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NITROGEN FERTILISER EFFECTS ON PERENNIAL RYEGRASS NUTRITIVE AND NITRATE CONTENT DURING THE COOL SEASON

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Abstract

A study was undertaken to determine the effects of differing levels of nitrogen (N) application (0 (N1), 25 (N2), 50 (N3) and 75 kgN/ha (N4)) during late autumn (T1), early (T2) and late winter (T3) on the nutritive characteristics and nitrate content of perennial ryegrass. Changes in crude protein (CP) for all treatments at each application time were similar irrespective of level of N application. At the commencement of all treatments, the existing CP content was highest in N3, followed by N2, N1 and N0. Nitrate content decreased throughout T1 primarily due to dry conditions, whilst during T2, levels for N3 and N2 were significantly ($P<0.05$) higher than N1 and N0. During T3, nitrate content increased for all treatments throughout the 28 day period, with highest nitrate levels being observed during T3. The findings indicate that N fertiliser did not elevate nitrate content in perennial ryegrass to levels considered toxic. It is likely that environmental effects (rain and temperature) impacting on soil N mineralisation may have a greater impact on nitrate content than fertiliser N.

Keywords: Nitrogen, perennial ryegrass, crude protein, nitrate, metabolisable energy, neutral detergent fibre, water soluble carbohydrates

Introduction

Increased stocking rates on dairy farms in southern Australia have led to increased use of supplementary feeds or increased pasture dry matter (DM) production. Nitrogen (N) fertiliser has become an important management tool to achieve increased DM production (McKenzie and Jacobs 1997), particularly when growth rates are low (autumn and winter). It is known that N fertiliser can increase DM production, however effects on pasture nutritive characteristics and nitrate content are equivocal. Most studies have focussed on measuring pasture nutritive characteristics after a fixed timeframe, and therefore have been unable to elucidate the effects on pasture nutritive characteristics during the growing period. This is important, given the majority of dairy pastures in southern Australia are rotationally grazed according to growth rates and not set timeframes. Increased N fertiliser use has led to concerns with high crude protein (CP) content and elevated nitrate content affecting milk production and animal health respectively. This study determined the changes in the nutritive characteristics and nitrate content of perennial ryegrass receiving multiple applications of differing levels of N fertiliser during autumn and winter.

Material and Methods

This study was based on an existing three-year old N grazing trial. Briefly, four treatments of N fertiliser (0 (N0), 25 (N1), 50 (N2), and 75 (N3) kg N/ha) as urea (46% N) were replicated three times in grazed perennial ryegrass / white clover plots (30m x 30m). During 1999, N was applied in autumn (8 April; T1), early (4 June; T2) and late winter (20 August; T3). Sampling (three times per week) commenced on the day of application and continued for four weeks. Randomly cut pasture samples (to ground level) were taken along set transects within plots. Nutritive characteristics of processed perennial ryegrass samples were analysed using near infrared spectroscopy (NIR). NIR spectra were collected on all samples using a NIRSystems 6500 scanning monochromator in conjunction with Infrasoft International software. NIR calibrations for dry matter digestibility (DMD), CP, neutral detergent fibre (NDF) and water soluble carbohydrates (WSC) had been previously derived on large sample populations using the procedures of Shenk and Westerhaus (1991). Metabolisable energy (ME) values were calculated from predicted DMD values using SCA (1990). Nitrate analysis was undertaken using the method of APHA (1995). Statistical analysis was undertaken using a linear mixed model fitted using ASREML (Gilmour *et al*, 1997) interacted with a cubic smoothing spline of time to test for the effects of N applied on pasture nutritive characteristics. For nitrate content the exponential curve, y=A+B*R$^{\mathbf{x}}$ where A, B are constants and R = exp(-κ) , was used to describe nitrate y, in terms of time **x**.

Results

Changes in CP at each application time were similar irrespective of level of N application (Fig.1). At the commencement of all treatments, existing CP content of perennial ryegrass was highest in N3, followed by N2, N1 and N0. Responses during T1 were lower than for other times with CP increasing by approximately 2 percentage units within 10 days of N application and decreasing to original levels after 28 days. Application of N during the T2 resulted in CP being elevated by 8 percentage units for all treatments 17 days after N application, and during T3, the increase was 5 percentage units and occurred within 5 days of N application. Nitrate content decreased throughout T1 (Fig.2), whilst during T2, levels for N3 and N2 were significantly ($P<0.05$) higher than N1 and N0 over 28 days. During T3, nitrate content increased for all treatments throughout the 28 day period, with highest nitrate levels observed during T3. Changes in ME, NDF and WSC followed similar patterns for all treatments within each period with ME increasing during all treatment periods, NDF deceasing during T1 and T2 and increasing in T3, and WSC increasing during all treatment periods.

Discussion

Previous studies (McKenzie *et al*, 1999), based on 'once off' applications of N fertiliser have shown that N fertiliser may elevate pasture ME, CP content while decreasing NDF and WSC content. In the current study, there was already an N effect prior to applying N fertiliser. Presumably this residual effect was a carry over from previous N applications with the trend being particularly evident in T2 and T3, and to a lesser extent T1. While N fertiliser tended to impact upon pasture nutritive characteristics, the trend was not significant, presumably because of the existing N effect. Available soil moisture and rainfall data indicate that during T1 soil moisture was well below field capacity and therefore responses to applied N were not expected to be high. In contrast, soil moisture was at field capacity during T2 and therefore responses to N were optimal, whilst during T3 the soil became slightly waterlogged and responses tended to decline more rapidly than those found in T2. Such responses have particular importance in western Victoria where the provision of pasture in late autumn and winter is an integral component of the predominantly winter calving pattern. Crude protein content reached levels close to 30% during T2 and T3. If pasture constitutes a major component of the diet, the energy cost associated with excreting excess CP as urea is likely to reduce milk production and therefore provision of additional energy becomes an issue during such periods.

From the current results, N fertiliser did not elevate pasture nitrate content in perennial ryegrass over the ranges tested: 0-75 kg N/ha. It is likely that environmental effects (rain and temperature) impacting on soil N mineralisation may have a greater impact on nitrate content than fertiliser N. The reported (and anecdotal) evidence of nitrate poisoning in dairy cattle is more likely to be associated with other plant species known to be nitrate accumulators (e.g. cape weed, Italian ryegrass, cereals), than with perennial ryegrass. In conclusion the application of N had no detrimental effect upon the nutritive characteristics of the pasture, although elevated CP content may be an issue in some situations. Nitrate concentrations were not considered to have reached toxic levels. This study also highlighted the changes that occur over a given time period (28 days), and this is of particular importance in a rotational grazing system where pastures are grazed when 'ready' as opposed to after a defined time period.

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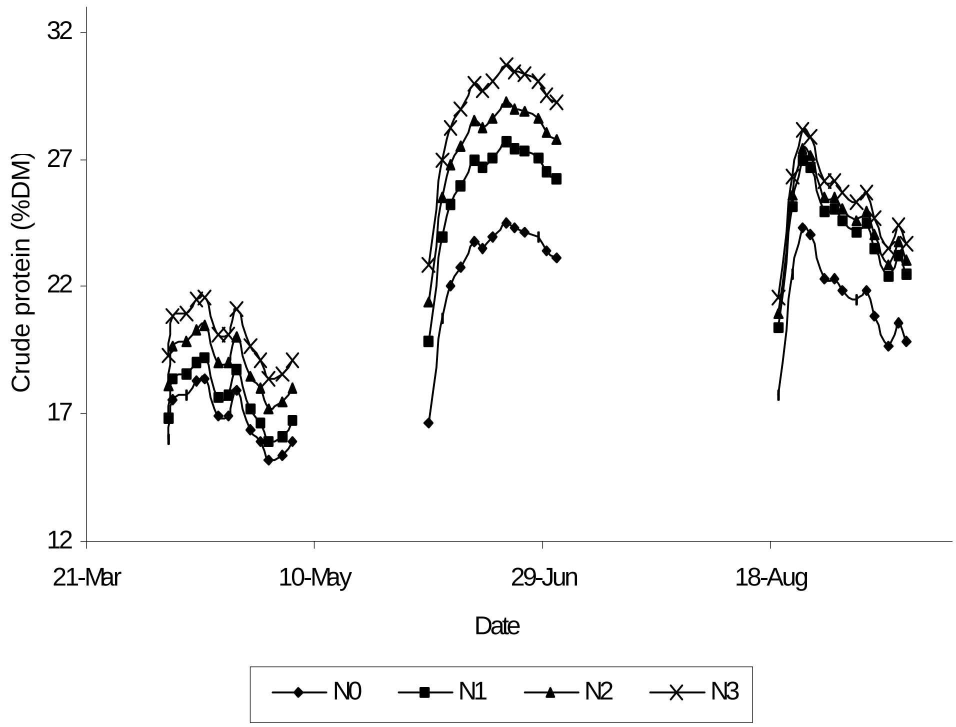

Figure 1 - The effect of timing and level of nitrogen application (0 (N1), 25 (N2), 50 (N3), 75 kg N/ha (N4)) on the crude protein content (% DM) of perennial ryegrass.

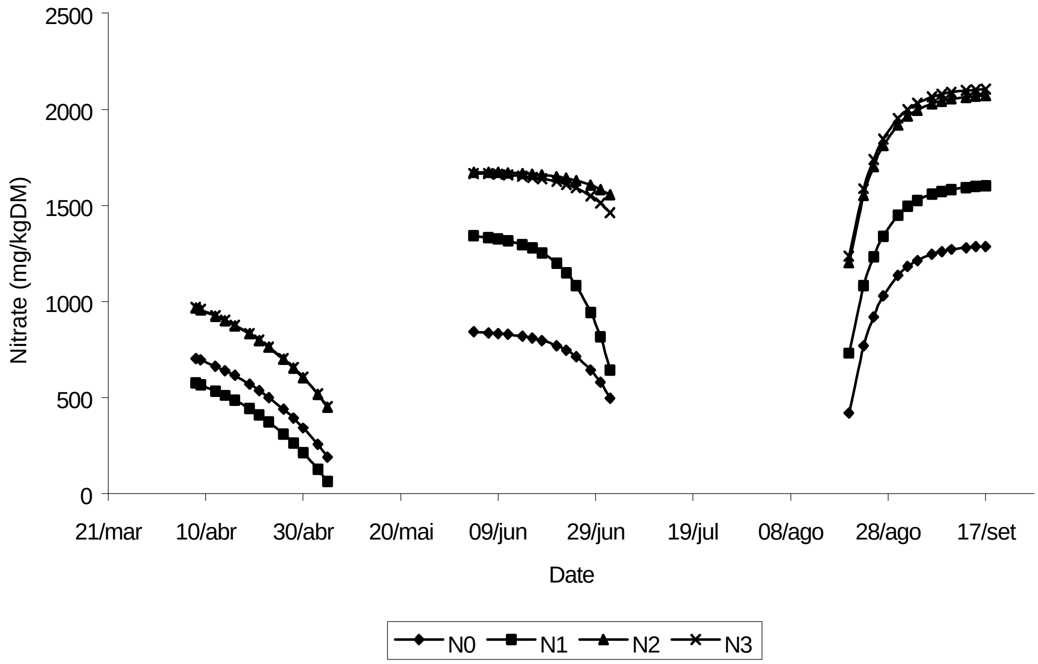

Figure 2 - The effect of timing and level of nitrogen application (0 (N1), 25 (N2), 50 (N3), 75 kg N/ha (N4)) on the nitrate content (mg/kg DM) of perennial ryegrass.