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Nitrogen mineralisation in deciduous forest soils in south Sweden in gradients of soil acidity and deposition

Ursula Falkengren-Grerup[a]*, Jörg Brunet[b], Martin Diekmann[c]

[a]*Department of Plant Ecology, Ecology Building, Lund University, S-223 62 Lund, Sweden*
[b]*Department of Conservation Biology, Swedish University of Agricultural Sciences, Box 7072, S-750 07 Uppsala, Sweden*
[c]*Department of Mathematics, Natural and Computer Sciences, University College of Gävle/Sandviken, S-801 76 Gävle and Department of Ecological Botany, Uppsala University, Villavägen 14, S-752 36 Uppsala, Sweden*

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Abstract

Net nitrogen mineralisation was studied in 600 deciduous forests in four geographically separate regions of southern Sweden. The total nitrogen deposition in the forests varied between 7 and 17 kg ha^{-1} $year^{-1}$. The most frequent canopy-dominant tree species was *Quercus robur*, others being *Acer platanoides*, *Carpinus betulus*, *Fraxinus excelsior*, *Tilia cordata* and *Ulmus glabra*. Soil pH (0.2 M KCl) varied between 3.1 and 7.7 and the C/N ratio between 8 and 50 in soil sampled 5 cm below the litter layer. The potential net mineralisation rate, measured in a 15-week laboratory incubation experiment, could be explained to 20% by soil pH and to <10% by the C/N ratio. Nitrification occurred at any pH and was almost complete at pH > 4.5. The most striking finding was that rates of net nitrogen mineralisation and nitrification were by far the highest in the southernmost region, especially in the most acid soils, rates about twice as high as in the other regions. Sites that differed in the dominant tree species did not differ in net nitrogen mineralisation. Nitrogen deposition explained 30% of the variation in mineralisation rate. It is suggested that the high nitrogen deposition in recent decades has favoured ammonification through increasing the nitrogen pool in the soil and altering the quality of the organic matter, the microbial community adapting to the acidified soils and the increased nitrification.

Keywords: Deciduous forests; net nitrogen mineralisation; nitrification; nitrogen deposition; soil pH

Introduction

Nitrogen is a limiting nutrient in most temperate and boreal forests. Only recently, the increase in nitrogen deposition in parts of Europe and the American NE has changed the nutrient balance, nitrogen now frequently being found in excess of other nutrients. Soil nitrogen is bound in organic matter, only a small percentage being readily available for mineralisation to an inorganic form. Ammonium and nitrate usually constitute less than one percent of the total nitrogen pool. Some studies have found soil pH to be positively related to net nitrogen mineralisation (e.g. Kriebitzsch, 1978), whereas other studies have found no relationship between the two. (Nyborg and Hoyt, 1978; Curtin et al., 1998). Nitrification can vary between sites and within a soil profile, depending on the presence of autotrophic and heterotrophic micro-organisms and of acid-tolerant and acid-sensitive nitrifiers (Gundersen and Rasmussen, 1990; Barraclough and Puri, 1995).

Nitrogen deposition often increases the nitrogen content of the litter (Berg and Matzner, 1997). In experiments involving an increase or a reduction in nitrogen input, net mineralisation increases when nitrogen is added and decreases when it is removed (Gundersen et al., 1998). Other studies have shown a positive effect of nitrogen deposition on potential nitrification, total nitrogen in the forest floor and litter quality (McNulty et

* Corresponding author. Tel.: +46-46-222-44-08; fax: +46-46-222-44-23; e-mail: ursula.falkengren-gerup@planteco.lu.se