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Nitrogen balance in acid sulfate soil lysimeters under different water management

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Reclamation of permanently saturated potential acid sulphate (AS) soils for cultivation or other purposes has negative environmental impacts, as drainage triggers soil acidification that subsequently causes off-site harm, e.g. deterioration of ecosystems in recipient watercourses. In addition, the subsoil layers of AS soils are typically high in N and OC, which gives rise to concern for their potential to produce GHG emissions to atmosphere and high N loads to watercourses.

One option to manage soil acidification is to raise groundwater level. In this study, we investigated the effect of raised water table on the N balance of AS soils in ten meso-scale monolithic lysimeters equipped with water level control and probes e.g. for redox measurements. Reed canary grass (RCG) was cultivated in eight lysimeters: four with a high water table (HWT), and four with a low water table (LWT) mimicking normal drainage of cultivated fields. In spring, the lysimeters were fertilized as recommended for RCG (N 90, P 5 and K 40 kg/ha). They were watered with artificial rain water mimicking the local long-term average precipitation. The discharge water was analyzed for dissolved N (Shimadzu TOC-VCPH/CPN). The total N in the dried plant samples was determined by the Dumas combustion method (VarioMax-CN). Gas emissions were measured by using closed chambers and analysing the gas composition by GC.

The N mass balance was calculated as follows: $N_{balance}$= N_{input}- N_{output} where the only input term was $N_{fertilization}$ and output terms were $N_{harvest}$, $N_{leaching}$and $N_{emission}$. In all treatments, the $N_{balance}$ was negative. Even though the RCG dry-matter yield was highest in HWT (16 t/ha *vs.* 12 t/ha in LWT), the $N_{harvest}$ was highest in LWT (142.2 kg-N/ha *vs.* 112.7 kg-N/ha in HWT). Furthermore, $N_{leaching}$(3.6 kg-N/ha in HWT and 2.3 kg-N/ha in LWT) and $N_{emission}$ (cumulative N_2O emission of 4.0 kg-N/ha in 161 days, n.s. difference between HWT and LWT) were lower than reported for AS soils in some field scale studies. The lower $N_{leaching}$ was partly due to the high transpiration and N uptake by RCG. Additionally, the negative $N_{balances}$ obtained were supposedly attributable to large plant-available N pools in the subsoil.

Actually, the N_{min} content in the 15-cm subsoil horizons (C1) in the lysimeters corresponded to 124 kg–N_{min}/ha in the field scale. Evidently, the high $N_{harvest}$ in LWT was attributable to the roots penetrating down to the bottom of lysimeters. In HWT, on the contrary, the roots accumulated mainly in the topsoil. Consequently, the $N_{harvest}$ in HWT was lower than in LWT.

In AS soil fields, low groundwater table maintains continuous soil acidification exerting harmful off-site effects. High water tables facilitates only the growth of water tolerant plants, such as RCG with negative $N_{balance}$. However, high groundwater levels in AS soil may lead to mobilization of iron from secondary minerals (e.g. jarosite) as a response to lowered redox potential in watersaturated soil. In addition, in case the plants are not harvested, the mobilization of N in the subsequent years will be high.