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**EFFECT OF MICROELEMENT FERTILIZATION
ON THE QUALITY AND NUTRITIONAL VALUE
OF THE MEADOW SWARD HAY
PART II. THE CONTENT OF MACROELEMENTS***

**WPLYW NAWOŻENIA MIKROELEMENTAMI
NA JAKOŚĆ I WARTOŚĆ POKARMOWĄ SIANA RUNI ŁĄKOWEJ
CZ. II. ZAWARTOŚĆ MAKROELEMENTÓW**

Abstract: The one-factor field experiment was designed by means of random block sampling in four replicants (fields of 2.0 × 5.0 m area). The experimental field was located on the acid brown soil (type II B) of the V quality class. The study was conducted in the years 2006–2008 in the individual farm in Pilica administrative district, in Zawiercie county, in the region of Krakow–Czestochowa Jura, at the altitude of 320 m.

The kind of microelement fertilizer was the determining factor in the study. During the experiment foliar fertilizers were applied in the form of single microelements (copper, zinc, manganese) as well as multicomponent preparation – Plonvit P, containing elements in the form of chelates. It was stated that applied fertilization had the most spectacular effect on the sodium content in the meadow sward. As a result of foliar application of multicomponent preparation, copper and manganese significant increase of average content of this element was observed in comparison with the non-fertilized field (2.34; 1.98 and 1.09-time higher values, respectively). Moreover, it was found that foliar treatment with examined microelements caused elevation of calcium and magnesium level by 46.0 % and 45.7 %, respectively. Treatment with the multicomponent fertilizer also resulted in the increased phosphorous content above the standard level. Additionally, applied foliar fertilizers narrowed the proportions between the sum of univalent and divalent cations in the meadow sward.

Keywords: meadow sward, fertilization with microelements, chemical composition

The high level of nitrogen, phosphorus and potassium treatment as well as intensive agricultural production affects the enhancement of microelements uptake by plants, what results in their deficiency both in soil and in plants. The amounts of microelements that are retained by the soil during the application of basic mineral and organic fertilizers usually cannot cover the plant requirements for these components. Therefore,

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there is a need to apply microelement fertilizers [1–3]. Although these elements are absorbed in small quantities they are essential for the proper proceeding of many biochemical and physiological processes in plants [4]. Microelements significantly influence not only the yield level but most of all they positively affect its quality as well as the content of organic and mineral compounds in forage [5, 6].

Therefore, the aim of the three-year long field experiment was an estimation of the effect of foliar fertilization with microelements in the form of chelated multicomponent preparation or single microelements on the content of macroelements in the meadow sward and the proportions between them.

Materials and methods

The study was conducted in the years 2006–2008 on the individual agricultural farm in Solca, in the Pilica administrative district. The experiment was designed by the method of random block sampling, in four replicants, on the brown, acid soil ($\text{pH}_{\text{KCl}} = 5.2$) of the V quality class. The soil contained medium levels of assimilable potassium, manganese and zinc and were poor in assimilable phosphorus and copper.

During the vegetation period (April–September) the total rainfall amounted to 338.1 mm; 375.4 mm and 320.3 mm, and the mean temperatures reached the values of 15.2, 14.3 and 14.9 °C, respectively for the years 2006, 2007 and 2008.

During the experiment plants were treated with foliar preparation of 14 % zinc chelate (chelator – EDTA+DTPA) in a dose of 100 g Zn · ha⁻¹, manganese chelate 14 % Mn (chelator – EDTA+DTPA) in a dose of 100 g Mn · ha⁻¹, copper chelate 12 % Cu (chelator – EDTA+DTPA) in a dose of 60 g Cu · ha⁻¹ as well as Plonvit P in a dose of 2 dm³ · ha⁻¹. The fertilizers were applied for each regrowth.

Zinc, manganese and copper were dosed in such proportions to achieve the equal contents of the relevant microcomponents in the single fertilizers and in the multicomponent preparation. Plonvit P is a concentrated, multicomponent, microelement fertilizer containing in a single dose of 2 dm³: 100 g Zn, 100 g Mn and 60 g Cu in the form of chelates. The spraying solutions were prepared by dissolution of the proper amounts of chelates containing microelements in such water volume to obtain the volume of working liquid corresponding to 300 dm³ · ha⁻¹. The tap water of the medium hardness degree was used for that purpose.

The first spraying with microelements was done after the beginning of the spring vegetation, the following – after the harvesting at the stage of the initial sward regrowth but not later than 3 weeks before the next mowing. During the investigation period the basic mineral fertilization was also applied: under I regrowth – 80 kg N · ha⁻¹ and under II and III regrowths – 60 kg N · ha⁻¹ for each regrowth in the form of ammonium saltpetre. Phosphorus was applied once in the spring, in the amount of 120 P₂O₅ · ha⁻¹ as a triple superphosphate and potassium – under the first and third regrowths in a dosage of 60 kg K₂O · ha⁻¹ (for each regrowth) as 57 % potassium salt. The experimental fields had the area of 10 m².

In the collected plant material the chemical composition of forage, the content of dry matter by drying at 105 °C, phosphorus and magnesium were determined –

colorometrically by the vanadium-molybdenic method, potassium, sodium and calcium – by the flame photometry [7].

On the basis of the obtained results the proportions of the univalent to divalent sum of cations (K + Na) : (Mg + Ca) in the meadow sward were calculated.

All results were subjected to the analysis of variance and verified using the Tukey test at the significance level of $\alpha = 0.05$.

Results and discussion

The conducted study revealed that fertilization with microelements significantly affected the chemical composition of the meadow sward. Foliar application of both the single elements and the multicomponent Plonvit P, which contain the elements in the form of chelate complexes, had the most spectacular influence on the sodium content in the meadow flora (Table 1).

Table 1

The weighted mean of macroelement content and the ionic proportions in the meadow sward as affected by the fertilization with microelements (mean for three years)

Examined parameter	Fertilized objects					Mean	LSD _{0.05}
	Control	Multicomponent fertilizer	Cu	Zn	Mn		
P content [g · kg ⁻¹ d.m.]	2.34	3.27	3.08	3.25	3.04	3.00	0.37
K content [g · kg ⁻¹ d.m.]	16.31	22.20	16.71	18.99	16.94	18.23	3.97
Ca content [g · kg ⁻¹ d.m.]	3.51	7.71	4.31	6.07	4.00	5.12	2.59
Mg content [g · kg ⁻¹ d.m.]	1.03	1.81	1.68	1.64	1.32	1.50	0.31
Na content [g · kg ⁻¹ d.m.]	0.120	0.402	0.358	0.132	0.251	0.253	0.150
(K + Na) : (Ca + Mg)	1.63	1.10	1.25	1.12	1.44	1.26	0.32

The highest sodium level was observed for the object treated with multicomponent fertilizer. The plants from that field contained 70% higher Na level than the plants collected from the non-fertilized object. Foliar application of multicomponent preparation, zinc, copper and manganese affected also the significant elevation of the mean calcium content when compared with the control object and the differences reached the values of: 55, 42, 19, 12 %, respectively. The great diversification as dependent on the foliar application of microelements was found for magnesium. The highest increase of its content was observed after the treatment with copper and zinc (besides the multicomponent fertilizer). The Mg level was 39 and 37 %, respectively higher than that of the control object. Copper is an element that takes part in the transformational processes of iron compounds in plants and affects the growth and anatomical structure

of many tissues [8]. Zinc is an activator of many enzymes and plant hormones and participates in the synthesis of vitamins B, C and P. Zinc affects the growth and development and enhances the plant good condition [9]. In our investigations we stated also the increase of phosphorus and potassium content after the foliar application of microelements. As a result 26 % higher phosphorus and 13 % higher potassium levels in relation to the control objects were found under the treatment with microelements.

The quality of plant crops is estimated not only on the basis of optimal concentrations of certain elements but also the proportions between them are of a great importance as the feeding value is taken into consideration [10, 11].

The obtained results indicate that microelement fertilization affected the decreased proportion of univalent to divalent cations. It is worth emphasizing, that the lowest value of the above mentioned ratio was found for the sward foliar fertilized with the solution of multicomponent preparation and zinc.

Conclusions

1. The application of single microelement fertilizers as well as multicomponent Plonvit P preparation highly affected the sodium content in the meadow flora. Foliar application of manganese, copper and Plonvit P caused significant elevation of the Na level by on average 52, 66 and 70 %, respectively in relation to the control object.

2. Fertilization with the examined microelements caused the elevation of calcium and magnesium content by 37 and 36 % on average, in comparison with the control object.

3. The treatment with multicomponent Plonvit P resulted in the highest increase of the examined macroelements. The application of that fertilizer affected 45 % (on average) higher content of the macroelements when compared with the control field.

4. The application of copper, zinc and manganese influenced the elevated content of the examined macroelements by 30, 26 and 23 %, respectively in relation to the control object.

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**WPŁYW NAWOŻENIA MIKROELEMENTAMI NA JAKOŚĆ
I WARTOŚĆ POKARMOWĄ SIANA RUNI ŁĄKOWEJ
CZ. II. ZAWARTOŚĆ MAKROELEMENTÓW**

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Abstrakt: Jednoczynnikowe doświadczenie polowe założono metodą losowanych bloków, w czterech powtórzeniach (poletka o wymiarach 2,0 × 5,0 m). Na polu doświadczalnym występowała gleba brunatna kwaśna (rzęd II B – gleby brunatne ziemne), zaliczana pod względem bonitacyjnym do klasy V. Doświadczenie prowadzono w latach 2006–2008 w indywidualnym gospodarstwie rolnym położonym w gminie Pilica, powiat zawierciański na Jurze Krakowsko-Częstochowskiej, na wysokości powyżej 320 m n.p.m.

Czynnikiem doświadczenia był rodzaj nawożenia mikroelementowego. W doświadczeniu zastosowano dolistnie nawożenie pojedynczymi mikroelementami (miedź, cynk i mangan) oraz wieloskładnikowy nawóz zawierający pierwiastki w formie schelatowanej – Plonvit P. Wykazano, że zastosowane nawożenie największy wpływ wywierało na zawartość sodu w runi łąkowej. W wyniku dolistnego stosowania wieloskładnikowego nawozu oraz miedzi i manganu stwierdzono znaczny wzrost średniej zawartości tego pierwiastka – w porównaniu z obiektem nienawożonym – odpowiednio: 2,34; 1,98; i 1,09-krotnie. Ponadto stwierdzono, iż dolistne zastosowanie badanych mikroelementów spowodowało wzrost zawartości wapnia i magnezu odpowiednio o 46,0 i 45,7 % w porównaniu z obiektem kontrolnym. Wykazano również, że nawożenie wieloskładnikowym nawozem spowodowało wzrost zawartości fosforu ponad wartość normatywną. Ponadto zastosowane nawozy dolistne zawężyły stosunek sumy kationów jednowartościowych do sumy kationów dwuwartościowych w runi łąkowej.

Słowa kluczowe: ruń łąkowa, nawożenie mikroelementami, skład chemiczny