

Herbs in high producing organic grasslands – effect of management

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Abstract

In many organic grasslands herbs are established due to their expected beneficial properties for nutritive value and biodiversity. However, knowledge about grassland herbs is limited. Three mixtures were therefore established at different grazing/cutting and fertilization managements to examine the growth potential and feeding value. The competitiveness of the different species varied greatly. Chicory, plantain and caraway were competitive in mixtures with traditional grassland species. Lotus and salad burnet were weak competitors and chervil and sainfoin were very weak. The feeding value was also highly variable. Caraway had high digestibility of organic matter, also compared with the traditional grassland species, whereas plantain and salad burnet had lowest digestibility. The management, grazing, cutting, slurry and sward age, affected the proportion of the herb species. The proportion of caraway increased at cutting, slurry application and sward age. The proportion of plantain also increased at cutting but decreased at slurry application and sward age. The proportion of chicory increased with slurry application and decreased with sward age independently of cutting/grazing. The experiment showed that inclusion of herbs in the sward increased the biodiversity, made the herbage mass more diverse without affecting the dry matter yield.

Introduction

On Danish organic dairy farms, herbs are often sown together with grass/clover – broadcast or strip sown. Diverse swards increase ecosystem services and sustainability (Tilman et al., 1996), but the amount of herbs in the sward is often limited (Smidt & Brimer, 2005). The expectations are that herbs contribute to greater biodiversity, better drought tolerance, higher N utilization in the cow, higher mineral content, reduced parasitism, and a positive effect on the milk and meat quality. However, knowledge about herbs in intensively managed swards is very limited. An experiment was therefore established to examine the growth potential and feeding value.

Materials and methods

The study was carried out in an organic dairy cattle crop-rotation system on loamy sand running since 1987 at Research Centre Foulum in Denmark (9°34'59 E, 56°29'22 N). Three seed mixtures were established by undersowing spring barley (*Hordeum vulgare*) in 2006, 2007 and 2008 and were composed of: mix-1) perennial ryegrass (*Lolium perenne*), white clover (*Trifolium repens*) and red clover (*Trifolium*

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pratense), mix-2) mix-1 together with herbs (chicory (*Cichorium intybus*), long-leaved plantain (*Plantago lanceolata*), caraway (*Carum carvi*), lotus/birds foot trefoil (*Lotus coniculatus*), salad burnet (*Poterium sanguisorba*), sainfoin (*Onobrychis vicifolia*) and chervil (*Anthriscus cerefolium*)) and mix-3) mix-2 together with festulolium (*Festulolium braunii*) and lucerne (*Medicago sativa*). The seeds were sown at 0-1 cm depth at a rate of 26 kg ha⁻¹. The seed rate of the single species is shown in Table 1. In 2007-2009 the sward was either grazed continuously by heifers or cut four times. In 2007 there was only 1-year-old sward, in 2008 1- and 2-year-old, and in 2009 1-, 2- and 3-year-old swards. Further there were two application levels of cattle slurry: 0 and 200 kg total N ha⁻¹. There were two replicates. During the spring growth and 2nd regrowth, parts of the grazed plots were fenced off and harvested at the same time as the cut plots. The botanical composition at cut 1 and 3 was determined by hand separation of subsamples. Herbage quality at cut 1 and 3 was determined in the single species of mix-3; in vitro organic matter digestibility (IVOMD) (Tilley & Terry, 1963), fibres (NDF and ADL; van Soest), and N (Dumas).

Results and discussion

The three mixtures represent a standard mixture for cutting and grazing (mix-1), a mixture including herbs (mix-2), and a mixture also including festulolium and lucerne with the aim to increase the persistence (mix-3). The annual dry matter (DM) yield of mix-1 and mix-2 was not significantly different, with an average in 2007-2009 of 12.2 and 12.5 t/ha, respectively. The yield of mix-3 was higher, 13.2 t/ha ($P < 0.0001$), and the difference between mix-3 and the two others increased with age.

Tab. 1: Seed rate and botanical composition of the three mixtures. Mean of age and fertilization

Species	Seed rate			Grazing			Cutting		
	1	2	3	mix-1	mix-2	mix-3	mix-1	mix-2	mix-3
	% of total weight			% of herbage dry matter					
Festulolium			31						
P. ryegrass	82	66	28	54.8 ^a	47.6 ^{ab}	48.9 ^{ab}	43.3 ^b	24.4 ^c	29.4 ^c
W. clover	14	12	5	23.5 ^a	17.5 ^{bc}	16.1 ^{bc}	19.8 ^{ab}	14.4 ^c	8.8 ^d
R. clover	4	3	1	20.3 ^b	16.9 ^{bc}	12.0 ^c	35.8 ^a	32.3 ^a	12.5 ^c
Lucerne			15			3.5 ^b			28.7 ^a
Chicory		3	3		7.1 ^{ab}	7.9 ^a		7.9 ^a	5.6 ^b
Plantain		3	3		7.6 ^{bc}	7.1 ^c		14.1 ^a	10.2 ^b
Caraway		3	3		2.1 ^b	2.4 ^b		5.4 ^a	3.4 ^{ab}
Lotus		2	2		0.5 ^b	1.0 ^a		0.8 ^{ab}	0.5 ^b
S. burnet		3	3		0.3	0.3		0.3	0.4
Chervil		2	2		0	0		0	0
Sainfoin		3	3		0	0		0	0

P. ryegrass in mixture 3 include festulolium

Different letters within rows indicate significant difference ($P < 0.05$)

Chervil and sainfoin did not establish as they were out-competed during the establishing year, and they do not appear to be useful in highly productive

multispecies grasslands. Chicory, plantain and caraway were the herb species with the highest competitiveness (Table 1). Lotus and salad burnet had a low competitiveness. The heifers grazed all species with the exception of the inflorescence of plantain.

The proportion of herbs in the herbage was higher under cutting than grazing; on average 29 and 18 % of DM respectively. In grazed plots the inclusion of herbs in the sward decreased both the proportion of grass and clover (mix-2 compared with mix-1, Table 1). However, in cut plots the herbs mostly decreased the proportion of grass, which is surprising, as the habit of the herbs is more like clover than grass. Under grazing there was only a small proportion of lucerne in mix-3, which partially may be due to the choice of a variety for cutting (Pondus). In grazed plots there were nearly no differences in the proportion of the herbs in mix-2 and mix-3, indicating that *Festulolium* did not affect the competitiveness of the grass. *Festulolium* is otherwise known to be a tougher competitor than perennial ryegrass, but this seems not to be the case under grazing. Under cutting there was a high proportion of lucerne in mix-3, especially at the expense of red clover, which more or less has a habit similar to lucerne, but also the proportion of the herbs, especially plantain decreased.

Under grazing the proportion of grass and white clover increased and the proportion of red clover decreased compared to cutting. Plantain and caraway decreased under grazing whereas chicory, lotus and burnet were not affected by cutting/grazing management (Table 1).

The competitiveness of the herbs was also affected by sward age (Table 2). The plantain proportion dramatically decreased with sward age, whereas caraway increased significantly especially in spring growth, where it constituted up to 30 % of herbage dry matter (data not shown). The proportion of chicory and caraway increased by slurry application, whereas the proportion of plantain decreased.

Tab. 2: Proportion (% of DM) of the main herbs in relation to sward age (years) and slurry application, respectively. Chicory (Cc), Plantain (Pt) and caraway (Cw)

Age	Cc	Pt	Cw	Slurry	Cc	Pt	Cw
1	8.6	19.0 ^a	1.4 ^b	0 N	6.7 ^b	14.5 ^a	3.4 ^b
2	9.0	8.3 ^b	6.4 ^a	200 N	10.1 ^a	12.0 ^b	5.2 ^a
3	6.7	6.0 ^b	8.9 ^a				

Different letters within columns indicate significant differences ($P < 0.05$)

Herbage quality varied significantly between the herb species. In vitro organic matter digestibility (IVOMD) of caraway was high in spring growth and it maintained a high digestibility during the growing season (Table 3). IVOMD of all other herbs were lowest in midsummer, as it is the case for the traditional grassland species, when temperature is highest. The lignin (ADL) content was relatively low in caraway. The digestibility and cell wall composition of chicory was more or less comparable with red and white clover. Plantain and lotus were comparable with lucerne, the cell wall content (NDF) in lotus was however lower. Salad burnet was only present in the first part of the growing season every year, and the digestibility was rather low. Sanderson et al. (2003) reported nearly the same nutritive value of plantain and chicory in monoculture and thus did not confirm the shown results. The leguminous species had

especially in spring a higher content of crude protein (CP) than the non leguminous species. In summer growth this difference was reduced.

Tab. 3: Herbage quality of the single species in spring growth and 2nd regrowth. Mean of years. In vitro organic matter digestibility (IVOMD), neutral detergent fibre (NDF), lignin (ADL) and crude protein (CP).

Species	Spring				Summer			
	IVOMD	NDF	ADL	CP	IVOMD	NDF	ADL	CP
	% of OM	% of DM			% of OM	% of DM		
Grass	83.1 ^a	42.5 ^a	1.8 ^f	8.8 ^e	74.3 ^b	51.7 ^a	2.5 ^f	17.7 ^d
W. clover	81.5 ^b	21.9 ^f	2.6 ^d	21.3 ^{ab}	73.2 ^b	30.4 ^e	4.9 ^c	23.5 ^a
R. clover	79.0 ^c	26.5 ^d	2.4 ^{de}	19.3 ^c	70.4 ^c	34.2 ^d	3.9 ^d	19.3 ^c
Lucerne	71.2 ^e	34.0 ^b	4.8 ^b	20.4 ^b	62.9 ^d	40.2 ^c	6.6 ^{ab}	21.3 ^b
Chicory	84.2 ^a	23.5 ^e	2.2 ^e	10.5 ^d	68.4 ^c	35.2 ^d	3.8 ^d	13.4 ^f
Plantain	72.8 ^d	33.8 ^b	5.5 ^a	10.3 ^d	57.5 ^e	46.6 ^b	6.5 ^b	11.8 ^d
Caraway	83.3 ^a	27.7 ^d	2.6 ^d	10.0 ^d	81.7 ^a	23.6 ^e	3.0 ^e	16.1 ^e
Lotus	73.0 ^d	26.7 ^d	4.4 ^{bc}	22.1 ^a	63.0 ^d	36.4 ^d	7.1 ^a	21.1 ^b
S. burnet	61.0 ^f	30.1 ^c	3.9 ^c	9.7 ^d	-	-	-	-

Different letters within column indicate significant difference (P<0.05)

The herbage quality of the whole sward with calculation based on results in table 1 and 3 showed that mix-1 had the highest IVOMD, lowest NDF and ADL and lower CP. Mix-1 had thus the highest feeding value with traditional calculation of feeding value. But as the feeding value of the single herb species varied highly, the effect of herbs will depend of the species composition. In this experiment the proportion of caraway increased significantly and the proportion of plantain decreased much with increasing sward age. This affected the feeding value, as caraway had a high and plantain a low feeding value.

Conclusions

Multispecies and highly productive grasslands can be established by broadcasting seed mixtures. The best competitors were chicory, plantain and caraway of the herb species in this experiment. The herb species varied strongly with respect to growth, competitiveness and herbage quality and to the effect of different management. The effect on the total herbage therefore strongly depended on the herb species.

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