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Changes in nitrogen cycling potentials in a small agricultural catchment under different land uses

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The aim of the present study was to investigate changes in (i) nitrogen (N_2) fixation, (ii) net nitrification, and (iii) denitrification potentials under different land uses in a small catchment (21 km^2) in Balaton Upland, Hungary. Soil samples were collected from the following six land use types in three replicates: mixed forest (oak and wattle), forest (oak), grapevine, arable land (winter wheat), orchard (apricot), and grassland. All nitrogen cycling experiments were carried out under dark conditions in a temperature-controlled laboratory environment. The investigations were implemented under three temperatures 10, 20, and 30 °C to represent the typical vegetation season temperature range in the investigated catchment. Potential nitrogen (N_2) fixation was measured as ethylene (C_2H_4) production from acetylene (C_2H_2) reduction. Potential denitrification rates were measured using the acetylene block technique.

Potential N_2 fixation was positively correlated with temperature or no change was observed. Rates decreased as temperature was increased from 10 to 20 °C in the cases of arable, orchard, and grassland, while did not change in the case of the forest samples. When the temperature was increased to 30 °C, the N_2 fixation potentials also increased significantly ($p < 0.017$) compared to 10 to 20 °C. When investigating the net nitrification of the soils, we found negative correlation with temperature increase, the highest values were retrieved at 10 °C (average net nitrification was 0.2793 nmol N g^{-1} wet weight soil hr^{-1}), while the lowest at 30 °C (average net nitrification was -0.0681 nmol N g^{-1} wet weight soil hr^{-1}). Potential denitrification values were the highest at 20 °C. Forest soils did not show substantial differences in potential denitrification rates while varying temperatures; however, within land uses all values retrieved at the investigated temperatures were significantly different ($p < 0.0174$). Overall, we found that land use types can significantly influence the soils' nitrogen cycling processes, especially when fertilizer amendment is regularly applied. Potential nitrogen cycle components under different land use types, which are less influenced by anthropogenic activities (e.g. forest soils), were found to be less sensitive to temperature changes.