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Nitrate leaching in grazed grasslands of different composition and age.

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Abstract

In a field experiment at Research Centre Foulum a suction cup technique was used to investigate nitrate leaching from grassland depending on composition (grass-clover or perennial ryegrass), management (grazing or cutting) and age of the swards (1, 2, or 8 years). In the newly established swards nitrate leaching from grass-clover and ryegrass were similar but at increasing sward age nitrate leaching from the fertilized ryegrass increased dramatically compared to a constant low level from the unfertilized grass-clover.

Keywords: nitrate leaching, N_2 fixation, grass-clover, ryegrass, perennial pastures

Introduction

In cut grassland systems N efficiency is high and consequently nitrate leaching is often very low (Simmelsgaard, 1998). Grazing by e.g. dairy cows has a marked effect on the grassland N cycle and increases the loss potential dramatically. A considerable build-up of N takes place in grazed grassland and the extent depends on fertilisation, feeding of dairy cows, stocking density, time of grazing and the botanical composition of the sward (Cuttle and Scholefield, 1995). Furthermore, the age of the pasture is important since a new equilibrium is reached after a number of years, after when an N surplus is lost by leaching. When comparing older and newly reseeded pastures nitrate leaching losses were 50% lower in the newly reseeded fields compared to the permanent pasture, as average of the first five years after reseeding (Scholefield *et al.*, 1993).
The objectives of this study were to investigate the effect of pasture composition, management and age on nitrate leaching.

Materials and Methods

Unfertilized grass-clover and fertilized perennial ryegrass (300 kg N ha^{-1}) were established in 1993, 1999 and 2000 in adjacent plots in a block design with two replicates. The swards established in 1993 were grazed 1994-2000 and the swards established in 1999 were grazed in 2000 by dairy cows approximately 150 days per year. Within the block design were plots of cut grassland established in 1993. Thus in 2000-2001 the simultaneous nitrate leaching from newly established swards, swards grazed for 1 and 7 years and swards cut for 7 years was investigated. Each plot was equipped with ceramic suction cups and nitrate leaching was estimated as described by Eriksen (2001). For annual nitrate leaching the statistical analysis was made on log-transformed data to obtain homogeneity of variance, but results in the figure are presented as arithmetic means with SE.
In 2001, N_2 fixation was estimated in 1st, 2nd, and 8th year grass-clover pastures on the basis of clover dry matter production using an empirical model (Høgh-Jensen *et al.*, 1998).

Results and Discussion

Both type of grassland and the age influenced nitrate leaching significantly with a strong interaction between the two (Figure 1). Thus, nitrate leaching was very low for grass-clover (average 6 kg N ha^{-1}) and similar for all sward types in contrast to ryegrass where nitrate leaching increased dramatically with increasing sward age. Following the establishment of ryegrass under sown in barley, nitrate leaching was only 6 kg ha^{-1} increasing to an average of 17 and 60 kg in swards grazed 1 and 7 years, respectively. Apparently, the build-up of soil N has reached equilibrium at 7 years of grazing resulting in a larger part of the fertilizer input being lost through leaching.
In order to explain the difference between nitrate leaching from ryegrass and grass-clover, N_2 fixation was estimated in the following year. From April to September N_2 fixation was 117, 148, and 89 kg N ha^{-1} for the 1st, 2nd, and 8th year grass-clover, respectively. The decreasing N_2 fixation in the older

sward may, at least partly, explain that leaching losses were lower in grass-clover than in the fertilized ryegrass sward, as the clover component appears to equalize differences in soil N availability in swards of different age. In the estimates it was assumed that the proportion of clover N derived from the atmosphere (%Ndfa) was unaffected by sward age, and the lower N_2 fixation in the 8th year grass-clover only reflects lower production rates. It is likely that %Ndfa was reduced in the older sward, further decreasing the N_2 fixation input. This is currently under investigation.

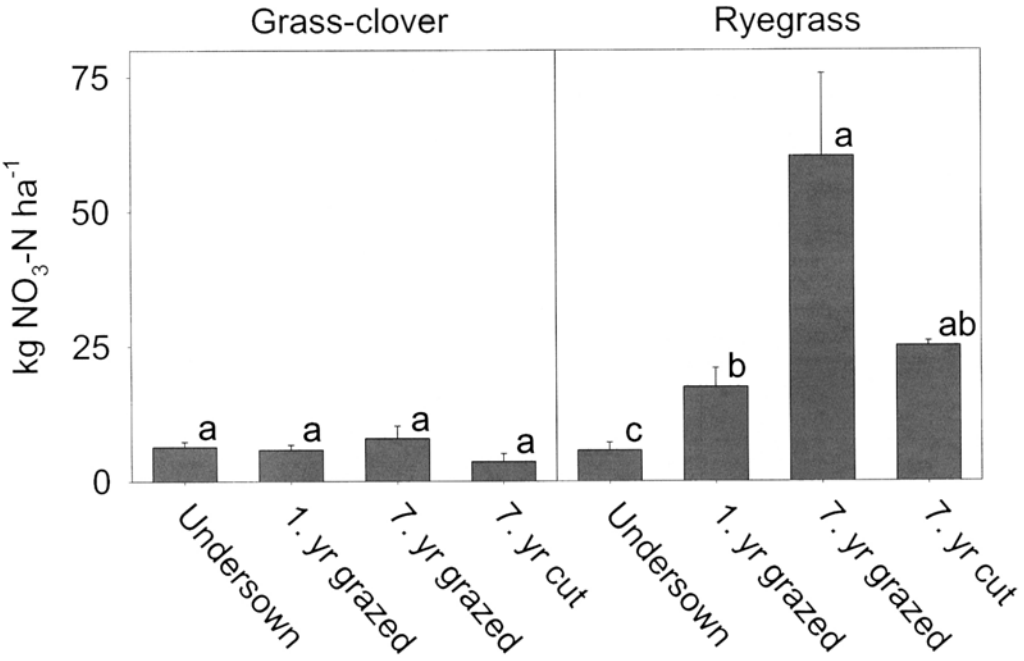

Figure 1. Nitrate leaching from grasslands of different composition, management and age. The swards were established by undersowing in barley. Bars with the same letter are not significantly different within each grass type ($P<0.05$). Error bars: SE.

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