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Effect of amino acid fertilization on chemical composition and nutritive value of sward of Italian ryegrass-lucerne mixture

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The aim of the study was to determine the effect of using an amino acid preparation on productivity and nutritive value of a mixture of Italian ryegrass (Lolium multiflorum Lam.) and alfalfa (Medicago sativa L.). The following fertilizer treatments were prepared: control without amino acid fertilization; experimental with different amino acid doses (1, 1.5, 2 and 2.5 dm3·ha–1 per regrowth). The plant material was analyzed for basic chemical composition using the standard method and for nutritive value using the INRA units. The results showed that increasing dose was paralleled by increased concentration of crude protein, and in some cases also of crude fat. Due to the higher protein content, plants from the plots fertilized with amino acids were characterized by higher PDIN and PDIE values compared to control plants. No significant differences were observed for UFL and UFV values.

Key words: amino acids, Italian ryegrass, alfalfa, nutritive value, chemical composition

Foliar fertilization of plants with amino acids is a new concept of providing plants with nutrients. Amino acids are organic compounds, which are the basic building blocks of proteins, fulfilling various functions within a plant: structural (building), metabolic and transport (Liu et al., 2008). The amino acid is a natural carrier of nutrients, easily recognizable by plants and a growth driver (Liu and Bush, 2006).

In the agricultural cultivation, amino acids can constitute an alternative source of nitrogen. Amino acid preparations are used as drivers mainly for the growth of fruit and vegetables. The scientific experiments demonstrated a positive impact of using these preparations on crop yield, plant growth and mitigation of the negative effects of environmental stress (El-Zohiri and Asfour, 2009; Sadak et al., 2015). Stress conditions such as high temperature or drought have a negative impact on plant metabolism, which translates directly into the decrease of the quantity and quality of crop yield. Research shows that using amino acids in the periods of stress reduces considerably the negative effect of a stress-causing factor and prevents adverse effects of the stress (Haghighi et al., 2008; Abo-Sedera et al., 2010). It was proven that amino acids such as glutamate, cysteine, phenylalanine and glycine can have a direct or indirect influence on weakening of plant oxidative stress (Denisov and Afanas'ev, 2005; Ashraf and Foolad, 2007; Gill and Tuteja, 2010), therefore using these preparations can be an alternative used to mitigate the effects caused by oxidative stress.

Italian ryegrass, as a fast growing species, ensuring high yields of plant green material requires favourable climatic conditions. Likewise, lucerne *(Medicago sativa)*, is one of the most important forage legumes, used extensively in feeding dairy cows (Mohammed et al., 2012; Hassanat et al., 2014). In Poland, unfortunately, the last years have seen a decrease in rainfall during the vegetation period, which has a negative impact on the quality and chemical composition of plants, including grass mixtures.

Scientific research results available in the literature indicate that using amino acids in agricultural crops has a positive impact on the increase of plant yielding, however, there are no reports on the effect of amino acids on grasses used in feeding ruminants. For this reason, research was undertaken in order to determine the impact of using amino acid preparation on the productivity and nutritional value of mixture composed of Italian ryegrass and lucerne.

Material and methods

The research was carried out on an individual farm located in the Małopolska Voivodeship in the Krakow District. The experiment was set up in a randomized block design with four replications, the area of the test plots was 10 square meters. In the experimental plot there was degraded humus formed from loess, included in I soil quality class. The content of available forms of phosphorus (11.4 $mg \cdot 100\ g^{-1}$ of soil), potassium (15.3 $mg \cdot 100\ g^{-1}$ of soil) and magnesium (8.3 $mg \cdot 100\ g^{-1}$ of soil) in the soil was average.

The following fertilizer combinations were accepted for the study:

Control group without fertilizing with amino acid preparation;

and plots sprayed with AGRO-SORB® Folium preparation at a dosage:

1.0 $dm^3 \cdot ha^{-1}$ per regrowth;
1.5 $dm^3 \cdot ha^{-1}$ per regrowth;
2.0 $dm^3 \cdot ha^{-1}$ per regrowth;
2.5 $dm^3 \cdot ha^{-1}$ per regrowth;

The mixture composed of Jeanne variety of Italian ryegrass (*Lolium multiflorum* Lam.) registered in the Polish National List of Agricultural Plant Varieties in 2000 and Perfecta variety of lucerne registered in the Polish National List of Agricultural Plant Varieties in 2004 were used for testing. The proportion of Italian ryegrass in the mixture was 60%, whereas 40% of lucerne. The mixture was sown until 15 April in the quantity of 35 $kg \cdot ha^{-1}$. The following basic mineral fertilization was used: 40 kg $N \cdot ha^{-1}$ for the first cut, 30 kg $N \cdot ha^{-1}$ for the second and third cut each in the form of ammonium nitrate; phosphorus in all the tested plots on a one-off basis in the spring in the amount of 120 kg $P_2O_5 \cdot ha^{-1}$ in the form of triple superphosphate and potassium – 60 kg $K_2O \cdot ha^{-1}$ for the first and third cut each as 57% potassium salt.

Green material was mown in the stage of earing of Italian ryegrass, whereas lucerne was reaped between budding and flowering stage, the next regrowth was cut with a seven week break in between. The contents of basic nutrients was determined by the Weende analysis (AOAC, 2005). Feeding value was measured using INRA system by means of Winwar programme, version 1.6 (DJG). Tabulated coefficients of intestinal protein degradation were used to estimate PDIN and PDIE values. The results obtained underwent a statistical analysis. In the first place, the goodness of empirical fit of individual observed traits was verified with normal distribution by means of the Shapiro-Wilk test. Then, two-factor analysis of variance (ANOVA) was carried out in order to assess the impact of cut, dose and cut × dose interaction on the values of different traits observed in the experiment. Average values and standard deviations for different levels of both tested factors were calculated. Values of the least significant differences (LSD) were estimated at 0.05, which served to test the significance of differences. The Pearson linear correlation coefficients were used to assess the correlation of the observed traits. All the calculations in the scope of statistical analysis were made using GenStat 18 statistics package.

Results

The results of the analysis of variance show a significant statistical influence of the cut on the values of all the observed traits, except for crude ash. However, the dose and cut × dose interaction determined all the investigated traits (Table 1).

The data concerning dry matter yields in sward of Italian ryegrass and lucerne mixture were presented in Table 2. The analysis of the volume of dry matter yield per individual cuts and in applied fertilizer treatments show significant differences in yielding, caused by a dose of amino acid preparation and the next cut in the year. The crop of dry mass yield ranged from 2.013 to 6.034 $t \cdot ha^{-1}$ with great variation observed. The highest total yield of dry matter was noted in case of the mixture derived from the plot, where the largest dose of amino acid preparation was used.

The difference was 15% in comparison to the control group. Good crop yields were also received from the plot, where 2.0 $dm^3 \cdot ha^{-1}$ of amino acid preparation was used. Determined nutrient contents in the studied plants were presented in Table 3. Lower content of basic nutrients was observed in the plants derived from the control group, i.e. without using amino acid preparation. Crude protein content ranged from 126.8 to 249.4 $g \cdot kg^{-1}$ d.m. As a result of a growing dose of amino acid preparation, crude protein content increased in plants – by 6, 12, 21 and 27% respectively. The content of crude fat, designated as ether extract, varied from 20 to 50 $g \cdot kg^{-1}$ d.m. in roughage feeds, whereas in the studied plants, the value was from 16.5 $g \cdot kg^{-1}$ d.m. to 42.2 $g \cdot kg^{-1}$ d.m. In case of crude fibre in the studied plants, it was stated that its content ranged from 215.1 to 306.2 $g \cdot kg^{-1}$ d.m. in particular variants and was the highest in the control variant. It was observed that as the dose of amino acids increased, the percentage of fibre decreased.

Table 1. Mean squares from two-way analysis of variance for the observed traits

Źródło zmienności Source of variation	Pokos Cut	Dawka Dose	Pokos×Dawka Cut×Dose	Residual
	Liczba stopni swobody Degrees of freedom			
	2	4	8	30
Plon Yield	39.58***	0.309***	0.249***	0.022
Popiół surowy Crude ash	37.05	214.25***	34.08*	13.6
Białko ogólne Crude protein	14658***	2716***	459.8***	38.22
Włókno surowe Crude fibre	656.12***	1808.46***	1011.01***	50.87
Tłuszcz surowy Crude fat	35.64***	197.05***	178.11***	0.722
ADF	2976.31***	3621.25***	3690.17***	91.59
ADL	6716.2***	1909.1***	1710.9***	4.296
NDF	4460.7***	1816.6***	7532.2***	190.2
Cukry rozp. Soluble carbohydrates	5952.62***	622.08***	544.77***	10.19
JPM UFL	0.01212***	0.00418***	0.00681***	0.00045
JPŻ UFV	0.01040***	0.00561***	0.00852***	0.00037
BTJN PDIN	5561.66***	974.13***	139.41***	13.13
BTJE PDIE	1107.163***	141.297***	39.505***	8.16

* P<0.05; ** P<0.01; *** P<0.001.

In terms of energy value, a wide variation in regard to UFL was not noted in the tested variants, the amount ranged from 0.66 to 0.84 kg^{-1} d.m. However, the value of protein was much more varied and ranged from 86.6 to 154.2 for PDIN and 82.9–114.0 $g \cdot kg^{-1}$ of dry matter for PDIE. In comparison to the control group, the value of protein increased in plants derived from the plots fertilized with amino acid preparation by 4, 10, 19 and 25% PDIN and by 3, 5, 6 and 12% PDIE respectively.

Table 2. Mean values and standard deviations (SD) for dry matter yield (t ha^{-1}) in sward of ryegrass-lucerne mixture for different cuts and amino acid preparation fertilization doses

Pokos Cut	Dawka Dose	Wartość średnia Mean value	od. st. SD
I	Kontrola Control	4.642	0.146
	1 dm^3 ha^{-1}	5.276	0.112
	1.5 dm^3 ha^{-1}	5.247	0.193
	2 dm^3 ha^{-1}	5.347	0.196
	2.5 dm^3 ha^{-1}	6.034	0.222
II	Kontrola Control	3.118	0.147
	1 dm^3 ha^{-1}	3.08	0.145
	1.5 dm^3 ha^{-1}	3.157	0.149
	2 dm^3 ha^{-1}	3.256	0.153
	2.5 dm^3 ha^{-1}	3.103	0.146
III	Kontrola Control	2.038	0.110
	1 dm^3 ha^{-1}	2.013	0.109
	1.5 dm^3 ha^{-1}	2.13	0.114
	2 dm^3 ha^{-1}	2.371	0.089
	2.5 dm^3 ha^{-1}	2.094	0.112
$NIR_{0.05}$		0.247	

The obtained results show that 45 out of 78 pairs of traits were statistically significantly correlated (Figure 1). The dry matter yield was significantly positively correlated with the content of water soluble carbohydrates (r=0.72), and negatively with: crude protein (-0.68), ADL (–0.54), UFL (–0.41), UFV (–0.35), PDIN (–0.70) and PDIE (–0.70). The content of total ash was positively correlated with the content of crude fat (0.37) and water soluble carbohydrates (0.32), whereas negatively with: crude protein (–0.35), ADF (–0.31), ADL (–0.33) and PDIN (–0.36).

Crude protein was positively interdependent with: NDF (0.38), ADL (0.67), UFL (0.43), UFV (0.43), PDIN (1.00) and PDIE (0.95), whereas negatively with crude fibre (–0.37) and water soluble carbohydrates (–0.79). The content of crude fibre was positively correlated with ADF (0.53), and negatively with: UFL (–0.62), UFV (–0.64), PDIN (–0.37) and PDIE (–0.47). However, the content of crude fat was directly proportional to NDF (0.50), and inversely proportional to ADF (–0.39). ADF was significantly correlated to: ADL (0.80), water soluble carbohydrates (–0.54), UFL (–0.51) and UFV (–0.58) (Figure 1). Moreover, linear correlation was found between ADL and: water soluble carbohydrates (–0.86), PDIN (0.66) and PDIE (0.49). UFL was strongly correlated with UFV (0.99), whereas PDIN with PDIE (0.96). Besides, PDIN and PDIE were correlated with: NDF, water soluble carbohydrates, UFL and UFV (Figure 1).

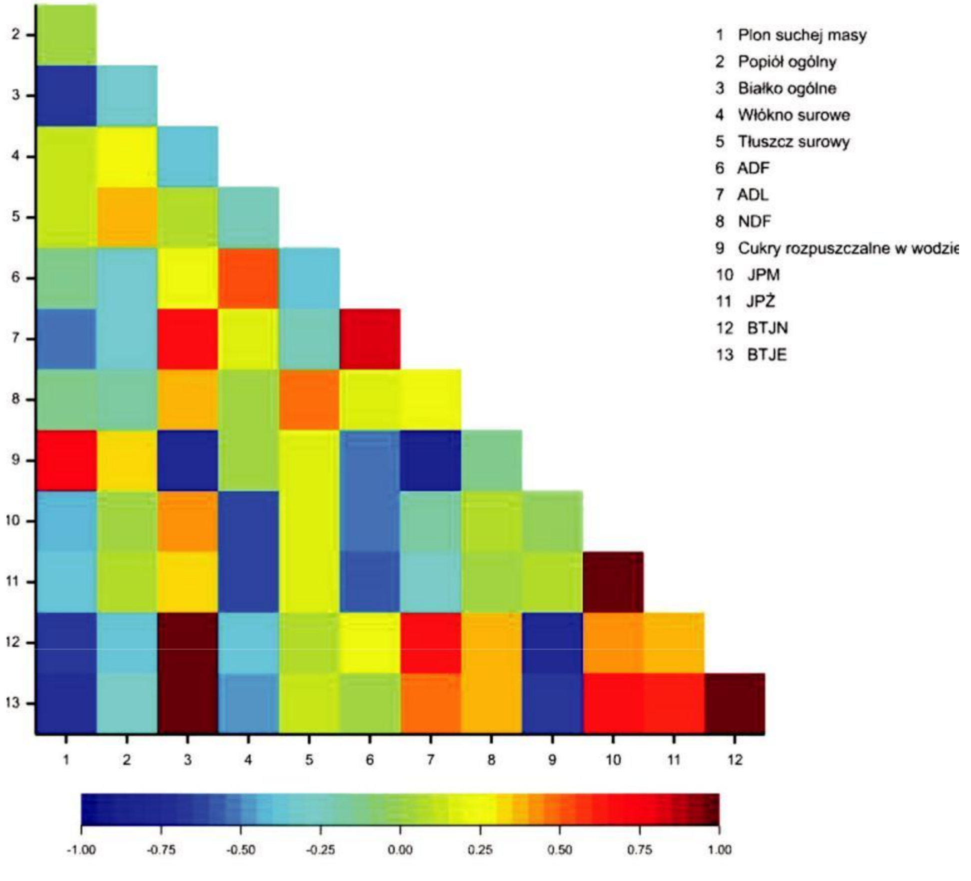

Fig. 1. Heat map for coefficients of Pearson's linear correlation between observed traits (r_{kr}=0.29)

Table 3. Mean values and standard deviations (SD) for chemical composition (g kg^{-1} DM) in sward of Italian ryegrass-lucerne mixture for different cuts and amino acid fertilization doses

Cecha Trait		Popiół ogólny Crude ash		Białko ogólne Crude protein		Tłuszcz surowy Crude fat		Włókno surowe Crude fibre		NDF		ADF		ADL		Cukry rozpuszczalne w wodzie Water soluble carbohydrates	
Pokos Cut	Dawka Dose	Śred. Mean	od. st. SD	Śred. Mean	od. st. SD	Śred. Mean	od. st. SD	Śred. Mean	od. st. SD	Śred. Mean	od. st. SD	Śred. Mean	od. st. SD	Śred. Mean	od. st. SD	Śred. Mean	od. st. SD
I	Kontrola Control	115	2.86	136	10.72	24.2	0.55	277	9.85	494	6.64	343	8.77	32.17	0.38	85.3	11.2
	1 $dm^3\ ha^{-1}$	118	3.76	148	4.71	31	0.99	247	7.86	437	13.9	297	9.47	26.16	0.83	82.9	2.64
	1.5 $dm^3\ ha^{-1}$	123	3.91	163	5.19	29.3	0.93	266	8.48	438	14	312	9.95	30.6	0.98	69.3	2.21
	2 $dm^3\ ha^{-1}$	114	2.85	191	4.79	34.6	0.87	265	3.78	565	14.2	376	9.44	83.39	2.1	56.5	1.42
	2.5 $dm^3\ ha^{-1}$	104	3.12	210	5.27	34.1	0.86	244	6.13	530	13.3	358	8.99	73.83	1.86	53.4	1.34
II	Kontrola Control	116	3.9	194	6.55	30	1.01	252	8.51	533	18	355	11.96	83.63	2.82	57.5	1.94
	1 $dm^3\ ha^{-1}$	120	2.33	191	3.71	41.3	0.80	271	5.26	567	11	353	6.85	68.04	1.32	36.8	0.71
	1.5 $dm^3\ ha^{-1}$	111	3.76	203	6.84	31.4	1.06	267	9.02	559	18.9	320	10.80	47.95	1.62	60.2	2.03
	2 $dm^3\ ha^{-1}$	108	7.41	208	4.04	16.6	0.32	266	4.1	485	9.4	402	7.81	102.9	2	26.6	0.52
	2.5 $dm^3\ ha^{-1}$	104	4.37	214	7.23	19.1	0.64	254	8.57	490	16.6	394	13.28	99.55	3.36	22.5	0.76
III	Kontrola Control	116	3.63	210	4.07	18.9	0.37	300	5.82	467	9.07	401	7.78	120.2	2.33	22.4	0.44
	1 $dm^3\ ha^{-1}$	116	1.97	230	7.78	36.3	1.22	228	7.68	478	16.1	327	11.02	80.86	2.73	28.2	0.95
	1.5 $dm^3\ ha^{-1}$	115	2.62	233	4.52	32.5	0.63	244	4.74	524	10.2	366	7.10	97.61	1.89	34	0.66
	2 $dm^3\ ha^{-1}$	114	2.01	242	8.15	37.9	1.28	258	8.7	540	18.2	335	11.32	91.24	3.08	29.3	0.99
	2.5 $dm^3\ ha^{-1}$	109	3.43	244	4.74	24.2	0.47	219	4.25	518	10	301	5.83	58.05	1.13	42.1	0.82
$NIR_{0.05}$		6.149		10.308		1.417		11.89		23		15.96		3.456		5.323	

Table 4. Mean values and standard deviations (SD) for nutritive value traits (content in 1 kg DM) of different cuts and amino acid fertilization doses

Cecha Trait		JPM UFL		JPŻ UFV		BTJN PDIN		BTJE PDIE	
Pokos Cut	Dawka Dose	Śred. Mean	od. st. SD	Śred. Mean	od. st. SD	Śred. Mean	od. st. SD	Śred. Mean	od. st. SD
I	Kontrola Control	0.724	0.023	0.656	0.021	88.8	2.83	84.94	2.71
	1 dm^3 ha^{-1}	0.724	0.023	0.656	0.021	91.7	2.92	85.9	2.74
	1.5 dm^3 ha^{-1}	0.714	0.023	0.647	0.021	101	3.23	88.8	2.83
	2 dm^3 ha^{-1}	0.676	0.022	0.589	0.019	118	3.75	92.66	2.95
	2.5 dm^3 ha^{-1}	0.705	0.022	0.627	0.020	129	4.12	98.45	3.14
II	Kontrola Control	0.761	0.026	0.692	0.023	121	4.07	98.86	3.34
	1 dm^3 ha^{-1}	0.705	0.014	0.627	0.012	119	2.3	94.96	1.84
	1.5 dm^3 ha^{-1}	0.741	0.025	0.662	0.022	127	4.27	99.85	3.37
	2 dm^3 ha^{-1}	0.685	0.013	0.597	0.012	130	2.53	97.9	1.9
	2.5 dm^3 ha^{-1}	0.712	0.024	0.633	0.021	134	4.5	100.8	3.4
III	Kontrola Control	0.676	0.013	0.587	0.011	130	2.53	97.9	1.9
	1 dm^3 ha^{-1}	0.821	0.028	0.74	0.026	143	4.84	109.7	3.7
	1.5 dm^3 ha^{-1}	0.734	0.014	0.656	0.013	145	2.81	105.7	2.05
	2 dm^3 ha^{-1}	0.741	0.025	0.662	0.022	150	5.07	108.7	3.67
	2.5 dm^3 ha^{-1}	0.842	0.016	0.773	0.015	153	2.96	114.5	2.22
$NIR_{0.05}$		0.036		0.032		6.043		4.763	

Discussion

Amino acid fertilization is used in order to obtain the best possible yielding and the highest quality, especially in environmental conditions unfavourable to the growth and development of plants. The sufficient supply of plants with essential nutrients is a prerequisite for their healthy growth and development, and consequently for high yields. Roughage feeds coming from grassland are of considerable importance, particularly in feeding cattle. Green feed, silage and hay are the basis for feeding ruminants, particularly on smaller farms, therefore they should be characterized by high quality and nutritional value (Baranowski and Richter, 2002; Karaś, 1997).

On the basis of the results obtained in the conducted experiment it can be concluded that foliar application of amino acids has a beneficial effect on the chemical composition and nutritional value of the sward of Italian ryegrass and lucerne. Research on the possibility of using amino acids in fertilization of plants is carried out mainly on arable crops, particularly on vegetables (El-Zohiri and Asfour, 2009; Ahmed et al., 2011; Sadak et al., 2015; Kandil et al., 2016). However, previous research by the authors suggests that amino acid fertilization has also a beneficial effect on the growth of plants of meadow sward (Radkowski and Radkowska, 2018; Radkowski et al., 2018). Amino acids play a key role in plant metabolism, including the availability of proteins, which are one of the most important factors that facilitate proper formation of cells. Thon et al. (1981) indicated that amino acids are the source of nitrogen, easily available for plant cells, which is absorbed faster than inorganic nitrogen. The increase of green material and dry matter is the consequence of life processes of plants which proceed in a proper way. The positive effect of the application of these biocatalysts on the growth of plants might also result from the fact that some amino acids, like phenylalanine or ornithine can stimulate the gibberellin biosynthesis (Walter and Nawacki, 1978). The higher yield ability on the plots cultivated with amino acids, observed in the experiment, corresponds to the results of the experiments performed on arable crops (El-Zohiri and Asfour, 2009; Ahmed et al., 2011; Tarraf et al., 2015). The research was carried out on various plant species and gave a positive result in the form of higher yield of the above-ground matter. The study conducted on soy indicated that using amino acids had a positive impact on the amount of fresh matter and crop yields (Saeed et al., 2005). Ahmed et al. (2011) also proved that the application of amino acids increased significantly the height of plants, stem diameter, fresh and dry matter of leaves in *Hibiscus sabdariff*. Similar effects were found in potato cultivation, where significant vegetative growth of plants, plant height and dry matter yields were obtained (El-Zohiri and Asfour, 2009). The application of amino acid fertilization also had a positive impact on vegetative growth of fenugreek (*Trigonella foenum-graecum* L.), obtaining greater number of leaves, twigs, greater plant height and also larger weight of fresh and dry matter (Tarraf et al., 2015). Gamal El-Din and Abd El-Wahed (2005) obtained similar results in case of camomile cultivation. In the authors' own studies (Radkowski et al., 2018) it was also proved that foliar fertilization with amino acids had a positive effect on yielding of meadow sward and utilization of nutrients. The application of a dose of amino acids in quantity of 4,5 $dm^3 \cdot ha^{-1}$ significantly ($P \leq 0.05$) improved plant height, which resulted in higher dry matter yield. The highest yield was noted in the first year and it was 1.74 $t \cdot ha^{-1}$ d.m. compared to the control. The research by Kandil et al. (2016) indicated that amino acids can increase yields of fresh and dry matter, because they play an important role in plant metabolism and assimilation of proteins, necessary for the creation of new cells. Moreover, the application of amino acids has a positive impact on the content of chlorophyll and its components in plants (Shehata et al., 2011). Therefore, by the improvement and regulation of growing conditions and the influence on the intensity of photosynthesis we can increase yielding and plant performance.

Scientific findings indicate that amino acid fertilization has a positive impact on the chemical composition of plants. As was mentioned earlier, the majority of the conducted research concerns arable crops. Tests carried out on lettuce, cabbage, onion, pak choi Chinese cabbage and other leafy vegetables indicated that using amino acids led to the increase of the total nitrogen content and to the partial reduction of nitrate content (NO_3) in leaves (Gunes et al., 1994; Chen and Gao, 2002; Wang et al., 2004). The research by Liu et al. (2008) also showed the increase of N content in plant sprouts, with the reduction of nitrates (NO_3) by 24–38%. This is probably due to the fact that plants preferred amino acids as a source of reduced nitrogen and therefore the application of stimulators led to the reduction of nitrate intake. Higher content of crude protein in vegetation cultivated with amino acids corresponds to the results of research by Zewail (2014). The study of these authors proved that as the doses of amino acids increased, the content of crude protein in leaves of *Phaseolus vulgaris* L. was also higher. Similar results were also obtained in the research conducted by Pooryousef and Alizadeh (2014). Minimum content of crude protein in feed, essential for healthy digestive processes in gastrointestinal tract of cattle should amount to 150–170 $g \cdot kg^{-1}$ d.m. (Brzóska, 2008). The content of crude protein in the tested variants of the sward of perennial ryegrass and lucerne was well-diversified, in plants from unfertilized plots it was below the optimal standard, whereas in plants derived from the plots where higher doses of amino acids were applied, it exceeded recommended values.

In this study, in case of the majority of the tested variants, optimal fat content was observed to be within recommended standards for roughage feeds in the range of 20 to 50 $g \cdot kg^{-1}$ d.m. (Brzóska and Śliwiński, 2011). An exception to this were the variants with applied higher dose of amino acids per second cut and a variant without fertilizing in the third cut. The feeds from grassland used in feeding ruminants should contain from 200 to 250 $g \cdot kg^{-1}$ d.m. of crude fibre and the content should not exceed 280 $g \cdot kg^{-1}$ d.m. (Brzóska, 2008). The conducted studies revealed no significant differences among various variants, however, they showed the tendency towards lower content of NDF and ADL under the influence of amino acid fertilization. The feeds from the tested plots, estimated in units of energy (UFL) in INRA system had values similar to the tabulated ones. The highest values in terms of energy were observed in plants from the control group and from the plots with lower doses of amino acid preparation.

The research carried out indicates the positive influence of amino acid fertilization on yielding and basic chemical composition of sward composed of perennial ryegrass and lucerne. The study found that there was a significant influence of amino acid preparation on yields of the tested mixture and a significant increase of yielding in comparison to the control group and on the content of crude protein. It was noted that with increasing dose of preparation, concentration of crude protein was significantly higher, which translates into higher values of PDIN and PDIE compared to the plants from the control group. However, the applied fertilization did not have a significant impact on the values of UFL and UFV energy units. The analyses and determinations carried out, indicated that using higher doses of amino acid preparations make it possible to obtain high quality feed for livestock.

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Effect of amino acid fertilization on chemical composition and nutritive value of sward of Italian ryegrass-lucerne mixture

SUMMARY

The aim of the study was to determine the effect of using an amino acid preparation on productiv-ity and nutritive value of a mixture of Italian ryegrass (*Lolium multiflorum* Lam.) and alfalfa (*Medicago sativa* L.). The following fertilizer treatments were prepared: control without amino acid fertilization; experimental with different amino acid doses (1, 1.5, 2 and 2.5 $dm^3 \cdot ha^{-1}$ per regrowth). The plant material was analysed for basic chemical composition using the standard method and for nutritive value using the INRA units. The results showed that increasing dose was paralleled by increased concentration of crude protein, and in some cases also of crude fat. Due to the higher protein content, plants from the plots fertil-ized with amino acids were characterized by higher PDIN and PDIE values compared to control plants. No significant differences were observed for UFL and UFV values.

Key words: amino acids, Italian ryegrass, alfalfa, nutritive value, chemical composition