ECOLOGICAL CHEMISTRY AND ENGINEERING A

Vol. 17, No. 10 2010

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EFFECT OF FERTILIZATION WITH MICROELEMENTS ON THE MACROELEMENT CONTENT IN TIMOTHY GRASS (*Phleum pratense* L.)

WPŁYW NAWOŻENIA MIKROELEMENTAMI NA ZAWARTOŚĆ MAKROELEMENTÓW W TYMOTCE ŁĄKOWEJ (*Phleum pratense* L.)

Abstract: A one-factor field experiment established by means of random block sampling, in four replicants, was located on the degraded chernozem with loess subsoil. The kind of fertilization with microelements was an assessed factor. Foliar fertilizers were applied in the form of single microelements (copper, zinc, manganese) and the multicomponent formulation Plonvit P containing elements in the form of chelates. It was found that applied fertilization had the most spectacular effect on the magnesium content in timothy grass. As a result of foliar fertilization with the multicomponent formulation, copper and manganese, significant increase of the average content of this element was observed (by 52 %, 79 %, 85 %, respectively). Moreover, it was determined that foliar fertilization with the examined microelements caused elevation of the calcium and potassium level by 31 % and 22 % (respectively) when compared with the control object. Fertilization with copper had a negative effect on the phosphorus content, whereas application of manganese negatively influenced the level of sodium. Fertilization with the multicomponent fertilizer, copper and manganese narrowed proportions between the sum of univalent and divalent cations in timothy grass.

Keywords: timothy grass, fertilization with microelements, chemical composition

Fertilization is considered as one of the most important factors influencing the content of mineral components in timothy grass [1]. Not only fertilization with macroelements is of great importance but also application of microelements [2–4]. These components are responsible for regulation of enzymatic processes proceeding in plants as well as affect the content of macroelements [5]. The quality of plant yield is influenced not only by the mineral component content but also by the proportions between them [6].

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The aim of the three-year study was an estimation of foliar fertilization with microelements in the form of a chelated multicomponent preparation or single microelement on the macroelement content and their proportions in timothy grass.

Material and methods

The 3-year field experiment was run in the Plant Cultivation Station in Skrzeszowice near Krakow, in the years 2004–2006. The experiment was set up by the method of random blocks as one-factor, in four replicants, on the degraded chernozem. The content of assimilable forms of phosphorus, potassium, zinc, manganese and copper was characterised with average level.

In the research the following forms of microelements were applied as foliar fertilizers:

– Zinc chelate 14 % Zn (chelator EDTA + DTPA) in a dose of 100 g Zn $\cdot$ ha^{-1} for each swath.

– Manganese chelate 14 % Mn (chelator EDTA + DTPA) in a dose of 100 g Mn $\cdot$ ha^{-1} for each swath.

– Copper chelate 12 % Cu (chelator EDTA + DTPA) in a dose of 60 g Cu $\cdot$ ha^{-1} for each swath.

– Plonvit P in a dose of 2 $dm^3 \cdot ha^{-1}$.

Plonvit P is a multicomponent, concentrated microelement fertilizer containing elements in the chelated form. Doses of single microelements and the dose of Plonvit P were adjusted in such proportions as to achieve the same content of selected microcomponents in the single fertilizers or in the multicomponent preparation. The fertilizer dose of 2 dm^3 recommended by the producer, contains: 100 g Zn, 100 g Mn and 60 g Cu. The solutions for spraying were prepared by dissolution of respective doses of microelements chelates in such an amount of water as to achieve the working fluid volume of 300 $dm^3 \cdot ha^{-1}$. Tap water of medium hardness was used for this purpose. Spraying of plants was done annually as follows: I spraying – in spring, after the beginning of the vegetation period, then after the harvesting during the first stage of the sward regrowth, but not later than 3 weeks before the following mowing. In each year of the experiment the following basic mineral fertilization was performed: under the I swath 80 kg N $\cdot$ ha^{-1}, for II and III 60 kg N $\cdot$ ha^{-1} (for each swath) as ammonium saltpetre, phosphorus once in the spring in the amount of 120 kg $P_2O_5 \cdot ha^{-1}$ as triple superphosphate and potassium for the first and third regrowth 60 kg $K_2O \cdot ha^{-1}$ (each swath) as 57 % potassium salt.

In the experiment timothy grass of the Skald cultivar was cultivated on the fields of the 10 m^2 area. The harvested plant material was each time subjected to the analysis of the forage chemical composition. The dry matter content was determined by the drying method at 105 ^{o}C. The phosphorus and magnesium content was analysed by the colorimetric vanadium-molybdenic method, whereas the content of potassium, sodium and calcium using the flame photometry method [7].

On the basis of the results obtained proportions between the sum of univalent and divalent cations (K + Na):(Mg + Ca) in timothy grass were determined.

Presentation of the results was limited to the average values from all investigated years. All results were subjected to the analysis of variance considering the Tukey test at a significance level of α = 0.05.

Results and discussion

This work revealed the important influence of applied fertilization on the content of microelements in timothy grass (Table 1). As a result of foliar spraying with mangenese and multicomponent fertilizer significant increase of the phosphorus content in timothy grass was found. Fertilization with the multicomponent preparation, copper, zinc and manganese contributed to a significant increase of the potassium content. The differences of its level in comparison with the control object amounted to 16, 21, 38 and 14 %, respectively.

Table 1

Weighted mean of macroelements and ionic proportions in timothy grass as affected by the fertilization with microelements (means for three years of the study)

Examined parameter	Fertilized objects					Mean	$LSD_{0.05}$
	Control	Multicomponent fertilizer	Cu	Zn	Mn		
P content [g · kg^{-1} d.m.]	2.40	2.66	2.13	2.39	2.56	2.43	0.252
K content [g · kg^{-1} d.m.]	21.71	25.27	26.37	30.02	24.65	25.61	3.771
Ca content [g · kg^{-1} d.m.]	1.92	3.34	1.92	2.79	2.03	2.40	0.869
Mg content [g · kg^{-1} d.m.]	1.70	2.58	3.04	1.83	3.15	2.46	0.780
Na content [g · kg^{-1} d.m.]	0.175	0.204	0.181	0.328	0.167	0.21	0.085
(K+Na) : (Ca+Mg)	2.38	1.73	1.97	2.69	1.77	2.06	0.520

In our study we found that foliar application of the multicomponent fertilizer as well as zinc and manganese resulted in significant growth of the calcium content in timothy grass (74, 45 and 6 %, respectively) when compared with the control object.

As a result of fertilization with the multicomponent preparation, copper, zinc and manganese a significant elevation of the magnesium level was achieved, whose concentration increased respectively by 52, 79, 8 and 85 % in comparison with its content in timothy grass harvested from the control, non-fertilized object. Magnesium is an important grass component, its presence in a plant affects the metabolism and energy transformation. Magnesium takes place in about 300 enzymatic reactions but also constitutes the active center of a chlorophyll molecule [6]. Copper plays an important role in chlorophyll synthesis and stabilization. Manganese acts in the process of photosynthesis, in absorption and assimilation of several nutrients as well as in regulation of plant hormones [8, 9].

In the present work a visible impact of foliar application of the multicomponent fertilizer and zinc preparation on the higher sodium level in timothy grass was observed. The difference in relation to the control object amounted to 17 and 87 %, respectively. The physiological role of sodium in plants is not well known, however according to physiologists this element, like zinc, acts in transformational processes of nitrogen compounds in plants.

The quality of harvested plant crops is defined not only on the basis of optimal levels of particular elements but, when estimating the feeding value, relations between them are also of great importance [10, 11].

On the basis of the results obtained it was concluded that fertilization with the multicomponent fertilizer, copper and manganese narrowed proportions between the sum of univalent and divalent cations (K + Na):(Mg + Ca) (Table 1). It is worth emphasizing that the lower value of the mentioned above ratio occurred in the timothy grass sprayed with the solution of multicomponent preparation and with manganese solution.

Conclusions

1. Foliar fertilization with microelements positively influenced the potassium, calcium, magnesium and sodium content in timothy grass.

2. Significant increase of potassium and sodium content in timothy grass was achieved after foliar application of zinc, whereas the calcium content was positively affected by the treatment with Plonvit P and zinc and magnesium after sprying plants with copper and manganese preparations.

3. Timothy grass spraying with microelements in the form of the multicomponent preparation – Plonvit P contributed to the significant increase of the calcium and magnesium content.

4. Copper and zinc fertilization led to the reduction of the phosphorus content in the examined plant material.

5. Fertilization with the multicomponent fertilizer, copper and manganese narrowed proportions between the sum of univalent and divalent cations in timothy grass.

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WPŁYW NAWOŻENIA MIKROELEMENTAMI NA ZAWARTOŚĆ MAKROELEMENTÓW W TYMOTCE ŁĄKOWEJ (*Phleum pratense* L.)

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Abstrakt: Jednoczynnikowe doświadczenie polowe założono metodą losowanych bloków, w czterech powtórzeniach, na czarnoziemie zdegradowanym o podłożu lessowym. Czynnikiem doświadczenia był rodzaj nawożenia mikroelementowego. Stosowano dolistnie pojedyncze mikroelementy miedzi, cynku i manganu oraz wieloskładnikowy nawóz Plonvit P, zawierający pierwiastki w formie schelatowanej. Wykazano, że zastosowane nawożenie największy wpływ wywierało na zawartość magnezu w tymotce łąkowej. W wyniku dolistnego stosowania wieloskładnikowego nawozu, miedzi i manganu stwierdzono znaczny wzrost średniej zawartości tego pierwiastka – w porównaniu z obiektem nienawożonym – odpowiednio o 52 %, 79 % i 85 %. Stwierdzono, że nalistne stosowanie badanych mikroelementów spowodowało średnio wzrost zawartości wapnia i potasu odpowiednio o 31 % i 22 % w porównaniu z obiektem kontrolnym. Wykazano, że nawożenie miedzią spowodowało spadek zawartości fosforu, a nawożenie manganem zmniejszenie zawartości sodu w stosunku do kontroli. Nawożenie wieloskładnikowym nawozem, miedzią i manganem zawęziło stosunek sumy kationów jednowartościowych do sumy kationów dwuwartościowych w tymotce łąkowej.

Słowa kluczowe: tymotka łąkowa, nawożenie mikroelementami, skład chemiczny