

White clover content and grassland productivity in simulated grazing systems

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Abstract

Maintaining white clover (*Trifolium repens*) content in grasslands is a challenge for high output eco-efficient dairy farms on mineral soils that use biological N-fixation as a relevant source of N-input. Lower cutting height and cutting at an early growth stage have positive effects on the white clover content in grass-clover mixtures in mowing systems. Our objective was to quantify the effect of three grazing systems (rotational, continuous and lenient strip stocking) on clover content and dry matter production. Grazing was simulated with a Haldrup grass harvester and dried cattle manure pellets were applied to resemble the organic matter input from grazing cattle (50 kg N ha⁻¹ yr⁻¹). The experiment was established on sandy soil in 2011 in four replicates in sown grass-clover. Average clover content measured in June and October 2014 was lowest for lenient strip stocking and highest for continuous stocking. This resulted in 2014 in the highest grassland dry matter production for continuous stocking (15.0 Mg DM ha⁻¹) and the lowest for lenient strip stocking (6.9 Mg dry matter (DM) ha⁻¹). Rotational stocking occupied an intermediate position (11.9 Mg DM ha⁻¹).

Keywords: white clover content, stocking, persistence, production, high output dairy systems

Introduction

Eco-efficient dairy farms on mineral soils with a low N-delivering capacity often use clover in grassland for its ability to fix atmospheric N₂ in symbioses with *Rhizobium* bacteria. To have a stable high output of grass-clover pastures on mineral soils, the clover content should be maintained at approximately 20-40%. However, persistency of white clover can be a challenge. Grass mixture, clover cultivar, soil properties, fertilization level and weather conditions are all known to influence the persistency of white clover. Moreover a lower cutting height and cutting at an early growth stage have a positive effect on the white clover content in grass-clover swards under mowing (Schils and Sikkema, 2002; Seresinhe, 1992). Both factors are also expected to influence the white clover content under grazing. However, in the Netherlands grassland management is mainly based on pure-grass stands and therefore little attention is put on clover and its maintenance in grassland. The objective of our experiment was to measure the effect of the three most commonly used grazing systems in the Netherlands (rotational, continuous and lenient strip stocking) on clover content and dry matter production, on a mineral soil with a low N-delivering capacity. Since continuous stocking has the lowest stubble height and lowest height at defoliation it was hypothesised that continuous stocking had the highest clover content. We expected that lenient strip stocking would have the lowest clover content because of the highest stubble height. Moreover it was hypothesised that rotational stocking, with an intermediate clover content but a leaf area for photosynthesis close to lenient strip stocking, would have the highest dry matter (DM) production.

Material and methods

In 2011 a grassland field experiment was established on a sandy soil in Wageningen, the Netherlands. The site has an average temperature of 9.8 °C, average rainfall of 797 mm and a N-delivering capacity (including wet-deposition) of 30 kg N ha⁻¹ yr⁻¹. A mixture of perennial ryegrass (*Lolium perenne* L. cvs. Barflip and Barforma), tall fescue (*Festuca arundinacea* Schreb. cvs. Barolex and Bariane) and white clover

(*Trifolium repens* L. cvs. Alice and Riesling) was sown. Seeding rate was 30 kg grass and 3 kg clover ha⁻¹. The experiment consisted of three treatments: continuous, rotational and lenient strip stocking, in a randomised block design with four replicates. Plot size was 2.75×10 m. The three grazing systems were simulated by mowing with a Haldrup grass harvester at different stubble heights and grass heights at the time of defoliation (Table 1). Fields were fertilized in one application with cattle manure pellets (50 kg N ha⁻¹ yr⁻¹) to resemble the organic matter input from grazing cattle. Furthermore, fields were fertilized with sufficient P, K and micronutrients to compensate for the nutrients that were removed by mowing. At each harvest in 2014 biomass was weighed from a strip of 1.50×10 m, sampled and dried at 70 °C. In July and October 2014, prior to each harvest, samples were taken from two quadrats (0.25 m²) for determination of the clover content. Grass and clover were separated by hand and subsequently dried at 70 °C. The effect of grazing system on clover content and DM production was assessed with SPSS, 19th edition using one-way ANOVA ($P<0.05$).

Results

Clover content was on average 45% in July compared to 34% in October. Fields under continuous stocking had significantly higher clover content than fields under lenient strip stocking (Table 2). DM production was significantly affected by the stocking system. Continuous stocking had the highest DM production followed by rotational stocking. The average clover content was positively correlated with DM production ($r=0.53$).

Discussion

Continuous stocking resulted in the highest clover content, while this was lowest for lenient strip stocking. The lower clover content under lenient strip stocking was most likely a result of shading by grasses (due to stubble height and/or grass height) which is known to reduce the number of leaf-bearing nodes and number of growing points (Lüscher, 1989; Seresinhe, 1992). Furthermore, Schwank *et al.* (1986) reported that light competition is the main factor that limits the proportion of clover in mixed swards. Our findings were in line with Seresinhe (1992) who investigated the effect of cutting heights of 4 cm and 10 cm on regrowth of perennial ryegrass-clover mixtures under similar climatic conditions in a two-year field experiment. In the second production year, the defoliation treatment of 10 and 4 cm had clover proportions of 30 and 41%, respectively.

Table 1. Overview of simulated grazing systems with stubble height and average grass height at the time of defoliation (incl. stubble height) in 2014.

	Stocking		
	Continuous	Lenient strip	Rotational
Stubble height (cm)	4	10	4
Average grass height at defoliation in 2014 (cm)	11	17	18
Number of cuts per year (n)	9	8	4

Table 2. White clover content and dry matter (DM) production in 2014 as affected by stocking system.¹

	Stocking		
	Continuous	Lenient strip	Rotational
Average white clover content (%)	52 a	27 b	40 ab
DM-production (kg DM ha ⁻¹ year ⁻¹)	14,985 a	6,937 c	11,914 b

¹ Values followed by the same letter in a row are not statistically different at the 5% error level.

Contrary to our hypothesis, the DM-production of fields under continuous stocking was higher than under rotational stocking. Lower yields were obtained under rotational and lenient strip stocking, probably due to a lower clover proportion and thus a lower amount of nitrogen being fixed. Apparently, the nitrogen had a more limiting effect on production than leaf area for photosynthesis. On a soil with higher nitrogen-delivering capacity the difference would probably have been smaller or reversed.

Conclusions

On a high-output eco-efficient dairy farm on mineral soils with a low N-delivering capacity that depends on white clover for N-input, the influence of the grazing system on clover content is highly determinative for DM production. Grazing systems with a low stubble height and low height at defoliations are to be preferred on these farms.

Acknowledgements

We would like to thank Frans Bakker (Unifarm, Wageningen UR) and Johnny Qin for their assistance during the collection of the data and Evert-Jan Bakker (Biometris, Wageningen UR) for his input regarding the statistical analysis.

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Volume 20
Grassland Science in Europe