneration was 1.62 (std.err.=0.15) and that for the no-cover treatment was 1.60 (std.err.=0.16). The results indicate the importance of further studies using EEFM analysis to assess the quality of dissolved organic matter in shallow groundwater.

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