Vegetation change of mountainous hay meadows to intensified management regime in organic farming

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Abstract

The whole vegetation assemblage of 60 relevés (4 m²) in a block design was examined at two mountainous hay meadow stands over a two-year period. All sites were situated at a certified organic farm, managed according to the guidelines of organic farming since 1995. According to the traditional management, acreages are mowed two times per year followed by grazing and solid manure fertilisation in autumn. The effect of management intensity (two, three, four cuts per year and adapted fertilisation) was tested for coverage of most frequent species: *Trisetum flavescens*, *Dactylis glomerata*, *Poa pratensis*, *Poa trivialis*, *Festuca pratensis*, *Lolium perenne*, *Trifolium repens*, *Taraxacum officinale* agg., *Carum carvi* and *Achillea millefolium*. Our main interest was to detect how fast cover changes of different species occur. During the investigation period of two years, almost all taxa showed a significant alteration when mown more than 2 times a year. Stolon- and rosette-forming plants profited from increased management whereas tall tuft grasses lost coverage.

Keywords: hay meadow, management intensity, meadow species, cover percentage

Introduction

Managed, semi-natural grassland accounts for about half of the agricultural area in Austria, but still remains the cornerstone of dairy farming. In 2009 almost 25% of permanent grassland was managed organically, especially in the mountainous regions. At the same time, organic farms enlarged their average field areas to a greater extent than conventional farms (BMLFUW, 2009). According to the concept of a closed substance cycle the majority of nutrients necessary for milk and beef production should be obtained from the farm's own forage. Thus, in order to increase forage quality, farmers often increase their cutting frequencies and rate of organic fertilising (Karrer *et al*., 2010). This process strongly alters species assemblages on former traditionally managed permanent grassland stands. Depending on growth form and susceptibility to nutrients, plant species react by increasing or decreasing coverage. However, the rates of change in cover of traditionally managed non-sown mountainous hay meadows remain unclear and are tested in an on-farm field experiment. In this paper trends of two years of the investigation are discussed.

Materials and methods

The pilot farm is located in the Upper Styrian Pöls valley on the crystalline bedrock of the ‚Niedere Tauern'. Cattle breeding is carried out, based on hay meadows and pastures. After a vegetation survey in 2008, the two most homogenous meadows were selected at 920 and 980 m, resp., both facing 230° SW and characterised by an average inclination of 25%. Soil type is cambisol dominated by sandy loam, at a pH of 5.3 to 5.8. Annual mean temperature at the farm ranges from 4 to 6°C and annual precipitation from 1000 to 1100 mm. The grassland refers to

the association *Cardaminopsido halleri-Trisetetum flavescentis*, typical for mountainous hay meadows cut two times a year (Bohner *et al*., 2000). No sowing of cultivars was performed within 15 years before the experiment. The meadows were cut two times a year and fertilized by manure 15 years before the experiment. At the two selected meadow fields we established 30 plots (4 m²) arranged in an incomplete block design, meaning that three out of all six treatments are aligned in one column, where we applied different cutting frequencies and different types of organic fertilisation (Table 1). At each cutting level we used two different types of organic fertiliser resulting in six treatments, all with five pseudo replicates per field. Before each mowing we recorded cover percentage of each species based on Schechtner (1958). Statistical analysis was implemented with proc MIXED of SAS 9.2 ($P < 0.05$) for species specific mean cover percentages (average of all measures per single species and year) of the whole growing season 2010. The result of the cutting impact was displayed as LS-means (LSMEANS). Test of pairwise differences were arranged with Tukey-Kramer and significant differences between LS-means are shown with different lower-case letters (Table 2).

Table 1. Treatments and mowing dates 2009 and 2010

Management options			Mowing date			
Treatment	Cut/year	Fertiliser	1	2	3	4
1	2	Manure	June 1-8	Aug. 17-20		-
2	2	Slurry	June 1-8	Aug. 17-20		-
3	3	Manure	May 16-23	July 18-21	Sept. 13-29	-
4	3	Slurry	May 16-23	July 18-21	Sept. 13-29	-
5	4	Manure	May 9-12	June 27-30	Aug. 1-5	Sept. 13-29
6	4	Slurry	May 9-12	June 27-30	Aug. 1-5	Sept. 13-29

Results and discussion

Changes in annual average cover percentage of the most frequent species in 2010, as well as differences in cutting frequency levels are shown in Table 2. The tuft grasses *Trisetum flavescens*, *Dactylis glomerata*, *Lolium perenne* and *Festuca pratensis* reproduce by a number of shoots that remain connected to the parent plant after mowing. *T. flavescens* and *F. pratensis* declined in treatments cut three or four times, in contrast to *L. perenne*, which is smaller in habit and more susceptible to intensive management. This observation corresponds to inverse effects documented by Briemle (1994), i.e. a decrease of *L. perenne* but an increase of *T. flavescens* after three years of extensification. So far, management has had no impact on cover percentage of *D. glomerata*, which can be explained by its life span, which for tussock grasses was determined to be six to eight years (Schmitt, 1995). *Carum carvi* shows increasing cover values with increasing management intensity. This taxon is known to fill gaps quickly in intensively managed meadows by seedling establishment (e.g. Dierschke and Briemle, 2008). *Poa pratensis*, a valuable grass with subterranean shoots, significantly lost cover with ascending cutting frequency. This is surprising, as cultivars of this species are used in seed mixtures for intensively managed meadows and pastures (e.g. Starz *et al*., 2010). Obviously, regional ecotypes in extensively used hay meadows are not susceptible to intensification. *Poa trivialis* is a grass forming numerous aboveground down-bending shoots after the first mowing. It increased in treatments with three and four cuts a year through capturing free gaps. *Trifolium repens* also increased its coverage expanding by above-ground runners. These two species profit most from a four-cut management, also shown in the adjoining ‚Enns valley' (Karrer *et al*. 2010).

Table 2. Analysis of variance and pairwise differences of coverage (averages over field 1 and 2) for dominant grassland species in 2010 influenced by varying management intensity.

Parameter	Cutting frequency			
	2 LSMEAN	3 LSMEAN	4 LSMEAN	*P*
Trisetum flavescens	32 [a]	15 [b]	15 [b]	**<0.0001**
Dactylis glomerata	8 [a]	9 [a]	10 [a]	0.1767
Lolium perenne	4 [b]	8 [a]	9 [a]	**<0.0001**
Festuca pratensis	4 [a]	4 [ab]	3 [b]	**0.0197**
Taraxacum officinale agg.	9 [a]	9 [ab]	7 [b]	**0.031**
Carum carvi	4 [c]	5 [b]	8 [a]	**<0.0001**
Poa pratensis	18 [a]	16 [a]	13 [b]	**<0.0001**
Poa trivialis	12 [b]	16 [a]	18 [a]	**<0.0001**
Trifolium repens	22 [b]	21 [b]	30 [a]	**<0.0001**
Achillea millefolium	18 [a]	10 [b]	3 [c]	**<0.0001**

Conclusion

After two years we recorded significant changes in coverage of the most frequent meadow species due to management intensification. Short-lived rosette herbs reproducing predominantly by seeds, and plants with aboveground creeping stems, benefit most from increasing cutting intensity. On the other hand, tall tussock grasses lost cover abundance and left open space. Valuable forage crops decreased in cover with higher management intensity except for *Lolium perenne* and *Trifolium repens*. Our results are in accordance with observations of several farmers, that meadows became patchy after an increase in mowing frequency on traditional mountainous hay meadow stands without seeding of suitable species and cultivars.

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