ID # 04-34

EFFECTS OF FERTILIZER RATES AND PASTURE TYPE ON SOIL MINERAL NITROGEN CONCENTRATION UNDER DAIRY PASTURE

T.A. Cox[1], D.F. Chapman[1], and F.R. McKenzie[2]

[1]ILFR, The University of Melbourne, Victoria 3010, Australia

[2] DNRE, Warrnambool, Victoria 3280, Australia

Abstract

The effects of three rates of nitrogen (N) fertilizer applied to monocultures of perennial ryegrass (*Lolium perenne* L.) and white clover (*Trifolium repens* L.), and mixed ryegrass / clover swards, grazed by dairy cows on soil mineral nitrogen levels in the top 10cm of soil were studied on a dryland pasture in south-western, Victoria, Australia. Ammonium and nitrate were monitored for 14 months. Clover monocultures had significantly greater NO_3^- levels, however a similar trend was not observed for NH_4^+. Increasing fertilizer application rate significantly increased both NO_3^- and NH_4^+ levels under all pasture types.

Keywords: nitrate, ammonium, mineral nitrogen, *Trifolium repens*, *Lolium perenne*

Introduction

Dairy producers in south-western Victoria, Australia, have increased nitrogen fertilizer application rates to boost pasture growth rates and fill feed supply gaps. There are concerns about the effects of N application in the wider environment, for example, leaching into groundwater. This paper presents data on soil mineral nitrogen changes under a range of nitrogen fertilizer application rates and pasture types.

Material and Methods

The experiment was conducted on a grazed dairy pasture at Glenormiston in south-western Victoria (142°55'E, 38°15'S, mean annual rainfall 739mm). Annual rainfall for 1998 and 1999 was 553mm (74% of average) and 541mm (73% of average) respectively. A randomised block design with four replicates was used. Three nitrogen fertilizer (urea) treatments (0, 150, and 500 kg N ha^{-1} yr^{-1}) were applied in split applications in April, July and September. Plots were grazed on a rotational basis, with a stocking rate of 2.0 Friesian cows ha^{-1}.

Banvell (dicamba) and Fusilade (fluazifop-p) were used to create monocultures of perennial ryegrass and white clover from a mixed grass / clover pasture. A third pasture treatment comprised a mixture of the two species ranging from 14% - 2% white clover content; clover content decreased with increasing nitrogen application rates.

Soil was sampled to a depth of 10cm using a corer, then bulked and mixed. Fifteen grams of soil was extracted with 100ml 2M KCl for one hour (Rayment and Higginson, 1992). The extract was filtered, then filtrates were analysed for nitrate and ammonium by colorimetry using a Bran+Leubbe Autoanalyser III. Samples were collected every six weeks, from October 1998 to December 1999.

Dry matter production was measured by difference between pre- and post-grazing pasture masses using a calibrated rising plate meter.

Results and Discussion

Concentrations of mineral nitrogen present as nitrate were significantly ($P<0.05$) higher under clover monocultures than either pure grass, or grass/clover swards (Figure 1). Plots receiving 500 kg N ha^{-1} yr^{-1} contained significantly ($P<0.05$) greater NO_3 levels than plots receiving either 0 or 150 kg N ha^{-1} yr^{-1} (Figure 1). These elevated levels indicate that

the amount of herbage grown by all pasture types was insufficient to utilise all the nitrate available. There was no interaction between fertilizer and pasture treatments, except for the June sampling date when nitrate levels were higher for clover monocultures than other pastures at 0 and 150 kg N ha^{-1} yr^{-1}, but not at 500 kg N ha^{-1} yr^{-1} (data not shown, $P<0.05$).

Ammonium levels were also significantly greater ($P<0.05$) for plots receiving 500 kg kg N ha^{-1} yr^{-1}. The peaks observed in April and September 1999 (Figure 2) were caused by the application of fertilizer N within two weeks prior to samples being obtained from the field. The effect was short-lived, presumably due to conversion to nitrate and subsequent uptake of nitrate by actively growing plants. Despite high concentrations present, no significant ($P<0.05$) differences in ammonium levels were detected under the three pasture types for any sample date (Figure 2). Total dry matter production for the 1999 growing period (Apr - Dec) was significantly ($P<0.05$) greater in the 500 kg N treatment (4700 kg DM ha^{-1}) than in the other fertilizer treatments (average 3990 kg DM ha^{-1}, $P<0.05$). There were no differences in total pasture production between the three pasture types. Pure clover swards, and all plots receiving 500 kg N ha^{-1} yr^{-1}, had high nitrate contents during the summer months, at a time when mineral nitrogen levels would be expected to decrease following the period of most rapid pasture growth (Vaughan *et al.*, 1986). The lower average rainfall during the measurement period may have limited plant uptake, leading to accumulation of mineral nitrogen in the soil through the summer period. High levels of nitrate under clover monocultures were probably a result of continuing N fixation by plants, in addition to the inputs of fertilizer. Fixation of atmospheric nitrogen has been shown to contribute up to 63% of clover's total nitrogen requirements even when well supplied with mineral N (Davidson and Robson, 1985).

The results support the proposition of MacDuff et al. (1990) and Parsons *et al.* (1991) that the presence of N-demanding grass can control the mineral N concentration in pasture

soils to environmentally-acceptable levels, even when moderate levels of N fertilizer are applied. In this study, ammonium and nitrate concentrations in soils receiving 150 kg N ha^{-1} yr^{-1} were not significantly higher than soils receiving no added N (Figures 1b, 2b). However, they were much higher when 500 kg N was applied ha^{-1}, and when clover was grown alone. Grass/clover pastures with relatively low clover contents and receiving moderate rates of N fertilizer (the mainstay of dairy production in Victoria) are unlikely to create conditions where large amounts of N may be leached. This conclusion is supported by nitrogen balance results from southern Australia dairy systems (Eckard *et al.*, 2001).

References

Davidson, I.A. and Robson M.J. (1985). Effect of nitrogen supply on the grass and clover components of simulated mixed swards grown under favourable environmental conditions. II. Nitrogen fixation and nitrate uptake. Annals of Botany **55**:697-703

Eckard, R.J., Chapman D.F., White R.E., Smith A., Chen D. and Durling P. (2001). Nitrogen balances in high rainfall, temperate dairy pastures of south eastern Australia. Proceedings of the XIX International Grassland Congress (this volume).

MacDuff, J.H., Jarvis S.C. and Roberts D.H. (1990). Nitrates: leaching from grazed grassland systems. In: Nitrates-Agriculture-Eau, ed. R. Calvert, pp. 405 – 410. INRA, Paris.

Parsons A.J., Orr R.J., Penning P.D. and Lockyear D.R. (1991). Uptake, cycling and fate of nitrogen in grass-clover swards continuously grazed by sheep. Journal of Agricultural Science **116**:47 - 61.

Rayment, G.E. and Higginson F.R. (1992). Australian Laboratory Handbook of Soil and Water Chemical Methods. Inkata Press, Melbourne.

Vaughn, C.E., Center D.M. and Jones M.B. (1986). Seasonal fluctuations in nutrient availability in some northern California annual range soils. Soil Science **141**: 43-51

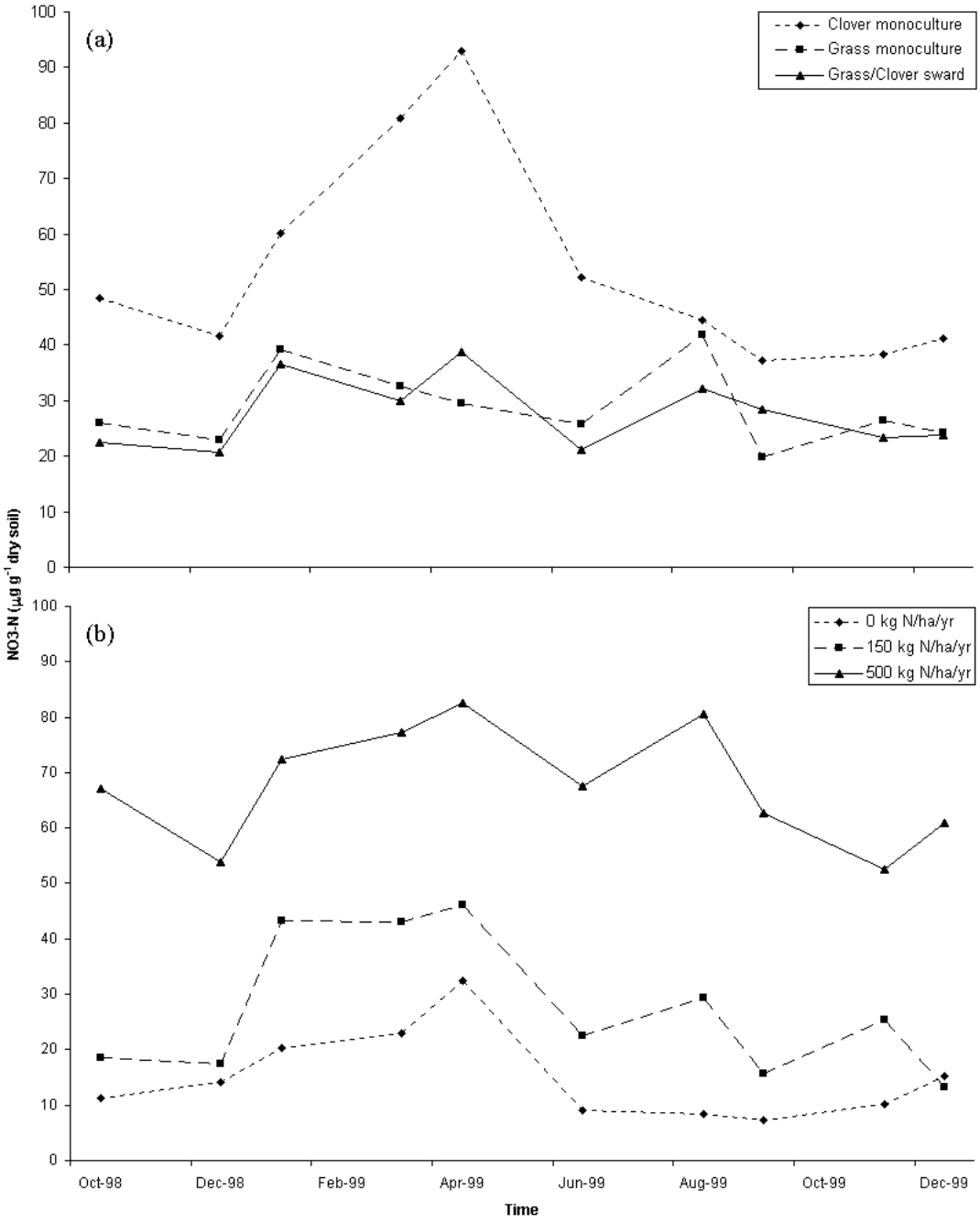

Figure 1 - Effect of pasture type (a) and nitrogen fertilizer (b) on soil nitrate levels.

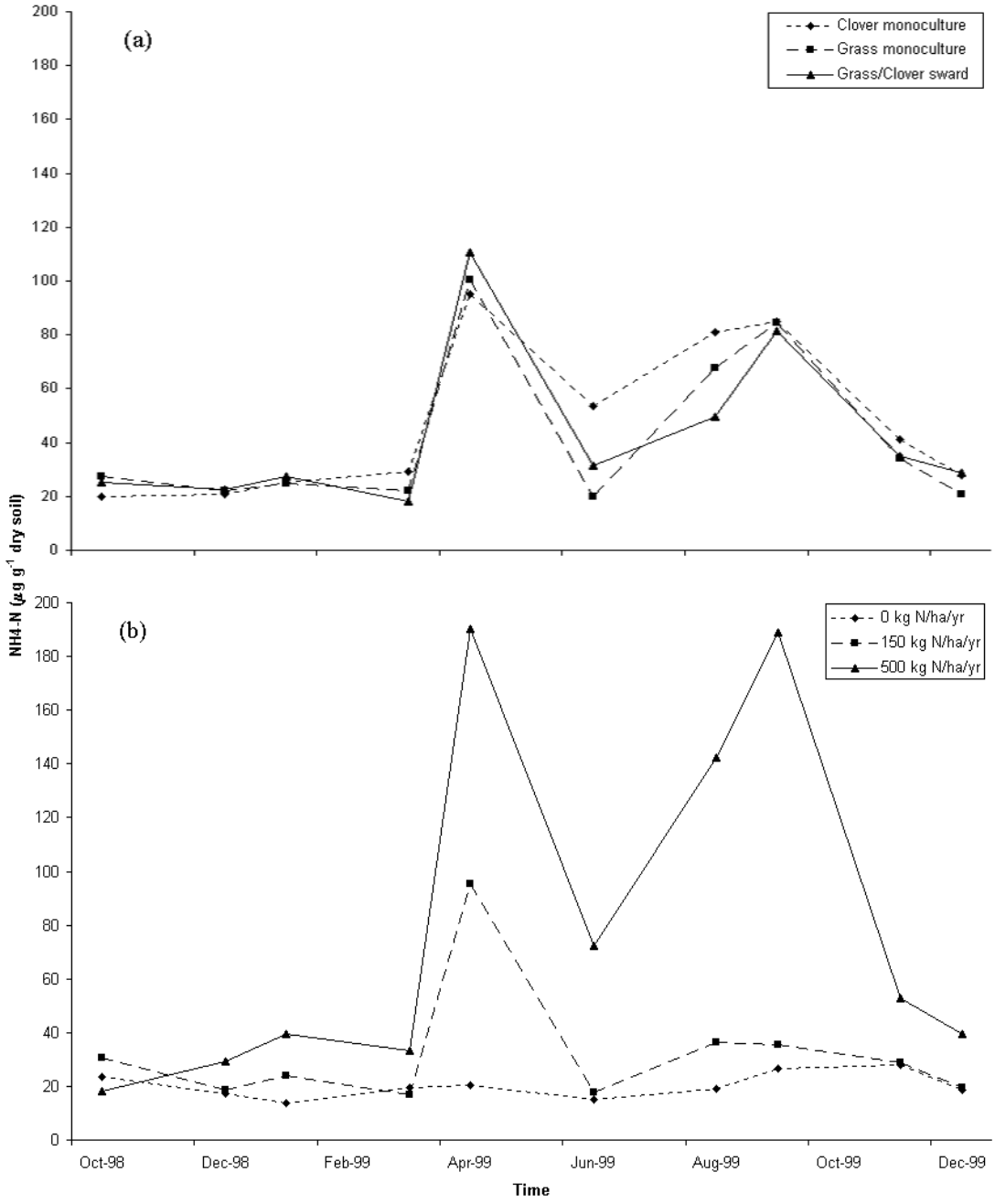

Figure 2 - Effect of pasture type (a) and nitrogen fertilizer (b) on soil ammonium levels.