

## A note on the effects of paddock size on the white clover content of swards grazed by sheep

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The maintenance of a high white clover content in mixed swards under sheep grazing has been a challenge to date. This paper presents the results of an experiment in which the effect of the length of a grazing period on the botanical composition of a mixed sward was studied. Paddocks ranging in size from 0.014 to 0.133 ha were rotationally grazed by a flock of seven dry ewes. Consequently, grazing periods ranged from 1 to about 8 days. On all paddocks, the proportion of perennial ryegrass declined progressively during the grazing season, regardless of paddock size. The proportions of both white clover and creeping bentgrass content increased on all paddocks during the same period. For white clover, the size of the increase was negatively related to paddock size, whereas a positive relationship was found between the paddock size and the magnitude of the increase in creeping bentgrass. This suggests that the proportion of white clover may be increased under sheep grazing by implementation of strip-grazing.

*Keywords:* *Agrostis stolonifera*; creeping bentgrass; sheep grazing; *Trifolium repens*; white clover

### Introduction

In recent years there has been renewed interest in the use of white clover (*Trifolium repens*) as a sustainable alternative to fertiliser nitrogen. However, the performance of white clover has frequently been reported to be compromised when grazed

by sheep (e.g. Curll, 1982; Evans, Williams and Evans, 1992; Laws and Newton, 1992). Declining white clover contents have been related to the preferential grazing by these animals, as a result of which white clover is defoliated more frequently than grasses (Milne *et al.*, 1982; Laws and Newton, 1992; Binnie and Chestnutt, 1994).

However, the degree to which sheep can express their preference for white

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clover, and hence the white clover performance, depends to a large extent on the grazing management regime imposed. It is well accepted that when grazed by sheep, white clover is affected most severely under a regime of continuous grazing, and to a lesser extent under rotational grazing (Hay, Brock and Thomas, 1989; Evans, Williams and Evans, 1992). More specifically, Laws and Newton (1992) reported higher clover and animal performances when sheep were rotated over six small paddocks, than when rotated over three larger paddocks. Both Curll (1982) and Schulte, Lantinga and Struik (2003) suggested that with longer grazing periods, sheep may have a greater opportunity to graze selectively and, consequently, that a high white clover content may be sustained under a regime of strip-grazing. Therefore, an experiment was conducted to study the effect of the duration of the grazing period in a rotational sheep-grazing system on the white clover content of a mixed sward.

#### Materials and Methods

The experiment was conducted on a heavy clay soil at the organic farm of Johnstown Castle Research Centre, in the south-east of Ireland (52°17' N, 6°30' W). In spring 2000, nine paddocks were laid out in a field which had been reseeded with perennial ryegrass (*Lolium perenne*) and white clover (*Trifolium repens*) in 1996, and which had received cattle farmyard manure (25 t/ha) in 1997. The field had been managed organically, which means that no artificial fertiliser or any herbicides had been applied.

The paddocks differed in size from 0.014 to 0.133 ha. In early April 2000, the herbage of all paddocks was removed, and from the 3 May, the paddocks were rotationally and sequentially grazed by a flock of seven dry ewes. The order in

which the paddocks were grazed initially was randomised for paddock size and subsequently maintained during the season. Each paddock was grazed until a residual sward height of 5 cm was reached, as measured by the average of 50 cumulative readings from a rising plate meter. The annual stocking rate was identical for all paddocks at 13.3 ewes/ha. However, the average time required to reach the residual sward height ranged from 1 day on the smallest paddocks (short grazing periods) to approximately 8 days on the largest paddocks (long grazing periods). On average, paddocks were grazed at intervals of approximately 30 days. As a result, between May and October 2000, seven paddocks were grazed five times, whereas the remaining two paddocks were grazed four times. During the month of June, each paddock was topped at 5 cm, immediately after grazing, in order to remove generative grass tillers.

The day before each grazing, the botanical composition of each paddock was determined on a dry matter basis, using the dry weight rank (DWR) method for botanical composition (t Mannelje and Haydock, 1963), on 50 randomly selected quadrats (3 dm<sup>2</sup>) per paddock. The procedure for yield correction (Jones and Hargreaves, 1979) was followed, using sward height of the individual quadrats (as measured by rising plate meter) as the indicator of relative quadrat yield, rather than the commonly used visual assessment and grouping of quadrats into "yield categories".

During the 4 years since reseeding, the entire site had been invaded by creeping bentgrass (*Agrostis stolonifera*) and by some minor weed species, of which rough-stalked meadowgrass (*Poa trivialis*) was most prominent. At the start of the current experiment (April 2000) the average (s.d.) proportional botanical composition of the nine paddocks was 0.62 (0.039) perennial ryegrass, 0.08 (0.041) white clover, 0.12

**Table 1.** Regression equations for the effects of number of grazings, paddock size and paddock size  $\times$  number of grazings on the absolute change in the proportion of perennial ryegrass, white clover and creeping bentgrass in a sward

Dependent variable <sup>1</sup>	Independent variables	Intercept	Slope	R <sup>2</sup>	P
Perennial ryegrass	No. of grazings	0.0563	-0.0759	0.61	<0.001
White clover	No. of grazings	-0.0288	0.0686	0.58	<0.001
	Paddock size $\times$ no. of grazings		-0.0003		
Creeping bentgrass	Paddock size	0.0512	-0.0006	0.55	<0.001
	Paddock size $\times$ no. of grazings		0.0004		

<sup>1</sup>Difference between initial proportion and the proportion at subsequent observations.

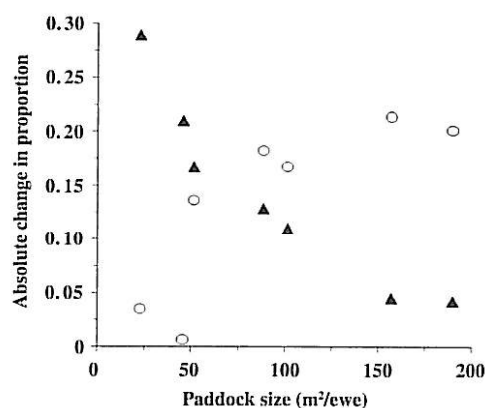
(0.048) creeping bentgrass, and 0.18 (0.033) other species, on a dry matter basis.

Multiple linear regression was used to examine the effects of paddock size (expressed as m<sup>2</sup>/ewe) and the number of times the paddock had been grazed (at each time of sampling) and their interaction on the absolute change in the proportions of perennial ryegrass, white clover and creeping bentgrass, respectively, since the start of the experiment. In each analysis, insignificant ( $P > 0.05$ ) independent variables were sequentially excluded (in order of insignificance) until significant independent variables only remained.

### Results and Discussion

On all paddocks, the perennial ryegrass content decreased significantly ( $P < 0.001$ ) as the number of times it had been grazed increased. This decrease was not related to paddock size and there was no interaction between the paddock size and the number of grazings (Table 1). By October 2000, the proportion of ryegrass had declined on average by 0.20 (s.e. 0.034) on a dry matter basis. Contrastingly, the proportion of white clover increased significantly ( $P < 0.001$ ) after each grazing. Additionally, this increase was significantly ( $P < 0.001$ ) and negatively related to the

interaction between the paddock size and the number of grazings (Table 1). This means that the increase in the white clover proportion was highest (0.29) on the smallest paddock (22.9 m<sup>2</sup>/ewe) and became progressively smaller as paddock size increased. On the largest paddock (190 m<sup>2</sup>/ewe) the increase in the white clover proportion did not exceed 0.04. This is visualised in Figure 1, in which the absolute changes in the proportions of white clover and creeping bentgrass at the



*Figure 1: The effect of paddock size on the absolute changes in the proportions of white clover ( $\blacktriangle$ ) and creeping bentgrass ( $\circ$ ) for the seven paddocks that were grazed five times during the grazing season.*

end of the grazing season are plotted against the paddock size.

The proportion of creeping bentgrass also increased during the grazing season. This increase was significantly and positively related to both paddock size ( $P < 0.05$ ) and the interaction between the paddock size and the number of grazings ( $P < 0.001$ ) (Table 1). The equation shows that the increase in bentgrass proportion was highest (*ca.* 0.21) on the largest paddocks, and this effect was progressively magnified after each grazing.

In other mixed swards, similar declines in the proportion of perennial ryegrass during the summer months have been observed (Frame, 1990; Evans, Williams and Evans, 1992; Laws and Newton, 1992) and this can be explained by the diverging seasonal growth patterns of perennial ryegrass and white clover. Therefore the increase in the proportion of white clover in all paddocks is not surprising. However, the fact that the magnitude of the increase in white clover was negatively related to paddock size supports the proposal by Curll (1982) and Schulte, Lantinga and Struik (2003), that strip-grazing may reduce the opportunity for sheep to express their preference for white clover. During long grazing periods (i.e. on the larger paddocks), sheep were allowed to select for regrowing white clover tissue for as long as 8 days. As a result, it can be hypothesised that white clover was defoliated more severely than the other species (see also Binnie and Chestnutt, 1994), which may have compromised its competitiveness. Under strip-grazing (i.e. on the smaller paddocks), each clover stolon was at most defoliated only once during each grazing, because the sheep were moved out of these paddocks after one day. Contrastingly, Schulte and Neuteboom (2002) noted that creeping bentgrass may be actively avoided by grazing animals

when these are allowed to graze selectively and this may explain why creeping bentgrass increased most prominently on the larger paddocks, with virtually no increase under strip-grazing.

The results of the present study suggest that a regime of strip-grazing can effectively increase the proportion of white clover and simultaneously prevent the expansion of creeping bentgrass in swards grazed by sheep. However, especially with sheep grazing, the benefits of this higher clover content should be evaluated against the increase in the fencing and labour costs which would be involved.

#### References

- Binnie, R.C. and Chestnutt, D.M.B. 1994. Effect of continuous stocking by sheep at four sward heights on herbage mass, herbage quality and tissue turnover on grass/clover and nitrogen fertilised grass swards. *Grass and Forage Science* **49**: 192–202.
- Curll, M.L. 1982. The grass and clover content of pastures grazed by sheep. *Herbage Abstracts* **52**: 403–407.
- Evans, D.R., Williams, T.A. and Evans, S.A. 1992. Evaluation of white clover varieties under grazing and their role in farm systems. *Grass and Forage Science* **47**: 342–352.
- Frame, J. 1990. Herbage productivity of a range of grass species in association with clover. *Grass and Forage Science* **45**: 57–64.
- Hay, M.J.M., Brock, J.L. and Thomas, V.J. 1989. Density of *Trifolium repens* plants in mixed swards under intensive grazing by sheep. *Journal of Agricultural Science, Cambridge* **113**: 81–86.
- Jones, R.M. and Hargreaves, J.N.G. 1979. Improvements to the dry-weight-rank method for measuring botanical composition. *Grass and Forage Science* **34**: 181–189.
- Laws, J.A. and Newton, E. 1992. The grazing management of sheep on grass-white clover permanent pasture. *Irish Journal of Agricultural and Food Research* **31**: 143–156.
- 't Mannetje, L. and Haydock, K.P. 1963. The dry-weight-rank method for the botanical analysis of pasture. *Journal of the British Grassland Society* **18**: 268–275.
- Milne, J.A., Hodgson, J., Thompson, R., Souter, W.G. and Barthram, G.T. 1982. The diet ingested by sheep grazing swards differing in white clover

- and ryegrass content. *Grass and Forage Science* **37**: 209–218.
- Schulte, R.P.O. and Neuteboom, J.H. 2002. Advanced analysis of dry-weight-rank data to discriminate direct and indirect interactions between white clover and grasses in a multi-species pasture under a range of management strategies. *Grass and Forage Science* **57**: 113–123.
- Schulte, R.P.O., Lantinga, E.A. and Struik, P.C. 2003. Analysis of the production stability of mixed grasslands. I: A conceptual framework for the qualification of production stability in grassland ecosystems. *Ecological Modelling* **159**: 43–69.

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