Herbage and milk production from a grass-only sward and grass-white clover swards in an intensive grass-based system

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Abstract

White clover (*Trifolium repens* L.; clover) can increase the sustainability of grass-based dairy systems and has the potential to increase milk production. This experiment compared milk production from a perennial ryegrass (PRG) sward receiving 250 kg N ha^{-1} yr^{-1} (Gr250), a PRG-clover sward receiving 250 kg N ha^{-1} yr^{-1} (Cl250) and a PRG-clover sward receiving 150 kg N ha^{-1} yr^{-1} (Cl150) in a rotationally grazed system in 2013 and 2014. Three groups of cows were allocated to graze each sward in 2013 and 2014 (n=14 and 19, respectively). Clover inclusion into PRG swards had no effect on the total herbage production. There was a treatment×week interaction on sward clover content; Cl150 had greater clover content in the second half of the grazing year. Treatment had an effect on cumulative milk yield (MY) and milk solids (MS) production. The Cl150 had lower cumulative MY compared to Cl250 (6,055 and 6,343 kg milk cow^{-1}, respectively); there was no significant difference between Cl150 and Gr250 (6,055 and 5,912 kg milk cow^{-1}, respectively); and Cl250 had greater cumulative MY than Gr250 (6,343 and 5,912 kg milk cow^{-1}, respectively). The MS yield of the clover treatments were significantly greater than the Gr250 and were similar between both clover treatments.

Keywords: *Trifolium repens* L., nitrogen, dairy cow, milk production

Introduction

White clover (*Trifolium repens* L.; clover) can increase the sustainability of grass-based dairy systems by reducing nitrogen (N) fertiliser application and has the potential to increase milk production (Ledgard, 2002). Clover and perennial ryegrass (*Lolium perenne* L.; PRG) have different temperature responses and different seasonal growth patterns (Davies, 1992). Fertiliser N can compensate for lower herbage production on PRG-clover swards due to low clover growth rates in spring. High N-fertiliser application rates can reduce sward clover content (Harris *et al.*, 1996). Previous research has shown the benefit of clover over PRG for milk production, particularly in the second half of the year (July onwards) (Egan *et al.*, 2013; Riberio Filho *et al.*, 2003). The objective of the current study was to compare herbage production of and milk production from a PRG-only sward receiving 250 kg N ha^{-1} with PRG-clover swards receiving 150 or 250 kg N ha^{-1}.

Materials and methods

A farm systems experiment was established at Teagasc, Animal and Grassland Research Innovation Centre, Moorepark, Fermoy, Co. Cork Ireland (52°09'N; 8°16'W) in 2013. This experiment compared herbage and milk production from a PRG sward receiving 250 kg N ha^{-1} yr^{-1} (Gr250) and PRG-clover swards receiving 250 kg N ha^{-1} yr^{-1} (Cl250) or 150 kg N ha^{-1} yr^{-1} (Cl150) in an intensively grazed system over two grazing seasons (2013 and 2014). Spring-calving Holstein-Friesian dairy cows were blocked on calving date, pre-experimental milk yield (MY) and milk solids yield (MS) and parity, and randomly allocated to one of the three treatments (n=14 in 2013 and n=19 in 2014). All treatments were stocked at a whole-farm stocking rate of 2.74 cows ha^{-1}. Cows remained on their respective treatment for the entire grazing season. This was a farm systems experiment and annual fertiliser rates were applied across the whole farm. Fertiliser N was applied after each grazing; N application was similar on all treatments until late May, after which N was reduced on Cl150 for the remainder of the year. Herbage was allocated

daily to achieve a target post-grazing sward height of 4 cm. Pre-grazing herbage mass (>4 cm; HM) was determined twice weekly using an Etesia mower (Etesia UK Ltd., Warwick, UK). Sward clover content was estimated twice weekly as described by Egan *et al.* (2013). Milk yield was recorded daily and milk composition (fat and protein concentrations) was measured weekly. Milk solids yield was calculated as the sum of milk fat and protein yields. Data were analysed using a mixed model in SAS with terms for treatment, time (week or rotation), year and the associated interactions. Fixed terms were year, treatment and week or rotation, and random terms were cow and paddock.

Results and discussion

Treatment had no significant effect (P>0.05) on herbage production (Table 1). Year had a significant effect (P<0.001) on herbage production: it was greater in 2014 (15.5 Mg DM ha^{-1}) than in 2013 (12.8 Mg DM ha^{-1}). There was a treatment×week interaction (P<0.01) on sward clover content. Clover content was similar on both clover treatments in both years until early July. From July to the end of the year, clover content was greater on the Cl150 than the Cl250. This increase in clover content on the Cl150 treatment coincided with the reduction in N fertiliser application to Cl150, similar to that reported by Ledgard and Steele (1992). Year had a significant (P<0.001) effect on sward clover content; it was greater in 2014 (0.27 g kg^{-1} DM) than in 2013 (0.23 g kg^{-1} DM). Frame and Newbould (1986) reported that sward clover content increased in the second production year. There was a significant treatment×week interaction (P<0.05) on daily MY and daily fat content. All treatments had a similar MY until experimental week 21 (July), after which the Cl250 and Cl150 treatment had greater daily MY compared to the Gr250 treatment until week 27, and thereafter in weeks, 30, 35 and 39 the clover treatments had greater MY than Gr250. The Cl150 treatment had greater fat content in experimental weeks 2, 4, 17, 20, 28 and 32. Treatment had an effect on cumulative MY and cumulative MS (P<0.001; Table 1). The Cl150 treatment had lower (P<0.05) cumulative MY compared to Cl250 (6,055 and 6,343 kg milk cow^{-1}, respectively); there was no significant difference between Cl150 and Gr250 (6,055 and 5,912 kg milk cow^{-1}, respectively); and Cl250 had greater (P<0.001) cumulative MY than Gr250 (6,343 and 5,912 kg milk cow^{-1}, respectively). Treatment had a significant effect on daily and cumulative MS. The MS yield of the clover treatments was greater (P<0.001) than the Gr250 (Table 1; Figure 1) and was similar between both clover treatments.

Table 1. Daily and cumulative milk production and cumulative herbage production on grass only swards receiving 250 kg N ha^{-1} (Gr250) and grass clover swards receiving 150 kg N ha^{-1} and 250 kg N ha^{-1} (Cl150 and Cl250, respectively) and average sward clover content on Cl150 and Cl250.

	Cl150	Cl250	Gr250	S.E.[1]	TRT	Year	Week	TRT[2] × week	TRT × year
Milk yield (kg^{-1} cow^{-1} day^{-1})	21.13	22.05	20.62	0.44	0.001	NS[3]	0.001	0.05	NS
Milk solids (kg^{-1} cow^{-1} day^{-1})	1.69	1.70	1.58	0.03	0.001	NS	0.001	NS	NS
Milk fat (%)	4.58	4.47	4.43	0.26	NS	NS	0.001	0.05	NS
Milk protein (%)	3.61	3.58	3.62	0.05	NS	NS	0.001	NS	NS
Cumulative milk yield kg^{-1} cow^{-1} year^{-1})	6,055	6,343	5,912	126	0.001	NS	-	-	-
Cumulative milk solids (kg^{-1} cow^{-1} year^{-1}	485	489	454	2.85	0.001	NS	-	-	-
Annual herbage production (kg DM ha^{-1})	14,355	14,317	14,233	434	NS	0.001	-	-	-
Clover content (g kg^{-1} DM)	0.27	0.24	-	0.02	NS	0.001	0.001	0.01	NS

[1] S.E. = standard error.

[2] TRT = treatment.

[3] NS=not significant.

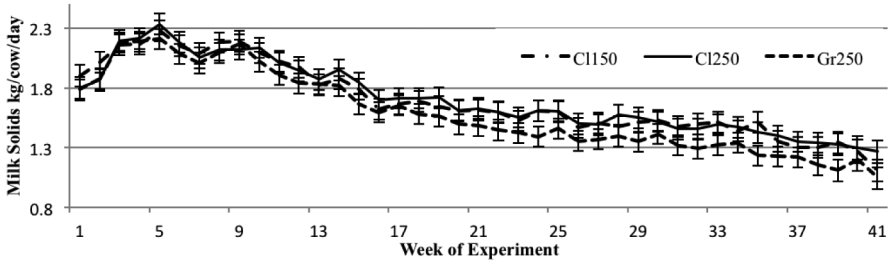

Figure 1. Effect of sward type on daily milk solids yield for cows grazing a grass-only sward receiving 250 kg N ha^{-1} (Gr250) and grass-clover swards receiving 150 kg N ha^{-1} and 250 kg N ha^{-1} (Cl150 and Cl250, respectively) for each week of experiment. Error Bars represent standard error.

Conclusions

Clover inclusion into PRG swards had no effect on the total herbage production. White clover had a positive effect on milk production (yield and solids) regardless of N fertiliser application rate in both production years. The greatest difference observed in both years was from July onwards when clover content was at its highest.

Acknowledgements

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