Effects of pasture type and management on the clover content and nutritive value of dairy pastures in south west Victoria

Z.N. Nie, D.F. Chapman, R. Clements and E.R. Letts

Department of Animal Production, University of Melbourne, PMB 6200, Terang, VIC 3264

Abstract

The effects of species mixture, management and soil type on pasture production and persistence were studied in 2 grazing trials. Five pasture mixtures, combined with 3 management treatments, were established on a heavy and a light textured soil in south west Victoria in April 1998. The 5 mixtures were: 1) ‘old persistent’ type; 2) ‘district mix’; 3) ‘new persistent clover’; 4) ‘triple mix’; and 5) ‘high producing’. Treatments 1, 2, 3 and 5 were ryegrass-based, whereas treatment 4 contained cocksfoot, phalaris and tall fescue. All were sown with clover. The 3 management treatments involved increasing levels of fertiliser input and weed and pest control. In 1998/99, the triple mix and old persistent pastures produced 297 – 335 kg DM/ha/yr of clover, almost double that of district mix and high producing type, although their total pasture yields were lower. Pasture nutritive characteristics differed between pasture types and management had a significant impact on CP and digestibility. The results indicate that both pasture type and management affect the quality of pasture available for dairy cattle, and will therefore impact on milk production.

KEY WORDS

Pasture yield; clover yield; soil type; feed quality.

Introduction

High quality pasture is essential for maximising milk production of pasture-based dairy systems. In south west Victoria, over 80% of feed for dairy cattle is derived from pasture - the cheapest source of feed. Pasture legumes, particularly white clover (*Trifolium repens*), can contribute significantly to feed quality and nitrogen fixation in dairy systems (4). Mason (8) estimated that white clover alone contributes $390m annually to the Australian dairy industry, of which 69% is from milk production and 23% is from nitrogen fixation.

Clover growth and content in pasture mixtures can be affected by environment (climate and soil types), management (fertiliser use, pest and weed control, and grazing management etc.), plant genotype and competition from the companion grass (6, 7). Although many studies (eg. 1, 3, 10) have been undertaken to identify the impact of these factors, little systematic research has been done to study the 3 major impacts (environment, management and plant genotype) and their interactions on clover growth and feed quality. Such information is critical for improving the feed use efficiency and profitability of dairy farms. This paper reports the effects of pasture genotype, management and environment on pasture and clover growth and feed quality on 2 contrasting soil types in south west Victoria during 1998-1999.

Materials and methods

Trial site and treatment

Trials were conducted on 2 sites in south west Victoria. One was at DemoDAIRY (142?52'89"E, 38?16'22"S), near Terang, on a duplex soil with a heavy clay sub-soil. The other was on a commercial farm (142?41'62"E, 38?24'01"S) at Naringal with a light-textured sedimentary soil. Average annual rainfall is 790 and 750 mm at DemoDAIRY and Naringal, respectively. Full details of the sites are given by Nie et al. (9).

Five pasture mixtures were sown at DemoDAIRY and Naringal in April 1998 and combined with 3 management treatments. The 5 pasture mixtures were: 1) 'old, persistent' pasture [Irrigation white clover, Victorian perennial ryegrass (*Lolium perenne*)]; 2) 'current district mix' (perennial ryegrass, large-leafed white clovers, sub clovers (*Trifolium subterraneum*)]; 3) 'new persistent clover' (as in 2 for grasses, but including a base of stoloniferous clover types such as 'Grasslands Prestige' and 'Grasslands Sustain'); 4) 'triple mix' [tall fescue (*Festuca arundinacea*), phalaris (*Phalaris aquatica*), cocksfoot (*Dactylis glomerata*) and white clover]; and 5) 'high producing' [short-lived ryegrass (e.g. *Lolium multiflorum*), perennial ryegrass, white clovers, sub clovers, red clover (*Trifolium pratense*) and chicory (*Cichorium intybus*)]. The 3 management treatments were A. control - current farm practice with one fertiliser application (N:P:K:S = 30:35:60:40 kg/ha) and one spraying for weed and pest control (Tigrex 500 and Fastac 100 ml/ha) in autumn; B. 'full nutrient supply' – as in A for weed and pest control, but with a total of N:P:K:S = 90:90:120:90 kg N/ha applied three times (autumn, late winter and mid spring); and C. 'full nutrient supply and pest and weed control' – as in B for fertilisers, but sprayed three times (autumn, early and mid spring) for pest and weed control. The 15 treatment combinations (5 pasture types x 3 management treatments) were randomly allocated within 3 replicates at each site.

Measurement

Pasture and clover yield were measured by cutting one 0.5 m^2 quadrat to 2 cm above ground level under an exclusion cage from late July to November 1999. The fresh herbage samples were weighed, and then 2 sets of subsamples were taken from the well-mixed fresh samples. One set was oven-dried at 100 ?C for 24 hours to estimate pasture dry matter yield. The other was dissected into clover and other botanical components to estimate their content. Clover yield was calculated based on clover % and the total pasture yield. Herbage cuts were generally made within a few days after the plots were grazed, and the exclusion cage moved to a new site in the plot after cutting. Trial sites were grazed by the farm dairy herd according to the farm's normal grazing program. On 7^{th} (Naringal) and 8^{th} (DemoDAIRY) November 1999, pasture samples (400-500 g fresh weight) were collected from under cages for nutritive value analysis. All 5 pasture types were sampled, but only management treatments A and B were included. The samples were oven-dried at 60 ?C for 48 hours, then ground for the analysis of crude protein (CP), metabolisable energy (ME), digestibility and neutral detergent fibre (NDF) by NIR spectroscopy.

Statistical analysis

Data were analysed using General Analysis of Variance model of Genstat 5 (5). A pooled randomised complete block (RCB) (factorial) over time model was used to analyse the general effects of pasture type, management and environment on total pasture yield, clover yield and clover content. A pooled RCB (factorial) model was used to analyse nutritive value data.

Results and Discussion

Pasture yield, clover yield and clover content

Pasture type effects

There were significant ($P<0.05$) differences in pasture yield, clover yield and clover content between pasture types (Table 1). The clover content in this study was generally low and there was large variation among treatments and between seasons (range 0-15% of total DM). The lower pasture yield of triple mix was a result of slow growth of the 3 deep-rooted grasses during the establishment year (9). However, triple mix produced significantly ($P<0.05$) more clover than the other pasture types which also contained large-leaved white clovers (district mix and high-producing). This may have been due to less competition from the companion grasses in the establishment year in the triple mix treatment (7), and higher survival rates of clover stolons in summer in this treatment (9). The clover content of the old persistent and triple mix pasture types was higher than all other pasture types.

Table 1. Mean pasture yield (kg DM/ha/yr), clover yield (kg DM/ha/yr) and clover content (%) of 5 pasture types at DemoDAIRY and Naringal during 1998 - 1999.

Pasture type	Pasture yield	Clover yield	Clover %
Old persistent	7689[a]	335[a]	3.8[a]
District mix	8011[a]	158[c]	2.0[c]
Persistent clover	8143[a]	200[bc]	2.5[b]
Triple mix	7012[b]	297[ab]	4.0[a]
High producing	7829[a]	167[c]	2.1b[c]
s.e.m.	*209.0**	*38.9**	*0.44**

** *P*<0.05; means with different superscripts are significantly different.

Management and site effects

Treatments B and C significantly (P<0.01) increased pasture yield compared with treatment A (Table 2). However, these 2 treatments also reduced clover content (P<0.01). There was a trend for both clover content and yield to decline with higher rates of fertiliser addition, and with more frequent spraying for weed and pest control. The decline in clover growth and content with high fertility is mostly attributed to the increased competition from N-boosted grasses (7). The decline resulting from more-intensive weed and pest control was probably due to the use of Tigrex – a herbicide which does not kill clover, but does retard its growth.

There was a significant interaction (P<0.05) between management and site on clover yield. At Naringal, treatment A resulted in 29% higher clover yield compared with treatment B (yield = 331 kg/ha/yr), which in turn outyielded treatment C (138 kg/ha) by 140%. At DemoDAIRY, however, there was no significant (P>0.05) difference between treatments although there was a trend for reduced clover yield in treatments B and C. The different responses to management treatments at the two sites were probably related to differences in grazing management and soil type. At DemoDAIRY pasture was grazed less frequently than at Naringal, particularly in spring, which could have resulted in shading of clovers by companion grasses and poor clover growth (12). As a consequence, tall grass plants may have protected the prostrate clover plants by reducing their exposure to chemicals (e.g. Tigrex), resulting in no effect of more-intensive weed and pest control on clover growth at DemoDAIRY. At Naringal, however, pasture was grazed more frequently. In addition, the soil was light-textured with lower water-holding capacity. A combination of the detrimental effects of Tigrex and moisture stress after close grazing (2) may explain the poorer clover growth under treatment C at this site.

Table 2. Mean pasture yield (kg DM/ha/yr), clover yield (kg DM/ha/yr) and clover content (%) under various management treatments (A. control; B. full nutrient supply; and C. full nutrient supply and pest and weed control) at DemoDAIRY and Naringal during 1998 - 1999.

Management	Pasture yield	Clover yield	Clover %

A	6882^{b}	307^{a}	4.0^{a}
B	8148^{a}	238^{ab}	2.7^{b}
C	8181^{a}	150^{b}	1.9^{b}
s.e.m.	*112.4***	*27.7**	*0.27***

* *P*<0.05; ** *P*<0.01; means with different superscripts are significantly different.

Nutritive value

Pasture type effects

Triple mix had higher (P<0.01) CP than all other pasture types, and persistent clover and high-producing types had higher (P<0.01) CP than district mix (Table 3). The old persistent type was not significantly (P>0.05) different from all other types except for triple mix. The higher CP content of triple mix was probably due to its high clover content (Table 1) and the high quality of the grass cultivars used in this treatment (11). The relatively low CP content of the old persistent type may have reflected the poorer quality of the old Victoria perennial ryegrass in comparison with the new cultivars. The ME content of triple mix and old persistent type was significantly (P<0.01) lower than that of other types, although the difference was only 0.3 – 0.5 MJ/kg DM. Digestibility varied in the same manner to ME among pasture types. Old persistent type was highest in NDF, whereas the high producing type was lowest (Table 3).

Table 3. Mean crude protein (CP, % of DM), metabolisable energy (ME, MJ/kg DM), digestibility (%) and neutral detergent fibre (NDF, %) of 5 pasture types at DemoDAIRY and Naringal in October 1999.

Pasture type	CP	ME	Digestibility	NDF
Old persistent	16.4^{bc}	10.5^{b}	72.1^{b}	58.5^{a}
District mix	15.2^{c}	10.8^{a}	73.6^{a}	57.6^{ab}
Persistent clover	18.4^{b}	10.8^{a}	74.2^{a}	56.7^{bc}
Triple mix	20.9^{a}	10.3^{b}	71.0^{b}	57.8^{ab}
High producing	17.4^{b}	10.8^{a}	73.6^{a}	56.3^{c}
s.e.m.	*0.76***	*0.07***	*0.42***	*0.61***

*** P<0.01; means with different superscripts are significantly different.*

Management and site effects

Treatment B significantly increased the CP content of pasture (P<0.01) and its digestibility (P<0.05), but did not change ME and NDF level (P>0.05), compared with treatment A (Table 4). The effects of site on

CP were marginal (P<0.1) with the mean CP of all treatments at Naringal (19.5%) higher than that (15.9%) at DemoDAIRY. This was probably due to higher incidence of species such as winter grass (*Poa annua*) and capeweed (*Arctotheca calendula*) at the latter site. There were no differences in ME, digestibility and NDF between sites.

Table 4. Mean crude protein (CP, % of DM), metabolisable energy (ME, MJ/kg DM), digestibility (%) and neutral detergent fibre (NDF, %) under various management treatments (A. control; and B. full nutrient supply) at DemoDAIRY and Naringal in October 1999.

Management	CP	ME	Digestibility	NDF
A	16.1	10.6	72.5	57.0
B	19.2	10.7	73.3	57.8
s.e.m.	*0.48***	0.04^{ns}	*0.26**	0.27^{ns}

* *P*<0.05; ** *P*<0.01; ^{ns} not significant.

Conclusion

Pasture type and management affected the clover content and quality of pasture available for dairy cattle. Triple mix and old persistent type had higher clover contents and yields than the district mix and high producing types, although their total pasture yields were lower. Increased fertiliser rates and more frequent spraying for weed and pest control reduced clover content and yield. There was a significant management by site interaction on clover yield. CP, ME, digestibility and NDF contents differed between pasture types. Triple mix had the highest CP content, whereas district mix, persistent clover and high producing types were highest in ME. High fertiliser input considerably increased CP and digestibility. Further information is being collected from these sites to establish trends in clover performance and nutritive value over several years and seasons.

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