

## Short-term effects of cutting frequency and organic fertilizer on species composition in semi-natural meadows

Angeringer W.<sup>1</sup>, Karrer G.<sup>1</sup>, Starz W.<sup>2</sup>, Pfister R.<sup>2</sup> and Rohrer H.<sup>2</sup>

<sup>1</sup>Institute of Botany, University of Natural Resources and Applied Life Sciences (BOKU), 1180 Vienna, Austria; <sup>2</sup>Agricultural Research and Education Centre (AREC), Institute of Organic Farming and Farm Animal Biodiversity, 8952 Irdning, Austria; wolfgang.angeringer@boku.ac.at

### Abstract

Permanent hay meadows in montane regions serve as advertising subjects for food industry, considered as highly diverse, flowering and healthy forage in ruminant production. On the other hand, farmers tend to intensify their cutting and fertilising regime on accessible sites, which may result in low diverse, uniform stands of high fodder quality for ruminants. Traditionally, Austrian mountain farmers mow their meadows two times a year without periodic re-sowing. We tried to analyse changes in vegetation under different management regimes in a triannual case study consisting of a block design with 30 sub-plots on two comparable mesophilic meadows of the *Arrhenatheretalia* R. Tx. 1931 in the Eastern Alps. The effect of management intensity (2, 3, 4 cuts; manure vs slurry) was tested for species coverage, e.g. dominants like *Trisetum flavescens*, *Dactylis glomerata*, *Trifolium repens*, *Taraxacum officinale* and *Achillea millefolium*. The results show changes in abundance of widespread meadow species after three years due to management intensification. Stolon- and rosette-forming plants profited from increased management whereas tall tuft grasses lost coverage. While the less foraging grass *Poa trivialis* accelerated, on the other hand valuable species as *Poa angustifolia* declined in abundance. Hence, there will be limits to intensification on permanent grasslands, dependent on site condition and species composition.

**Keywords:** *Arrhenatheretalia*, cutting frequency, organic fertilizer, meadow species

### Introduction

In Central Europe, semi-natural meadows in mountain regions that are unsuitable for crop production, offer an important source for grazing and conservation of silage and hay in livestock breeding. Austrian grasslands contribute to about half of agricultural area (1.38 m ha<sup>-1</sup>). Therefrom, 25 m ha<sup>-1</sup> can be described as traditionally used semi-natural grassland with a maximum of two cuts or grazing terms per year. However, the greater part, 0.48 m ha<sup>-1</sup>, belongs to improved meadows, used more than 3 times per year with adapted fertilization (BMLFUW 2015). During the last centuries, a clear management intensification occurred due to socio-economic changes. Meadows having appropriate climatic and soil conditions in lowland regions and in mountain areas were transformed to uniform swards consisting only of a few productive species (Bassler *et al.*, 2011; Dietl, 1995; Isselstein *et al.*, 2005). Inclination limited management intensity during past centuries, this might change with availability of modern machinery along with growing farm size due to structural changes in agriculture. In this case study, the floristic changes of representative *Arrhenatheretalia* stands in Styria, Austria, due to management intensification were analysed.

### Materials and methods

The experiment was carried out in the Upper Styrian Pöls valley on the crystalline bedrock of the 'Niedere Tauern', Austria. After a vegetation survey in 2008, the two most homogenous meadow fields were selected at 920 and 980 m a.s.l., both facing 230° SW and characterised by an average inclination of 25%. Soil type was a typical cambisol structurally dominated by sandy loam. In 2009 the following average soil parameters were observed: pH (CaCl<sub>2</sub>) 5.7±0.17 mg kg<sup>-1</sup> (site 1) and 5.9±0.15 mg kg<sup>-1</sup> (site 2); P (CAL) 36±8 mg kg<sup>-1</sup> (site 1; low P availability) and 71±17 mg kg<sup>-1</sup> (site 2, high P availability);

K (CAL)  $133 \pm 41$  mg kg<sup>-1</sup> (site 1, good K availability)  $271 \pm 68$  mg kg<sup>-1</sup> (site 2, high K availability). Annual mean temperature at the farm ranges from 6.5 to 8 °C and annual precipitation from 850 to 1040 mm from 2009 to 2011. The original mesophilous grassland referred to the association *Cardaminopsido halleri-Trisetum flavescens* (Bohner and Sobotik, 2000), typical for mountainous hay meadows on crystalline bedrock. No sowing of cultivars was performed within 15 years before the experiment. 30 plots á 4 m<sup>2</sup> were arranged at each site in a block design. The six treatment factors included 2, 3 and 4 cuts, in combination with application of either slurry or manure. Before each mowing we recorded cover percentage of each species. Statistical analysis were implemented with proc MIXED of SAS 9.2 ( $P < 0.05$ ) for species specific mean coverage on 1 to 3 of June in 2012. The resulted model LS-means were displayed as percent coverage together with standard error of the model (SEM). Test of pairwise differences were arranged with Tukey-Kramer and significant differences are shown with different lower-case letters. For a detailed experiment description see Starz *et al.* (2015).

## Results and discussion

How the treatments influenced mean coverage of dominant species, is shown in Table 1. The tuft grass *Festuca pratensis* lost abundance in intense mowing regime, in contrast to *Lolium perenne*. Perennial ryegrass, a grass of short stature was more susceptible to intensive management. Meadow fescue was the single grass which seems sensitive to slurry application, as already mentioned in Dietl *et al.* (1998). Management had no impact on coverage of *Dactylis glomerata*, which can be explained by its life span, which was estimated to be six to eight years (Schmitt, 1995). There was no effect of the treatments on coverage of *T. flavescens* in this study, but former findings showed a decline of this species due to increased cutting regime (Angeringer *et al.*, 2011). The herbs *Crepis biennis*, *Taraxacum officinale* and *Achillea millefolium* showed declining cover values with increasing management intensity, especially the subterranean shoots forming *A. millefolium*. *Poa angustifolia*, a valuable grass with subterranean runners, significantly lost cover with intense mowing. In 2012, aggregate taxon *P. pratensis* was divided into small-leaved *P. angustifolia* and broad-leaved *P. pratensis*. This became necessary, because regional ecotypes of the latter were not susceptible to intensification as mentioned before (Angeringer *et al.*, 2011). On the other hand, cultivars of *P. pratensis* are used in seed mixtures for intensively managed meadows and pastures in Austria (Starz *et al.*, 2010). *Poa trivialis* is a grass which was able to form numerous aboveground down-

Table 1. Influence of treatments on cover percentage (%) of species with high continuity (>90%) in 1-3 June 2012 (n=60).

Parameter	Cutting frequency			Organic fertilizer					
	2	3	4	SEM	P-value	Slurry	Manure	SEM	P-value
	%	%	%			%	%		
<i>Lolium perenne</i>	11b	14b	19a	1.3	0.0008	15	15	1.1	0.8410
<i>Poa trivialis</i>	7a	10a	22b	1.5	<0.0001	14	12	1.3	0.1279
<i>Poa angustifolia</i>	22a	21a	16b	1.2	0.0010	19	21	0.9	0.0479
<i>Poa pratensis</i>	1a	1a	2a	0.4	0.1442	2	1	0.3	0.5621
<i>Trisetum flavescens</i>	16a	12a	14a	1.3	0.0899	15	14	1.2	0.3485
<i>Dactylis glomerata</i>	4a	3a	4a	0.4	0.1303	4	4	0.4	0.1067
<i>Festuca pratensis</i>	3ab	4b	2a	0.4	0.0165	2	3	0.3	0.0345
<i>Crepis biennis</i>	10a	7b	5b	0.6	<0.0001	7	7	0.5	0.4261
<i>Taraxacum officinale</i>	7a	6b	6b	0.4	0.0096	6	7	0.3	0.0605
<i>Achillea millefolium</i>	15a	16a	8b	0.9	<0.0001	13	13	0.7	0.9473
<i>Trifolium repens</i>	12a	13a	15a	1	0.0938	12	14	0.9	0.0673

<sup>1</sup> Tested with GLM Proc, Mixed, post-hoc test Tukey-Kramer in different lower-case letters.

bending shoots after the first mowing. It increased in treatments with three and four cuts a year through capturing free gaps by those organs. There were no changes in coverage of the single legume in this study, *Trifolium repens* though there was a slight preference for intense cutting and manuring.

## Conclusions

After three years of different management regime, we recorded significant changes in coverage of the most frequent meadow species due to cutting regime, but few responses to the type of organic fertiliser. Species in permanent grassland stands competed for nutrients and gaps. Most of the well-adapted hay meadow species decline in coverage due to intensification, e.g. *P. angustifolia*. Of the valuable forage crops, only *L. perenne* increased in coverage after intensification. Thus, the occurring gaps are susceptible for settlement of less palatable species as *P. trivialis*. This field experiment demonstrated the development of montane *Arrhenatheretalia* meadows from species-rich stands to fragile swards consisting of undesirable species if mowed more often without reseeding.

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