# The influence of modified pratotechnics of unmanaged grasslands on the amount of mineral nitrogen in lysimetric waters of the rhizosphere

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**ABSTRACT**

In 2001–2004, the influence of various ways of farming unmanaged grasslands on the mineral nitrogen content in lysimetric waters was monitored. Field trials with 11 variants were performed 420 m above sea level, at depths of 0.2 and 0.4 m, 4–5 times annually. The average amount of $N_{min}$ released per ha per year in lysimetric waters ranged from 0.84 to 5.12 kg. The upper layer to a depth of 0.2 m had a higher content. The conclusive difference, in comparison with properly farmed control, was with the black fallow and in the variant where fallow followed mulching. With the exception of this method of farming the pratotechnics of unmanaged grasslands – mulching did not increase the load of rhisosphere, either by the overall mineral nitrogen, or by the concentration of N-$NO_3^-$. Even by using fallow for a four-year period, a conclusive increase in the content of $N_{min}$ was not observed.

**Keywords:** unmanaged grasslands; mineral nitrogen; lysimeters

The content of nitrogen in soil is studied from various aspects, first of all in arable land and deep profiles. It is especially about forms $NO_3^-$ and $NH_4^+$ i.e. mineral nitrogen which is monitored from the point of view of plant nutrition, ecology and also economics. The specific environment of the rhizosphere of unmanaged grasslands provides somewhat different conditions, in comparison with arable land, for the metabolism of organisms, which are responsible for the conversion of nitrogen. With the exception of physical properties, there is a smaller thickness of topsoil, higher content of $C_{ox}$ and usually a lower pH. It becomes apparent that the content of carbonaceous matters plays an especially important role here, in connection with nitrogen conversion and mobility. Nitrification bacteria are aerobic organisms and their activity (oxidation of $NH_4^+$ to $NO_3^-$) is proportional to the input of organic matter. Nitrogen cannot be accumulated in soil over a long period other than in soil organic matter (Kubát et al. 1999). Plant matter of grasslands can, thanks to its relatively high carbon content, bind nitrogen in organic form and gradually remineralise it (Dykyjová et al. 1989). With the support of C, the nitrate content decreases (Balík et al. 2003, Števlíková et al. 2003, Vaněk et al. 1999, 2003).

In this context, permanent support of grass organic matter can, by mulching, influence the conversion and content of mineral nitrogen in the rhizosphere and the subsequent wash out of $NO_3^-$ in underground waters. Present results document differences in the concentration of $NO_3^-$ and $NH_4^+$ in the top soil layer under unfertilized grasslands and in lysimetric waters. A higher concentration is interrelated with more fertile soil and a higher proportion of clover crops, concentration decreases with depth (Svoboda et al. 2004). There are also differences in the method of farming (Fiala 2004). Svobodová and Šantrůček (2004), however, did not discover large differences in topsoil under grasslands. But, on the other hand, the best mulching results were reached at chemical ($C_{ox}$, $N_t$, pH) and microbial (carbon of biomass of micro-organisms, extracellular microbial carbon, respiration, ammonification and nitrification)

Supported by the Ministry of Agriculture of the Czech Republic, Project No. MZE 0002700601.

parameters of grass-covered black soils (Voříšek et al. 2002).

Current measures, concentrated on protecting water from pollution by nitrates from agricultural sources, are a set of recommendations for farming agricultural soil and are also connected to grants for agricultural practice. The purpose of this project is therefore to discover the impact of the method of farming unmanaged grasslands in the content of mineral nitrogen in rhizosphere water and therefore the threat posed to underground waters by nitrates.

## MATERIAL AND METHODS

Mineral nitrogen in lysimetric waters of the rhizosphere of unmanaged grasslands was monitored in 2001–2004 in the foothills of the Jizerské hory at 420 m above sea level. The field trial was in acid cambisol, pH(KCl) 5.0, $C_{ox}$ 3.62%, $N_t$ 0.32%, P 16, K 106, Mg 64 mg/kg with unmanaged grassland with a majority of red fescue, association *Trifolio-Festucetum rubrae*, Oberdorfer 1957, 12% clover crops. Growth was not fertilized. Lysimetric water sampling and analysis using a SAN plus-Skalar continuous-flow colorimeter was carried out 4–5× annually (also in winter) depending on the rainfall.

Setting the experiment: the experiment had 11 variants in four repetitions, the size of each plot was 37 $m^{-2}$, each variant had, in four repetitions, a lysimeter at a depth of 0.2 and 0.4 m in an area of 0.1 $m^{-2}$.

1. control (2× cutting, 30.5.–10.6. and 10.–20.8. material removed)
2. green fallow (left without cutting)
3. rotation of fallow with mulching (1st year fall., 2nd year mulching 2× 30.5.–10.6. and 10.–20.8.)
4. rotation of fallow with harvest (1st year fallow, 2nd year 1× cut. 15.7., material removed)
5. rotation of mulching with harvest (1st year mulching 2×, 2nd year 1× cutting 15.7., material removed)
6. mulching 1× (25.5., material left)
7. mulching 1× (15.7., material left)
8. mulching 1× (25.9., material left)
9. mulching 2× (30.5.–10.6. and 10.–20.8., material left)
10. mulching 3× (25.5., 15.7., 25.9., material left)
11. black fallow (maintained mechanically – rotavator)

## RESULTS AND DISCUSSION

Figures 1 and 2 document the influence of particular ways of farming unmanaged grasslands on the amount of mineral nitrogen ($N_{min}$) in soil depths of 0.2 and 0.4 m. In both depths there was, understandably, the most $N_{min}$ released in lysimetric waters per annum, in black fallow, i.e. 5.12 , respectively, 9.03 kg/ha. In comparison with the control model, there was a further conclusive difference (Duncan's test) in variant 3 where fallow was turned by mulching. Here, average values of 3.74 kg/ha in depth 0.2 m and 3.50 kg/ha in depth 0.4 m were measured. The control variant where the cut matter was removed had 1.67 and 1.46 kg/ha of $N_{min}$. During the 4-year monitoring period, the endangerment of underground waters, even by green fallow (2.37 and

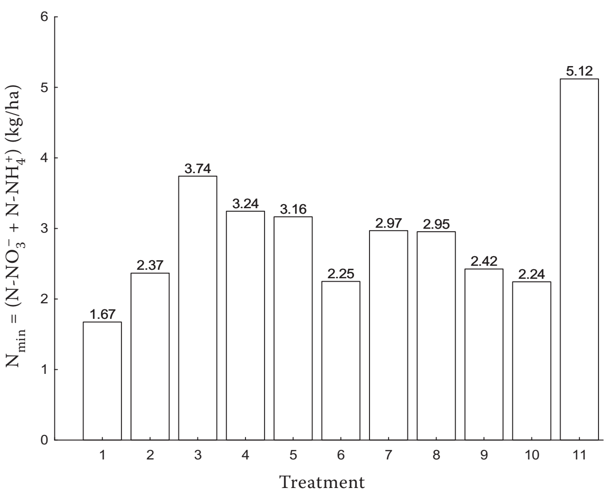


Figure 1. Average amount of mineral N per year in depth 0.2 m

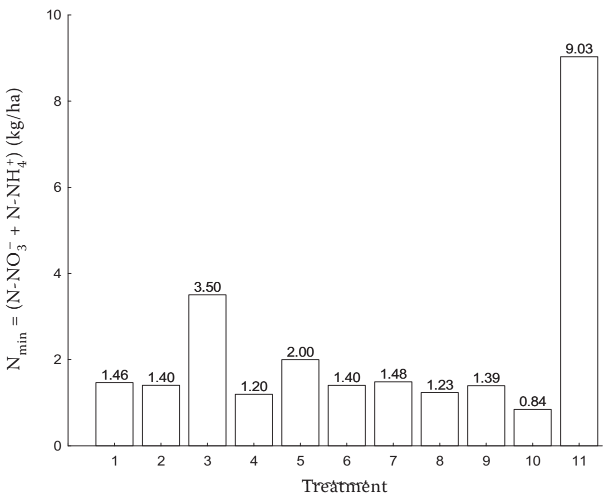


Figure 2. Average amount of mineral N per year in depth 0.4 m

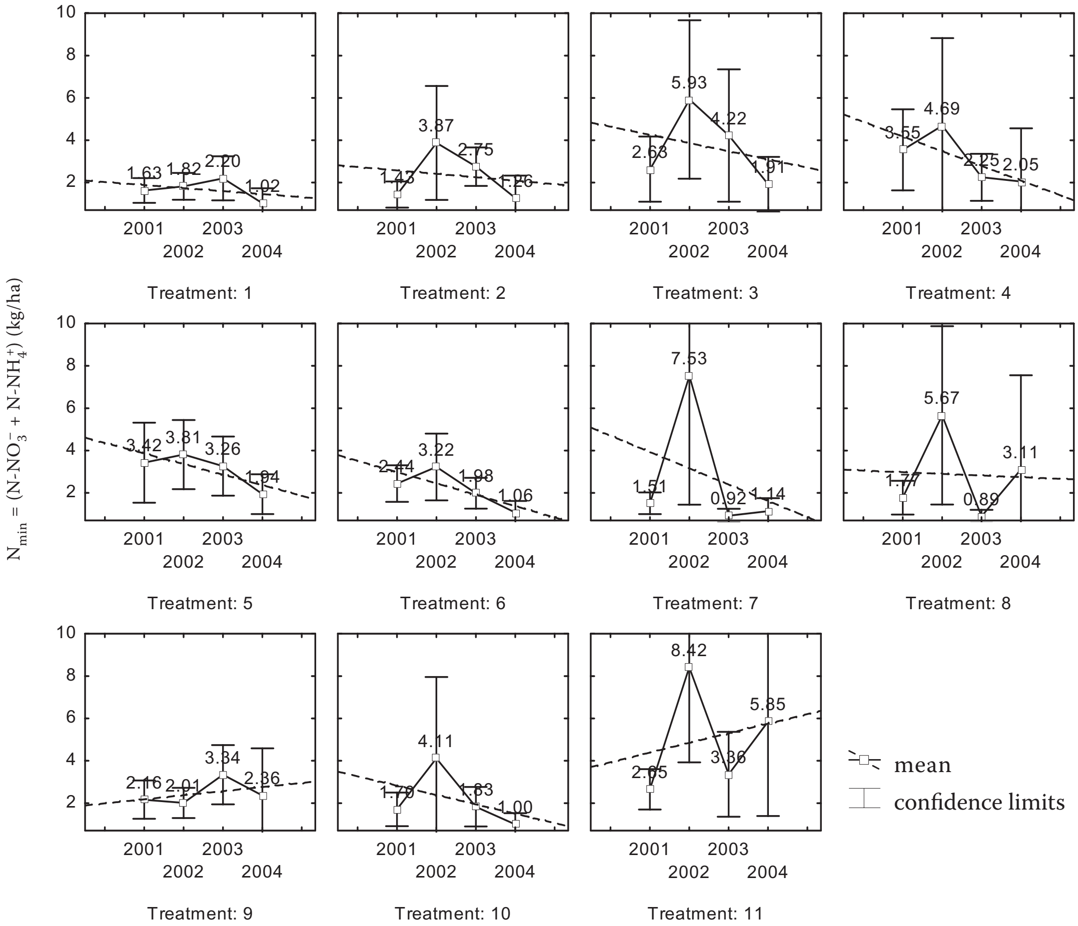


Figure 3. Amount of mineral N years in depth 0.2 m in 2001–2004

1.40 kg/ha), did not occur. The deeper layer of 0.4 m had a conclusively lower amount of $N_{min}$ than the upper layer of 0.2 m. Similar results were measured in soil, beneath unfertilized permanent grasslands, by other observers as well. The content of $N_{min}$ in depth 0.3 m was 4.2 mg/kg, i.e. 2.3 mg of $N\text{-}NO_3^-$ and 1.9 mg of $N\text{-}NH_4^+$. In the lower layer of 0.6 m it was less – 1.3 mg of $N\text{-}NO_3^-$ and 0.6 mg of $N\text{-}NH_4^+$ (Svoboda et al. 2004). In arable land, which was not fertilized by manure, in a depth range of 0.25–0.50 m, it was found to be 8–18 mg of $N\text{-}NO_3^-$/kg with a higher content in the upper layer (Vaněk et al. 1999, 2003, Haberle et al. 2004). The content of $N\text{-}NH_4^+$, usually found in the upper layer 0.5 is 9.2 mg/kg (Králová and Růžek 1998, Haberle et al. 2004). The stated amounts are comparable with lysimetric waters of cambiums beneath grasslands, i.e. 5.9 kg of $N_{min}$/ha (Kopec 1995). In the lysimetric waters of unfertilized arable lands measured in depths 0.2–0.6 m, there was, per ha and per year, 1.47 kg of $N\text{-}NO_3^-$ (Balík et al. 2003). However, a tremendous difference in the dilution of $N_{min}$, was revealed through a term of applying fertilizers. In the autumn, with fertilization, up to 50% of the input N was diluted at the depth of 0.3 m (Mouchová et al. 1990).

Resulting from the mulching of these grasslands, the accumulation of above-ground plant biomass, which decomposes and releases N, occurs. However, after a four-year period at either depth, the amount of $N_{min}$ was not conclusively increased with this technology (Figures 3 and 4). The concentration of $N_{min}$ found in lysimetric waters was dependant on the amount of filtered water present. Between the amount of distilled water and the content of $N_{min}$ there is a non-direct correlative dependency $r = -0.167$. This is about the same as the normal amount of rainfall $r = -0.177$ ($P < 0.05$).

The average concentration of $N\text{-}NO_3^-$ according to the variants and depths of the sampling, is illustrated in Figure 5. Among the variants, there is not a conclusive difference observed in either depth, with the exception of variant 11, black fallow. The values of $N\text{-}NO_3^-$, on average from 1.49 to 5.54 mg/l, as we measured, are in comparison with other's results lower. E.g. Rupp et al. (2003) states that in depths 0.3 and 0.5 m,

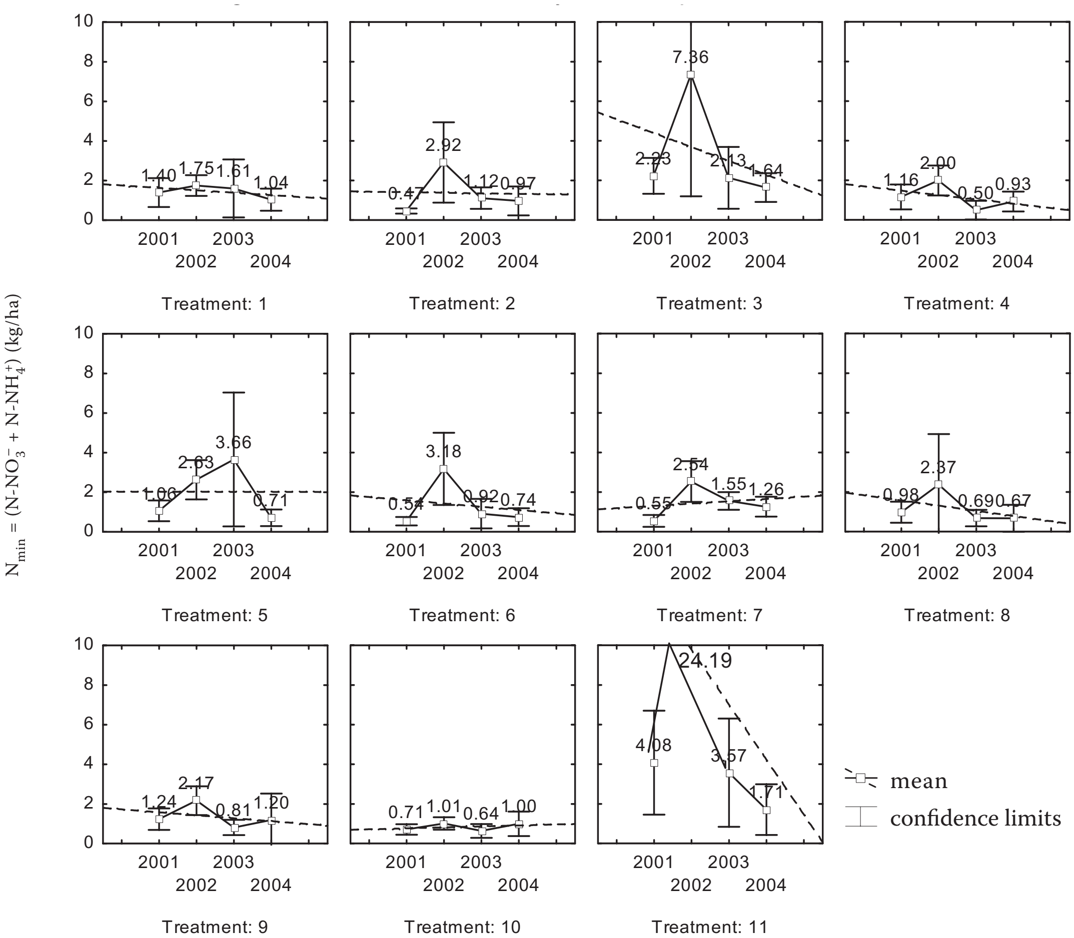


Figure 4. Amount of mineral N years in depth 0.4 m in 2001–2004

in soil with a lower content of turf concentration, 7.0 mg of $N\text{-}NO_3^-$/l and 3.7 mg of $N\text{-}NH_4^+$/l. Under unfertilized permanent grasslands in a depth of 0.5 m there in cambium, there was 12.5 mg of $N\text{-}NO_3^-$/l and 0.18 mg of $N\text{-}NH_4^+$/l, on average, in the 8 years measured (Eder 1991). Svobodová et al. (2004) states only small differences were found in the concentration of $N\text{-}NO_3^-$ in lysimetric waters

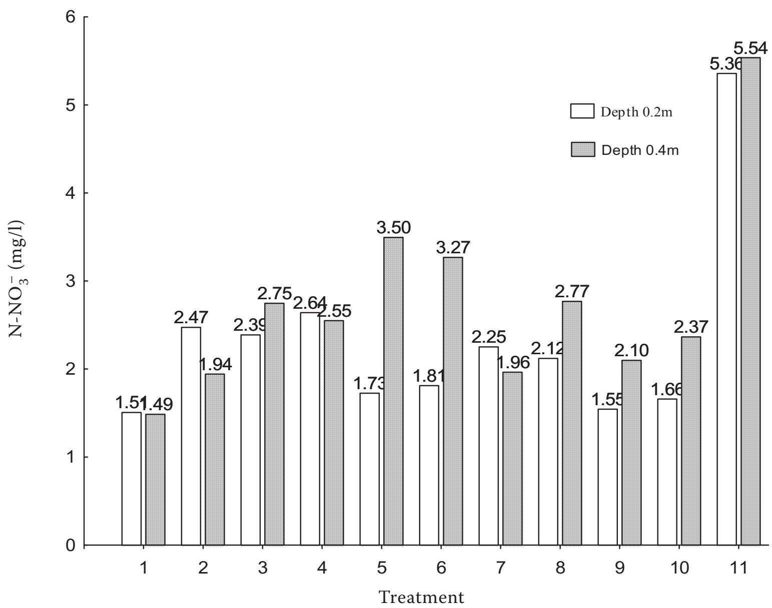


Figure 5. Average concentrations of $N\text{-}NO_3^-$ in lysimetric water

between methods of the farming of clover-grass crops – 7.45–8.82 mg/l, however, under grasslands 3.9–7.0 mg and under clover crops were found 6.0–17.0 mg of N-$NO_3^-$. On the contrary, Borin et al. (2003) measured unfertilized soils at only 4 mg of N-$NO_3^-$/l.

Modified pratotechnics of unmanaged – mulching did not conclusively increase the environment of rhisosphere due to the amount of $N_{min}$ in contrast to properly farmed land with the cut matter removed. The exception was variant 3 – the technology of turning the fallow by mulching. Even the green fallow did not conclusively increase the $N_{min}$. Understandably, the increase in the content of $N_{min}$, conclusively happened, with black fallow.

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Received on April 12, 2005

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