Different harvesting strategies and cultivar mixtures for grass silage production in Finland

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Abstract

Scandinavian milk and beef production is based on high-quality grass silage. Harvesting time of grass, especially in the first cut, is the major factor that determines the optimization of dry matter yield and forage digestibility, and the subsequent improved feeding efficiency and productivity of the animals. The aim of this study was to explore how the number of harvests, three different cultivar mixtures and timing of the last harvest affect the amount and nutritive value of total yield and overwintering of the sward. The experiment was conducted at Maaninka and Sotkamo, Finland, during the 2013-2014 growing seasons. Experimental design of the study was split-split-plot with four replicates. Plots were sown with a mixture of timothy (*Phleum pratense* L.) and meadow fescue (*Festuca pratensis* Huds.). Three different mixtures of varieties of these species were used. The three-cut harvesting strategy produced higher dry matter and energy yield and higher digestibility than the two-cut harvesting strategy. Delaying the second cut increased the total dry matter yield and decreased D-value more than delaying the third cut. Differences between cultivar mixtures were observed but the interaction with number of harvests was minor.

Keywords: cultivar mixture, dry matter yield, D-value, grass, harvesting strategy

Introduction

Harvesting time of grass is the major factor for optimization of dry matter yield and forage digestibility, especially in the first cut. The daily change of digestibility (Kuoppala, 2010) and the accumulation of yield (Virkajärvi *et al.*, 2012) is faster in the first cut than in the regrowth. The three-cut strategy, which provides better utilization of the entire growing season than the two-cut strategy, is becoming more common in northern Finland, but there are few data available of growth rate and changes in nutritive value for this strategy. Typical forage grass leys are based on mixtures of timothy and meadow fescue. There are two different types of timothy in the Nordic regions: early varieties with good regrowth ability and lower digestibility, and late ones with moderate regrowth and high digestibility. Differences of digestibility with Nordic meadow fescue varieties are minor. Good winter hardiness is essential for both species. The aim of this study was to explore how the number of harvests, in combination with different cultivar mixtures and timing of the last harvest, affect the amount and nutritive value of total yield and the overwintering of the sward.

Materials and methods

The study was conducted as a field experiment at Maaninka (63°08' N, 27°19' E; loam soil type) and Sotkamo (64°11' N, 28°33' E; sandy clay loam), Finland, during the growing seasons of 2013-2014. Experimental design of the study was split-split-plot with four replicates. Plots were sown with a mixture of timothy (*Phleum pratense* L., 14 kg ha^{-1}) and meadow fescue (*Festuca pratensis* Huds., 6 kg ha^{-1}). The main plot was two (2H) or three (3H) harvests per growing season, the subplot was the cultivar mixture, and the sub-subplot was the early (EC) or the late (LC) last harvest. Three different cultivar mixtures were used: Tuure-Ilmari (T+I), Rubinia-Valtteri (R+V) and Grindstad-Inkeri (G+I). T+I represented the mixture of moderate development rate and high digestibility, which was hypothesized to be well suited for 2H. R+V and G+I represented the mixtures of good ability of regrowth and therefore more suitable for 3H. The EC of 2H plots were done at 5 weeks and LC of 2H plots at 7 weeks after the first cut. LC of 3H plot was done at the end of growing season and the EC, on average, at 24 d before. 2H plots were fertilized with 100 kg N ha^{-1} for both cuts and 3H plots were fertilized with 90 kg N ha^{-1} for 1^{st} and 2^{nd} cuts and 50 kg N ha^{-1} for third cuts.

Dry matter yield (DM yield, kg DM ha^{-1}) and D-value (g kg^{-1} DM; near-infrared spectrometry, Valio Ltd.) were determined for each cut. Weighted means of D-value for annual DM yields were calculated. Energy yield (ME yield, GJ ha^{-1}) was calculated as DM yield × 0.016 × D-value × 1000^{-1}.

Statistical analyses were performed using ANOVA (Mixed procedure of the SAS 9.3). The LC plots only were used for these analyses.

Results and discussion

Both experimental years were favourable for the growth of the third cut. The three-cut strategy produced approximately 1,500 kg DM ha^{-1} higher DM yield and 23 g kg^{-1} DM higher D-value than the two-cut strategy (Table 1) with 30 kg ha^{-1} $year^{-1}$ higher N fertilization. The success of the three-cut strategy was better than had been obtained previously (Hyrkäs *et al.*, 2012), and is explained by the favourable weather conditions in this study. The division of DM yield between cuts was approximately 50:50 in 2H and 35:35:30 in 3H.

G+I produced higher DM yield and lower D-value than T+I. The success of R+V varied between experimental sites (Table 1). Differences between ME yields were similar than between DM yields. Unexpectedly, only minor or no interaction between number of harvests and cultivar mixtures were found in this study. At Sotkamo there was tendency that the yield of T+I was lower than R+V and G+I in 3H but quite similar in 2H (P=0.057).

Table 1. Dry matter (DM) yields and digestibility values (D-value) in the total yield of growing season in the both experimental sites.[1]

Harvests (H)	Cultivar mixture (M)	Year (Y)	Maaninka DM yield kg DM ha^{-1}	Maaninka D-value g kg^{-1} DM	Maaninka ME yield GJ ha^{-1}	Sotkamo DM yield kg DM ha^{-1}	Sotkamo D-value g kg^{-1} DM	Sotkamo ME yield GJ ha^{-1}
	T+I		9,310 a	685 c	102.2 a	9,180 a	695 b	102.2 a
	R+V		9,650 a	678 b	104.8 a	9,650 b	694 b	107.1 b
	G+I		10,490 b	668 a	112.3 b	9,800 b	682 a	107.1 b
SEM			199	1.6	2.02	305	2.1	3.47
2H		2013	8,670	679	94.2	8,650	693	95.8
2H		2014	9,260	641	94.9	9,120	675	98.5
3H		2013	10,910	697	121.5	10,180	703	114.5
3H		2014	10,430	691	115.1	10,230	690	113.0
SEM			214	1.9	2.16	331	2.7	3.80
P value	H		0.002	<0.001	0.001	0.012	0.006	0.010
	M		<0.001	<0.001	<0.001	<0.001	<0.001	0.010
	Y		NS	0.001	NS	NS	0.017	NS
	H × M		NS	NS	NS	0.057	NS	0.083
	H × Y		0.002	<0.001	0.030	0.085	NS	NS
	M × Y		NS	NS	NS	NS	NS	NS
	H × M × Y		NS	NS	NS	NS	NS	NS

[1] ME = metabolisable energy; T+I = Tuure-Ilmari; R+V = Rubinia-Valtteri; G+I = Grindstad-Inkeri; SEM = standard error of the mean, NS = not significant, P>0.10. Values marked with the same letter do not differ (Tukey's test).

The proportion of timothy in the mixture varied between sites despite the same amounts of seed sown: it was approximately 70% at Maaninka, but only 20% at Sotkamo.

The average daily growth rate between EC and LC was +130 kg DM d^{-1} in the second cut and +20 kg DM d^{-1} in the third cut. The daily change of D-value was -2.5 g d^{-1} and only -0.2 g d^{-1}, respectively. These rates of change were clearly lower than published earlier for the first cut, 190 kg DM d^{-1} and -5-(-5.3) g d^{-1} (Kuoppala, 2010; Rinne *et al.*, 2010) as expected. The observed change in D-value in the second cut was somewhat faster than reported previously (-1.4 g d^{-1}; Kuoppala, 2010). Changes at the end of the growing season are slow and the importance of timing of harvests therefore decreases. There was no evidence of winter damage observed during the winter of 2013-2014.

Conclusions

The three-cut strategy is a good alternative to optimize both the high yield and digestibility of silage, although it requires slightly higher N inputs and favourable weather conditions. There are differences between the yield and digestibility of different cultivar mixtures but the interaction with number of harvests was only minor in this study. Timing of the second cut has a notable impact on the amount and nutritive value of the total yield, but the influence of date of third harvest is small.

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