Influence of different intensity grassland utilization on lysimetric water quality in North Moravia Region

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Abstract

This paper disserts on influence estimation of different grassland load with simulated cattle grazing on underground (lysimetric) water quality and potential environmental risk. Tracked period was from 1st October 2004 to 11th January 2007. During estimated period we took seventeen samplings. At percolate we have observed the content of $N\text{-}NH_4^+$, $N\text{-}NO_3^-$, $N\text{-}NO_2^-$, total P, Ca, SO_4^{-II} and pH. On basis of lysimetric water volume and concentrations of particular forms of inorganic nitrogen we have revealed year leaching of this nutrient from one hectare. We found not differences in phosphor concentration in percolate among different stocking rate during estimated years in our conditions. The higher nitrate nitrogen contents in percolate were in winter and spring period. We quantified the annual leaching of mineral nitrogen on the level 4.21 $kg.ha^{-1}.year^{-1}$ in treatment with the load of 0.9 $LU.ha^{-1}$, 5.15 $kg.ha^{-1}.year^{-1}$ in treatment with the load of 1.4 $LU.ha^{-1}$, and 5.35 $kg.ha^{-1}.year^{-1}$ in treatment with the load of 2 $LU.ha^{-1}$.

Introduction

The grazing and cutting of grassland is more important and traditional agricultural practice in less favourable areas (LFA). The permanent grasslands are very important and precious part of landscape in all countries of Europe. In the Czech Republic the grasslands form fourth part from acreage of agricultural land with average year production 2500-2800 thousand t DM. At the present time is in the Czech Republic high contribution of arable land (72.4%) and consequently is probable to expect the increase of grassland acreage. With this increase is concerted the choice of sustainable management. The optimal fertilization of grassland is one of principal rationalizing measures, enabling realization of production potential of grassland and preserving the out production functions (KRAJCOVIC, 1997).

Lysimeter studies are viewed as a way to explain better biogeochemical phenomena occurring in the soil and, therefore to explain potential causes of nutrient leaching under different agricultural systems.

The fertilizers are principal means of production in crop production and these are closely compacted with farming in soil. These influence of nutrients acceptability and intensity of biological process in soil. The typical characteristic of fertilizers is, that affect (directly and indirectly) on grow and development of plants, on amount and quality of yield. The animal manures are regarded in arable land, but also in grassland, as fundamental. The using of animal manure has particular importance in LFA, whe-

Table 1: **Agrochemical soil proprieties**

Diagnostic horizon	pH_{KCl}	CEC [mmol(p+) .kg-1]	C_{org} [%]	Ratio C:N	P [mg.kg-1]	K [mg.kg-1]	Ca [mg.kg-1]	Mg [mg.kg-1]
Am	4.63	141	1.34	10.0	53	109	1799	124
Bv	4.60	130	0.73	9.5	78	62	1442	97
Bv/Cc	4.41	139	0.33	8.4	27	53	1753	131
Cc	4.44	151	0.19	10.5	29	45	1875	166

Table 2: **The precipitation and temperature in Rapotin during evaluated season**

Year	Month	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
2004	Precipitation [mm]	96.9	31.8	11.9	34.3	20.9	65.4	51.5	59.3	41.0	49.8	114.1	40.9
	Temperature [°C]	-9.7	-1.4	2.2	8.93	11.6	15.4	16.93	17.5	12.1	9.4	3.43	1.1
2005	Precipitation [mm]	90.0	45.0	27.5	23.5	76.0	50.0	78.0	69.0	19.0	56	120	74.6
	Temperature [°C]	-1.3	-4.5	-0.7	8.9	12.7	15.6	18.3	15.7	13.4	4.9	3.1	-1.7
2006	Precipitation [mm]	36.1	63.7	62.7	62.2	63.5	78.1	52.0	110.0	7.2	24.5	19.1	35.2
	Temperature [°C]	-8.4	-2.6	-1.8	9.3	12.8	17.0	20.5	15.2	14.5	10.1	8.5	5.1

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re is the low substitution of arable land and the high contribution of grassland. Therefore in these areas the using of animal manure and grazing is in interest of nutrient cycle conservation (HOLUBEK et al., 2001). Permanent support of organic matter can influence the conversion and content of mineral nitrogen in the rhizosphere and the subsequent leaching of NO_3^-. Present results document differences in the concentration of NO_3^- and NH_4^+ in the top soil layer under unfertilised grasslands and in lysimetric waters. A higher concentration is interrelated with more fertile soil and a higher proportion of clover crops, concentration decreases with depth (SVOBODA et al., 2004). There are also differences in the method of farming (FIALA, 2004). SVOBODOVA and SANTRUCEK (2004), however, did not discover large differences in topsoil under grasslands.

The aim of this work was to evaluate the soil leaching of mineral nitrogen, sulphate and phosphorus by different stock rate of pasture in condition of Hruby Jesenik.

Material and method

The experiment was founded in 2004 on RICB Rapotin holdings. The locality is situated in 390-402 m above sea level and it comes under the geomorphologic division Hruby Jesenik (northwest of Moravia). Geomorphologic sub grade is deeper diluvium of mica schist. The soil is sandy-loam, type cambisol (horizons Am-Bv-B/C-C). The basic agrochemical soil proprieties are showed in *table 1*. *Table 2* shows the temperature and precipitations during touched season. In the locality is semi natural permanent grassland with these predominant species: *Lolium perenne, Dactilys glomerata, Poa pratensis, Trifolium repens* and *Taraxacum sect. Ruderalia*.

Plots with different pasture load were arranged in a completely randomised block design with four replicate blocks. Plot size was 12.5 m². The plots were not grazed (pasture was simulated), but cut in dependence of grassland load, which was follows:

A - Stocking rate 0.9 LU.ha^{-1} (it corresponded 54 kg.ha^{-1} N and 2 cuts per year)

B - Stocking rate 1.4 LU.ha^{-1} (it corresponded 84 kg.ha^{-1} N and 3 cuts per year)

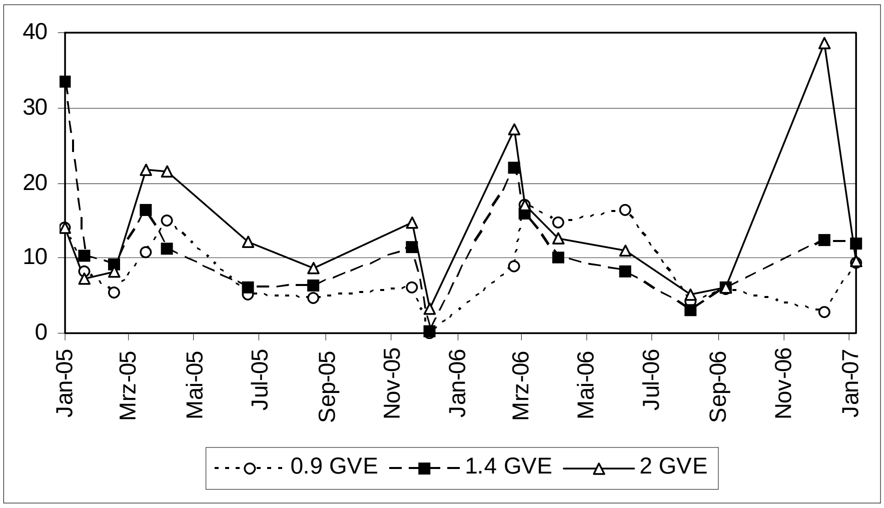

Figure 1: **The nitrate concentrations in percolate during estimated period [mg.l^{-1}]**

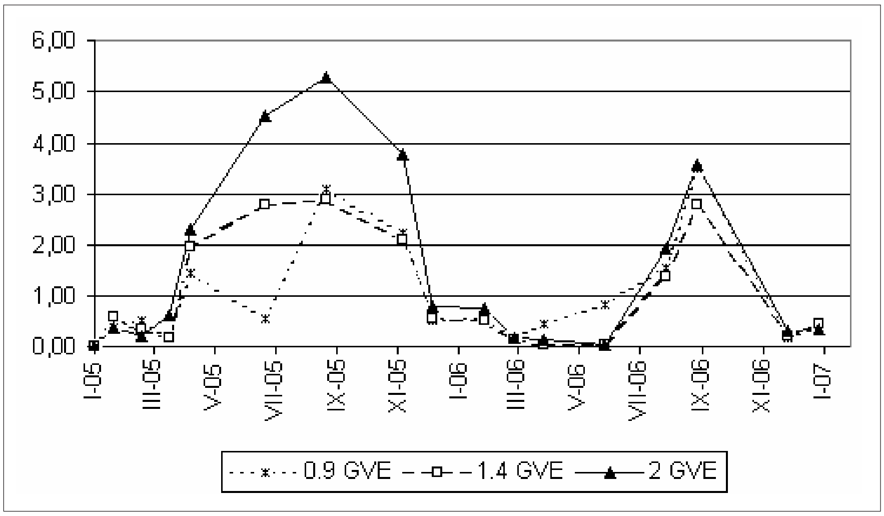

Figure 2: **The ammonia concentrations in percolate during estimated period [mg.l^{-1}]**

Table 3: **The principal indicators of lysimetrics water quality (mean 2005 - 2006)**

Treatment	Percolate l.m^{-2}	N-NO_3^- [mg.l^{-1}]	N-NO_2^- [mg.l^{-1}]	N-NH_4^+ [mg.l^{-1}]	P_{tot} [mg.l^{-1}]	SO_4^- [mg.l^{-1}]	Ca [mg.l^{-1}]	pH
0.9 LU	42.65	8.79	<0.02	0.97	0.16	24.78	37.38	5.96
1.4 LU	41.43	11.41	<0.02	1.00	0.17	17.64	29.15	6.04
2 LU	34.41	14.05	<0.02	1.48	0.16	13.87	31.54	5.91

C - Stocking rate 2 LU.ha^{-1} (it corresponded 120 kg.ha^{-1} N and 4 cuts per year)

The animal manure we have applied in beginning of vegetation and during vegetation after the first cut. After every application we analysed fertilizers and then on basis of nitrogen contents we have counted actual dosage. The lysimeters were at a depth of 0.4 m in an area of 0.25 m^{-2}. We estimated the content of N-NH_4^+, N-NO_3^-, N-NO_2^-, total P, Ca, SO_4^{-II} and pH in percolate.

We processed the acquired data by the statistical program SPSS 13.0 for Windows (ANOVA).

Results and discussion

The primary aim of lysimeter measurements on the base of analyses of percolation water is a monitoring of nutrient movement; especially of nitrogen in soil (CERMAK, KLEMENT, 2005).

The nitrate concentration is very variable in environment during year. The va-

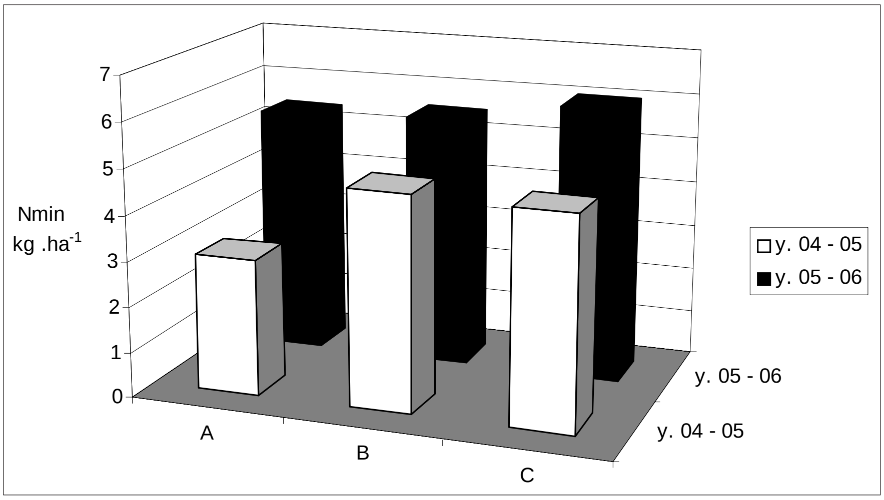

Figure 3: **Leaching of mineral nitrate**

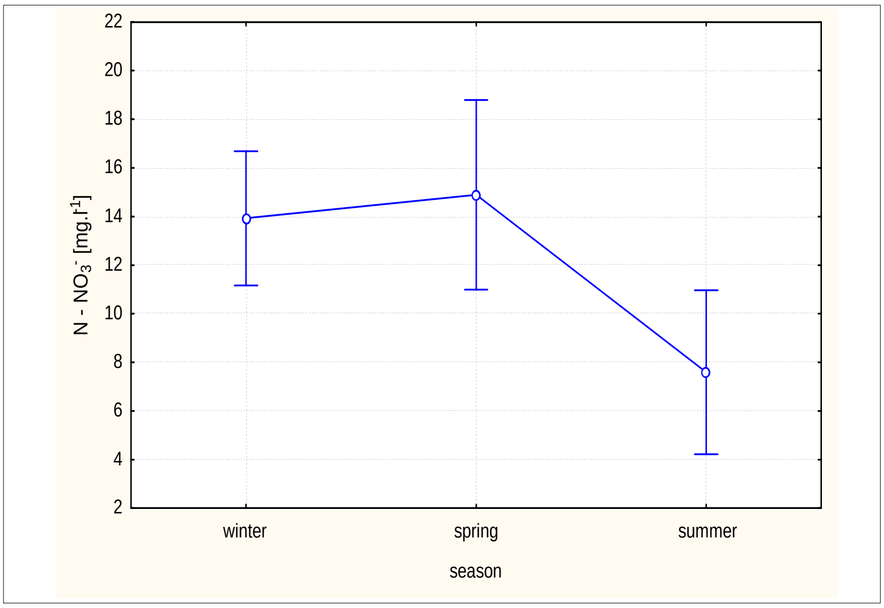

Figure 4: **Concentration of nitrate nitrogen in yearly seasons**

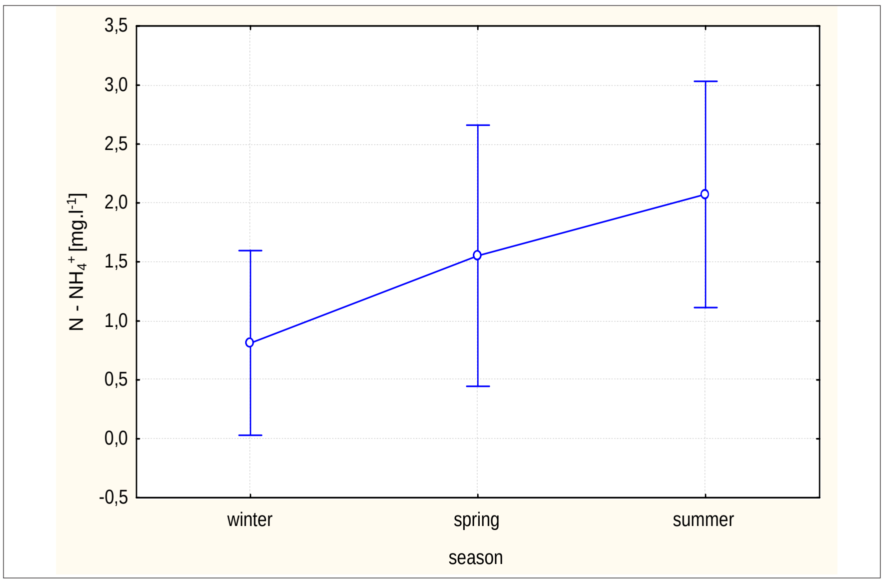

Figure 5: **Concentration of ammonia nitrogen in yearly seasons**

lues of nitrate concentration are in *figure 1*. WESSOLEK et al. (1994) describes nitrate leaching in sandy soils under different cultures. He shows different nitrate concentrations in root zone: in gardening soils 200 - 350 $mg.l^{-1}$, in arable land 120 - 240 $mg.l^{-1}$ and in soil under grassland without fertilization <40 $mg.l^{-1}$. We noticed N-NO_3^- concentrations in relation from 0.10 to 17.19 $mg.l^{-1}$ in treatment with the load of 0.9 $LU.ha^{-1}$, from 0.15 to 33.47 $mg.l^{-1}$ in treatment with the load of 1.4 $LU.ha^{-1}$, and from 3.22 to 38.64 $mg.l^{-1}$ in treatment with the load of 2 $LU.ha^{-1}$. The values of nitrite concentrations are lover as 0.02 $mg.l^{-1}$ during the whole estimated period. The values of ammonia concentrations are variables too (see *figure 2*), but are not statistically significant. ZAVADIL and KVITEK (1997) found, that nitrate leaching is in maximum in winter and spring. The nitrate nitrogen concentration is minimal in percolate during vegetation season. Our results affirmed this establishment ($P<0.05$, see *figure 4*). We could not evaluate the leaching of nutrients in autumn, because the precipitations were very poor during evaluated period.

In the *table 3* are shown the average concentrations of estimated forms of nitrogen, calcium, total phosphorus, sulphate and pH. We found not differences of concentration of total phosphorus among treatments. Our resultants are in concordance with KOPEC (1993) results, but markedly lower as values found by FIALA (2006) and EDER (1991). We can suppose that lower concentrations in our grassland were caused of negative phosphorus balance (RZONCA et al., 2007) and of content of available phosphorus in soil. The correlation between content of available P in soil and total P in percolate was low, but significant ($r = 0.3$, $P<0.05$).

The highest concentration of sulphate was with the load of 0.9 LU (mean 24.78 $mg.l^{-1}$) and the lowest with the load of 2 LU (mean 13.87 $mg.l^{-1}$)

We hold the summa of mineral nitrate soil washing as the most telling indicator of environmental burden, because this value talks about the nitrate discipline with respect of water regime. Our results are shown in *figure 3*.

We can to say the follows partial conclusions on basis of our results:

- We found not differences in phosphor concentration in percolate among different stocking rate during estimated years in our conditions.
- The higher nitrate nitrogen contents in percolate were in winter and spring period.
- We quantified the annual leaching of mineral nitrogen on the level 4.21 $kg.ha^{-1}.year^{-1}$ in treatment with the load of 0.9 $LU.ha^{-1}$, 5.15 $kg.ha^{-1}.year^{-1}$ in treatment with the load of 1.4 $LU.ha^{-1}$, and 5.35 $kg.ha^{-1}.year^{-1}$ in treatment with the load of 2 $LU.ha^{-1}$.

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By authors

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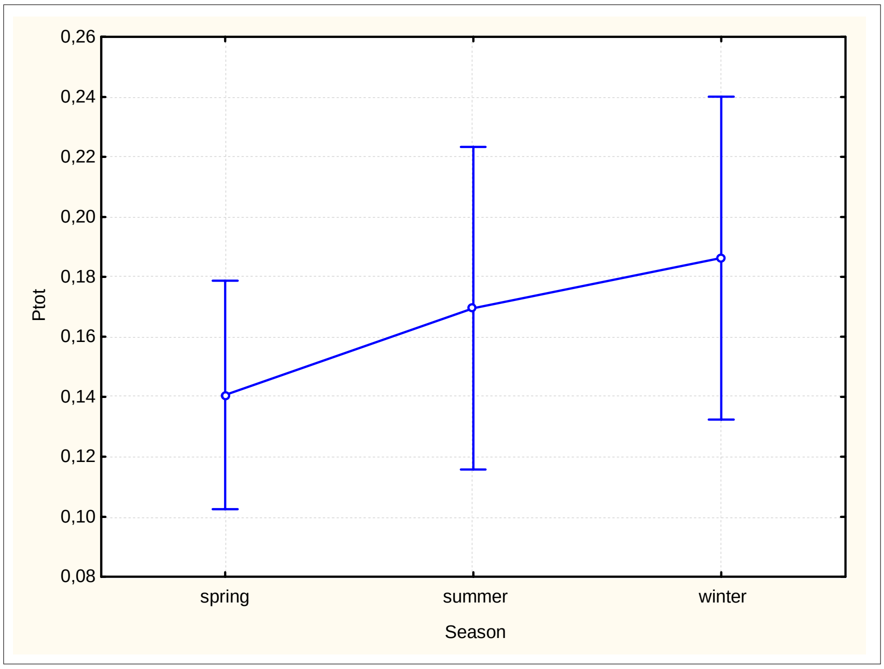

Figure 6: **Concentration of total phosphor [$mg.l^{-1}$] in yearly seasons**