THE CHANGES IN STAND COMPOSITION IN RENEWED GRASSLAND AFTER 20 YEARS

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ABSTRACT

The Grasslands in the Czech Republic cover nearly 1 milion ha and fulfil a range of functions. Grasslands used for animal nutrition usually consist from few species. In order to maintain the grassland quality is necessary a grassland management consisting mainly of fertilization and mowing. When is a grassland quality very low is often inevitable the renewal of grassland. Due to these measures it is possible to obtain the herbage of high forage quality.

The highest representation of grasses was observed in 1992 (92 %). The most represented species from grasses was *Lolium perenne*. In the following years the ratio of grasses was reversed in favour of herbs. The herbs were the most represented in 2012 (52 %). The differences between years 1992 and 2012 in the groups of grasses and other herbs were statistically significant ($P<0.05$). The index of diversity reached the highest values in 2002 in all variants. Absolutely highest value of diversity index was observed in 2002 in the variant with PK (18.8 = very high diversity).

Key words: nitrogen, botanical composition, species richness, Hill's diversity index, agrobotanical groups

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INTRODUCTION

Grasslands are the most widespread cover of the planet right after forests. In the Czech Republic they cover nearly 1 milion ha. In our country they arose as communities substitute to forests and play an unsubstituable role in the animal nutrition. Grasslands are characterized by high value of diversity which is also reflected in other functions (Gibson D.J. 2008). Besides the primary function of production the grasslands fulfil a number of non-production functions such as protection of soil, air, water, recreation function and ecological function. Grasslands are very often used for animal nutrition. These grasslands usually consist from few species opposed to meadows filing a benefit function. For this meadows are characterized tall grasses of a high quality. In order to maintain the grassland quality is necessary a grassland management consisting mainly of fertilization and mowing. Failure to appropriate of the grassland management and extension of weed species is often inevitable the renewal of grassland (Kohoutek *et al*. 2007). Due to these measures it is possible to obtain the herbage of high forage quality.

MATERIAL AND METHODS

The simple plot is situated in the cadastre of the village Kameničky and belongs to the protected landscape area of Žďárské vrchy. The trial plot is situated SW with a slope of the gradient of 3 %. Mean annual temperature (1951-2000) is 5.8 °C and mean total annual precipitation amounts is 758.4 mm. Soil type is acidic Luvic Stagnosol on the gneiss diluvium. Soil is loamy sand to loam. The experiment was established in 1992 by using the renewal of grassland. During the renewing wasn't used a chemical treatment of weeds which allowed a rapid onset of native species into renewed grassland. This species were used for renewal: *Festulolium pabulare* (12 kg.ha^{-1}), *Trifolium pratense* (3 kg.ha^{-1}), *Trifolium repens* (2 kg.ha^{-1}), *Lolium perenne* (8 kg.ha^{-1}) and *Dactylis glomerata* (4 kg.ha^{-1}). The experiment was established by the using the method of split compartments in four repetitions. Each plot is sized 15 m^2 (1.5m × 10m). The studied factor was fertilization with levels: no fertilization, PK fertilization, N90+PK fertilization and N180+PK fertilization. For comparing were selected years 1992, 2002 and 2012 of three cuts stand. Nitrogen was supplied in the form of ammonium nitrate with limestone at a total dose of 90 kg.ha^{-1} and 180 kg.ha^{-1}. This dose was divided into three parts and applied in three terms (1/3 in spring, 1/3 after 1st cut and 1/3 after 2nd cut). Potassic and phosphoric fertilizers were applied in spring. Phosphorus was applied in the form of Hyperkorn at a dose of 30 kg.ha^{-1} and potassium was applied in the form of potassium salt at a dose of 60 kg.ha^{-1}. The stands were harvested at three terms (early June, early August and early October).

Assessed characteristics included the share of individual agro-botanical groups in the 1st cut forage, Hill's diversity index, number of species and changes in stand composition (ZPS total and of indivudual agrobotanical group). In order to establish the share of individual species or agro-botanical groups in the harvested forage, samples are taken of above-ground biomass from permanently staked plots (0.5 m^2). The samples of above-ground forage biomass were divided into individual species and dried at 60 °C. Subsequently, their weight was ascertained in dry state and the proportions of individual species are expressed as percentages from the total weight of dry forage. Hill's diversity index (Hill M.O. 1973) was calculated according to the formula:

$N_2 = (\sum x_i)^2 / \sum x_i^2$, where N_2 is the index of diversity and x_i proportion of i-th species in the stand

ZPS (Klimeš F. 1994) was calculated according to the formula:

ZPS (%) = 0.5 * Σ $|x_i-y_i|$, where ZPS is the change in stand composition, x_i means the percentage of species in one year (%) and y_i denotes the representation of individual species in the following year

Statistical evaluation was conducted with using the Statistica 6.0 CZ programme by multi-factorial analysis of variance (ANOVA) and by Tukey test.

RESULT AND DISCUSSION

The biggest change in the stand composition (ZPS) was found between 1992-2002 in the unfertilized variant (83.5 %) and variant with N90 (85.2 %). The changes in the stand composition in this period were greater in comparison with the period 2002-2012 (Tab. 1). These high changes in ZPS were caused by an air raid of species from surrounding areas to the initially sown sward consisting of five species. If we compare the ZPS of the individual agrobotanical groups we find that the largest change in ZPS was in the group of grasses in the period of 1992-2002 in an unfertilized variant (Tab. 1). The difference in the percentage representation of grasses in 1992 was statistically significant ($P<0.05$) when compared with other years (Tab. 2). High different in ZPS was also found in the group of herbs in the same period and variant. The table 2 shows that while the proportion of grasses in 1992 was the highest of all groups in the following years the ratio was reversed in favour of herbs, this difference was statistically significant ($P<0.05$). Skládanka, Hrabě and Macháčková (2006) mention that the annual change in the stand composition is in the range of 30-60 %. The last studied group were clovers, in this group was the highest ZPS observed between years 2002-2012 in the variant with PK. The positive effect of PK fertilizers on the abundance of clovers was also observed by Jančovič *et al.* (1999). The highest proportion of clovers was observed in 2012 (8.2 %), this difference was statistically significant ($P<0.05$) when compared with other years (tab. 2).

Differences were also found between representation of the agrobotanical groups in the particular variants. The highest proportion of grasses was found in the variants with additional nitrogen (tab. 2). The difference between unfertilized variant and variant with N180 was statistically significant ($P<0.05$). The group of herbs exhibited an opposite trend where their representation with increasing doses of fertilizers decreased from 54.2% for unfertilized variants to 28.6% for the variant with N180 the difference was statistically significant ($P<0.05$). Ostrčilová *et al.* (2010) mention the fact that the representation of legumes and herbs are influenced by the dominance of grasses.

ZPS total	non fertilization	PK	N90+PK	N180+PK	ZPS of the grasses	non fertilization	PK	N90+PK	N180+PK
1992-2002	83,5	66,2	85,2	75,1	1992-2002	29,2	21,7	20,2	16,1
2002-2012	51,2	55,4	60,6	52,1	2002-2012	4,5	1,9	5,1	5,6
ZPS of the clovers					ZPS of the other herbs				
1992-2002	0,9	3,4	0,1	0,5	1992-2002	28,3	18,4	20,3	16,6
2002-2012	1,3	7,9	3,8	0,4	2002-2012	5,8	6	1,4	5,3

Table 1: The changes in stand composition in individual variants and years, total and in individual agrobotanical groups

The clovers was the most represented in the variant with PK (9.8 %), the differences between this variant and unfertilized variant was statistically significant ($P<0.05$). The positive effect of PK fertilizer to increase the proportion of legumes was demonstrated by Mrkvička and Veselá (2002).

Year/variant	Grasses	Clovers	Other herbs
1992	92[a]	1,0[a]	7,1[a]
2002	48,3[b]	2,8[a]	48,8[b]
2012	39,8[b]	8,2[b]	52,0[b]
non fertilization	44,3[a]	1,6[a]	54,2[a]
PK	58,3[ab]	9,8[b]	31,9[b]
N90+PK	66,8[b]	3,9[ab]	29,3[b]
N180+PK	70,7[b]	0,7[a]	28,6[b]

Table 2: Shares [%] of agro-botanical groups in the individual experimental variants and in individual years, average values in the same columns with different upper indices are statistically significant at a level of P<0.05

The highest value of diversity was found in variants with additional PK in 2002 with value of 18.8 this value corresponding to a very high diversity. In this variant was found 39 different species. Overall, in this year was found the highest value of diversity in all variants when compared with other years (tab. 3). The lowest value of diversity index was observed in 1992 when the stand was founded by planting from five species. In this year were the numbers of species from 10 in variant with N90 to 15 in variant with PK. The low values of diversity index were caused by a high representation of grasses particularly due to the high proportion of *Lolium perenne* hindered the development of other species. To the rapid development of the species in the renewed stand also contributed the absence of chemical measure. In year of 2012 there was a stabilization of the species composition and the diversity index varied from 3.4 in unfertilized variant to the 8.8 in the variant fertilized with N90.

Index of diversity					The numbers of species				
	non fertilization	PK	N90+PK	N180+PK		non fertilization	PK	N90+PK	N180+PK
1992	3,2	5,1	2,6	2,3	1992	13	15	10	14
2002	13	18,8	13,5	10,1	2002	37	39	34	29
2012	3,4	8,5	8,8	5,6	2012	24	27	26	22

Table 3: Hill's diversity index and numbers of individual species

CONCLUSIONS

The highest change in stand composition was noted between years 1992-2002 in the variant unfertilized (83.5 %) and variant fertilized with N90 (85.2 %). In this period were observed the highest changes in stand composition in the unfertilized variants in the agrobotanical group of grasses (29.2 %) and other herbs (28.3 %). These high changes were caused by high proportion of *Lolium perenne* in 1992. This species is characterized by a rapid development in the stand on the other hand it is species very sensitive to the frost so there were a decline in its representation and expansion of herbs. Those two things caused the high value of ZPS. In agrobotanical group of clovers was observed the highest change in stand composition (7.9 %) in the period 2002-2012 in the variant with PK. The highest representation of grasses was in 1992 (92 %) the differences was statistically significant (P<0.05). In the following years the ratio of grasses was reversed in favour of herbs. The clovers were represented the most in the variant with PK (9.8 %) the differences was

statistically significant (P<0.05). The highest species diversity was achieved in 2002. In this year was also observed the highest number of species in all variants.

REFERENCES

GIBSON, D. J., 2008: *Grasses and Grassland Ecology*. Oxford, 322 s. ISBN 0191546097

HILL, M.O., 1973: Reciprocal Averaging: An Eigenvector Method of Ordination. *Journal of Ecology*, roč. 63, s. 597-613.

KLIMEŠ, F., 1994: Ekologické a ekonomické aspekty uplatnění dočasných travních porostů. *Metodika, UZPI*, Praha (2): 36 s.

KOHOUTEK, A., ODSTRČILOVÁ, V., NERUŠIL, P., KOMÁREK, P., 2007: Obnova trvalých travních porostů v LFA, Výzkumný ústav rostlinné výroby, Praha, 24 s.

JANČOVIČ, J., HOLÚBEK, R., ŠANTRŮČEK, J., 1999. Botanical and production changes of permanent grassland after cessation of mineral fertilization. In Rostlinná výroba, roč. 45, s. 3-27.

MRKVIČKA, J., VESELÁ, M., 2002: Influence of Fertilization Rates on Species Composition, Duality and Yields of the Meadow Fodder. In: Rostlinná výroba, roč. 48, s. 494-498.

ODSTRČILOVÁ, V., KOHOUTEK, A., KOMÁREK, P., NERUŠIL, P., 2010: Vliv frekvence sečení a úrovně hnojení na botanické složení trvalého travního porostu na fluvizemě glejové na Malé Hané v průměru roků 2003-2009 In Kvalita píce z travních porostů a chov skotu v měnících se ekonomických podmínkách, Kunín, s. 107-118

SKLÁDANKA, J., HRABĚ, F., MACHÁČKOVÁ, H., 2006: Vliv hnojení a povětrnostních podmínek na změny druhové skladby travního porostu asociace Sanguisorba-festucetum comutatae. Acta univezsitatas agriculturae at silvicurturae Mendelianae Brunensis, č.4, s. 61-69.