Optimizing Yield and Quality of Orchardgrass Pasture in Temperate Silvipastoral Systems

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OPTIMIZING YIELD AND QUALITY OF ORCHARDGRASS PASTURE IN TEMPERATE SILVIPASTORAL SYSTEMS

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Abstract

The objective of this study was to provide grazing management recommendations for a silvipastoral system by determining the effects of shade and nitrogen (N) on the pattern of dry matter accumulation and nutritive value of orchardgrass (*Dactylis glomerata*) in a sub-humid temperate environment. Orchardgrass in open pasture (100% transmittance) and under 10 year old *Pinus radiata* tree shade (60% transmittance) at 200 stems/ha was used as the main plot and nitrogen (0 and 300 kg N/ha as synthetic urine) was the subplot factor. Dry matter (DM) production of orchardgrass in the first 60-day spring rotation was similar in open and shade conditions (2.6 t/ha) but approximately doubled by the application of N. In the 60-day summer rotation, DM production was about 22% lower in the shaded plots and was increased by about 60% by the addition of N. Crude protein and organic matter digestibility declined with herbage age and the onset of reproductive tiller growth. It was concluded that to maximise DM production without compromising pasture quality, grazing management of orchardgrass should be similar in open and shaded pastures in spring (30-35 day regrowth) but a shorter regrowth length used for open (20 days) than silvipastoral (25-30 days) systems in summer.

Keywords: Crude protein, *Dactylis glomerata*, digestibility, grazing management, nitrogen, orchardgrass, *Pinus radiata*, shade, silvipastoral, synthetic urine

Introduction

Research with widely spaced *Pinus radiata* has suggested that orchardgrass may be the most suitable grass for silvipastoral systems due to its shade tolerance (West *et al*., 1991).

Optimising dry matter (DM) production and nutritive value (crude protein (CP%) and organic matter digestibility (OMD)) of orchardgrass for grazing requires knowledge of how these factors change with time in a silvipastoral system. Typically, DM accumulation is slower in silvipastoral than in open pasture. Thus, a longer regrowth may be necessary to maximise pasture production. However, orchardgrass forage quality decreases rapidly with maturity (Calder and McLeod, 1968). Furthermore, the lack of clover and presence of obvious green urine patches covering 20-25% of orchardgrass pastures indicates that they are frequently nitrogen (N) stressed.

The aim of this study was to measure herbage production and nutritive value to provide grazing management recommendations for orchardgrass in a silvipastoral system in a sub-humid temperate environment. To do this, the effect of two light levels and two nitrogen treatments, using synthetic urine, on the orchardgrass pasture was determined over two 60-day grazing periods in spring and summer 1999.

Material and Methods

This experiment was conducted in silvipastoral plots at Lincoln University, Canterbury, New Zealand. Details of the site were given in Mead *et al.* (1993). The mean soil moisture content in the top 500 mm was measured every 10 days using Time Domain Reflectometry and was always above 24% for the first rotation and 19% for the second rotation. These values were always higher than half of the maximum available water content of the site (mean field capacity= 29%) indicating that treatments were not moisture stressed.

The *Pinus radiata* trees were planted in July 1990 at 1000 stems/ha and were periodically thinned to the present 200 stems/ha with 7 m between rows. Orchardgrass and clover spp. were sown in September 1990 in three 46.2 x 42.0 m (0.194 ha) main plots. At the same time three orchardgrass plots (27.5 x 18 m) were established in an adjacent open site. Plots have been grazed by sheep since 1993. The experiment used orchardgrass in open pasture (100% transmittance) or under tree shade (60 % transmittance) as main plots and nitrogen (0 or 300 kg N/ha as synthetic urine (Fraser *et al.*, 1994)) as the subplot factor. Usually 400-500 kg N/ha is found in sheep urine patches but orchardgrass has low N content therefore the lower rate of 300 kg N/ha was used. The main plots were grazed by sheep but the subplots were excluded from grazing using 2.5 m^2 exclusion cages. Separate sites were used for the spring (1 September-30 October) and summer (1 November-31 December 1999) 60-day studies. Total DM production, reproductive tiller number and DM yield, CP % and OMD of vegetative tillers were measured every 10 days. Flowers and reproductive stems were excluded from the CP and OMD analyses because they were largely ungrazed. This was confirmed by residual cuts where reproductive tillers were 50-60% of the total residual DM material compared with 27% in pre-grazing in the open and 10% under trees.

Results and Discussion

The DM yields after 60 days were up to 5.3 t/ha in rotation 1 (spring), compared with 8.2 t/ha in rotation 2 (summer) although this included 2.8 t/ha of reproductive tillers (Figure 1). The added nitrogen approximately doubled ($p<0.01$) DM production in both rotations and in open and shaded plots. Indeed there was no effect of shade on DM production in rotation 1 but a 25 % increase in both nitrogen treatments in rotation 2. This difference was mainly due to tiller population and height which increased from 3460/m^2 and 24.0 cm to 3790/m^2 and

35.3 cm with the addition of nitrogen in the open and from 2670/m^2 (26.3 cm) to 2920/m^2 (36.4 cm) under trees. Nitrogen also promoted fertile tiller numbers, particularly in the open, with 398/m^2 in the no nitrogen treatment and 490/m^2 with added nitrogen. These results highlight that orchardgrass was frequently N stressed and responded to N fertilizer in this silvipastoral system. This supports Joshi *et al.* (1999) who showed a similar increase in DM production for shaded orchardgrass in urine patches. The lack of reproductive tillers in silvipastoral treatments (Figure 1) may improve utilisation of orchardgrass under trees compared with open pasture.

N also increased CP content by about 10 units in open and shaded conditions (Figure 2). In contrast to DM production, the CP percentage declined in all treatments at about 0.3 units/d and was lowest at the end of each rotation (Figure 2). However, the decline in rotation 2 was more linear, starting in the first 10-day period compared with after about 30 days in rotation 1.

The OMD was similar across treatments at about 83% in rotation 1 and 75% in rotation 2 although it declined by 0.16 OMD units per day in both rotations. Thus, the patterns of change in DM accumulation and nutritive value (CP % and OMD) of orchardgrass pastures in the open and silvipastoral systems were similar but the total DM was reduced under trees. This implies the grazing management under both systems should be similar. The slower rate of DM accumulation in the spring and lack of reproductive development indicates a 30-35 day regrowth would maximise spring growth without compromising pasture quality. This corresponds to grazing with a pasture mass of about 3 t/ha in the N treatment compared with 2 t/ha in no N pasture. In summer, the onset of warmer temperatures and flower emergence, and the earlier onset of the decline in CP %, suggests the regrowth should be shortened to about 20 days in the open pasture and 25-30 days in the silvipastoral system. This would correspond to a pre-grazing mass of 3-4 t/ha in the N fertilised plots or 2 t/ha in unfertilised plots.

The different recommendations and patterns of DM accumulation between spring and summer suggest different environmental factors were limiting production in each period. In spring the similarity between shaded and open N treatments indicates shade was not limiting production. The implication was that the 10.8 ºC mean temperature was limiting growth. In summer, the temperature increased to 13.2 ºC and ceased to limit production. The effect of reduced PAR receipts was apparent in the shaded treatments. However, the 22% reduction in DM was less than the 40% reduction in PAR in shaded treatments. This supports the classification of orchardgrass as a shade tolerant species.

In conclusion, orchardgrass DM production and nutritive value were increased by the addition of N as synthetic urine in open and shaded pastures, in spring and summer. Grazing management of orchardgrass should be similar in open and shaded pastures in spring (30-35 days regrowth) to maximise DM production without compromising nutritive value. Shorter regrowth is necessary for open pasture (20 days) compared with silvipastoral (25-30 days) in summer when the majority of reproductive tillers are produced.

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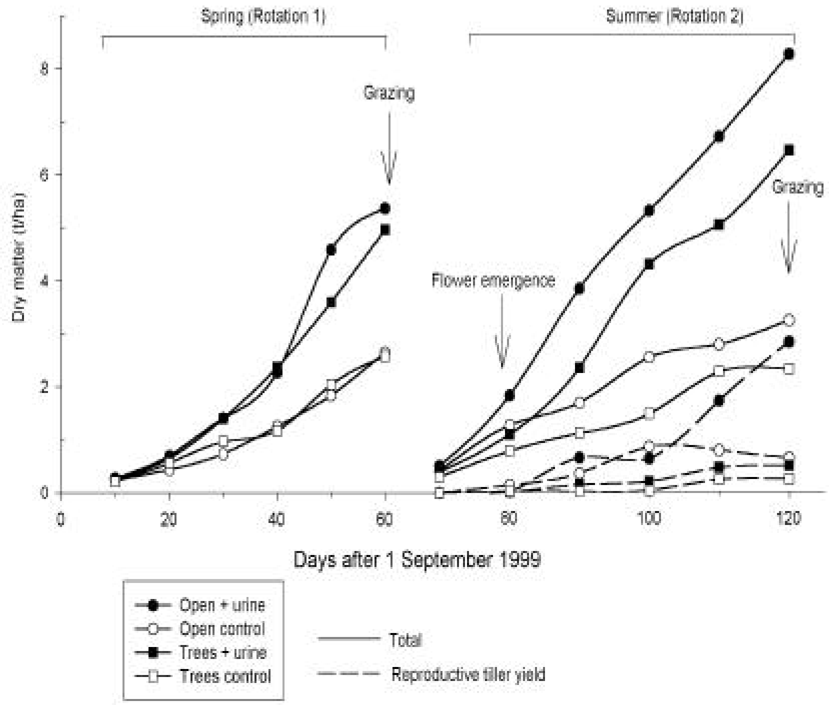

Figure 1 - Mean dry matter production of orchardgrass pasture during two 60-day grazing periods in open and silvipastoral conditions, with and without the application of 300 kg N/ha as synthetic urine. Maximum SE for both rotations is 0.21 t/ha.

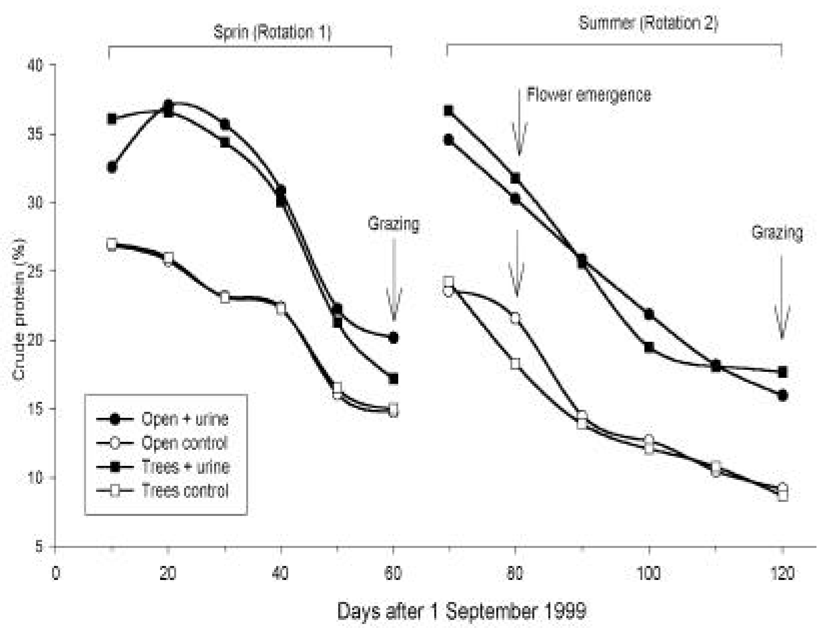

Figure 2 - Mean crude protein content in vegetative tillers of orchrdgrass grown with or without 300 kg N/ha in shaded or open environments. Maximum SE for both rotations is 1.4%.