Nitrogen fertiliser effects on perennial ryegrass crude protein and nitrate content

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ABSTRACT

A study was undertaken to determine the effects of differing levels of nitrogen (N) (0 (N1), 25 (N2), 50 (N3) and 75 kgN/ha (N4)) during late autumn (T1), early (T2) and late winter (T3) on the crude protein (CP) 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 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 for dairy cows. 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.

KEY WORDS

Nitrogen, perennial ryegrass, crude protein, nitrate.

INTRODUCTION

Increased stocking rates on dairy farms in southern Australia have led to increased use of supplementary feeds or the need for increased pasture dry matter (DM) production. Nitrogen (N) fertiliser has become an important management tool to achieve increased DM production (4), particularly when growth rates are low in autumn and winter. It is known that N fertiliser can increase DM production, however effects on pasture nutritive characteristics and nitrate contents 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 that 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 CP and nitrate content of perennial ryegrass receiving multiple applications of differing levels of N fertiliser during autumn and winter.

MATERIALS AND METHODS

This study was based on an existing three-year old N grazing trial. 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 commenced immediately prior to each application and continued 3 times per week for four weeks. Randomly cut pasture samples (to ground level) were taken along set transects within plots. The CP content of the ryegrass fraction was determined using near infrared spectroscopy (NIR). Nitrate analysis was undertaken using the method of APHA (1). Statistical analysis was undertaken using a linear mixed model fitted using ASREML (3) 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, $y=A+B*R^{x}$ where A, B are constants and $R = \exp(-\kappa)$, 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. Prior to N application the CP content of perennial ryegrass was highest in N3, followed by N2, N1 and N0 (Figure 1a). 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, whilst during T2, levels for N3 and N2 were significantly ($P<0.05$) higher than N1 and N0 over 28 days (Figure 1b). During T3, nitrate content increased for all treatments throughout the 28 day period, with highest nitrate levels observed during T3.

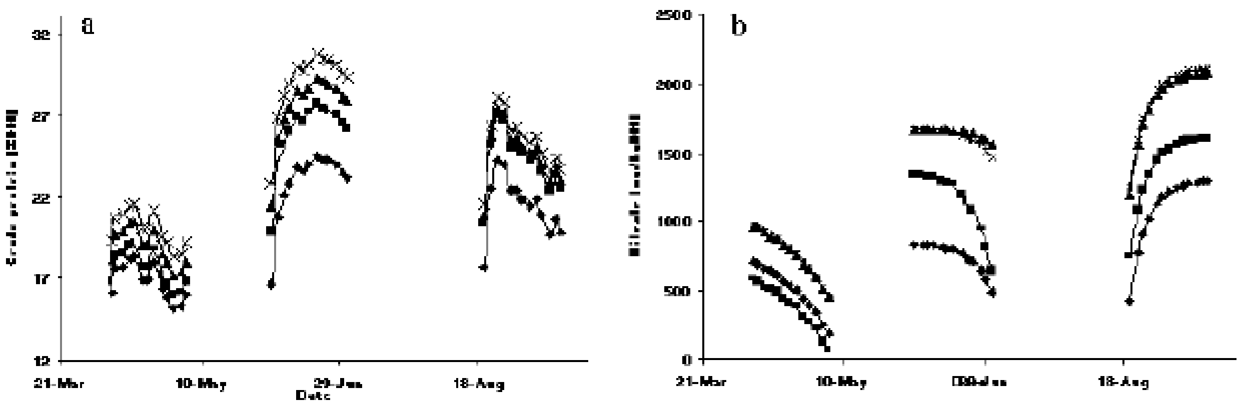

Figure 1. The effect of timing and level of nitrogen application (0 (◆), 25 (+), 50 (▲), 75 kg N/ha (Φ)) on the crude protein (a) (%DM) nitrate content (b) (mg/kg DM) of perennial ryegrass.

DISCUSSION AND CONCLUSION

Previous studies (5), 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 a residual effect of previous N applications, which was particularly evident in T2 and T3, and to a lesser extent T1. While N fertiliser tended to impact upon pasture CP, the trend was not significant. 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 (6) 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 (2). This study also highlighted the changes that occur over a typical grazing interval 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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