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Effect of fertilization level and cutting pattern on species diversity of meadow stand

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Introduction

The distribution of grasslands and their floristic composition is related to the climate at the largest scale. Particular grassland is affected by bedrock, soil, water regime, altitude, nutrient status, local climate, disturbance etc (Gibson, 2009). Grasslands provide not only production functions but also large scale of ecosystem services such as nutrient cycling, sequestration of carbon dioxide, prevention of soil loss and many others. Ability of grasslands to afford both production and ecosystem functions depends among others on the floristic composition (Chytry, 2007). Semi-natural permanent meadows, as a result of the concurrence of many factors, represent a great reservoir of biodiversity. The aim of this contribution is to asses the effect of intensity of grassland management on its species diversity.

Materials and Methods

A small plot trial was established in 2003 within a permanent meadow, which was established in the 1990s. The site is located near Vatín, Vysočina Region, Czech Republic, at 535 m above sea level. Annual rainfall average is 618 mm; mean annual temperature is 6.9 °C. Soil is gleyic fluvisol on the quaternary fluvial deposits, bedrock is biotitic gneiss. The trial was designed in the form of split blocks with four replications. Area of the plot was 10 m^2. There were four treatments of nutrition level combined with four treatments of cutting intensity. Exploitation intensity: Intensive (C4) – four cuts per year, first cut on 15^{th} May, subsequent cuts at 45 day intervals; mid-intensive (C3) – three cuts per year, first cut on 30^{th} May, subsequent cuts at 60 day intervals; low-intensive (C2E)) – two cuts per year, first cut on 15^{th} June, next after 90 days; extensive (C2L)) – two cuts per year, first cut on 30^{th} June, next after 90 days. Nutrition level: 0 – no fertilization; PK – $N_0 + P_{30} + K_{60}$ kg·ha^{-1}; N90PK – $N_{90} + P_{30} + K_{60}$ kg·ha^{-1}; N180PK – $N_{180} + P_{30} + K_{60}$ kg·ha^{-1}. Total amount of N was applied in split applications of 1/3:1/3:1/3:0 (4 and 3 cut) and 1/2:1/2 (2 cut system). Cover of each species was assessed by cover estimation method right before the first cut of the year. Average values from years 2004–2012 are presented in this paper. Results were processed through ANOVA in the STATISTICA software.

Results and Discussion

The effects of both fertilization level and cutting pattern on species richness were highly significant (Table 1). When averaging cutting pattern treatments, the total number of species decreased along with increasing fertilization rates from 29.4 (no fertilization) to 27.8 (N180PK). A significant interaction was observed between cutting and fertilization treatments, there were maximal counts detected in non-fertilized plots within each treatment of cutting pattern. With the exception of the four-cut control swards where the lowest number of species was observed (Fig. 1). The absolutely highest species richness was observed in three-cut non-fertilized plots (31.0), whilst the lowest was in two-late-cut swards receiving highest fertilization rates (26.1). Hejcman *et al*. (2007) reported on higher species richness in swards without nitrogen and phosphorus fertilization and pointed out that there was a clear trend towards a decrease of species richness with increased actual sward height. Data from the long-term Park Grass experiment clearly showed a negative effect of biomass yields on species richness (Silvertown *et al*., 2006). Also, according Tilman (1987), addition of nitrogen significantly influences an increase of biomass and plant height, which leads to decrease in species diversity. When comparing cutting pattern treatments, species richness increased together with harvest intensity from 27.2 species (C2L) to 29.6 (C4). Maximal numbers of species were always found in four-cut plots except the case mentioned above. Low numbers were detected within two-cut management, especially in late date of harvest in combination with high rates of fertilization.

Table 1: Mean values of evaluated parameter (S = number of species)

Factor	Level	S	Factor	Level	S
	0	29,4		C4	29,6
	PK	28,7		C3	29,1
Fertilization level	N90PK	28,0	Cutting pattern	C2E	28,0
	N180PK	27,8		C2L	27,2
	p-value	<0,01		p-value	<0,01

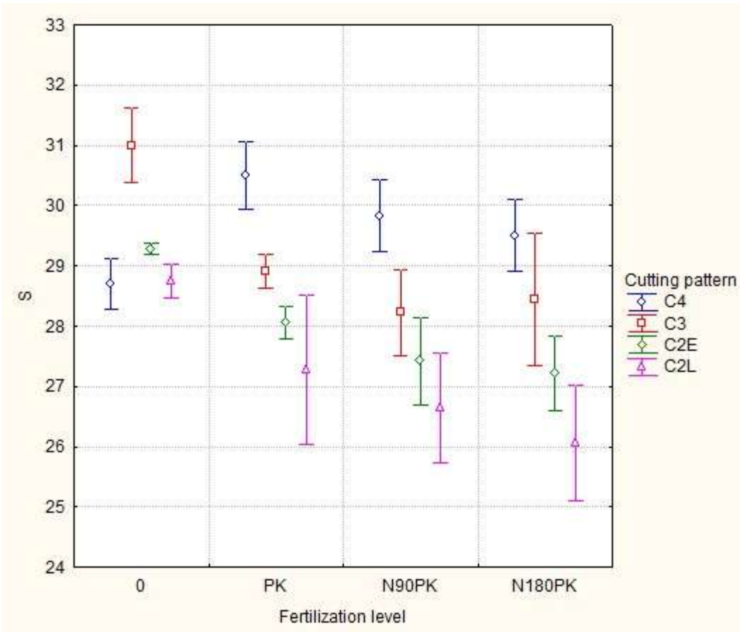

Fig. 1: Species richness (S) in relation to cutting pattern and fertilization level interaction (error bars represent standard error)

Conclusion

Cutting pattern significantly affected species diversity of the meadow stand. Numbers of species increased together with harvest intensity. The highest species richness was found in four-cut swards (29.6 averaged over fertilization levels) and it declined towards late double-cut regime (27.2). Fertilization level also caused significant differences in species richness. Species richness decreased along with increasing fertilization rates from 29.4 (no fertilization) to 27.8 (N180PK). The highest values of all diversity indices were detected in non-fertilized plots, while the lowest were in plots receiving N180PK. Number of species was evaluated and found to be significantly affected by both, fertilization level and cutting pattern.

References

Gibson, D. J. 2009. *Grasses and Grassland Ecology*. New York: Oxford University Press, 305 p.

Chytry, M. 2007. *Vegetace České republiky. 1. Travinna a kerickova vegetace*. Praha: Academia, 528 p.

Hejcman, M., M. Klaudisova, J. Schellberg and D. Honsova. 2007. The Range grassland experiment: plant species composition after 64 years of fertilizer application. *Agriculture, Ecosystems and Environment*, 122 (2): 259–266.

Silvertown, J., P. Poulton, E. Johnston, G. Edwards, M. Heard and P. Biss. 2006. The Park Grass Experiment 1856–2006: its contribution to ecology. *Journal of Ecology*, 94 (4): 801–814.

Tilman, D. 1987. Secondary succession and the pattern of plant dominance along experimental nitrogen gradients. *Ecological Monographs*, 57: 189–214.

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