Nitrogen compounds found in soil in the form of mineral and organic bonds are available to microbes and plants as NO$_3^-$ and NH$_4^+$, produced in consequence of ammonification, nitrification and N fixation. The laboratory experiment was conducted on samples of podzolic sandy soils. Soil samples were taken in the surroundings of Achema. The objective of the study was to determine the effect of soil contamination on the nitrification process. The results demonstrate large variations between sample sites. There was no significant difference in nitrification rate between soils samples.

**Key words:** nitrification, nitrogen deposition

### Introduction

The availability of nitrogen to plants is determined by the rate at which ammonium and nitrate are produced through the processes of nitrogen mineralization and nitrification in the soil. Nitrogen is the limiting element in many natural ecosystems. Only recently, the increase in nitrogen deposition in parts of Europe and America has changed the nutrient balance, nitrogen now frequently being found in excess of other nutrients (Falkengren-Grerup et al., 1998). Accumulation of nitrogen through the deposition in forest soils may therefore cause considerable changes in ecosystem structure and function (Falkengren-Grerup, Schöttelndreier, 2004).

Nitrogen deposition often increases the nitrogen content of the litter. Litter decomposition and nitrogen mineralization rate is known to increase in soils affected by nitrogen deposition (Falkengren-Grerup et al., 1998). Other studies have shown a positive effect of nitrogen deposition on potential nitrification (McNulty et al., 1991). But in short-term experiments such effects are usually not found (Prescot, 1995). It is possible that prolonged nitrogen deposition and acidification select for a microbial community adapted to more acid and nitrogen-rich conditions, a capacity that may not have had time to develop in the shorter experiments.

The present study concerns the extent to which nitrogen deposition in the vicinity of Achema – one of the main pollution sources in Lithuania – in coniferous forests can account for variations in potential nitrification in the upper root horizon. The objective of this study was to determine potential nitrification rate under the influence of nitrogen deposition in coniferous forests soil.

### Materials and methods

Achema is situated in the central Lithuania (55°4’ N, 24°20’ E). It began operating since 1965. The main activity of the plant is the production of nitrogen fertilisers, ammonia, nitric acid, methanol, formalin, glues, carbonic acid and aluminium sulphate solution. Nitrogen fertilizer is produced by fixing nitrogen from the air. Large amount of energy is needed for this endothermic process and emission of ammonia, sulphur, nitrogen and carbon oxides comprise the main part of emission.

The entire area has been under air pollution stress since 1980 where the total annual deposition of sulphur at the distance of 1-2 km from the plant comprised about 50 kg and at the distance of 20-22 km over 30 kg, currently it was reduced up to 15 and 9 kg ha$^{-1}$, respectively. Annual deposition of nitrogen decreased also and it constitutes 15-17 kg ha$^{-1}$ 20-22 km from the plant (Armolačius, 1998). Air pollution is considered to be the main cause of a massive forest dieback that peaked in the beginning of the 1980s. The total amount of pollutants decreased to only 5-7 thousands tones annually from 1980 in comparison with 40 thousand t in the beginning of 1980s (Juknys et al., 2003)

The soil used in this experiment was chosen from the region in the study of coniferous forests. The sampled soil layer of these coniferous forest soils, being 10-15 cm soil below the litter layer, consisted of mineral soil. The soil was sampled in October, 2009.

The soil form this region was selected as it is under the continuous nitrogen deposition. Soil samples were taken from plots at different distances (2-9 km) to the east from the nitrogen fertilizers producer plant Achema. Soil was collected in adjacent matured pine forest from Dubrava Experimental and Training Forest Enterprise. Enterprise is in the region with background deposition and was chosen as a control.

Potential net nitrogen nitrification were measured in 6 hours laboratory incubation (25 °C), the soil was kept at 60% WHC by regular additions of distilled water. Incubation experiments were set up using 10 g
dry weight of soil in 150 ml bottles using three replicates of each sample. Initial (0 h) and after 2, 4 and 6 h levels of nitrite were measured spectrometrically at 540 nm.

**Results and discussion**

The potential nitrification rate is the nitrification rate that occurs under ideal conditions in which ample NH$_4^+$ is present, the soil is well aerated, and NH$_4^+$ diffusion is not restricted. On average 0.051 μg N-NO$_2$ was nitrified per g N mineralized per hour in plots under the influence of the nitrogen fertilizer producing plant pollution. In comparison of nitrified N in reference soils the values were positive and significantly higher – 0.994 (p < 0.05) (Fig. 1).

![Figure 1. Potential nitrification rate (μg NO$_2$-N/g/h) in coniferous forest soil under the influence of the nitrogen fertilizer producing plant pollution. Sample plot 8 – control. Values are means (± SE) of 3 replicates.](image)

Final nitrate levels changes with the distance increase showed no clear tendency (Fig. 1). Mainly in all sample soils nitrification rate was very low and negative. Almost no nitrification could be detected and this would be related to low soil pH. T.Persson and A. Wirén (1995) determined that potential nitrification in the mineral soil was inhibited at pH 4.0-4.5. This indicated the presence of acid sensitive nitrifiers what was characteristic to acid coniferous soils in the surroundings of Achema.

Despite initially identical soils from the same forest site type, there were no clearly pattern of change. Soil samples were taken in late autumn when senescence of leaves of these species supplies large quantities of litter for decomposition. T.A.J. van der Krift and Berendse F. (2001) found that the timing and the senescence of plant biomass and the amount of litter produced were responsible the higher net mineralization.

Because studied forest site type is rich in low fertility species they could slow down the N cycle. During succession the species from fertile habitats caused an increase in N mineralization, whereas species from much less fertile habitats had a relatively negative effect on the N release from the soil (van der Krift, Berendse, 2001). Bengtson et al. (2006) demonstrated that spatial distribution of vegetation and gross N transformation rates was closely related within a distance of a few meters. That means that plant diversity and productivity had a major influence on rates of N transformations.

Nitrogen mineralization rate is known to increase in soils affected by nitrogen deposition. In Swedish deciduous forests a difference in deposition of 10 kg N $^{-1}$ y $^{-1}$ seemed to cause up to an 80% higher soil nitrogen mineralization rate and a 90% higher nitrification rate (Falkengren-Grerup et al., 1998). To determine influence of nitrogen deposition was difficult due to the long-term nitrogen deposition and the succession of coniferous forests in the vicinity of Achema what have caused soil acidification. More knowledge about the below-ground status is needed to obtain a deeper insight into the effects of factors on nitrogen mineralization.

**Conclusions**

Potential nitrification rate did not responded to deposited and accumulated N in coniferous forests in the vicinity of Achema with varying N deposition. Low and negative nitrite levels in soil could be related to very acid pine soils.
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