

Effect of different extensive management treatments on the plant diversity of an upland meadow without forage utilisation

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Abstract

Effect of different managements on plant diversity of an upland permanent grassland was studied in the Jizera Mts., Czech Republic, from 2000 to 2010. Treatments applied were: cutting twice per year; mulching once, twice and three times per year and abandonment (control). Botanical composition was observed yearly at the end of May and the number of vascular plant species and Shannon's indices were calculated. During the experiment total number of plant species increased especially in multiple-managed treatments, whereas it slightly decreased in unmanaged and once-mulched treatments. Also, the number of species with cover $\geq 1\%$ was temporarily (2000-2008) increased in treatments with more frequent defoliation, but a decrease was recorded in the last two years. Shannon's index of diversity oscillated about 2.5 in all managed treatments while it rapidly decreased on unmanaged plots to less than 1.9. Twice-mulching per year can be an alternative management for upland grasslands without forage utilisation.

Keywords: grassland, mulching, cutting, abandonment, diversity, sward

Introduction

As a consequence of reduction of farm staff, the importance of grassland for forage use rapidly decreased in the Czech Republic especially on marginal areas in the last decade of the 20th century. Large areas remained without any management and these meadows or pastures often degraded. On abandoned grasslands the sward structure changed, and plant species richness and diversity decreased. Tall dicotyledonous plants and invasive species spread, and shrubs and trees have started to colonise unmanaged stands. Therefore mulching appeared to be a simple and low-cost procedure (Prochnow *et al.*, 2000) that could be used to manage many marginal grasslands or fallow farm land to prevent sward degradation and/or afforestation. After mulching, the plant biomass subsequently decomposes and released nutrients can return to ecosystem, whereas the regular multiple mowing of biomass usually leads to oligotrophication of stands by gradual nutrient losses. Most studies on mulching in the Czech Republic and other European countries (e.g. Kahmen *et al.*, 2002; Mašková *et al.*, 2009) were carried out in calcareous stands, wetland and mountain areas. However, results from the most widespread common upland grasslands are missing. Therefore the aim of our study was evaluate the changes of species richness and diversity in a common type of upland meadow under different management regimes over a 10-year period.

Material and methods

The experiment was carried out in the Jizerské Mts. in the northern part of the Czech Republic from 2000 to 2010. Altitude is 420 m, average annual temperature is 7.2°C and annual precipitation is 803 mm. The bedrock is a biotic granite underlying acid cambisol with pH_{KCl} 6.2, C_{ox} 2.7%; contents of available P, K and Mg were 28, 138 and 290 mg kg⁻¹, respectively.

The grassland had been sown in the 1980s and intensively managed afterwards (cutting twice per year and N, P, K fertilisation). However, in the five years before the experiment it was extensively used (occasional cutting or grazing) and during the experiment average forage production of the meadow (*Arrhenatherion*) was about 6.5 t DM per ha. Treatments were arranged in four complete randomized blocks in 5 m×10 m plots, of which the central 8.0×3 m area was assessed to avoid edge effects. Treatments were: 2x cutting with removal of the biomass (2C), unmanaged grassland (U), 1x mulching in July (1M), 2x mulching in June and August (2M) and 3x mulching in May, July and September (3M). During the experiment no fertilisation was applied.

Mulching was done with a Uni Maher UM 19 machine. Percentage cover of plant species was recorded at the end of May in each study year (nomenclature follows Kubát *et al.*, 2002). Plant species diversity changes were determined by calculating Shannon's diversity (SD) index and Shannon's evenness (SE). Repeated measures ANOVA (interaction year and treatment) were used to analyse vegetation data.

Results and discussion

Initial total number of plant species was about 30 per plot in all treatments. During the study we recorded gradual changes in the number of plant species under the different treatments ($P < 0.001$). In the multiple-defoliation treatments the number of species increased, especially on the 2C treatment (to almost 40 species). Species richness successively decreased on the once-mulched and unmanaged treatments: in last two years the numbers were 28 (1M) and 25 (U) (Figure 1). Increased species on frequently mulched treatments was in accordance with Moog *et al.* (2002) who found that mulching twice a year can be suitable management for the conservation of species-rich grasslands. Among the managed treatments, no significant differences were found when we compared number of species with cover $\geq 1\%$. However, on unmanaged plots it decreased significantly, especially during the first three and last five years.

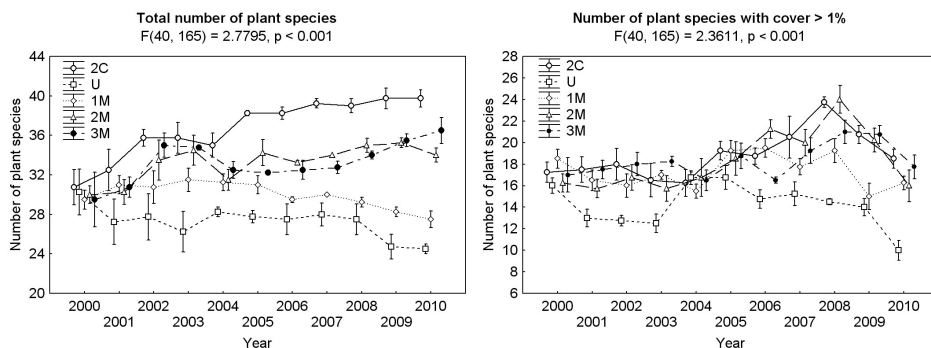


Figure 1. Total number of species and number of species with cover $\geq 1\%$ under different management treatments during the study years (2000-2010)

Not only total number of plant species, but also representation of all single species is important for diversity expression. The SD index was about 2.5 at start of the experiment and it decreased with some temporary fluctuation on the unmanaged treatment (Figure 2). After initial increase this index declined on the 3-times mulched treatments from year 4 to year 6, but then increased. The SD index of this treatment had similar values as the twice-cut one after 10 years of the experiment. There was high fluctuation of SD index among the study years; however, a negative effect of abandonment was evident. On the other hand, there was slight increase of plant species diversity on multiple-managed treatments. Bernhardt-Römermann

et al. (2009) reported that mulching is not suitable for long-term alternative management of species-rich calcareous grassland with traditional grazing management, because the mulching caused decrease of diversity in comparison with grazing. We suppose that mulching can be an acceptable management mainly for abandoned grassland because it can prevent reversion to forest, especially in marginal upland areas in the conditions of the Czech Republic. Nadolna (2009) similarly found that Shannon's index value on a once-cut treatment with biomass left on surface did not differ from cut treatment with biomass removal. There was markedly higher diversity in comparison with unmanaged plots. However, Mašková *et al.* (2009) mentioned that the species richness on a mown treatment increased similarly to that on a mulched treatment, but Shannon's diversity index and evenness were significantly lower on the mown treatment than mulched or fallow ones, probably related to nutrient depletion.

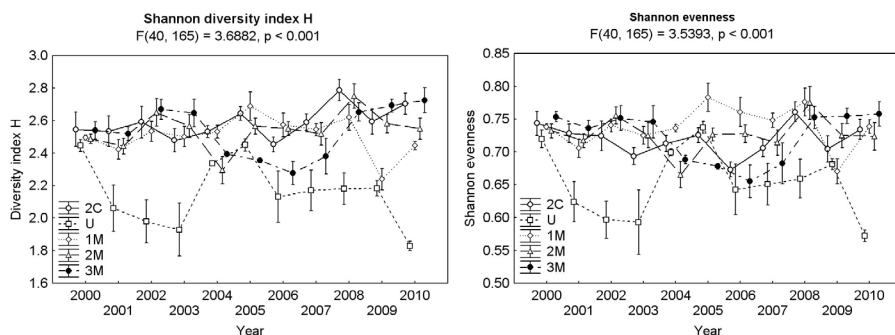


Figure 2 Changes in diversity of sward under different management treatments

Conclusions

The total number of plant vascular species increased on multiple-managed treatments, especially on the twice-cutting treatment with removal of biomass. However, it decreased on the once-mulched and as well as on unmanaged treatments. Similarly, plant species diversity was higher on frequently managed swards in comparison with abandonment or once-mulching. Mulching twice per year could be applied as an alternative management for upland grasslands (alliance *Arrhenatherion*) without forage utilisation.

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References

- Bernhardt-Römermann M., Kleyer M. and Poschold P. (2009) Substitutes for grazing in semi-natural grasslands - do mowing or mulching represent valuable alternatives to maintain vegetation structure. *Journal of Vegetation Science* 20, 1086-1098.
- Kahmen S. and Poschold P. (2008) Effects of grassland management on plant functional trait composition. *Agriculture, Ecosystems and Environment* 128, 137-145.
- Kubát K., Hrouda L., Chrtěk J. jun., Kaplan Z., Kirschner J., Štěpánek J. (eds.) (2002) Klíč ke květeně České republiky (Key to the flora of the Czech Republic). Academia, Praha, Czech Republic, pp. 928. (In Czech)
- Mašková Z., Doležal J., Květ J. and Zemek F. (2009) Long-term functioning of species-rich mountain meadow under different management regimes. *Agriculture, Ecosystems and Environment* 132, 192-202.
- Moog D., Poschold P., Kahmen S. and Schreiber K.F. (2002) Comparison of species composition between different grassland management treatments after 25 years. *Applied Vegetation Science* 5, 99-106.
- Nadolna L. (2009) The effect of restored grassland mowing on the productivity and environmental quality of fallowed grasslands in the Sudetes. *Woda - Środowisko - Obszary Wiejskie* 27, 89-105 (in Polish)