

Adam RADKOWSKI¹ and Iwona RADKOWSKA²

**EFFECT OF MICROELEMENT FERTILIZATION
ON THE QUALITY AND NUTRITIONAL VALUE
OF THE MEADOW SWARD HAY
PART I. THE CONTENT OF ORGANIC COMPONENTS
AND NUTRITIONAL VALUE**

**WPLYW NAWOŻENIA MIKROELEMENTAMI
NA JAKOŚĆ I WARTOŚĆ POKARMOWĄ SIANA RUNI ŁAKOWEJ
CZ. I. ZAWARTOŚĆ SKŁADNIKÓW ORGANICZNYCH
I WARTOŚĆ POKARMOWA**

Abstract: The aim of the conducted study was the determination of the quality and nutritional value of the meadow sward as affected by the fertilization with microelements. Monocomponent copper, zinc and manganese foliar fertilizers and multicomponent Plonvit P preparation, containing chelated elements, were applied during the experiment. The prepared plant material was subjected to the analyses of: elemental chemical composition by the standard method, NDF, ADF and ADL contents were determined using ANKOM Fiber Analyser apparatus according to the method described by Goering and Van Soest. The nutritional value was expressed in the units of INRA system (1988) using Winwar 1.6 software (DJG). The evaluation was performed on the basis of tabular coefficients of forage distribution in the rumen and intestines. Significant increase of the mean total protein, raw ash, ADF, ADL, NDF, BTJN and BTJE content was stated as the effect of foliar application of multicomponent preparation as well as copper, zinc and manganese fertilizers when compared with the non-fertilized object. However, slight decrease of the determined values was found in the case of raw fat and N-free extracts.

Keywords: meadow sward, microelement fertilization, the quality and nutritional value

The balanced mineral fertilization, both with micro- and macroelements, is required for the proper growth and development of cultivated plants. Microelements, however, absorbed by plants in very small amounts, significantly affect the yielding of cultivated plants as well as influence the qualitative forage characteristic [1, 2]. As the

¹ Department of Grassland, University of Agriculture in Krakow, al. A. Mickiewicza 21, 31–120 Kraków, Poland, phone: +48 12 662 43 61, fax: +48 12 633 62 45, email: rradkow@cyf-kr.edu.pl

² National Research Institute of Animal Production Balice n. Krakow, ul. Krakowska 1, 32–083 Balice, Poland, phone: +48 66 608 12 49, email: iradkowska@izoo.krakow.pl

microelements are constituents or activators of the most enzymes, their deficiency leads to significant perturbations of biochemical and physiological processes proceeding in plants [3, 4]. Microelements are provided from the soil simultaneously with the other mineral and organic fertilizers, but their amounts usually do not cover the fertilization requirements of plants, so there is a need to supplement their level in the form of microfertilizers. Therefore, the aim of the present study was to compare the effect of different microelements foliar fertilizers applied in the form of single, crystal chelates or as the multicomponent Plonvit P preparation, containing microelements in the chelated form, on the content of organic components as well as on the feeding value of the meadow sward.

Materials and methods

The field study was conducted in the years 2006–2008 in an individual agricultural farm in Solca, in the Pilica administrative district, in Zawiercie county, in Silesia province, at the altitude of 320 m. The one-factor experiment was designed by the method of random block sampling, in four replicants, in the brown, acid soil ($\text{pH}_{\text{KCl}} = 5.2$) classified to 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.

The kind of microelement fertilization was the determining factor of the experiment. Single microelements: zinc, manganese, copper and multicomponent Plonvit P preparation, containing elements in the form of chelate complexes, were applied. The following forms and doses of microelements were used:

- Zinc chelate 14 % Zn (chelator EDTA+DTPA) in a dose of $100 \text{ g Zn} \cdot \text{ha}^{-1}$ under each regrowth.
- Manganese chelate 14 % Mn (chelator EDTA+DTPA) in a dose of $100 \text{ g Mn} \cdot \text{ha}^{-1}$ under each regrowth.
- Copper chelate 12 % Cu (chelator EDTA+DTPA) in a dose of $60 \text{ g Cu} \cdot \text{ha}^{-1}$ under each regrowth.
- Plonvit P in a dose of $2 \text{ dm}^3 \cdot \text{ha}^{-1}$.

Plonvit P is a multicomponent, concentrated microelement fertilizer containing chelated elements. The doses of single microelements and Plonvit P were adjusted in such proportions to achieve the equal levels of the respective microelements in the single fertilizers and in the multicomponent preparation. Plonvit P fertilizer contains a single dose of 2 dm^3 , recommended by the producer: 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 as to obtain the volume of working liquid corresponding to $300 \text{ dm}^3 \cdot \text{ha}^{-1}$. The tap water of the medium hardness degree was used for that purpose. The application of fertilizers was done as follows: the first spraying – 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 investigated years the basic mineral fertilization was also applied: under I regrowth – $80 \text{ kg N} \cdot \text{ha}^{-1}$ and under II and III regrowths – $60 \text{ kg N} \cdot \text{ha}^{-1}$ for each regrowth in the form of ammonium saltpetre; phosphorus – once in the spring, in the amount of $120 \text{ kg P}_2\text{O}_5 \cdot \text{ha}^{-1}$ as a triple superphosphate and potassium – under the first and third regrowths in a dosage of $60 \text{ kg K}_2\text{O} \cdot \text{ha}^{-1}$ (for each regrowth) as 57 % potassium salt.

The area of each field amounted to 10 m^2 . In the collected plant material the chemical composition of the forage was determined. The content of the basic nutrients was evaluated by the Weenden method [5]. The feeding value was expressed in the INRA (Institut National de la Recherche Agronomique) system units using 1.6 Winwar software (DJG). The estimation of hay was performed using the tabular coefficients of forage distribution in rumen and intestines. Results of the 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 Tuckey at the significance level of $\alpha = 0.05$.

Results and discussion

On the basis of the obtained results the significant influence of the applied fertilization on the content of organic components and the feeding value of the meadow sward was stated (Table 1). As a result of foliar spraying with microelements a significant increase of crude protein content in the meadow sward was observed. The fertilization with the multicomponent Plonvit P preparation as well as with single microelements ie: zinc, copper and manganese contributed to the considerable growth of this component in relation to the control object – differences amounted to: 33, 33, 32 and 26 %, respectively. Foliar application of manganese, multicomponent fertilizer and copper influenced a significant drop in the crude fat content in the meadow sward (56, 41 and 24 %, respectively) in comparison with the control field. The treatment with copper, Plonvit P and manganese fertilizers affected higher concentration of crude fiber, which increased by on average 11.1; 6.2; and 5.8 % in comparison with its content in the meadow sward collected from the non-fertilized object. Our investigations revealed that the foliar application of copper, zinc, multicomponent and manganese fertilizers caused the decreased level of nitrogen-free extract. The respective values were 16.8; 14.8; 12.5 and 8.2 % lower than in the case of the control field. As the fiber fractions are taken into consideration it was found that ADF, ADL and NDF concentrations were positively affected by the foliar fertilization with microelements. The mean differences between the respective values for the fertilized objects and the control field reached the level of 7, 44 and 4 %.

As regards the energetic value, the examined foddors were characterized with comparable UFL and UFV levels. On the contrary, the protein value was much more diversified and fluctuated in the range of 49–73 for PDIN and 71–81 $\text{g} \cdot \text{kg}^{-1}$ d.m. for PDIE. The average difference between the values stated for the fields fertilized with microelements and the non-fertilized field was equal to 30 % for PDIN and 11 % for PDIE.

Table 1

The weighted mean content of organic components and the feeding value of the meadow sward as affected by the kind of microelement fertilization (mean for three years)

Parameter	Fertilized object					Mean	NIR _{0.05}
	Control	Multicomponent fertilizer	Cu	Zn	Mn		
	[g · kg ⁻¹ d.m.]						
Crude protein	80.6	120.3	118.7	120.1	109.2	109.8	9.0
Crude fat	29.9	21.2	24.1	29.3	19.2	24.7	3.5
Crude fiber	279.0	297.5	313.9	288.5	296.1	295.0	6.4
Nitrogen-free extract	542.4	482.0	464.2	472.5	501.3	492.5	4.3
Raw ash	68.1	79.1	79.1	89.6	74.2	78.0	6.5
ADF	326.8	345.5	369.5	331.2	359.3	346.5	6.4
ADL	27.1	50.8	58.5	35.5	50.1	44.4	9.3
NDF	531.8	566.6	590.4	516.5	537.1	548.5	5.8
UFL	0.75	0.74	0.74	0.75	0.73	0.74	11.32
UFV	0.66	0.66	0.66	0.66	0.64	0.66	30.19
PDIN	49.0	73.0	68.0	73.0	68.0	66.2	19.1
PDIE	71.0	81.0	78.0	81.0	78.0	77.8	6.3

* Means marked with the same letter are not statistically different following verification with the Duncan test ($P = 0.05$). ADF – acid detergent fiber, ADL – acid detergent lignin, NDF – neutral detergent fiber, UFL – feed Unit for Lactation (1700 kcal EN), UVF – meat Production Unit (1820 kcal EN), PDIE – protein digested in the small intestine supplied by rumen-undegraded dietary protein plus protein digested in the small intestine supplied by microbial protein from rumen-fermented organic matter, PDIN – protein digested in the small intestine supplied by rumen-undegraded dietary protein plus protein digested in the small intestine supplied by microbial protein from rumen-degraded protein.

The obtained results, as regards the feeding value of the examined plants, did not vary from the results reported by other authors [6]. It is worth emphasizing that under the conditions of foliar fertilization with microelements the forage quality of the meadow sward was significantly improved. The highest enhancement of the protein value was observed after the application of multicomponent preparation and zinc fertilizer, which is the cofactor of many enzymes and whose deficiency affects perturbations in the carbohydrates metabolism as well as auxins, DNA and RNA synthesis [2]. The function of zinc as a regulator of the level of saccharides and energetic balance was also emphasized by Grzywnowicz-Gazda [7]. The obtained results are partly consistent with the data found in literature concerning other cultivated plant species [8, 9].

Conclusions

1. The fertilization with multicomponent Plonvit P preparation as well as with single microelements ie: zinc, copper and manganese contributed to the considerable increase of the crude protein content in relation to the control object – by 33, 33, 32 and 26 %, respectively.

2. The treatment with copper, multicomponent and manganese fertilizers affected higher concentration of crude fiber, which increased by on average 11.1; 6.2; and 5.8 % in comparison with the non-fertilized object.

3. Foliar application of manganese, multicomponent fertilizer and copper influenced 56, 41 and 24 % (respectively) drop in the crude fat content in the meadow sward in comparison with the control field.

4. The fertilization with microelements resulted in 30 % and 11 % (on average) higher level of the protein value expressed as PDIN and PDIE (respectively).

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WPŁYW NAWOŻENIA MIKROELEMENTAMI NA JAKOŚĆ I WARTOŚĆ POKARMOWĄ SIANA RUNI ŁĄKOWEJ CZ. I. ZAWARTOŚĆ SKŁADNIKÓW ORGANICZNYCH I WARTOŚĆ POKARMOWA

¹ Katedra Łąkarstwa, Uniwersytet Rolniczy im. Hugona Kołłątaja w Krakowie

² Instytut Zootechniki – Państwowy Instytut Badawczy w Balicach koło Krakowa

Abstrakt: Celem podjętych badań było określenie jakości i wartości pokarmowej runi łąkowej w zależności od zastosowanego nawożenia mikroelementowego. Stosowano dolistnie pojedyncze mikroelementy miedzi, cynku i manganu oraz wieloskładnikowy nawóz Plonvit P, zawierający pierwiastki w formie schelatowanej. W przygotowanym materiale roślinnym oznaczono podstawowy skład chemiczny metodą standardową, analizy na zawartość NDF, ADF i ADL przeprowadzono za pomocą aparatu ANKOM Fiber Analyser, według metody zaproponowanej przez Goeringa i Van Soesta. Wartość pokarmową wyceniono w jednostkach systemu INRA 1988 za pomocą programu komputerowego Winvar, wersja 1.6. firmy DJG. Do wyceny posłużono się tabelarycznymi współczynnikami rozkładu pasz w żwaczu oraz jelitach. W wyniku dolistnego stosowania wieloskładnikowego nawozu oraz miedzi, cynku i manganu stwierdzono znaczny wzrost średniej zawartości białka ogólnego, popiołu surowego, ADF, ADL, NDF, BTJN oraz BTJE w porównaniu z obiektem nienawożonym. Natomiast w przypadku tłuszczu surowego oraz wyciągów niezawierających azotu i JPM odnotowano nieznaczne obniżenie się ich zawartości.

Słowa kluczowe: ruń łąkowa, nawożenie mikroelementami, jakość i wartość pokarmowa