MACROELEMENT, HEAVY METAL AND SELENIUM CONTENT OF GRASS SPECIES AND DICOTYLEDONS

Julianna TASI

Department of Grassland Management, Crop Production Institute, Faculty of Agricultural and Environmental Sciences, Szent István University, Gödöllő, Hungary, e-mail: Tasi.Julianna@mkk.szie.hu

Abstract: Data on the composition of fodder from pastures (grass, meadow-hay) can be frequently found in literature, but data on the element contents of the grass or non-grass species composing natural grasslands are scarce. In order to analyse the element contents of plants, samples were collected over 3 years (1998-2000) from different types of natural grasslands. On non-fertilised grasslands, the dominant species was *Festuca pseudovina*. The dominant species on the fertilised grasslands were *Poa pratensis*, with *Bromus inermis* or *Elymus repens* being dominant at some sites. The results showed that leguminous plants had the highest contents of four of the five macroelements, while the highest level of K was found in dicotyledonous plants. The Na and Ca contents of the plants were higher on non-fertilised grasslands, while the level of all other macroelements was higher in plants from fertilised grasslands. Since the Se contents showed a high dispersion, only a trend was observed, indicating that the Se content of grass species is not significantly lower than that of other grassland plants. On non-fertilised grasslands, grass species contained the most Cr and Pb, while leguminous plants contained the most Cd. In fodder from fertilised grasslands, the highest quantity of Cd and Cr was found in grass species, and the most lead in non-leguminous dicotyledons.

Keywords: grass species, dicotyledons, macroelement content, heavy metal content

Introduction

Data on the composition of fodder from pastures (grass, meadow-hay) can be frequently found in the literature. Analyses have been carried out to compare regions (Köles et al., 1997), or species (Centeri et al., 2007; Kádár, 1995). The effect of fertilisation and changes in the composition of grasslands utilised at different times have also been examined (Bajnok et al, 2000; Magyar et al., 2005; Penksza et al., 2005; Póti et al., 2007; György et al., 2007). The above studies generally refer to sown grass species, or in certain cases to sown dicotyledons (Opitz v. Boberfeld et al., 2006). Data relating to the element contents of the grass or non-grass species composing natural grasslands are either scarce or inadequately summarised.

Materials and methods

To analyse the element contents of plants, samples were collected over 3 years (1998-2000) from different types of natural grasslands. The botanical composition of the sampling sites was determined by Balázs's quadrat method (Balázs, 1949). In 1999 and 2000 the plants in all the green samples were divided into groups of grass species, leguminous species and other dicotyledons. The Cd, Cr, Pb and K, Na, Ca, Mg, P and Se contents of each group were measured using a spectrometer. Soil characteristics are presented by *Table 1*. The sampling sites can be divided into two categories: fertilised and non-fertilised. The non-fertilised grasslands received no mineral fertilisers, and as these sites were under grazed, manure from sheep grazing was of insignificant quantity. In these grasslands, the dominant species was *Festuca pseudovina*. The dominant species in the fertilised grasslands were *Poa pratensis*, though *Bromus inermis* or *Elymus repens* were dominant at some sites.

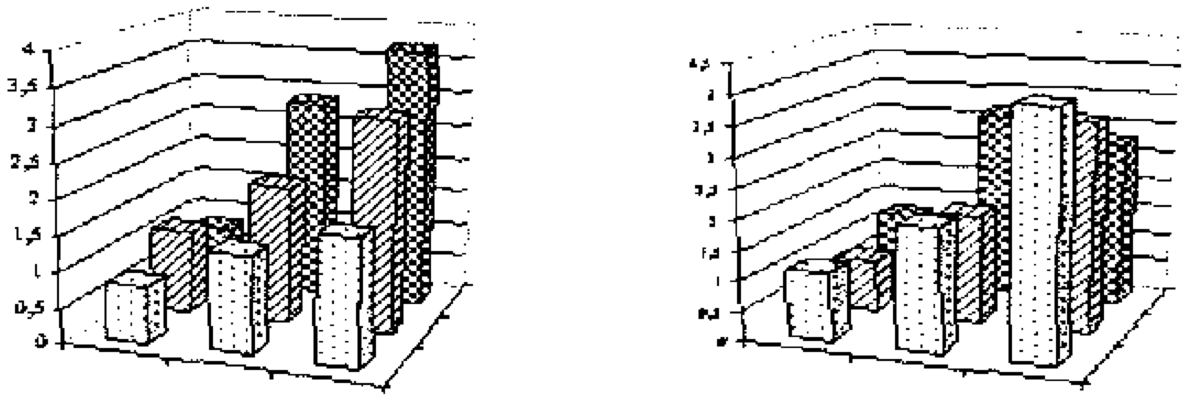
Table 1. Main soil characteristics of the examined fields

Site	Soil layer (cm)	K_A***	pH_{KCl}	Humus (%)	NH_4-N*	NO_3-N*	AL-P_2O_5**	AL-K_2O**	Cd **	Cr **	Pb **
Grasslands with poor nutrient supply, no fertilisation											
Jákot-puszta a	0-20	47	4,2	2,57	0,2	0,2	21,1	115,6	2,6	35,3	15,7
Szendrö a	0-20	46	6,6	2,5	0,3	0,4	18,4	91,3	1,0	17,5	24,0
Törtel a	0-20	44	8,1	1,8	0,3	0,5	391,7	350,7	1,0	23,2	9,4
Mean	*0-20*	*45,6*	*6,3*	*2,3*	*0,3*	*0,3*	*143,7*	*185,9*	*1,5*	*25,3*	*16,3*
Jákot-puszta a	20-40	42	4,2	0,9	0,2	0,1	6,8	86,3	2,8	40,0	13,6
Törtel a	20-40	47	8,7	1,0	0,1	0,4	140,7	307,3	1,0	24,1	5,4
Mean	*20-40*	*44,5*	*6,4*	*0,9*	*0,1*	*0,3*	*73,8*	*196,8*	*1,9*	*32,0*	*9,5*
Grassland with abundant nutrient supply, fertilised											
Jákot-puszta b	0-20	53	5,3	2,5	0,5	1,2	279,8	570,7			
Szendrö b	0-20	45	5,1	2,5	0,7	0,4	14,8	98,4	0,3	31,3	22,1
Mean	*0-20*	*49*	*5,2*	*2,5*	*0,6*	*0,8*	*147,3*	*334,6*			
Jákot-puszta b	20-40		4,9	1,3	0,5	0,2	59,2	314,7			
Szendrö b	20-40								0,1	40,7	20,4

* mg 100 g^{-1}, **mg 1000 g^{-1}, *** upper limit of plasticity

Results and discussion

Figure 1. shows the average heavy metal contents of grass species, leguminous species and other dicotyledons. The data presented here represent the May measurements.



a *b*

Figure 1. Average heavy metal content of fodder (mg kg^{-1}) on non-fertilised (a) and fertilised (b) grasslands

The analysed grasslands showed a high variation in the heavy metal contents of the plant groups. On non-fertilised grasslands the most Cd was found in leguminous plants, while on fertilised grasslands the most Cd was found in grass species. In general, fertilised grasslands contained more Cd. The toxic standard of 0.5 mg kg^{-1} in fodder was exceeded in each plant group, on both types of grassland. Grass species contained the most Cr on both grassland types. The lowest Cr content was found in leguminous plants on fertilised grasslands. Clover species in the fodder from non-fertilised grasslands accumulated more Cr than the other dicotyledons. The Cr content was higher in the total fodder from fertilised grasslands and exceeded an average plant quantity of 1 mg kg^{-1}. The greatest quantity of lead was absorbed by grasses on non-fertilised grasslands, and by non-leguminous dicotyledons on fertilised grasslands. Except for the grass species, the plants on fertilised grasslands contained more lead than the plants on non-fertilised grasslands. A lead content of 10 mg kg^{-1} or more is considered toxic in grass fodder, but this level was not approached by any of the grassland plant groups.

Table 2 shows the average macroelement content of grass species, leguminous species and other dicotyledons. As expected, these average data showed that grass species contained fewer macroelements than other grassland plants. Leguminous plants contained the highest quantity of four of the five macroelements examined, while K accumulated mostly in other dicotyledonous species. The macroelement content on non-leguminous grassland species was many times that of grasses, but the difference between leguminous and other grassland species was insignificant. The Na and Ca content of the fodder from non-fertilised grasslands exceeded that of the fertilised grasslands. The elements K, Mg, and P were found in greater quantities in fodder from fertilised grasslands than in fodder from non-fertilised grasslands.

The macroelement content of the sampled grass fodders was sufficient to meet the nutritional requirements of sheep.

Table 2. Average heavy metal, macro- and microelement contents of fodder on fertilised and non-fertilised grasslands (1999-2000)

Element	Units	Grasses	*CV%*	Leguminous	*CV%*	Other dicots	*CV%*
Non-fertilised grasslands							
K	mg kg^{-1}	1244.0	*27,7*	18223,3	*10,7*	2344,0	*28,0*
Na	mg kg^{-1}	1989,2	*20,2*	4992,7	*113,3*	3687,0	*29.5*
Ca	mg kg^{-1}	4452,2	*20,5*	14560,0	*31,4*	13162,5	*34,7*
Mg	mg kg^{-1}	1131,7	*19,7*	2873,3	*14,0*	2582,5	*7,7*
P	mg kg^{-1}	2102,5	*18,2*	2763,3	*10,2*	2592,5	*17,8*
Se	µg kg^{-1}	578.5	*74,3*	738,7	*25,6*	546,5	*36,0*
Fertilised grasslands							
K	mg kg^{-1}	18915,0	*9.4*	24353,3	*30,7*	27335,0	*7,8*
Na	mg kg^{-1}	613,2	*16,5*	2698,3	*25,0*	1591,2	*0,6*
Ca	mg kg^{-1}	3470,0	*5,7*	12995,0	*11,9*	10900,0	*8.5*
Mg	mg kg^{-1}	1240.0	*26.2*	4125.0	*4,9*	3602.5	*37,5*
P	mg kg^{-1}	3244.2	*32,4*	3476.7	*13,9*	3550.0	*18,5*
Se	µg kg^{-1}	703,5	*33,3*	648,7	*58,2*	846,2	*45,0*

The Se content of the fodder showed a variation of more than 30 % over habitats and years, so only a tendency was observed between fertilised and non-fertilised grasslands. Leguminous plants on non-fertilised grasslands contained more Se than on fertilised grasslands, and there was no significant difference in Se content between grasses and non-leguminous dicotyledons. On fertilised grasslands non-leguminous dicotyledons contained more Se than leguminous plants and grass species. The desirable quantity of Se in bulk fodders is 0.05-2 mg kg^{-1}. The grassland fodders proved to be neither deficient in Se, nor to reach the toxic level of 5 mg kg^{-1}.

Conclusions

The botanical composition of natural grasslands was 70 % of grass species, and 30 % of leguminous species and other dicotyledons in a three years study. Highest accumulation rate of Na, Ca, Mg, P, Se and Cd was found in leguminous species in case of high fertility soils/sites. Other dycotiledonous species were also proved to contain higher concentration of these elements in comparison with grass species. From among the 3 heavy metals examined higher amounts of Cr and Pb were accumulated in grass species. As a consequence of that these pastures provide poor quality fodder only. Since these sheep pastures are located far away from industrial plants and high traffic roads, therefore soil of the site itself – in respect to the values of soil acidity and the high Cr values of toxicity range (*Table 1.*), and/or the mineral fertilizer, if applied (especially in case of Cd) can be the source of pollution.

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