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Fate and effects of nitrogen added in a long-term experiment to a sub-alpine forest in Switzerland

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Atmospheric nitrogen deposition was artificially increased for 27 years (1995-2022) by sprinkling rain water enriched with NH_4NO_3 ($+22 \text{ kg ha}^{-1} \text{ y}^{-1} \text{ N}$) to a small headwater catchment in a spruce (*Picea abies*) forest growing on gley soils at Alptal (central Switzerland). This treatment was compared to a control in a paired catchment design. Nitrate leaching increased already during the first rain events after starting the treatment and continued to increase within the first 5 years. Later, it increased again markedly after part of trees had been girdled then felled in 2010. As shown by ^{15}N labelling, most of the added N remained in the soil. In plots receiving the same treatment, this lowered the C/N ratio, changed the composition of the fungal community and tended to reduce the total microbial biomass, the abundance of Collembola and soil respiration. Soil acidification was observed in those plots located on small mounds but was effectively buffered in topographical depressions. Denitrification was clearly increased, but other processes like mineralisation were not significantly affected. Over time, trees took up about 1/10 of the added N and used it mainly to build larger needles. Their growth was slightly improved, presumably by a better use of the light in their relatively open canopy. Both the soil microbiote and the trees showed signs of limitation by other nutrients like P and Mg, but the poor aeration remained the major limiting factor of the gley soils on this site.