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QUALITY OF THE GRASS-LEGUME SWARD AS AFFECTED BY THE PHOSPHORUS-POTASSIUM FOLIAR FERTILIZATION

JAKOŚĆ RUNI TRAWIASTO-MOTYLKOWATEJ NA TLE DOLISTNEGO NAWOŻENIA FOSFOROWO-POTASOWEGO

Abstract: The investigations were conducted in the years 2006–2008 on the grass-legume sward, on the brown acidic soil classified to the V quality class. The aim of the experiment was to evaluate the influence of the foliar fertilization with Alkalin PK 10:20 (phosphorus and potassium fertilizer) on the yielding and the quality of the meadow sward.

Foliar application of the Alkalin increased the dry matter yield by the 11 % (on average) in relation to the control object. Moreover, it was found that foliar utilization of Alkalin resulted in the increased organic components' content (total protein, raw fat) and the concentration of mineral components (raw ash, phosphorus, potassium, calcium and sodium). The application of this preparation in a dose of $3.0 \text{ dm}^3 \cdot \text{ha}^{-1}$ caused the average growth of the above-mentioned components by 14, 33, 32, 38, 44, 58 and 42 %, respectively, when compared with the control object. On the other hand, decreased contents of the crude fiber as well as its ADL and NDF fraction were observed.

Keywords: meadow sward, foliar fertilization, yield, quality

Many investigations proved that plants assimilate nutrients not only through the root system, but also by the aboveground parts. The plants can even 80–100-time more efficiently assimilate components by the leaf surface than by the roots. Foliar fertilization has many advantages, first of all gives the possibility of fast and effective supplementation of the deficiency of nutrients directly to the leaves, regardless of the water availability in the soil as well as root system functioning [1, 2]. Therefore, the foliar fertilization is especially important when the root system is not fully developed as well as during dry periods [3].

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The response of plants on the applied foliar fertilization depends first of all on the plant species, the form of fertilizer, concentration and frequency of its application as well as at which stage of plant growth it is utilized. This fertilization is beneficial not only for the yielding but also for the plant resistance to diseases, pests and droughts [4].

Moreover, because of the lower concentration of the active substance foliar fertilization constitutes lower environmental load in comparison with the soil fertilizers. The investigations revealed that during the first year after the application only approximately 10–12 % of phosphorus is utilized, the remaining amount is accumulated in the soil or washed out [5].

Because of the plant high susceptibility to the leaf damage the foliar fertilization requires precise control of the amount of dosage and the term of its application.

Despite many conducted examinations there is no unequivocal estimation of the effect of the foliar fertilization with macrolelements on the level and quality of the yield, therefore the aim of the three-year field study was to evaluate the influence of the foliar fertilization with phosphorus and potassium on the quality of the grass-legume sward.

Materials and methods

The field experiment was conducted in the years 2006–2008 in the individual farms located in the administrative district of Gmina Pilica. The investigation was established by the method of random block sampling, in four replications, on the brown, acidic soil ($\text{pH}_{\text{KCl}} = 5.2$), of the V quality class. The soil contained medium level of assimilable potassium, manganese and zinc and was poor in assimilable phosphorus and copper.

During the vegetation period (April–September) the average rainfall amounted to 338.1; 375.4 and 320.3 mm, respectively in the year 2006, 2007 and 2008, whereas average air temperatures reached the values of 15.2; 14.3 and 14.9 °C, respectively.

The experiment included four objects: the control (without using the preparation) and three variants sprayed with Alkalin PK 10:20 (150 g P_2O_5 , 300 g K_2O in 1 dm^3 of fertilizer). The preparation was used once for each regrowth in three different doses: 1.5 $\text{dm}^3 \cdot \text{ha}^{-1}$, 2.0 $\text{dm}^3 \cdot \text{ha}^{-1}$ and 3.0 $\text{dm}^3 \cdot \text{ha}^{-1}$. The first spraying was applied at the beginning of the spring vegetation, the next one after the harvesting at the stage of initial sward regrowth but not later than 3 weeks before the next mowing. During the research the fundamental mineral fertilization was also applied which comprised: 80 kg $\text{N} \cdot \text{ha}^{-1}$ for the first regrowth, 60 kg $\text{N} \cdot \text{ha}^{-1}$ for the second and third regrowths in the form of ammonium saltpetre. The phosphorus was utilized once in the spring, in the amount of 120 kg $\text{P}_2\text{O}_5 \cdot \text{ha}^{-1}$ as a triple superphosphate and potassium for the first and third regrowths in a dose of 60 kg $\text{K}_2\text{O} \cdot \text{ha}^{-1}$ for each regrowth as a 57 % potassium salt. The area of each field amounted to 10 m^2 .

The collected plant material was subjected to the analysis of the fundamental organic components' content by the Weenden's method, phosphorus and magnesium content by the colorimetric vanadium-molybdenic method, potassium, sodium and calcium by the flame photometric method [6, 7].

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

Results and discussion

Our investigations revealed that foliar application of Alkalin PK in different doses (concentrations of $1.5 \text{ dm}^3 \cdot \text{ha}^{-1}$, $2.0 \text{ dm}^3 \cdot \text{ha}^{-1}$ and $3.0 \text{ dm}^3 \cdot \text{ha}^{-1}$) significantly affected the dry matter yield of the meadow flora. In all fertilization variants it had a positive yielding effect. Plants supplemented with the foliar preparation yielded higher amounts of dry matter when compared with the control object. The mean yield for three years of the investigations was the lowest in the case of the control sward (Table 1). The yield determined for the sward fertilized with Alkalin in a dose of $1.5 \text{ dm}^3 \cdot \text{ha}^{-1}$ was higher by $0.52 \text{ Mg} \cdot \text{ha}^{-1}$ followed by the variants fertilized with the concentration of $2.0 \text{ dm}^3 \cdot \text{ha}^{-1}$ and $3.0 \text{ dm}^3 \cdot \text{ha}^{-1}$ of this fertilizer. The latter resulted in $10.87 \text{ Mg} \cdot \text{ha}^{-1}$ average dry matter yield and it was higher in relation to the control variant by 15 %. The highest dry matter yield was observed for the examined swards in the year 2007, the lowest in 2008. The mean difference amounted to 8 % – for the fertilized objects and 8.7 % – for the control object and was statistically significant. The foliar fertilization is one of the factor of the modern production technology affecting the yield level and its quality. Conventional soil fertilization not always ensures the availability of the components required for the achievement of the high level and high quality yield [2, 8–9].

Table 1

The dry matter yields of the meadow sward

Dose of fertilizer	Years			Mean for the years (2006–2008)	
	2006	2007	2008		
	[Mg · ha ⁻¹]			[%]	
Control	9.74	9.81	8.83	9.46	100
Alkalin 1	9.98	10.43	9.54	9.98	106
Alkalin 2	10.54	10.73	10.12	10.46	111
Alkalin 3	10.87	11.32	10.42	10.87	115
LSD _{0.05}	0.44	0.56	0.52	0.51	—

Alkalin 1 – dose of $1.0 \text{ dm}^3 \cdot \text{ha}^{-1}$; Alkalin 2 – dose of $2.0 \text{ dm}^3 \cdot \text{ha}^{-1}$; Alkalin 3 – dose of $3.0 \text{ dm}^3 \cdot \text{ha}^{-1}$.

Under the foliar fertilization the assimilation of the nutrients is much faster than the assimilation by the root system [5]. Already during the 4–5 hours after the treatment 80 % of the fertilizer is assimilated by the plant. It is assumed that utilization of the mineral components from the foliar fertilizer reaches 90 %. Foliar fertilizers are characterized with the complete solubility in water and do not penetrate into the underground water. Foliar fertilization can also contribute to the increase of the yield even by the several dozen percent [5, 9–12].

Utilized foliar fertilization with Alkalin had the greatest influence, among all organic components, on the content of ADL fraction (17.38 %), total protein (14.76 %) and raw fat (12.20 %) of the meadow flora (Table 2). The highest diversifications in the content of selected mineral components was found in the concentrations of calcium (23.35 %),

phosphorus (16.42 %), potassium (16.24 %). The highest levels of these elements were determined for the object where Alkalin in a dose of $3.0 \text{ dm}^3 \cdot \text{ha}^{-1}$ was applied.

Table 2

The content of nutrients in the meadow sward

Content [g · kg ⁻¹ d.m.]	Object				LSD _{0.05}
	Control	Alkalin 1	Alkalin 2	Alkalin 3	
Raw ash	68.1	68.9	71.2	77.3	3.24
Total protein	80.6	81.5	82.3	107.4	7.27
Crude fiber	283.5	279.0	281.0	281.2	2.15
Raw fat	23.5	29.9	30.3	31.1	5.15
Non-nitrogen extract	544.3	540.7	535.2	503.0	27.51
ADF	323.1	326.8	329.1	329.4	3.96
ADL	37.6	27.1	27.3	27.3	2.70
NDF	543.8	531.8	535.6	536.0	4.95
P	2.34	2.38	2.45	3.24	0.26
K	16.31	23.16	23.22	23.53	5.19
Ca	3.51	3.64	3.72	5.53	0.58
Mg	1.03	1.04	1.04	1.06	ns
Na	0.12	0.14	0.15	0.17	0.02

Explanations as in Table 1.

Under the conditions of the high level of phosphorus and potassium deficiency foliar interventional fertilization with these elements is highly recommended. Phosphorus is the most easily assimilated in the form of phosphoric acid (H_3PO_4). It is transported slowly through the plant but faster than in the case it is assimilated through the root system. Foliar supplementation with phosphorus accelerates the plant growing, increases yielding and affects decreased level of mechanical breakages [2]. Application of potassium increases the efficiency of photosynthesis and respiration as well as decreases the losses caused by diseases [12].

Diversified phosphorus and potassium fertilization caused significant increment of the dry matter yield and the content of the examined components. The best results were achieved under the high level of fertilization ($3.0 \text{ dm}^3 \cdot \text{ha}^{-1}$), which were significantly higher than the values observed for the lowest ($1.5 \text{ dm}^3 \cdot \text{ha}^{-1}$), and also medium ($2.0 \text{ dm}^3 \cdot \text{ha}^{-1}$) level of fertilization.

Conclusions

1. The utilization of Alkalin fertilizer in three different doses positively affected the dry matter yield of the meadow sward. Alkalin applied in a dose of $3.0 \text{ dm}^3 \cdot \text{ha}^{-1}$ increased the dry matter yield by 15 % when compared to the control object.

2. Application of Alkaline had a significant influence on the total protein and raw fat content in the meadow flora. Foliar treatment with this preparation in a dose of $3.0 \text{ dm}^3 \cdot \text{ha}^{-1}$ caused the significant growth of the concentration of these components, which were respectively 33 and 32 % higher than the value found for the non-fertilized object.

3. The phosphorus-potassium fertilization in the amount of $3.0 \text{ dm}^3 \cdot \text{ha}^{-1}$ resulted in the increased phosphorus, potassium, calcium and sodium content, by respectively 38, 44, 58 and 42 % when compared with the control object.

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Abstrakt: Badania przeprowadzono w latach 2006–2008 na runi trawiasto-motylkowatej, na glebie brunatnej kwaśnej, zaliczanej pod względem bonitacyjnym do klasy V. Celem eksperymentu było określenie wpływu nawożenia dolistnego Alkalinu PK 10:20 (nawóz fosforowo-potasowy) na plonowanie oraz jakość runi łąkowej.

Dolistna aplikacja Alkalinu zwiększyła plon suchej masy w stosunku do obiektu kontrolnego średnio o 11 %. Ponadto stwierdzono, iż dolistne zastosowanie Alkalinu spowodowało wzrost zawartości składników organicznych: białko ogólne, tłuszcz surowy oraz składniki mineralne: popiół surowy, fosfor, potas, wapń i sód. Zastosowanie tego nawozu w dawce $3,0 \text{ dm}^3 \cdot \text{ha}^{-1}$ powodowało wzrost zawartości wymienionych składników odpowiednio o 14, 33, 32, 38, 44, 58 i 42 % w porównaniu z obiektem kontrolnym.

Natomiast odnotowano zmniejszenie zawartości dla włókna surowego oraz frakcji ADL i NDF.

Słowa kluczowe: ruń łąkowa, nawożenie dolistne, plon, jakość