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Grassland – a European Resource?

Edited by
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Postponing of the first harvest in semi-natural grasslands: decline in nutrient concentrations?

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Abstract

Postponing of the first harvest until summer is widely incorporated into agri-environmental schemes. In agriculturally improved grasslands a late harvest usually provides forage with much lower N, P and K concentrations than an early harvest. The question is how postponing of first harvest affects nutrient concentrations in biomass if late harvest is applied in semi-natural grasslands for the first time. A rapid seasonal decline of N, P and K concentrations in biomass was recorded in formerly unmanaged *Bromion* but not in formerly grazed *Cynosurion* and *Violion* grasslands. Approximately 50% of the grassland biomass consisted of species with persistent leaves in *Cynosurion* and *Violion*, while the proportion of these species was very low in *Bromion*. Total amounts of N, P and K in standing biomass were substantially higher in *Bromion* than in the other two grasslands in the spring, whereas no differences between sites were observed in the summer. Nutrient dilution and resorption in *Bromion* versus long leaf lifespan strategy in *Cynosurion* and *Violion* explain the different seasonal patterns of N, P and K concentrations. In conclusion, a one-time application of a late harvest need not decrease N, P and K concentrations in forage from grasslands formerly grazed in early spring.

Keywords: agri-environmental schemes, grazing, late harvest, leaf persistence, nutrient resorption

Introduction

The most frequent agri-environmental measure in grasslands is postponing of the first harvest until summer in order to assure reproduction of plants, insects and ground-nesting birds. In agriculturally improved grasslands a late harvest provides forage with much lower N, P and K concentrations than an early harvest. However, such sharp decline in nutrient concentrations is not necessarily recorded in unfertilized semi-natural grasslands (Donath *et al*., 2004). In infertile environments plants have to conserve nutrients (Eckstein *et al*., 1999), which is ensured either by nutrient resorption (supporting seasonal decline in nutrient concentrations in above-ground biomass) or by extending the leaf life span (keeping nutrient concentrations at approximately the same level for the whole season). The main aim of this study was to test whether postponing of the first harvest until summer decreases nutrient concentrations in forage less in grasslands with a higher proportion of species with persistent leaves.

Materials and methods

Three unfertilized grasslands (White Carpathian Mts, Czech Republic) were selected: (1) *Bromion* (49°05'58" N, 18°01'59" E), unmanaged 13 years before the start of the study, formerly managed by cattle grazing. (2) *Cynosurion* (48°56'20" N, 17°48'00" E), rotationally grazed by cattle from early spring for more than 25 years prior to the start of the study.

(3) *Violion* (48°53'47" N, 17°34'44" E), an old, eroded and continuously grazed pasture on a hilltop with more than 50 years history of sheep grazing beginning each year in early spring. Within each grassland we randomly selected 15 plots (each 1 m^2 in size) for biomass sampling in spring and another 15 plots in summer. In 2004 the spring standing biomass was sampled on 19 May in *Bromion* and *Violion* and on 7 June in *Cynosurion* (due to delayed growth at a higher altitude) and on 30 June at all sites for the summer term. Plots were neither grazed nor cut before sampling thus providing first growth biomass on all sampling dates. Prior to clipping, the biomass proportions of species in a sample were estimated. A total of 80 species was recorded from the three sites at both sampling dates. The leaf persistence was extracted from the BIOLFLOR database (Klotz *et al*., 2002): 46 species possessed leaves green only in the vegetation period and 34 species had persistent evergreen leaves (often living more than one year). Community leaf persistence was calculated using a binary coded variable (1 for species with persistent leaves) by weighting the trait values of species with their proportions in the biomass sample, thus community leaf persistence of a sample could range from 0 to 1. The biomass was harvested 3 cm above ground, dried at 55°C and taken to the laboratory for analyses of nutrient concentrations.

Results and discussion

The most productive *Bromion* exhibited a steep decrease in concentrations of N, P and K from spring to summer. In contrast, *Cynosurion* and *Violion* were characterized by relatively unchanged concentrations of N and P while concentrations of K increased (Figure 1). These results are in line with Alonso and García-Olalla (1997). Comparison of concentrations with the levels recommended for dairy cattle showed that the biomass was poor in P at all sites. With the exception of spring harvests in *Bromion* and *Violion*, N concentrations were below or at the lower limit of dairy cattle requirements. K concentrations higher than dairy cattle requirements are usually observed in many types of grasslands. However, the nutrient concentrations satisfy the lower nutritional requirements for beef cattle and sheep.

A gradient in community leaf persistence was recorded in the order *Bromion* < *Cynosurion* < *Violion* (Table 1). Total amounts of N, P and K in standing biomass in the spring were highest in *Bromion* that contained a relatively low proportion of species with persistent leaves (29% of biomass). In contrast, the lowest spring amounts of N, P and K were found in *Violion* with 64% of biomass created by species with persistent leaves. The total amounts of nutrients harvested in summer were similar in all grasslands and corresponded to the average values found by Smits *et al*. (2008) for peak standing biomass in unfertilized *Bromion erecti* grassland (50, 4 and 60 kg ha^{-1} of N, P and K, respectively). These divergent seasonal patterns match the differences in the ecophysiology of the dominant species: *Brachypodium pinnatum* in *Bromion* and *Festuca rubra* in both *Cynosurion* and *Violion*. It is known that *B*. *pinnatum* shows rapid senescence and retranslocation of nutrients into underground rhizomes, and that *F*. *rubra* typically keeps the leaf nutrient concentrations at the same level throughout the season.

Table 1. Average community leaf persistence and total amounts of nutrients (kg ha^{-1}) of harvested aboveground biomass from all sites in spring and summer. Two-way ANOVA, cells with the same letter row-wise are not significantly different at $P = 0.05$ (Tukey HSD test)

Site	*Bromion*		*Cynosurion*		*Violion*	
Date	spring	summer	spring	summer	spring	summer
Leaf persistence	0.29^{ab}	0.14^{a}	0.45^{cd}	0.41^{bc}	0.64^{e}	0.58^{de}
Total N	40.2^{bc}	55.9^{d}	30.5^{b}	39.3^{bc}	16.5^{a}	51.9^{cd}
Total P	3.7^{b}	4.2^{b}	2.9^{b}	3.6^{b}	1.2^{a}	4.2^{b}
Total K	44.2^{bc}	69.4^{d}	41.0^{b}	55.8^{bcd}	13.1^{a}	59.6^{cd}

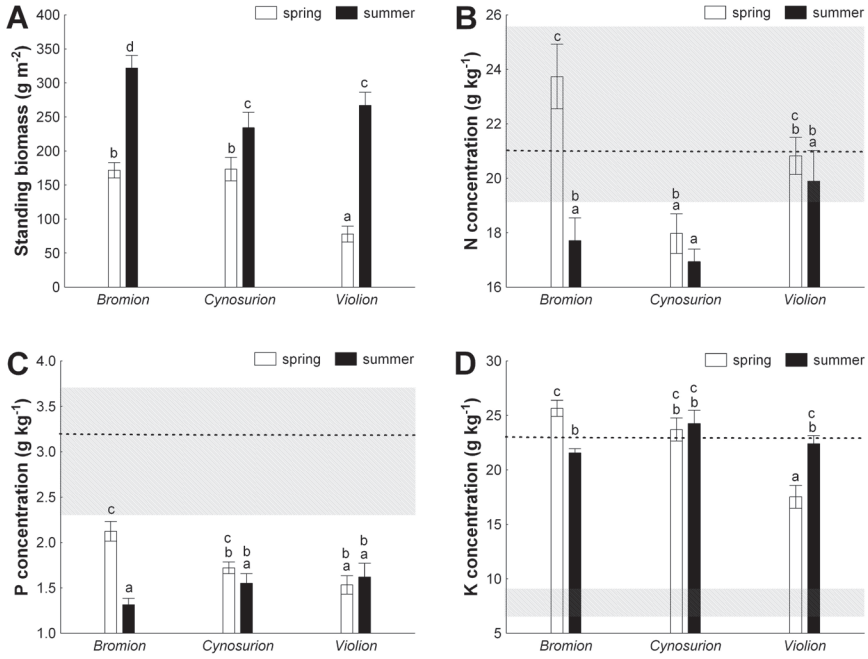

Figure 1. Dry matter standing biomass and concentrations of nutrients. Two-way ANOVA, error lines represent SE, bars with the same letter are not significantly different at $P = 0.05$ (Tukey HSD test). Punctuated lines indicate typical concentrations of nutrients in *Lolium perenne* (standard forage grass) in optimum time for harvest; grey zones indicate concentrations of nutrients recommended for nutrition of dairy cows (Whitehead, 2000)

Conclusions

Postponing first harvest until summer does not necessarily decrease N, P and K concentrations in forage from grasslands, where abiotic conditions and the long-term management regime support a high proportion of species with persistent leaves.

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