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The XX International Grassland Congress took place in Ireland and the UK in June-July 2005.

The main congress took place in Dublin from 26 June to 1 July and was followed by post congress satellite workshops in Aberystwyth, Belfast, Cork, Glasgow and Oxford. The meeting was hosted by the Irish Grassland Association and the British Grassland Society.

Proceedings Editor: D. A. McGilloway

Publisher: Wageningen Academic Publishers, The Netherlands

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The effect of forage legumes on mineral nitrogen content in soil

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Keywords: legumes, nitrogen, soil

Introduction The cultivation of forage legumes is often suggested as a possibility to improve nitrogen (N) utilisation in farming. However, previous studies have indicated examples in which the cultivation of legumes such as white clover has led to accumulation of large amounts of N in soil (Adams & Pattison, 1985). In this study the potential risks of N leaching were estimated by determining amount of mineral N in the soil.

Materials and methods The effect of forage legumes to the mineral N (ammonium and nitrate) content in soil was studied in Finland in three different locations: one in Southern Finland in Helsinki (60°13') and two sites in Northern Finland Ruukki (65°40') and Rovaniemi (66°35'). The legume species were red clover (*Trifolium pratense* L.), white clover (*Trifolium repens* L.), alfalfa (*Medicago sativa* L.), goats-rue (*Galega orientalis* Lam.) and common birds-foot-trefoil (*Lotus corniculatus* L.). Legumes were sown both as a monoculture and as a mixture with meadow fescue (*Festuca pratensis* Huds.). In addition, meadow fescue was grown as a pure culture with or without N fertiliser at 200 kg/ha. Soil samples were taken from three different layers: 0-33 cm, 33-66 cm and 66-100 cm and the experimental plots in three consecutive years both in the autumn after the growth period and in the spring soon after the melting of ground frost. After the cessation of third growth period the plant stands were ploughed and the soil samples were taken next autumn and the spring after.

Results The mineral N content in the soil samples in autumn was significantly higher in the pure forage legume stands than in the mixture stands or in pure meadow fescue stands (for instance white clover, Figure 1). This was a common feature to all study sites and years. The effect was observed for all legume species. However, there were no distinct differences between the pure legume stands. The plant stand with highest mineral N content in the soil varied between years and study sites. The highest mineral N contents were generally in the plots with high yield and presumably efficient N fixation. The mineral N content increased significantly from autumn to spring in every experiment site (Figure 1). In coarse soils the mineral N contents moved deeper more quickly than in clay soils. The leaching of N has probably taken place in every site, but the amount of mineralisation from soil organic matter has been greater than leaching. Nitrogen is mineralised during winter even in such harsh climatic conditions as in Finland (Bergström & Brink, 1986).

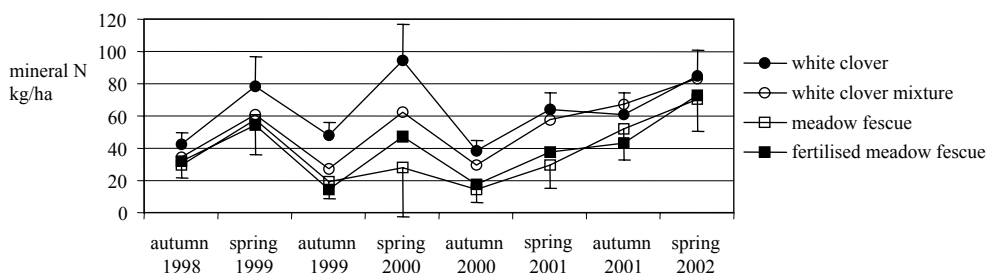


Figure 1 The amount of mineral nitrogen of meadow fescue, white clover and a mixed sward in the soil in Helsinki during 1998-2002. Estimates of confidence intervals (95%) are shown by error bars

Conclusions The cultivation of pure forage legumes will lead to accumulation of considerable amounts of organic N, which is vulnerable to leaching and denitrification when organic matter decomposes especially after cultivation of legume swards. One way to decrease the mineralisation of N is to leave tilling until late autumn.

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