Grass-clover under cutting conditions: a highly productive system of intensive, high quality forage production

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Abstract

In this experiment, we compared grass in pure stand (300 $N_{available}$ ha^{-1}) and grasses mixed with red and white clover (150 $N_{available}$ ha^{-1}) under cutting conditions. The experiment was conducted on a sandy loam soil (Merelbeke, Belgium) in 2011-2014. Perennial ryegrass (*Lolium perenne* – Lp), tall fescue (*Festuca arundinaceae* – Fa) and *Festulolium* (Fe) in pure stands were sown with and without clover. Grass-clover with 150 N ha^{-1} produced more dry matter (+ 1.11 Mg ha^{-1} $year^{-1}$) with a higher protein content in terms of crude protein % (+4.5%) and true protein digested in the small intestine (+13 g kg^{-1} dry matter (DM)), but lower energy concentration (-15 VEM (fodder unit milk) g kg^{-1} DM) compared to grass with 300 N ha^{-1}. The energy content of Lp cv Meloni and Fe cv Lifema was lower in the grass-clover 150 N management than in the grass 300 N and did not change for the other grasses. Barolex (Fa), Callina (Fa) and Hykor (Fe) had significantly higher DM production, but significantly lower energy and protein content in comparison with Lp. Lifema (Fe) was less productive than the other varieties/species but had a better quality compared to Hykor (Fe) and Fa.

Keywords: *Lolium perenne*, *Festuca arundinaceae, Festulolium Trifolium pratense*, *Trifolium repens*, grass-clover

Introduction

Nitrogen fertilization on grassland is restricted in Flanders (Belgium) in accordance with the EU Nitrate Directive. Grasses are thus prevented from reaching their full potential for dry matter and protein yield. Could red and white clover in the sward under cutting conditions compensate for the decrease in dry matter yield and protein content caused by using lower N inputs? In addition, the Flemish Government encourages farmers by means of subsidies to cultivate clover and grass-clover to produce more farm-grown proteins and to reduce the use of mineral fertilisers. *Lolium perenne* (Lp), *Festuca arundinacae* (Fa) and *Festulolium* (Fe) all have a high yield potential under cutting conditions (Cougnon, 2013), but Lp is the only grass commonly used and it is considered as a reference.

Materials and methods

In April 2011 a trial comparing the yield and quality of single grass species and the same species in combination with clover was established under cutting at ILVO in Belgium. The grass species were Lp cv. Meloni, Fa cv. Barolex and Callina, and Fe cv. Hykor and Lifema. The grasses were sown in pure stands or in combination with a mixture of *Trifolium pratense* (Tp) cv. Lemmon and *Trifolium repens* (Tr) cv. Merwi. (Mixtures of Lp and Fa varieties and/or Lp with Fe varieties were also sown with and without clovers but the results will not be discussed here.) Grasses and red clover were sown at 1000 germinating seeds per m^2 and white clover at 500 seeds per m^2 in field plots of 1.4×6 m. The trial design was a split plot design with 4 replicate blocks with presence of clover as main plot factor and the varieties as subplot factor. Mineral N fertilization was 300 kg N ha^{-1} for the pure grass and 150 kg N ha^{-1} for the grass-clover plots. Three, five, five and six cuts were harvested with a Haldrup forage harvester at a cutting height of 6 cm in 2011, 2012, 2013 and 2014, respectively. At each cut dry matter (DM) yield was measured and a grab subsample was separated into the individual sown species and unsown species (collectively). Samples were analysed by near-infrared spectometry for chemical composition and digestibility after

which energy (fodder unit milk – VEM) and protein content (true protein digested in the small intestine – DVE and rumen degraded protein balance – OEB) were calculated. DVE and OEB are parameters of protein quality developed by Taminga *et al.* (1994).

Results and discussion

The average dry matter yield of grass at 300 N and grass-clover at 150 N was 13,990 kg ha^{-1} and 15,100 kg ha^{-1}, respectively (Table 1). A mean difference in dry matter yield of 1,110 kg ha^{-1} in favour of grass-clover was observed; saving 150 N ha^{-1} year^{-1} and about 150 euro ha^{-1} year^{-1}. These results confirmed earlier results under intensive management in Flanders (De Vliegher and Carlier, 2008). There was a yield increase for every single variety when mixed with clover: the effect varied between 280 kg ha^{-1} (Barolex) and 2,000 kg ha^{-1} (Lifema).

The statistical analysis was done with 5 varieties and 7 mixtures but only results of the single varieties are reported here. The interaction between the two factors was significant. As a result the statistical analysis was done separately for grass 300 N and grass-clover 150 N and a comparison of the varieties was performed within each group.

Sown without clover, DM-yields of Fe cv. Hykor (15,860 kg DM ha^{-1}) and Fa cv. Barolex (15,210 kg DM ha^{-1}) and Callina (14,400 kg DM ha^{-1}) were significantly higher, while Fe cv. Lifema (11,850 kg DM ha^{-1}) was significantly lower in comparison with Lp cv. Meloni (12,610 kg DM ha^{-1}). When sown with clover a similar ranking of the varieties was observed but differences between the single varieties were smaller and Fe cv. Lifema (13,850 kg DM ha^{-1}) was significantly lower in DM yield in comparison with Lp cv. Meloni (13,940 kg DM ha^{-1}). The average content of clovers (red+white) was about 50% of the dry matter (40% red + 9% white) and clover content of Lp cv. Meloni (57%) was significantly higher

Table 1. Dry matter yield (2011-2014, Mg ha^{-1}), clover content (2011-2014, % in dry matter (DM)) and forage quality (2011-2013, per kg DM^{-1}) of grass species and varieties in pure stand and in mixtures with red + white clover. Three, five, five and six cuts were harvested at a cutting height of 6 cm in 2011, 2012, 2013 and 2014, respectively.[1,2]

Species	Cultivar	Clover content		Yield	Protein content[3]			Energy content[3]
		T. pratense	*T. repens*	DM	CP	DVE	OEB	VEM
		% in DM	% in DM	kg ha^{-1}	g kg^{-1} DM	g kg^{-1} DM	g kg^{-1} DM	kg^{-1} DM
Grass species 300 N ha^{-1} year^{-1}								
Lolium perenne	Meloni			12,610c(2)	153ab	83a	-4	914a
Festuca arundinaceae	Barolex			15,210a	150bc	73c	2	828c
	Callina			14,400b	147c	72c	1	823c
Festulolium	Hykor			15,860a	144d	71c	-3	827c
	Lifema			11,850d	153a	77b	-2	853b
Average				13,990	149	75	-1	849
Grass species + red and white clover 150 N ha^{-1} year^{-1}								
Lolium perenne	Meloni	45	12	13,940c	203a	94a	42	859a
Festuca arundinaceae	Barolex	35	10	15,490b	196b	88b	40	829c
	Callina	40	10	15,400b	193b	87b	38	824cd
Festulolium	Hykor	38	7	16,830a	187c	85c	33	821d
	Lifema	43	7	13,850c	193b	88b	36	838b
Average		40	9	15,100	195	88	38	834

[1] DM = dry matter; CP = crude protein; DVE = true protein digested in the small intestine; OEB = rumen degraded protein balance; VEM = fodder unit milk.

[2] Data with the same letter in the same column within a group are not significantly different ($P<0.05$).

[3] Forage quality is determined on the dataset 2010-2013.

than the others (Table 1). The average CP content of grass at 300N and grass-clover at 150 N was 149 g kg^{-1} DM and 195 g kg^{-1} DM respectively (Table 1). There was a mean difference in CP of 46 g kg^{-1} DM in favour of grass-clover. There was an increase of CP for every single variety when mixed with clover: the effect varied between 40 g kg^{-1} DM (cv. Lifema) and 50 g kg^{-1} DM (cv. Meloni). For forage evaluation even more attention is paid to true protein digested in the small intestine (DVE). When clover was used, the average DVE content was considerably higher: 88 g kg^{-1} (grass-clover) versus 75 g kg^{-1} (grass). Lp cv. Meloni with and without clover had a significant higher DVE content in comparison with the other varieties, but in grass-clover the range between the grass varieties decreased because the effect of clover was higher on the Fa and Fe varieties with the lowest DVE concentration (Table 1). The OEB value is a measure for the amount of protein that will be degraded in the rumen and can be transformed to microbial protein if enough energy is available in the rumen. If not, considerable N losses might occur to the environment. In grass-clover with150 N the content of this unstable protein was considerably higher in comparison with grass 300 N. Differences in OEB between grass varieties within a species were small. The average energy content of grass at 300 N and grass-clover at 150 N was 849 VEM and 834 VEM respectively (Table 1) and was in favour of grass 300 N. With or without clover Lp cv. Meloni and Fe cv. Lifema had significantly higher energy content compared with the others. When sown with clover the energy content decreased for grasses with a high energy content such as Lp cv. Meloni and Fe cv. Lifema (Table 1); for the other grasses the energy content was about the same.

Conclusions

Grass clover at 150 N ha^{-1} produced more dry matter (+ 1.11 Mg ha^{-1}) with a higher protein concentration in terms of CP (+45 g kg^{-1} DM), DVE (+13 g kg^{-1} DM) and OEB (+ 37 g kg^{-1} DM) but with a lower energy concentration (-15 VEM g kg^{-1} DM) compared to grass at 300 N ha^{-1}. The energy content of Lp cv. Meloni and Fe cv. Lifema was lower in the grass-clover 150 N management than in the grass 300 N management and did not change for the other grass varieties. Barolex (Fe), Callina (Fe) and Hykor (Fe) had a significant higher DM production, especially in pure stands with 300 N ha^{-1} but were significantly lower in terms of energy and protein content in comparison with Lp cv. Meloni. Lifema (Fe) had lower DM yield in comparison with the other varieties/species but with better quality herbage than Hykor (Fe) and Barolex (Fa) and cv. Callina (Fa) but lower quality compared to Meloni (Lp). Fa and Fe have a high yield potential, but especially for Fe there were substantial varietal differences.

Acknowledgements

We would like to thank the Agricultural Centre of Forage Crops the financial support.

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