Effects of different stocking rates with dairy cows on herbage quality in organic farming

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Abstract

In order to identify the effects of stocking rate of grazing dairy cows on herbage quality in organic farming, grazing experiments were conducted from 2004 to 2006. All lactating Holstein cows of one herd were divided into two groups during vegetation periods. The paddocks of the rotational pasture were split in a way that the low stocking rate group (LSR) had 15% more pasture area than the high stocking rate group (HSR). Post-grazing sward height for HSR was decisive for the simultaneous change of the sub-paddocks. Annual stocking rates for HSR were between 2.0 and 2.3 cows ha^{-1}. At regular intervals two grass strips per stocking rate were cut and sampled in the paddock to be grazed next. No differences were revealed concerning the strongly varying pre-grazing herbage mass with 1,235 (HSR) and 1,165 kg DM ha^{-1} (LSR). In the offered herbage mass for the LSR group, significantly lower ash, crude protein, absorbable protein in the duodenum based on energy or nitrogen available in the rumen, net energy for lactation, as well as higher neutral detergent fibre and acid detergent fibre contents were detected. Sugar values were unaffected. Referring to herbage mineral concentrations, only the potassium concentration was significantly lower in herbage for the LSR group. The allocation of a larger grazing area without pasture topping leads to a lower pasture quality, mainly from mid June to the end of August.

Keywords: pasture, herbage quality, stocking rate, organic farming, dairy cows

Introduction

In Switzerland, pasture-based milk production systems offer an optimal possibility to take advantage of the climate providing ample and regular grass growth, as well as minimizing the impact of topographic disadvantages. It is also well established that grazed grass is a low cost forage with a high nutrient value. According to the directives of Swiss organic farming, ruminants need to have access to pasture during the vegetation period to ensure a natural feeding system as well as for animal welfare. The efficiency of pasture use under organic farming, which in most cases implies restricted nitrogen supply, can still be improved.
The objective of this research was to study the effects of two different stocking rates with dairy cows on herbage quality in organic farming.

Materials and methods

The investigations were conducted from 2004 to 2006 on the farm 'l'Abbaye' in Sorens, Switzerland (46°39.767' N; 7°3.143' E). The conversion of this farm to organic farming started in 2003 and was officially finished in 2005. During the three vegetation periods (April to November) means of temperature (site at Payerne, 490 m above sea level (a.s.l.), and *ca.* 2 °C higher than around the farm) and sums of precipitation were: 13.2 °C, 819 mm; 13.3 °C, 748 mm, and 14.2 °C, 991 mm (MeteoSwiss). All lactating Holstein cows (on average 60 cows) were mainly fed pasture, and during the three vegetation periods were divided into two groups: high stocking rate (HSR) and low stocking rate (LSR). The sixteen paddocks of the rotational pasture system (total pasture area 33 ha, 800 to 900 m a.s.l.) were split such that

LSR had 15 per cent more pasture area available than HSR. The post-grazing sward height (POGSH) for HSR, measured with a rising plate meter (Filip's folding plate pasture meter, Jenquip, NZ) was decisive for the simultaneous change of the sub-paddocks for both groups. Every two weeks in 2004, and once per week in 2005 and 2006, respectively, two grass strips per stocking rate were cut (average cutting level 8.7 Units, 1 unit corresponds to a compressed sward height of 0.5 cm) and sampled in the paddock to be grazed next to evaluate the pre-grazing herbage mass (PRGHM) and herbage quality. Ash, crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF), total sugar, calcium (Ca), phosphorus (P), magnesium (Mg) and potassium (K) were analysed. Net energy for lactation (NEL) and absorbable protein in the duodenum, based on energy (APDE) or nitrogen (APDN) available in the rumen, were calculated according to RAP (1999). The signs test for paired samples was applied to compare data.

Results

Table 1. Pre-grazing herbage mass, botanical composition and mineral content.

	HSR			LSR			*P*
	Median	Minimum	Maximum	Median	Minimum	Maximum.	
PRGHM (kg DM ha^{-1})	1235	317	2774	1165	382	3234	-
Grasses (per cent)	71	42	95	72	41	96	-
Legumes (per cent)	12	2	55	15	1	55	-
Herbs (per cent)	5	1	45	6	0	50	-
Calcium (g kg^{-1} DM)	5.3	4.4	10.3	6.6	3.6	9.6	-
Phosphorus (g kg^{-1} DM)	4.4	3.7	5.6	4.4	3.4	5.5	-
Magnesium (g kg^{-1} DM)	2.0	1.5	2.6	1.9	1.5	2.6	-
Potassium (g kg^{-1} DM)	34.4	27.6	41.8	32.8	21.8	38.3	*

*Significant at $P < 0.05$.

Table 2. Herbage quality 2004-2006.

Period	1 Turnout-mid June			2 Until end of August			3 Until turn-in			Overall minimum (min.) and maximum (max.)			
										HSR		LSR	
	x_{HSR}[a]	x_{LSR}[a]	P	x_{HSR}[a]	x_{LSR}[a]	P	x_{HSR}[a]	x_{LSR}[a]	*P*	min.	max.	min.	max.
Ash[b]	104	102	-	103	99	*	120	118	-	81	197	84	167
NDF[b]	439	434	-	472	487	*	463	461	-	352	534	325	592
ADF[b]	255	241	-	284	304	*	273	278	-	206	329	214	360
CP[b]	173	164	-	167	143	**	185	180	-	132	229	113	224
Sugar[b]	93	97	-	64	61	-	51	55	-	42	146	41	134
APDE[b]	104	102	-	100	96	*	103	104	-	91	120	86	116
APDN[b]	115	109	-	110	94	**	123	120	-	87	152	74	149
NEL[c]	6.2	6.2	-	5.9	5.7	*	5.9	5.9	-	5.4	7.1	5.0	6.8

*Significant at $P < 0.05$, ** significant at $P < 0.01$.
[a]x_{HSR} median for HSR, x_{LSR} median for LSR.
[b]g kg^{-1} DM.
[c]MJ kg^{-1} DM.

From 2004 to 2006 the average stocking rates during the vegetation periods were for HSR 2.0, 2.3 and 2.3, and for LSR 1.7, 2.0 and 1.9 cows ha^{-1}. The average POGSH for HSR, as a criterion for simultaneous change of paddocks, and as an indicator for grazing severity for HSR, were 10.7 (2004), 9.7 (2005) and 9.0 Units (2006). The strongly varying PRGHM, botanical composition and mineral concentrations are shown in Table 1. No differences were revealed concerning the PRGHM. Proportions of grasses, legumes and herbs in the sward were similar, and remained similar, in both treatments. Herbage quality analyses of the herbage on offer showed that of Ca, P, Mg and K concentrations, only the K concentration was significantly lower in LSR. From mid June to end of August significantly lower values

for ash, CP, APDE, APDN and NEL, as well as higher NDF and ADF values, were detected in the offered herbage for LSR. Sugar values were unaffected by the different stocking rates.

Discussion

As concentrate feeding is limited in organic farming, the quality of the forage is extremely important for covering the requirements of dairy cows for milk production. The average nutritive value of herbage for HSR was relatively high, with a crude protein concentration of 174 g CP kg^{-1} DM, and 459 g NDF kg^{-1} DM, and 6.0 MJ NEL kg^{-1} DM, but considerable seasonal variation appeared. The CP and NDF values were comparable to the values reported in Kuusela *et al.* (2002) and Kuusela (2004), although conditions are quite different. Over the three experimental years the average Ca, P, Mg and K concentrations were similar to the data from Kuusela (2006) and are not, overall, sufficient to meet the requirements of dairy cows. Lower values for CP, APDE APDN and NEL, as well as higher NDF and ADF values for offered herbage in the LSR group, show a decreasing herbage quality during the second period from mid June to the end of August, with too lax grazing without pasture topping (cutting of pasture residues) and stocking rates that are too low.

Conclusions

The average nutritive value of herbage for HSR was relatively high, but considerable seasonal variations appeared. Higher pasture area allowance without pasture topping leads to a lower herbage quality from mid June to the end of August.

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