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CHEMICAL EVALUATION OF TWO TIMOTHY GRASS (*Phleum pratense* L.) CULTIVARS AS AFFECTED BY THE HARVESTING DATE PART II. MICROELEMENT CONTENTS[3]

CHEMICZNA OCENA DWÓCH ODMIAN TYMOTKI ŁĄKOWEJ (*Phleum pratense* L.) W ZALEŻNOŚCI OD TERMINU ZBIORU CZ. II. ZAWARTOŚĆ MIKROELEMENTÓW

Abstract: The goal of the present study was an assessment of microelements content in timothy grass in dependence on the time of the first swath collection. Two timothy grass cultivars were examined *ie*: Skala and Skald. They were mown three times during the vegetation period. The sward of the first swath was collected six times: the first time during the plant tillering and then at 7-day intervals. In collected green grass the dry matter content was evaluated by drying at 105 °C. After mineralization of hay samples Cu, Fe, Mn, Ni and Zn content was assessed by the ICP-AES method. The research was run in the years 2004–2006 on the pseudopodzol soil formed from light, dusty clay located shallow on the medium clay of good wheat complex.

The time of sample collection significantly affected the microelement content in the examined plants. Retardation of the first swath resulted in a lower level of copper, manganese and zinc. In the plants derived with the second and third swath copper, iron, manganese and zinc level decreased depending on the time of collection. Both cultivars were characterised with a slightly different chemical composition; higher iron, manganese, and zinc level was stated for Skala, whereas the Skald cultivar contained higher amounts of copper and nickel. It was found that average microelement content, with exception of nickel, in both cultivars of timothy grass exceeded the values assumed as optimal.

Keywords: harvesting time, timothy grass (*Phleum pratense*), microelement content

Retardation of the harvesting date of grasses affects a significant reduction of their feeding value [1]. Visible decrease of nutritional value is observed with plant ageing, therefore the right time of mowing is very important, especially in the case of the first

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swath because during this period grasses create large numbers of generative shoots, which after heading quickly get old and hard. Moreover, chemical composition is also affected by the fertilization, soil type and weather conditions [2, 3].

Among trace elements an important role is played by such microelements as: Fe, Mn, Zn and Cu, which are necessary for living organisms. On the other hand, these elements are required in small amounts and exceeding of their optimal level can have a toxic effect on living organisms [4, 5].

The aim of the present study was to evaluate the changes of the microelement content in timothy grass during the vegetation period depending on the time of the first swath collection.

Material and methods

The research was run in the years 2004–2006 in the Agricultural Experimental Station in Pawłowice near Gliwice, at the altitude of 250 m. The experiment was located on the pseudopodzol soil made from light, dusty clay located shallow on the medium clay of good wheat complex, on the standing after spring wheat. Acidity expressed as pH_{KCl} amounted to 6.3 and the contents of assimilable forms of macroelements were as follows: P_2O_5 = 8.1; K_2O = 11.8 and Mg = 10.2 mg · 100 g^{-1}.

During the vegetation period (April–September), rainfall amounted to 306.8 mm and 306.4 mm, respectively in 2005 and 2006, whereas average temperatures were: 14.9 °C and 16.0 °C, respectively.

Two timothy grass cultivars were taken into account, ie: Skala and Skald, which were mown three times during the vegetation period. The sward of the first swath was harvested six times: the first time during the plant tillering and then at 7-day intervals. The crops were collected, in dependence of the year, between 01.V–24.VI. The second swath was collected every time 6 weeks after the previous one. The last swath was collected at the same time for all variants. The grasses were sown on September 9, 2004 in four replicants, the area of each experimental field amounted to 10 m^2. In the same year fertilization was applied which comprised: 40 kg N, 100 kg P_2O_5 and 165 kg K_2O · ha^{-1}. In the years of full utilization nitrogen fertilizer was utilized in the amount of 200 kg N (80 kg N · ha^{-1} for the first swath, 60 kg N · ha^{-1} for the second and third swath), phosphorus – in a dose of 120 kg P_2O_5 · ha^{-1} (once in the spring) and potassium – in a dose of 120 kg K_2O · ha^{-1} (in two equal parts: in the spring and after the first regrowth).

The collected plant material was subjected to the analysis of forage chemical composition. The dry matter content was determined by drying at 105 °C. On the basis of the dry matter content in timothy grass the yields of dry matter per 1 ha were calculated. The plant samples underwent dry mineralization in muffle furnace at 450 °C [6]. Zn, Cu, Ni, Fe and Mn contents were determined using ICP-AES method (atomic emission spectrophotometry equipped with inductively coupled plasma torch).

Presentation of the results was limited to the average values from all investigated years. Results of field experiments were subjected to statistical analysis of variance and the significance of differences between average values was estimated on the basis of the confidence interval according to Tukey at the significance level of $\alpha = 0.05$.

Results and discussion

Time of harvesting had an important influence on the level of microelements in examined plants. Retardation of the first swath harvesting affected reduction of the copper, manganese and zinc concentration in plants (Table 1). After six weeks the copper content decreased by 21.5 % in the Skala cultivar and by 26.5 % in the Skald cultivar. A decline of manganese and zinc contents amounted to: 29.1 % – Skala, 32.3 % – Skald, and 60.8 % – Skala, 49.2 % – Skald, respectively. The highest iron content was achieved with the third harvesting time (heading stage of plants). During the following harvesting dates gradual decrease in its content was observed. However, nickel content in timothy grass was unaffected by the time of first swath harvesting. In the plants derived with the second and third swath the copper, iron, manganese and zinc level was slightly decreasing along with the following harvesting dates.

Table 1

Microelement content in two timothy grass cultivars as affected by the swath and harvesting date [mg · kg^{-1} d.m.] – mean values for 2005–2006

Swath	Time of harvest	Cu		Fe		Mn		Ni		Zn	
		A*	B*	A	B	A	B	A	B	A	B
I	1	13.8	14.7	180.4	251.8	118.6	89.5	2.6	3.1	222.8	197.0
	2	12.4	12.7	227.3	155.2	102.9	80.8	3.2	3.1	195.6	115.1
	3	12.2	12.5	435.2	353.4	99.8	74.7	2.8	3.1	132.1	114.7
	4	12.2	12.4	329.5	290.9	98.4	73.8	6.1	4.0	119.2	106.0
	5	11.0	10.9	286.9	176.5	95.8	73.1	4.0	3.1	114.9	100.2
	6	10.8	10.8	190.2	172.1	84.1	60.6	2.4	3.1	87.3	100.0
Mean		12.0	12.3	274.9	233.3	99.9	75.4	3.5	3.2	145.3	122.2
V [%]		8.9	11.6	8.9	8.9	11.2	12.7	39.4	11.5	36.0	30.5
$LSD_{0.05}$		1.73		106.32		23.49		1.43		60.96	
II	1	14.9	15.8	595.8	355.5	131.5	115.7	3.0	3.9	252.8	200.3
	2	12.9	14.0	424.6	338.8	122.2	98.9	3.5	3.0	227.0	134.2
	3	12.8	13.2	318.1	314.8	116.6	94.5	3.1	3.3	195.2	130.0
	4	12.5	11.2	267.0	313.3	106.5	87.0	4.6	2.8	164.5	118.0
	5	11.1	10.6	213.2	255.1	92.1	76.3	1.4	4.0	135.4	117.4
	6	10.9	10.2	209.4	250.6	89.8	74.0	3.1	4.5	102.3	97.3
Mean		12.5	12.5	274.9	233.3	109.8	91.1	3.1	3.6	179.5	132.9
V [%]		11.6	17.6	8.9	8.9	15.2	17.1	33.1	18.3	31.5	26.7
$LSD_{0.05}$		2.52		118.99		26.42		1.25		68.90	
III	1	13.5	14.3	351.3	339.9	138.7	147.6	2.3	3.4	164.1	137.8
	2	13.2	13.9	317.7	307.8	137.6	131.2	3.0	3.0	132.4	125.4
	3	12.8	13.3	280.1	256.6	120.6	129.2	3.0	3.8	126.0	113.4
	4	12.1	13.2	233.7	246.3	115.9	107.3	3.0	3.7	120.9	106.2
	5	11.6	12.9	230.4	213.6	113.2	104.3	3.2	3.1	102.3	100.9
	6	11.3	11.4	132.6	162.7	106.7	93.8	3.4	3.7	90.4	97.0
Mean		12.4	13.2	274.9	233.3	122.1	118.9	3.0	3.4	122.7	113.4
V [%]		7.1	7.5	8.9	8.9	10.8	17.1	13.2	10.0	20.9	13.7
$LSD_{0.05}$		1.40		75.10		23.80		0.61		27.98	

A – Skala cultivar; B – Skald cultivar; V [%] – coeffiecient of variation.

The nickel content in II and III cutting was also unaffected by the time of harvesting. According to established recommendations the amounts of microelements in forage covering nutritional requirements of animals are: Zn – 50 mg; Cu – 10 mg; Fe – 50 mg and Mn – 60 mg · kg^{-1} d.m. [7–9]. Assessment of the microelement content in both timothy grass cultivars revealed that the level of copper, iron, manganese and zinc was higher than the optimal one listed above. The limiting nickel content assumed for the plant evaluation as regards forage value amounts to Ni ≤ 50 mg · kg^{-1} d.m. [10]. In our study it was found that the content of the above-mentioned element in timothy grass cultivars did not exceed the limiting value.

Reduction of copper, iron, manganese and zinc content due to retardation of the first cutting can be explained with the dilution of components [11]. The obtained results revealed only slight differences in microelement content between both investigated cultivars. Higher iron, mangenese and zinc levels were reached in plants of the Skala cultivar, whereas plants of the Skald cultivar contained higher amounts of copper and nickel.

Taking into consideration all harvesting dates one can find that the highest diversification occurred in the nickel content in the first swath of the Skala cultivars and in the zinc content in both cultivars in all analysed swaths. The opposite phenomenon (the lowest degree of diversification) was observed for the copper concentration in the third swath of both timothy grass cultivars and for the iron content in all swaths of both cultivars.

Conclusions

1. Retardation of the first swath harvesting affected a reduction of the copper, manganese and zinc level in plants.

2. In the plants derived with the second and third swath copper, iron, manganese and zinc level decreased in dependence on the time of collection.

3. Only slight diversification was observed in chemical composition between both cultivars. A higher iron, manganese and zinc content was found for the Skala cultivar, whereas the Skald cultivar was richer in copper and nickel.

4. It was stated that microelement content, with the exception of nickel, in examined timothy grass cultivars exceeded the optimal values.

References

[1] Staniak M.: *Wpływ częstotliwości koszenia i rodzaju gleby na plonowanie i jakość suchej masy festulolium odmiany Felopa*. Ann. UMCS, 2004, Sec. E, **59**(4), 2001–2008.

[2] Borowiecki J. and Staniak M.: *Wpływ terminu koszenia pierwszego pokosu na poziom plonowania i zawartość białka Festulolium odmiany Felopa*. Zesz. Probl. Post. Nauk Rol. 2001, (474, 235–239.

[3] Czeladzka M. and Urbaniak K.: *Trwałość odmian życicy trwałej przy różnej częstotliwości koszenia*. Wiad. Odmianozn. COBORU, 1997, **68**, 3–21.

[4] Czuba R.: *Celowość i możliwość uzupełnienia niedoborów mikroelementów u roślin.* Zesz. Probl. Post. Nauk Rol., 1996, (434), 55–64.

[5] Gorlach E.: *Zawartość pierwiastków śladowych w roślinach pastewnych jako miernik ich wartości.* Zesz. Nauk. AR w Krakowie, 1991, **262**, Sesja Nauk. (34), 13–22.

[6] Ostrowska A., Gawliński S. and Szczubiałka Z.: Metody analizy i oceny właściwości gleb i roślin. Katalog. Wyd. IOŚ Warszawa 1991, 334 pp.
[7] Falkowski M., Kukułka I. and Kozłowski S.: Właściwości chemiczne roślin łąkowych. Wyd. AR Poznań 2000, 132 pp.
[8] Gorlach E.: *Zawartość pierwiastków śladowych w roślinach pastewnych jako miernik ich wartości*. Zesz. Nauk. AR w Krakowie, 1991, **262**, Sesja Nauk. (34), 13–22.
[9] Preś J. and Kinal S.: *Aktualne spojrzenie na sprawę zaopatrzenia zwierząt w mikroelementy.* Zesz. Probl., Post. Nauk. Roln., 1996, (434), 1043–1061.
[10] Kabata-Pendias A., Motowicka-Terelak T., Piotrowska M., Terelak H. and Witek T.: *Ocena stopnia zanieczyszczenia gleb i roślin metalami ciężkimi i siarką*. Ramowe wytyczne dla rolnictwa. Pamięt. Puław., 1993, **53**, IUNG, 20.
[11] Maciejewska M. and Kotowska J.: *Zawartość mikroelementów w sianie w warunkach zróżnicowanego NPK*. Biul. Magnezol. 2001, **6**(3), 295–303.

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Abstrakt: Celem badań była ocena zawartości mikroelementów w tymotce łąkowej w zależności od terminu zbioru I pokosu. W doświadczeniu uwzględniono dwie odmiany tymotki łąkowej: Skala i Skald, które koszono trzykrotnie w sezonie wegetacyjnym. W I pokosie ruń zbierano w sześciu terminach: pierwszy wykonano w fazie krzewienia się roślin, a następne w odstępach siedmiodniowych. W próbkach zielonki oznaczono zawartość suchej masy metodą suszarkową w temperaturze 105 °C. Po mineralizacji próbek siana oznaczono zawartość Cu, Fe, Mn, Ni i Zn, metodą ICP-AES. Badania przeprowadzono w latach 2004–2006 na glebie pseudobielicowej wytworzonej z gliny lekkiej pylastej, zalegającej płytko na glinie średniej zaliczanej do kompleksu pszennego dobrego.

Termin zbioru statystycznie istotnie wpływał na zawartość mikroelementów w roślinach. Opóźnienie zbioru pierwszego pokosu powodowało obniżenie się w roślinach zawartości miedzi, manganu i cynku. W roślinach II i III pokosu koncentracja miedzi, żelaza, manganu i cynku zmniejszała się w zależności od terminu zbioru. W składzie chemicznym stwierdzono niewielkie zróżnicowanie między odmianami, większe zawartości żelaza, manganu i cynku odnotowano u odmiany Skala, a miedzi i niklu u odmiany Skald. Stwierdzono, że zawartości mikroelementów w badanych odmianach tymotki łąkowej przewyższały wartości optymalne, poza zawartością niklu.

Słowa kluczowe: termin zbioru, tymotka łąkowa, zawartość, mikroelementy