EFFECT OF NITROGEN ON PASTURE YIELD AND QUALITY FOR SILAGE IN WESTERN VICTORIA

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Abstract

Nitrogen (N) fertiliser was applied at rates of 0 (N0), 25 (N1), 50 (N2), 75 (N3) and 100 (N4) kg/N ha to spring dairy pastures at two sites in western Victoria. Two weeks after N application plots were harvested weekly over a 7 week period. Increasing rates of N generally increased herbage DM yield regardless of length of lock up period. The yield response was greatest 7 weeks after nitrogen had been applied at both sites (Site 1, 26 kg DM/kg N: Site 2, 14.9 kg DM/kg N). Subsequent regrowth of pasture was increased by N application for the shorter lock up length. Botanical composition was unaffected by treatment during the harvesting period or in the subsequent autumn. Application of N gave rise to a linear increase in pasture ME and CP content at both sites until week 5. Thereafter, this response diminished and by week 8 there was a decrease in ME and CP content. NDF content was relatively unaffected by N application until week 8 of the study, at which point there was a linear increase. Application of N reduced the WSC content of pastures throughout the sampling period.

Key words: crude protein, dry matter, metabolisable energy, neutral detergent fibre, water soluble carbohydrates

The temperate climate in southern Australia leads to a pasture growth pattern, in which over 60% of dry matter (DM) production occurs between mid August and late November. Michell and Fulkerson (7) comment that maintaining grazing intensity through this period can improve pasture utilisation and subsequent milk production. To achieve these levels of grazing intensity in spring the conservation of surplus pasture into either silage or hay must become a component of pasture management.

Optimum harvest date for hay or silage is a compromise between DM yield and quality and, there-fore, may be defined as the time at which the yield of digestible DM per hectare is maximised (1).

Application of nitrogen (N) fertilisers has been shown to increase DM yield (2) and also to increase herbage metabolisable energy (ME) and crude protein (CP) and decrease water soluble carbohydrate (WSC) content (10). Such effects may be advantageous for the production of higher DM yields for silage, while improving, or at least maintaining, herbage nutritive quality.

This study determined the effect of differing rates of N application on pasture DM yield and quality for silage over a range of potential lock up lengths.

Materials and methods

The experiment was conducted at 2 sites in south western Victoria from August 1995 to June 1996. Site 1 was located near Terang (38^{o} 14' S; 142^{o} 55'E) on a fine sandy clay loam soil derived from quaternary basalt, while Site 2 was located near Simpson (38^{o}30' S; 143^{o} 13'E) on a sandy loam soil type derived from recent sediments. Soil tests and rainfall data are shown in Table 1.

On 10 (Site 1) and 12 September (Site 2), the experimental areas were divided into 140 plots of 2 m by 3 m and mown to a height of 5 cm estimated to represent a residual herbage mass of 1200 kg DM/ha. The DM yield and botanical composition of the mown material were recorded for use as a co-variate in the DM yield analyses. A factorial design within 4 randomised complete blocks was used. Five N rates, 0 (N0), 25 (N1), 50 (N2), 75 (N3) and 100 kg N/ha (N4) were applied as Urea fertiliser in a factorial combination with 7 lock up lengths, weekly from weeks 3 - 9 after the initial harvest, were allocated randomly to the 35 plots within each block. Nitrogen was applied one week after lock up and harvesting commenced three weeks after lock up.

Pasture DM yield was estimated using a sickle bar mower by cutting a 1.1 m by 3 m strip from each plot to a height of 5 cm. The cut material was collected and weighed. A sub-sample was taken weighed and dried at 100 ?C for DM determination. A sub-sample was taken, dried at 50^{o}C for 72 h, ground through a 1 mm screen and analysed for dry matter digestibility (DMD), crude protein (CP), neutral detergent fibre (NDF) and water soluble carbohydrates (WSC). Metabolisable energy (ME) was calculated from predicted DMD values.

Statistical analysis was undertaken using residual maximum likelihood with treatments being compared at equivalent cutting times based on their respective lock up date.

Results

At Site 1, N had no effect until four weeks after application (week five of lock up) (Table 2). Thereafter, there was an increase ($P<0.05$) in DM yield at rates above 50 kg N/ha (N2, N3, N4) compared with N0. This increase was apparent throughout the duration of the study. There was no effect on DM yield at Site 2 until week seven of lock up. At this time the N4 increased ($P<0.05$) DM yield compared with N0.

N responses (kg DM/kg N) for primary DM growth indicate that highest responses did not occur until at least week eight (seven weeks after application) at both sites.? There was some indication that responses at Site 1 were higher than those at Site 2, particularly prior to week eight of lock up. At Site 1, responses were all high at week eight (N1, 20.9:1; N2, 16.2:1; N3, 26.3:1; N4, 25.2:1), while at Site 2 responses were comparable to Site 1 for N1 and N2, but lower for N3 and N4 (N1, 23.3:1; N2, 17.5:1; N3, 11.7:1; N4, 17.2).

Nitrogen increased the ME compared with N0, however, the magnitude of the increase varied according to week and site (Table 3). At Site 1, N4 had a higher ($P<0.05$) ME value than N0 from week three to week six, whilst N3 was higher ($P<0.05$) from week three until week five. In contrast, by week nine N0 had a higher ($P<0.05$) ME content than all levels of N application. At Site 2, N3 was higher ($P<0.05$) than N0 in week 3, while N2, N3 and N4 were all higher ($P<0.05$) during week four. As with Site 1, by the end of the study N0 had a higher ($P<0.05$) ME content than all other treatments.

Nitrogen increased ($P<0.05$) the CP content of the total sward at all levels compared with N0 at Site 1 during weeks three and four. This effect diminished thereafter, with only N2, N3 and N4 being higher ($P<0.05$) at week five and only N4 higher ($P<0.05$) at week six. At Site 2 N2, N3, N4 had a higher ($P<0.05$) CP content than N0 at week three and N4 was higher ($P<0.05$) at week four. However, by week eight N0 had a higher ($P<0.05$) CP content than N3 and N4, and at week nine was higher ($P<0.05$) than N2, N3 and N4.

Nitrogen at N3 and N4 decreased ($P<0.05$) NDF content of pasture at week three compared with N0 at Site 1. However, by week eight NDF content of N0 was lower ($P<0.05$) than the values in N2, N3 and N4. Similar trends were observed at site 2. Initially in week three N3 had a lower ($P<0.05$) NDF content than N0, however after week six N2, N3 and N4 generally had higher ($P<0.05$) NDF contents than N0.

At week three, N0 had a higher ($P<0.05$) WSC than all other treatments at Site 1. This effect diminished over time, and at week four, WSC content in N0 was only higher ($P<0.05$) than N2, N3 and N4, by week five higher ($P<0.05$) than N3 and N4 and by week six only higher ($P<0.05$) than N4. At Site 2 there were no differences between treatments.

Discussion

In southern Australia nitrogen is not generally used on grazed pastures in spring, as pasture growth rates already exceed animal requirements during this period.? However, once paddocks are removed from the grazing rotation and locked up for forage conservation, there may be benefits in boosting growth rates and therefore DM yield to maximise yield of conserved forage per hectare.

It is well established that applied N will increase DM yield (11) and the results of this study are consistent with these findings. Previous studies have shown that the most efficient responses to N (kg DM/kg N applied) occur at applications rates between 45-60 kg N/ha (11).? In this current study the most efficient responses appeared to occur at rates between 75-100 kg N/ha.? Although this appears to be somewhat contradictory to the previous studies, this result may be in part explained by a lag phase in response occurring at lower rates of application. This lag phase may be a result of spring soil mineralisation releasing plant available N and masking effects of the lower levels of N application (4).

Responses at Site 2 were lower and more inconsistent than those at Site 1, which was somewhat surprising given the relatively higher nutrient status of the soil at Site 2. A possible explanation may have been the soil conditions at the time of fertiliser application. Site 2 was partially waterlogged, thus there may have been a reduction in the amount of N reaching the root zone.? Secondly, under such conditions, as the temperature increased and evaporation of moisture occurred, some of the dissolved urea may also have been lost through the process of volatilisation. Continued rewetting through light rainfall or heavy dews, followed by drying conditions may accentuate this effect (6).

Previous work has shown that application of N can increase pasture digestibility and CP, whilst decreasing WSC content (10). Any increase in ME is beneficial, however, the changes in ME need to be kept in context with any changes in DM yield. Thus, if ME and DM yield are both improved through the application of N, then the result is beneficial. In contrast, if DM yield is maximised through later cutting, any positive changes in ME may be lost. It is apparent therefore, if N is to be used, that management still needs to be based upon achieving high quality pasture for silage.

The optimum time to cut pasture in terms of attaining a high ME and maximising DM yield is at early ear emergence of the ryegrass component of the sward (J. Jacobs *unpub. data*). Using such criteria the DM yields and ME content of the pasture at site 1 would be 1.51, 1.73, 2.21, 2.35, 2.44 t DM/ha and 11.0, 11.3, 11.2, 11.1 and 11.4 MJ/kg DM for N0, N1, N2, N3 and N4 respectively. At site 2 the corresponding figures would be 1.76, 1.97, 2.08, 2.15 and 2.05 kg DM/ha and 11.3, 11.5, 11.2, 11.4 and 11.4 MJ/kg DM. Given, that there is little difference in ME, the effect of N has been to increase DM yield.

The increase in pasture CP is consistent with N application and Whitehead (11) comments that the greatest response is likely to be 2-3 weeks after appli-cation. Such increases in CP may have an implication, on the ensilability of the pasture (5). Herbage high in CP can be difficult to ensile, as some N compounds have a buffering effect, which may inhibit the required change in pH. Given that wilting can help alleviate this problem, higher levels of CP in pasture and thus in silage may actually be advantageous at feeding.

Fertiliser N generally has little effect upon NDF (9), although Moller *et al.* (8), did observe a reduction in NDF shortly after N application, a pattern consistent with this study.

The content of WSC in pasture is often substantially reduced by applied N (3). This reduction in WSC may have negative implications for the ensilability of the pasture. Water soluble carbohydrates are the primary substrate during ensilage for bacteria to utilise and produce fermentation acids, which in turn will lower pH and produce a stable product (5).

Conclusion

The results of this study indicate that application of N to a mixed sward locked up for forage conservation, can increase DM yield and provided pasture is harvested prior to ear emergence can also have a positive effect upon ME and CP. If N is applied it may be possible to shorten lock up lengths and allow pastures to return to the grazing rotation sooner or provide an opportunity for second harvest silage.

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