EFFECT OF TANNIN IN ANIMAL DIET ON NITRIFICATION RATE OF PASTURE SOIL UNDER DUNG PATCHES

J. R. Crush

AgResearch, Ruakura Research Centre, Private Bag 3123, Hamilton, New Zealand

ABSTRACT

The rate of formation of nitrate and ammonium in the soil under dung patches was compared for dung from animals fed either ryegrass (*Lolium perenne*)/white clover (*Trifolium repens*) or ryegrass/*Lotus pedunculatus* forage. Tannin derived from the Lotus did not inhibit ammonification in the soil under dung but nitrate formation was strongly inhibited. The results support the theory that polyphenolics may bind to nitrite in acid soils and cause immobilisation of mineral nitrogen. Apart from their effect of reducing the proportion of dietary nitrogen excreted in urine, tannins in animal diets may make a further contribution to reducing nitrate leaching from grazed pasture by slowing down nitrification of dung nitrogen.

KEYWORDS

Tannin, *Lotus pedunculatus*, nitrification, soil , nitrate, dung, leaching

INTRODUCTION

Cows grazing pasture excrete about 25% of dietary nitrogen (N) in dung patches (Haynes and Williams, 1993). Dung N may be deposited at rates equivalent to urine N (Petersen *et al*., 1956) but the N is more stable because of the carbon content of the faeces and urine N is accepted as the major source of nitrate-N leached from pastures (Ryden *et al*., 1984).Tannins in the diet of sheep increased the proportion of dietary N excreted in dung from 19 to 33% (Waghorn *et al*., 1994). This shift in excess dietary N away from urine would reduce the potential for nitrate leaching losses from pasture. In addition, as tannins apparently pass through the gut, the nitrification rate of organic N in dung containing tannins may be slower than for tannin-free dung. Plant residues that contain tannins decompose more slowly than those that are tannin free (Palm and Sanchez, 1991). This report describes measurement of nitrification rates under dung patches from animals fed diets with, or without tannins.

METHODS

Dung was collected and deep-frozen each day from housed animals fed ryegrass/white clover herbage or ryegrass/*Lotus pedunculatus* herbage.The experimental site was on a Te Kowhai soil (Typic Ochraqualf, fine-loamy over sandy, mixed, thermic) with pH 5.1. The pasture which had been mown and not grazed for 3 years, was 80% grass (*Lolium perenne, Paspalum dilatatum*), 10% legume (*Trifolium repens, Lotus tenuis*) and 10% weeds. The dung was thawed and individual collections were bulked and mixed. Dung from the tannin diet was firmer than dung from the pasture diet so water was added to the tannin dung until the texture of the dungs appeared similar. Five kg of moist dung was applied to 0.1m2 plots in early summer. There were 4 replicates of each treatment and the site was spray irrigated to maintain soil moisture above 50% field capacity. Five soil cores (0-300 mm x 25 mm) were taken at intervals from each plot and from untreated headlands for 11 weeks. Any dung adhering to the surface of the cores was removed. The cores were then bulked within replicates, sieved, mixed, and 5g subsamples extracted for 1 hr in 50 ml of 2N KCL containing 5 mg/l of phenyl mecuric acetate (Douglas and Bremner, 1970). Nitrate- and ammonium-N were measured in the extracts using flow injection analysis. The results were adjusted to a common dung patch N content to compensate for variation in N input caused by differences in N content of the dung (2.72, 2.75 % N in DM for pasture and tannin dungs) and moisture content of the dung (92, 79 % for pasture and tannin dungs) and analysed using Minitab.

RESULTS AND DISCUSSION

Soil ammonium-N reached peak concentrations very rapidly after the dung patches were formed (Fig. 1), with the highest concentrations measured in the treatments with tannin in the animal diet. Nitrate levels in the untreated soil remained low throughout the experiment (Fig. 2). This is normal for pasture soils not affected by excreta, when temperature and moisture allow rapid uptake of nitrate by the sward (Thompson and Coup, 1940). About 10 days after application of the dung, soil nitrate levels started to rise rapidly under the dung patches. The increase was greater and more sustained in dung patches derived from the ryegrass/ white clover diet than when the diet contained tannins derived from *Lotus* (Fig. 2). After 11 weeks the soil nitrate levels had returned to background levels. The difference between the dung treatments was significant at $P< 0.01$.

The pattern of initial rapid ammonification of dung N has been reported before eg Sugimoto *et al*. (1992) recorded peak ammonia volatilisation 10-15 days after dung application to pasture soil. The presence of tannins in the diet certainly did not inhibit ammonium formation, with the highest ammonium concentrations actually being recorded in the tannin treatments. However nitrate formation was slowed considerably in the tannin treatments. The results provide support for the theory that soluble polyphenolics bind to nitrite causing an apparent immobilisation of mineral N (Palm and Sanchez, 1991). This reaction readily occurrs in acid soil conditions.

It is well established that urine patches are the most important source of nitrate that leaches from grazed pasture. Any reduction in nitrification rate under dung is not likely to have a major impact on nitrate leaching losses. Lower nitrate concentrations will lower the potential for leaching and denitrification losses of cycling N and increase the uptake of N by pasture plants. The experiment was done on a site with few tannin containing species in the sward. Current research is looking at the effect of litter from swards high in tannins, on nitrification of both dung and urine N in pasture soils. The most important result to date has been the demonstration described here, that forage quality factors can have measurable effects on soil N transformations. This potentially provides a way to manage N cycling in pasture for production with reduced nitrate leaching.

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Figure 1
Soil ammonium-nitrogen concentrations in untreated soil, and in soil under dung from animals fed a ryegrass/white clover diet or a ryegrass/*Lotus* diet containing tannins.

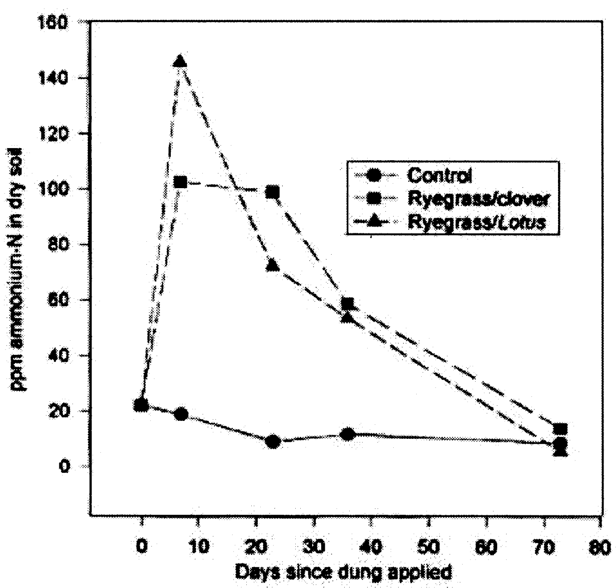

Figure 2
Soil nitrate-nitrogen concentrations in untreated soil, and in soil under dung from animals fed a ryegrass/white clover diet or a ryegrass/ Lotus diet containing tannins.