CHANGES IN GRASS PHYTOCENOSIS AFTER TEMPORARY CESSATION AND REPEATED FERTILIZATION OF STANDS

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Field trials were conducted to study the effect of fertilization, its absence and effect of repeated fertilization on floristic composition and production of dry matter of permanent grasslands. Diversified grass community is changed during eight years of fertilization by gradated nitrogen rates into grassland with 73 to 84% share of grasses. Phosphorus-potassium fertilization supports the development of dicotyledonous species and share of grasses is falling. After three-year cessation of fertilization unfertilized stand is typical by almost 50% share of dicotyledonous species, grass species (*Festuca pratensis* Huds., *Festuca rubra* L.) are disappearing and moss (20%) is spread in the stand. In the stand fertilized before cessation with PK-fertilizers the share of leguminous crops is significantly falling (by 24%), and the representation of the other meadow herbs and grasses is increasing. Absence of fertilization affects minimally the stand with 240 kg $N.ha^{-1}$, though the stand is thicker due to reduction of representation of grasses (by 80%) and the other herbs (by 3.5%). Absence of fertilization affected dry matter production, what manifested particularly in the second and third years of cessation. However, a sharp decrease of dry matter yields was recorded in the year after cessation within 40 and 72%. Absence of fertilization affected negatively the development of productivity, quality and floristic composition of grass phytocenosis. Minimum utilization of grassland starts as late as in the second year after cessation of the process of secondary succession. Repeated fertilization and regular utilization can damp this process and grassland can be revitalized.

permanent grassland; floristic composition; dry matter production; cessation of mineral fertilization, repeated fertilization of grassland

INTRODUCTION

Fertilization increases production capacity of permanent grasslands, but on the other side its biodiversity is falling. One of the potential prerequisites of regeneration of biodiversity is absence of mineral fertilization (Ollf, Bakker, 1991; Gáborčík, 1997; Mrkvička et al., 1997) with minimising of the other anthropogenic effects, but with such a possibility of cultivation

of grasslands which will preserve their species variability (Jančovič, 1996). In our conditions an attention was paid to the problem of absence of mineral fertilization and effect of its composition on floristic structure and productivity at the end of the 1960s (Lichner et al., 1966) at increase of the utilization of mineral fertilizers and recently when their application fell significantly (Jančovič, 1996; Gáborčík, 1997). There are a few data on repeated fertilization of grasslands after several-year cessation of fertilization or no greater attention was devoted to this problem (Jančovič, Vozár, unpubl.) The contribution wants to point out some problems connected with absence of mineral fertilization of grasslands and their repeated mineral fertilization and utilization.

MATERIAL AND METHODS

Experimental investigations with fertilization of grasslands (1986–1993) after its absence (1994–1996) and repeated fertilization (1997) were performed on permanent grasslands in the region of Strážovské vrchy (geological unit Malá Magura, locality Chvojnica). The territory of concern of the experimental site is situated at the altitude 600 m above sea level, with geographic altitude 48° 53' and longitude 18° 34'. Slope character of the terrain is ranging between 17° and 20°.

The site belongs to the region slightly warm, into subregion slightly arid with dominantly cold winter. According to long-term measurements average annual air temperature reaches here 6.5 °C, 11.1 °C for the growing season. Long-term average of the whole-year sum of precipitation is 848 mm, while it is 431 mm during the growing season. Soil-forming substrate of the site is geest of Jurassic schists with inserts of marls, on which acid cambisol was formed. Permanent grassland was identified as association of *Lolio-Cynosuretum* R.Tx 1937 in view of phytocenology.

Original variants of fertilization and rates of nitrogen are presented in Table I. Phosphorus and potassium fertilization was constant and determined at 30 kg $P.ha^{-1}$ and 70 kg $K.ha^{-1}$ annually.

The trial was established in four replications, area of harvest plot was 10 m^2. In the years 1986 to 1989 all variants were utilized in four cuts and in the years 1990 to 1993 differentially according to fertilization variants (2–3 cuts). During the years 1994 to 1996 fertilization was omitted and only one cut was used based on the methodology after Rychnovská et al. (1987) in the time of maximum biomass production (end of June). In 1997 after three-year cessation of fertilization, mineral fertilization (Table I) was again repeated as before cessation and the stand was utilized in three cuts. In autumn period of 1996 1 t $CaCO_3.ha^{-1}$ was applied to all variants fertilized

I. Variants and rates of nitrogen ($kg.ha^{-1}$)

Variant	Nitrogen rates in year			
	1st	2nd	3rd	4th
1	–	–	–	–
2	PK	PK	PK	PK
3	PK + 60 N	PK + 60 N	PK + 60 N	PK + 60 N
4	PK + 120 N	PK + 120 N	PK + 120 N	PK + 120 N
5	PK + 240 N	PK + 240 N	PK + 240 N	PK + 240 N

before to reduce the soil reaction, which lowered according to the different variants for the period of previous fertilization and its breaking within the range 0.3 to 0.8 pH. Botanical analysis was performed by the method of projective dominance before each utilization to find the changes in floristic composition of the stand in different variants (Regal, 1956). Agrochemical properties of the experimental site for stand establishment are given in Table II.

RESULTS AND DISCUSSION

As to phytocenology grasslands can be characterized as certain fragments of associations where anthropogenic factor is significantly applied (Holúbek, 1991; Jančovič, Holúbek, 1993; Jančovič, 1996).

The studied grass community before fertilization was floristically varied, with dominance of grass species (73%) where the other meadow herbs formed 25% share and leguminous crops were presented by 2%. Already in the first year of fertilization and utilization representation of different floristic groups changed (Fig. 1), mainly in variants with gradated nitrogen nutrition. Phos-

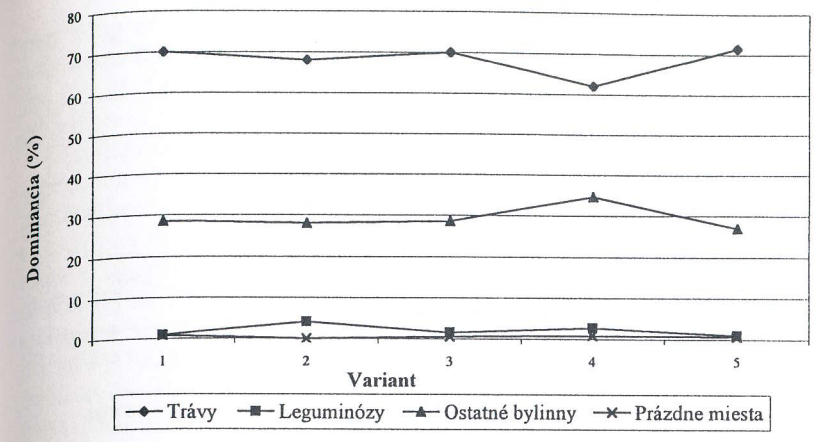
II. Agrochemical properties of experimental site

Depth of soil sampling (mm)	pH_{KCl}	C_{ox} ($g.kg^{-1}$)	N_t ($g.kg^{-1}$)	P	K	Mg	Ca	Sum of exchangeable basis cations ($mmol.kg^{-1}$)	Sorptive capacity ($mmol.kg^{-1}$)	Degree of sorptive saturation (%)
				$mg.kg^{-1}$						
0–100	4.6	36.0	4.0	15.7	66.0	113.7	850	48.1	138.0	34.1
101–200	4.6	24.0	2.8	4.3	120.0	91.9	750	44.8	133.0	33.7

phorus-potassium fertilization applied in the initial year of the trial without nitrogen emphasised herbal character of the stand with distribution of dicotyledonous herbs (*Leontodon autumnalis* L., *Taraxacum officinale* L., *Alchemilla vulgaris* L., *Plantago lanceolata* L., *Achillea millefolium* L., *Trifolium pratense* L., *Trifoloium repens* L., *Lotus corniculatus* L. and *Vicia cracca* L.).

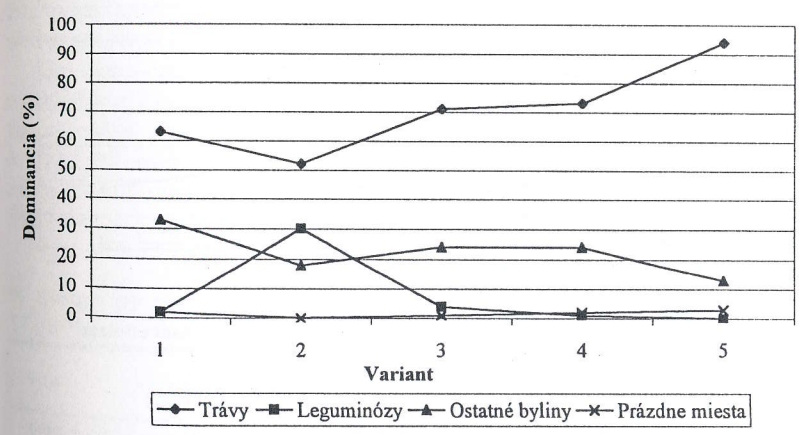
After eight years of mineral nutrition (Fig. 2) the share of grasses increased, except variants 1 and 2, what is known from studies of many authors (Krajčovič et al., 1968; Lichner, 1972; Folkman, 1985; Holúbek, 1991 and others). Only in the variant with 60 kg $N.ha^{-1}$ even after this period floristic composition similar to the first year of fertilization is preserved, but with slightly higher representation of leguminous plants (by 2.5%) and decrease of other herbs (by 4%).

After three-year elimination (1994 to 1996) of fertilization representation of floristic groups in all studied variants (Fig. 3). Unfertilized stand is after absence of fertilization characteristic by almost 50% representation of dicotyledonous species with dominance of *Leontodon autumnalis* L. (25%), *Alchemilla vulgaris* L. (7%) and *Achillea millefolium* L. (2.25%). Recess of *Festuca rubra* L. (from 26 to 9%) and particularly *Festuca pratensis* Huds. (from 17 to 2.5%) is reported. The share of *Anthoxanthum odoratum* L. (7%) and *Nardus strictas* L. (9%) is increasing. More than 30% decrease of grass species reflected in relatively high proportion of blank places (20%) with distribution of moss (*Polytrichum commune* HDW.), which modifies the moisture regime and suppresses mainly grasses by its aggression. In the variant with phosphorus-potassium nutrition the proportion of leguminous plants fell significantly (by 24%), previously affected by mineral nutrition, but according to Rabotnov (1974) also by periodicity of their occurrence. Such anthropogenically increased proportion of leguminous plants on originally oligotrophic sites is not a stable character, because their higher presence after elimination of fertilization is dependent on gradual withdrawal of applied nutrients (PK) and competitive relationships about these nutrients with wide-leaved herbs and aggressive grasses in the stand. In variants fertilized before with gradated nitrogen rate (variants 3 and 4) the proportion of grass species fell by 12% during three years of elimination and representation of leguminous plants and other meadow herbs increased. The cessation of fertilization affected at least the floristic composition in the variant with 240 kg $N.ha^{-1}$, though also here the proportion of grasses fell by 8% and proportion of other herbs by 2.5% and totally the stand was thinned (13.5% of blank places). In grass phytocenosis priority belongs to low grass species less demanding for nitrogen (*Festuca rubra* L., *Agrostis tenuis* Sibth., *Anthoxanthum odoratum* L., *Poa pratensis* L.). The proportion of the other meadow herbs is low and occurs according to different species from 0.25% to 2.5%.



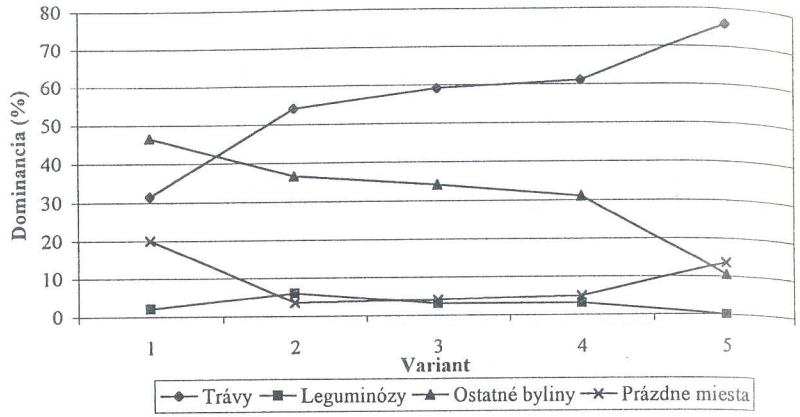
1. Representation and structure after the first year of fertilization (1986)

For Figs. 1–4: Dominancia = dominance, Trávy = grasses, Leguminózy = leguminous plants, Ostatné byliny = the other herbs, Prázdne miesta = blank places

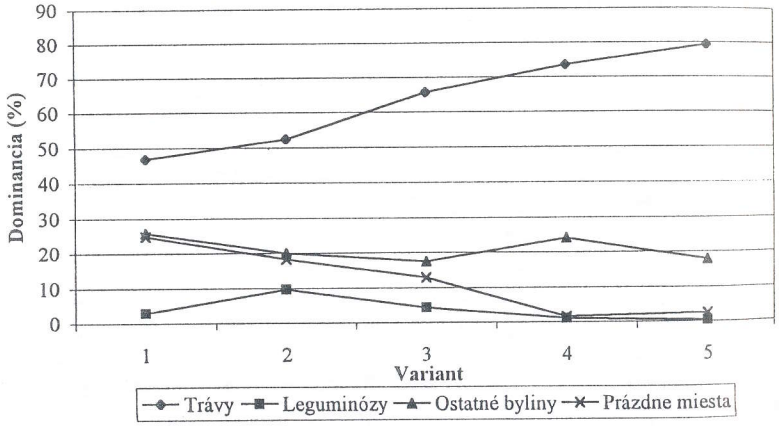


2. Representation and structure of the stand after long-term fertilization (1993)

After the period of absence of fertilization repeated fertilization (Fig. 4), mainly by gradated nitrogen (variants 3, 4, 5) increases the proportion of grasses and representation of the other meadow herbs is falling. Leguminous



3. Representation and structure of the stand after absence of fertilization (1996)



4. Representation and structure of the stand after repeated fertilization (1997)

plants are revitalizing in all variants and even at the rate of 240 kg $N.ha^{-1}$ they appear in the stand. On the contrary, in the variant with PK-fertilization the falling proportion of grasses and the other herbs, but representation of leguminous plants increased (by 3.6%) and the proportion of blank places rose almost five times (18.2%). In the control variant without fertilization the

proportion of grasses increased by more than 15%, leguminous plants (by 0.8%) and blank places (by 4.7%), while representation of the other herbs fell (by 20.8%), which did not stay increased pressure of more intensive utilization of the stand.

Cessation of mineral fertilization of the grassland after previous eight-year application of fertilizers reflected also in dry matter production (Table III). The last year of the trial (1993) with long-term drought was specific and it affected the development of yields in the period after elimination of fertilization (rainfall during the growing season reached only 308 mm, what is 36% of many year's average. In the first year of absence of fertilization (1994) increase of dry matter yields in all variants, starting from unfertilized control (by 96%), PK-fertilization (by 75%) and also variants with gradated nitrogen fertilization (on average by 54%) was recorded. In the second year of cessation (1995) decrease in dry matter yields was reported in all variants, except variants 1, 2 and 3, when dry matter production increased a sharp reduction of dry matter production in all variants, but particularly on unfertilized control (reduction by 71% compared with 1995). In the other fertilized variants dry matter production fell from 40% to 58% compared with 1995.

It is evident from the results obtained that cessation of application of mineral nutrients induces a lot of changes in permanent grassland. After three-year application floristic structure changes significantly, what affects also production and distribution of dry matter in the stand.

After three-year absence grassland started to adapt to mineral nutrition by repeated fertilization (Table IV), but also increase of frequency of utilization was recorded. However, generally low yields were reached on untreated control and PK-variant. There is only minimum difference in the sum of cuts compared with the first cut of initial year of the trial (1986), what was caused also by high proportion of blank places in the stand (18.2–24.7%).

III. Average dry matter yields after long-term fertilization, after its cessation and repeated fertilization ($t.ha^{-1}$)

Year	Sequence of cut	Variants				
		1	2	3	4	5
1986, beginning of fertilization	first cut	0.86	1.26	1.80	1.92	2.03
1993, cessation of fertilization	first cut	0.05	0.24	0.52	0.71	0.81
1994, absence of fertilization	one cut	0.48	0.95	1.10	1.62	1.76
1995, absence of fertilization	one cut	0.85	1.33	1.21	1.26	1.30
1996, absence of fertilization	one cut	0.25	0.56	0.64	0.76	0.71
1997, repeated fertilization	three cuts	0.97	1.49	3.03	3.82	4.95

IV. Dry matter yields (t.ha^{-1}) after repeated fertilization (1997)

Cuts	Variants				
	1	2	3	4	5
1st	0.38	0.45	1.30	1.75	1.42
2nd	0.25	0.47	0.86	1.18	1.87
3rd	0.34	0.57	0.87	0.89	1.66
Total	0.97	1.49	3.03	3.82	4.95

V. The effect of studied factors on dry matter production (two-factor variance analysis)

Factor	df	*F*	*P*
Year	5	35.96	++
Variant	4	6.00	++
Residue	36		

df – degree of freedom; *F* – calculated *F* value; *P* – significance

Gradated nitrogen fertilization after repeated fertilization (60 kg N > 120 kg N > 240 kg N) resulted in adequate increase of dry matter yield, but with different oscillation according to the split of nitrogen to different cuts. Maximum dry matter yield was obtained in the first cut in the variant with the lowest nitrogen rate, while the second and third cuts, without nitrogen addition, was recorded also in the variant with 120 kg N.ha^{-1}, where the third cut reaches only 51% of the first cut. Maximum production of dry matter was in the variant with 240 kg N.ha^{-1} with highest yields in the second (1.87 t.ha^{-1}) and third (1.66 t.ha^{-1}) cuts, which had the most favourable moisture regime, what resulted in better utilization of applied nitrogen. The basic statistic evaluation of the effect of investigated factors on dry matter production is given in Table V, from which follows highly significant difference between variants and dry matter production.

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JANČOVIČ, J. – VOZÁR, Ľ. (Slovenská poľnohospodárska univerzita, Nitra, Slovenská republika):

Zmeny v trávnej fytocenóze po dočasnom prerušení a opätovnom hnojení porastov.

Scientia Agric. Bohem., *30*, 1999: 149–158.

Cieľom experimentu bolo posúdiť vplyv minerálneho hnojenia, jeho absenciu a zaradenie opätovného hnojenia na floristicko-produkčné zmeny poloprírodného trávneho porastu.

Pokus bol založený na poloprírodnom poraste identifikovanom fytocenologicky ako zväz *Cynosurion* R.Tx. 1937, asociácia *Lolio-Cynosuretum typicum*, Jurko 1974. V období rokov 1986–1993 boli porasty hnojené stupňovaným N-hnojením (tab. II)

a využívané 3 až 4 kosbami; v rokoch 1994–1996 sa hnojenie prerušilo a realizovala sa iba jedna kosba, vychádzajúca z metodiky autorov Rychnovská et al. (1987), v termíne maximálnej tvorby biomasy (koniec júna). Po troch rokoch prerušovaného hnojenia sme v roku 1997 zaradili opätovné hnojenie, ktoré bolo aplikované pred obdobím prerušenia. Porasty sa využívali tromi kosbami v senokosnej zrelosti. Floristický rozbor sa realizoval pred každou kosbou metódou redukovanej projektívnej dominancie (Regal, 1956). Výsledky vplyvu sledovaných faktorov na produkciu sušiny boli vyhodnotené dvojfaktorovou analýzou rozptylu.

Pestré trávne spoločenstvo sa počas ôsmich rokov hnojenia stupňovaním dávky dusíka mení na trávny porast so 73% až 84% podielom tráv. Fosforečno-draselné hnojenie podporuje rozvoj dvojklíčnolistových druhov a podiel tráv klesá. Po trojročnom prerušení hnojenia je nehnojený porast charakteristický takmer 50% podielom dvojklíčnolistových druhov, ustupujú trávne druhy (*Festuca pratensis* Huds., *Festuca rubra* L.) a v poraste sa rozširuje mach (20 %). V poraste hnojenom pred prerušením PK-hnojivami výrazne klesá podiel leguminóz (o 24 %) a zvyšuje sa pokryvnosť ostatných lúčnych bylín a tráv. Prerušenie hnojenia minimálne ovplyvnilo porast s 240 kg $N.ha^{-1}$, i keď znížením pokryvnosti tráv (o 80 %) a ostatných bylín (o 3,5 %) sa porast preriedil. Absencia hnojenia ovplyvnila produkciu sušiny, čo sa prejavilo zvlášť v druhom a treťom roku prerušenia. Prudké zníženie úrod sušiny sa však zaznamenalo v roku po prerušení v rozpätí od 40 do 72 %.

Absencia hnojenia negatívne ovplyvňuje vývoj produktivity, kvalitu a floristickú skladbu trávnej fytocenózy. Minimálnym využitím trávneho porastu začína už v druhom roku po prerušení procesu sekundárnej sukcesie. Opätovným hnojením a pravidelným využívaním možno tento proces utlmiť a trávny porast revitalizovať.

trvalý trávny porast; floristické zloženie; produkcia sušiny; prerušenie minerálneho hnojenia; opätovné hnojenie trávneho porastu

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