Seasonal dry matter production of *Lotus corniculatus* in a dryland commercial sheep pastoral system

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Abstract

Lotus corniculatus (Birdsfoot trefoil, 'Grassland Goldie') may have a role in dryland pastoral systems in New Zealand, but there is little information available on its production under sheep grazing in these conditions. Dry matter (DM) production of *L. corniculatus* was measured monthly for 2 consecutive years in a systems approach experiment comparing it with perennial ryegrass (*Lolium perenne*)/white clover (*Trifolium repens*) pasture in the Wairarapa on the east coast of the North Island. The total DM produced for 2 years was 8.5 and 10.5 t/ha for *L. corniculatus* compared with 7.3 and 9.9 t/ha for pasture. Also, the moderate concentration of CT (18–29 g/kg DM) in *L. corniculatus* has been shown to increase sheep productivity (Wang *et al.* 1996ab; Min *et al.* 1999, 2001). This production advantage, combined with improved sheep performance, supports the potential use of *L. corniculatus* as a specialist forage in dryland areas.

Key words: condensed tannins, perennial ryegrass, *Lolium perenne*, white clover, *Trifolium repens*, pasture.

Introduction

Lotus corniculatus (Birdsfoot trefoil, 'Grassland Goldie') is a perennial forage legume tolerant of low soil fertility, drought conditions, soil acidity and impeded drainage (Heinrichs 1970; Douglas & Foote 1993), which normally limit survival of other legume species. Experimental evidence (Wang *et al.* 1996ab; Min *et al.* 1999, 2001; Ramírez-Restrepo *et al.* 2002) suggests that *L. corniculatus* is able to contribute to animal feed demands and environmental sustainability due to its seasonal forage production, high feeding value, and its moderate concentration of condensed tannins (CT) (Ramírez-Restrepo *et al.* 2003a,b). Research from glasshouse environments

and small plots has shown that *L. corniculatus* maintains its quality during maturity and comparatively high yield production occurs during summer (Ayala 2001; Bologna *et al.* 1996). However, little is known about its production throughout consecutive years under grazing conditions in a dryland environment in New Zealand.

Thus, the objective of this study was to determine annual and seasonal dry matter (DM) production of *L. corniculatus* under grazing management over two consecutive years relative to perennial ryegrass/white clover pasture.

Materials and methods

Nine hectares of *L. corniculatus* were established in a moderate soil fertility on 6/3/2000. The study was conducted from November 2000 to October 2002 at Massey University's Riverside farm, in the Wairarapa on the east coast of the North Island, New Zealand. Sowing rate was 20 kg/ha of coated/inoculated seed and was sown at 10 mm depth with a cone-type plot seeder equipped with double disc openers set 150 mm apart. Forage DM yields were calculated at monthly intervals under grazing from November 2000 to October 2002 using a systems approach. In this system, effects on plant production and effects of feeding upon sheep productivity (data not shown) were measured simultaneously. Similar areas of adjoining perennial ryegrass/white clover pasture were used as the control.

Patterns of DM production for both *L. corniculatus* and pasture were measured using two techniques. Firstly, we selected, marked and cut to ground level 8 random quadrats (0.180 m²) in a specific area to be grazed approximately 30 days later. To give an estimate of growth over a fixed period, a further 8 random quadrats in the same area were selected and protected with enclosure cages measuring 1.4 x 0.9 m,

which were sampled 30 days later before grazing commenced. Secondly, the post-grazing pasture mass was measured from 8 quadrats using cuts at ground level. This area was then allowed to regrow and was resampled from 8 different enclosure areas 30 days later. This measurement gave a second estimate of herbage growth rate. All plant samples were washed and dried overnight (16 h) in a forced-air oven (Contherm; Thermotec 2000; New Zealand) at 80 °C. The initial dates of sampling were staggered so that growth could be studied in successive overlapping periods of 30 days (Davies 1993).

The remaining areas of *L. corniculatus* and perennial ryegrass/white clover pasture were grazed by commercial flocks of sheep and cattle. Additionally, pasture paddocks were mechanically topped during summer to remove reproductive stem material, thus encouraging vegetative growth. During winter 2001, the *L. corniculatus* was sprayed with herbicide to control grasses (haloxyfop (a.i.), 300 g/ha). Broad-leaved weeds were controlled during the second wet season using 375 g/ha paraquat (a.i.) plus 225 g/ha diquat (a.i.) and metribuzin (a.i.) 700 g/ha.

Annual rainfall (Nov–Oct) was greater during the second year (967 v 1072 mm). The summer/autumn season (Jan–April) was drier during the first year than the second, accounting for 187 mm (19%) and 275 mm (26%) of the annual rainfall, respectively (Figure 1), and rainfall was about 4 mm below the 50-year average (New Zealand Metereological Service 1983).

Results and discussion

Over a 2 year period, 1536 forage samples were collected. The two DM measurement techniques gave

Figure 1 Mean rainfall during two consecutive years at Massey University's Riverside farm in the Wairarapa, on the east coast of the North Island, New Zealand, compared with the 50-year mean values (New Zealand Metereological Service 1983).

similar results, so the mean of both techniques is reported for all data. *L. corniculatus* was greater than perennial ryegrass/white clover pasture in first (8.5 ± 0.21 v 7.3 ± 0.21 t DM/ha) and second seasons (10.5 ± 0.25 v 9.9 ± 0.20 t DM/ha). The significance of the differences could not be calculated because this was a systems experiment without true replication. The extra production from *L. corniculatus* predominantly occurred over the summer/autumn period (Figure 2).

Figure 2 Mean cumulative seasonal dry matter (DM) production of *Lotus corniculatus* ('Grasslands Goldie') and perennial ryegrass/white clover pasture (Pwc) in a dryland farming system averaged over two years (2001 and 2002). (Vertical bars represent one standard error of the mean).

Monthly patterns of DM production were similar for *L. corniculatus* and pasture (Figure 3), with the principal production advantage of *L. corniculatus* occurring during lower summer/autumn rainfall in 2000-2001 rather than in the wet conditions of the 2001-2002 summer/autumn (Figure 3). The negative growth rates for some periods in late autumn and winter were due to low temperatures, resulting in *L. corniculatus* and pasture growth that was occurring more slowly than the rate of senescence.

DM production of both forages was similar in spring, but *L. corniculatus* had higher yields during summer/autumn and better feeding value, and higher digestibility and metabolisable energy concentration (Ramírez-Restrepo *et al.* 2003ab) than the perennial ryegrass/white clover pasture, throughout 2

Figure 3 Monthly growth rates of *Lotus corniculatus* ('Grasslands Goldie') (○) and of perennial ryegrass/white clover pasture (■) grown in the Wairarapa on the east coast of the North Island, New Zealand. Data collected from November 2000 to October 2002. Bars indicate pooled standard error.

consecutive years. This suggests *L. corniculatus* could be used productively in a commercial sheep dryland farming system.

Conclusions

Lotus corniculatus produced similar dry matter yield to perennial ryegrass/white clover pasture during spring and was more productive during summer/autumn. We recommend that the best use of DM produced by *L. corniculatus* under a dryland farming system is during the mating season in late summer/autumn, as it improved reproductive efficiency (16% units) and wool production (8%) of ewes, as well as lamb viability from conception to weaning, particularly in years with exceptionally dry autumn periods (Ramírez-Restrepo *et al.* 2003b). A second use is to feed *L. corniculatus* during spring to simultaneously increase body growth in lambs (26%) and both ewe and lamb wool production, with reduced pre-lambing anthelmintic drenching (Ramírez-Restrepo *et al.* 2002; Ramírez-Restrepo *et al.* 2003a).

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