

## **FEED VALUE OF MIXTURES OF *Festulolium braunii* (K. RICHT.) A. CAMUS WITH *Trifolium pratense* L. DEPENDING ON NITROGEN FERTILIZATION**

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**Abstract.** The aim of the research was evaluation of the influence of nitrogen fertilization dose and of various percentage of components on the content of organic and mineral substances and on the food value of festulolium mixtures with red clover. The study included two factors: percentage of red clover seeds in the mixture (40, 60 and 80%) as well as the level of nitrogen fertilization (0, 60, 120, 180 kg·ha<sup>-1</sup>). It was proved that the mixture with 80% part of legume plant seeds was characterized by the greatest content of total protein and ash constituents as well as by the optimum content of crude fibre. Increase of the percentage of red clover seeds in the mixture positively influenced the content of Ca and the decrease of molar ratio of K : (Ca + Mg), which improved the nutritive value of the feed. Mixtures not fertilized with nitrogen were characterized by greater content of protein and lower content of fibre, and they were better balanced, regarding protein and energy, than fertilized mixtures. Size of the nitrogen dose did not have a significant influence on the feed quality.

**Key words:** energy value of feed, feed unit for lactation, feed unit for meat production, festulolium, red clover, legume-grass mixture, protein value of feed

### **INTRODUCTION**

Legume-grass mixtures, apart from their great yielding potential, are distinguished by their beneficial chemical composition. Feed from mixtures is better balanced regarding protein and energy, compared to sole-crop sowing, which results in higher productivity of animals [Borowiecki and Ścibior 1997, Szyszkowska et al. 1997, Jolliffe and Wanjan 1999]. Growing mixtures does not require a large dose of nitrogen fertilizers, which significantly lowers the costs of feed production [Goliński 1998, Grzegorzczak 1999], and their after-effect allows significant limitation of mineral

fertilization of successively grown plants [Nowak and Sowiński 2007, Søegaard et al. 2007].

The nutritive value of plant material depends, among others, on the percentage of grasses and legumes in mixtures and on the nitrogen fertilization. The optimum yield and the quality of forage are provided by clover-grass mixtures which, according to different authors, should contain from 30 to 50% clover and from 50 to 70% grasses [Ciepiela et al. 1998, Kessler and Lehmann 1998, Sowiński et al. 1998, Kryszak 2003]. According to Goliński [2008] the presence of legumes in a grass sward on the level from 20 to 40% ensures obtaining productivity similar to grass sowing additionally fertilized with nitrogen on the level of  $180 \text{ kg} \cdot \text{ha}^{-1}$ . However, maintaining the desired proportion of components is difficult with regard to the inconstancy of habitat factors and to interaction of plants in the sward [Zannone et al. 1986] Festulolium hybrid is characterized by great competitive abilities towards other grasses and legumes, and strongly reacts to nitrogen fertilization [Borowiecki 1997, Ostrowski 2000, Søegaard and Weisbjerg 2007]. Therefore, to obtain expected percentage of particular components in the crop, which to a great extent determines the feed quality, an appropriate proportion of the seeds of these species in the sowing mixture and the optimum dose of fertilization should be determined.

The aim of the research was evaluation of the influence of nitrogen dose and of various percentage of components on the chemical composition and on the nutritive value of festulolium mixtures with red clover. It was assumed that the best, with regard to the nutritive value, would be the feed from the mixture in which the percentage of seeds of the grass component would be limited to 20%, and the nitrogen fertilization in the years of production would be  $60 \text{ kg}$  of nitrogen per ha.

## MATERIAL AND METHODS

Field experiment was conducted in 2-3-year series in the years 2005-2007 and 2006-2008 in Agricultural Experimental Station of Institute of Soil Science and Plant Cultivation in Grabów ( $51^{\circ}21' \text{ N}$ ;  $21^{\circ}40' \text{ E}$ ). Mixtures of festulolium (of the Sulino cultivar) with red clover (of the Nike cultivar) were sown on the grey-brown podsolic soil on the very good rye complex. The soil reaction was neutral, the mean content of P, K, Mg per 1000 g of soil was:  $\text{P}_2\text{O}_5$  – 144 mg (mean content),  $\text{K}_2\text{O}$  – 117 mg (low content), Mg – 40 mg (low content), C – 0.72%, humus – 1.23%, N-total – 0.06%. The experiment was conducted in the split-plot design, in four replications, on harvest plots of  $22 \text{ m}^2$ . In the scheme of the experiment two factors were included: percentage of red clover seeds in the mixture: 40, 60 and 80%, in relation to the mass of seeds sown in the pure sowing: festulolium –  $40 \text{ kg} \cdot \text{ha}^{-1}$  ( $750 \text{ plants} \cdot \text{m}^{-2}$ ), red clover  $12 \text{ kg} \cdot \text{ha}^{-1}$  ( $320 \text{ plants} \cdot \text{m}^{-2}$ ) and the levels of nitrogen fertilization: 0,  $60_{(3 \times 20)}$ ,  $120_{(3 \times 40)}$  and  $180_{(3 \times 60)}$   $\text{kg} \cdot \text{ha}^{-1}$ . Festulolium was sown in a sole-crop sowing on control objects and was fertilized with the nitrogen dose of  $180 \text{ kg} \cdot \text{ha}^{-1}$  and red clover without nitrogen fertilization. The mixtures were sown on 14 April 2005 and on 9 May 2006, rows every 12 cm, without a cover crop. The following doses of mineral fertilization were used ( $\text{kg} \cdot \text{ha}^{-1}$ ): in the sowing year N –  $60_{(2 \times 30)}$ , P – 26 and K – 66, in the years of production P – 22, K –  $66_{(33+33)}$  and nitrogen according to the experiment scheme.

In the first series in the first year of production, 3 cuts were harvested, in the second year 4 cuts, while in the second series in both years of production 4 cuts were obtained. At the time of harvest, from each plot 2 samples of 0.5 kg of forage were collected, one to determine the botanical composition, and the second one to determine the content of the air dry mass and for chemical analysis. In the plant samples the content of dry mass (with the use of the weight method at 105°C), crude fibre, crude fat and crude ash (with the use of conventional methods) were determined. The content of macroelements was determined after wet mineralization of the plant material (concentrated H<sub>2</sub>SO<sub>4</sub> + perhydrol): with the flow spectrophotometric method (N and P), with the flame emission spectrometry method (K) and with atom absorption spectrometry method (Ca and Mg). Protein and energy values of the feed from mixtures were calculated according to the French system, INRA [1988]. The results were elaborated for the random subblock design, significance of differences was compared with the use of Tukey's test on the level of significance P = 0.05. Calculations were carried out with ANWAR program (ZAZI IUNG Puławy).

Weather conditions at the time of research were diverse, especially the rainfall was characterized by a great changeability (Table 1). In 2005 there was a lot of humidity in May and July, however significant deficiencies in rainfall were noted in April, June and August. 2006 was even less beneficial for the growth and development of grasses. June and July were very dry, with high temperature of air (in July it was beyond the average temperature from many years by 4.1°C). Intensive rainfall occurred only in August and it was almost three times greater than the mean rainfall in this area. In the years 2007 and 2008 the total rainfall in vegetation period was by 30 and 12%, respectively, higher than the mean from many years, while its distribution was more even. Vegetation of plants in the first series of experiment (2005-2007) occurred in less favourable weather conditions, however mixtures in the second series of research (2006-2008) had better moisture conditions.

## RESULTS AND DISCUSSION

Density of plants after their emergence was quite good. The real percentage of clover was on average 13.3% in 2005 and 18.2% in 2006 in the mixture with 40% part of seeds of the legume component and 32.5 and 30.1% respectively with 60% and 50.6 and 66.1% with 80% part of red clover seeds at sowing (Table 2). Worse emergence of legume in 2005 was caused by less favourable moisture conditions in that period. Significant influence on the initial growth and development of clover also had huge competitiveness of festulolium in relation to the legume plant, which was reported by different authors [Borowiecki 1997, Ostrowski 2000, Ścibior and Gawel 2004]. Water deficiencies in summer months in the year of sowing caused considerable losses of clover, its percentage in the yield being much smaller compared with the percentage after emergence. It also found its reflection in the smaller percentage of clover in the dry mass yield in the first year of production (2007), however, its percentage in the second year increased significantly, with a greater soil humidification (Table 2).

Table 1. Meteorological conditions in periods of mixture vegetation  
 Tabela 1. Warunki meteorologiczne w okresach wegetacji mieszanek

Year of experiment Rok badań	Total of rainfalls – Suma opadów, mm												Mean daily air temperature – Średnia dobowa temperatura, °C											
	April kwiecień	May maj	June czerwiec	July lipiec	August sierpień	September wrzesień	sum suma	April kwiecień	May maj	June czerwiec	July lipiec	August sierpień	September wrzesień	mean średnia										
2005	10.2	84.0	46.3	132.8	36.8	43.6	353.7	8.6	13.5	16.1	20.0	17.5	14.8	15.1										
2006	30.1	53.4	38.2	10.0	219.5	13.8	365.0	9.0	13.6	17.4	22.4	17.9	15.5	16.0										
2007	13.3	74.6	99.9	75.5	151.7	77.4	492.4	8.7	15.2	18.7	19.2	19.1	12.8	15.6										
2008	71.8	87.6	51.1	85.4	54.5	70.9	421.3	9.0	13.1	17.6	18.9	18.9	12.5	15.0										
Mean from long term Średnia z wielolecia	39.0	57.0	71.0	84.0	75.0	50.0	376.0	7.7	13.4	16.7	18.3	17.3	14.4	14.4										

Harkot and Trąba [1998], among others, reported great influence of weather conditions on the mixture composition. Clover percentage in the harvested biomass in the years of production depended on the percentage of seeds of mixture components at sowing, on the level of nitrogen fertilization, and on the weather conditions in respective years of research. Greater percentage of clover in the sowing mixture affected its higher percentage in the dry mass yield, which corresponds to the results of Sowiński et al. [1997]. On the other hand, the increase of nitrogen dose caused the increase of the grass percentage in the yield. Many authors emphasize that intensive nitrogen fertilization eliminates legumes from the sward [Sowiński et al. 1997, Ciepiała et al. 1998, Kryszak 2003].

Table 2. Emergence and percentage of red clover in the yield of mixtures, %  
Tabela 2. Wschody oraz średni udział koniczyny łąkowej w plonie mieszanek, %

Percentage of red clover Udział koniczyny %	Dose of nitrogen Dawka azotu kg·ha <sup>-1</sup>	Emergence Wschody		Percentage of red clover in dry matter yield Udział koniczyny w suchej masie plonu							
				sowing year rok siewu*		first year of production pierwszy rok użytkowania		second year of production drugi rok użytkowania			
		series – seria									
		I (2005)	II (2006)	I (2005)	II (2006)	I (2006)	II (2007)	I (2007)	II (2008)		
40	0	13.2	24.7	8.7	1.4	66.1	24.0	74.7	70.7		
	60	10.0	17.0	8.4	1.5	45.3	18.8	50.1	66.4		
	120	15.2	17.7	7.6	3.1	45.7	11.1	42.8	56.2		
	180	14.8	13.2	9.2	2.2	37.7	2.8	34.0	40.1		
	mean średnia	13.3	18.2	6.2	2.0	48.7	14.2	50.4	58.4		
60	0	35.7	25.6	16.9	6.4	70.0	41.8	78.0	78.7		
	60	33.2	29.2	8.5	6.1	58.5	23.6	61.9	75.8		
	120	31.6	32.3	11.3	3.3	48.9	11.0	56.3	57.0		
	180	29.4	33.3	13.5	6.2	48.9	9.2	46.6	47.9		
	mean średnia	32.5	30.1	12.6	5.5	56.6	21.4	60.7	64.8		
80	0	56.7	54.3	10.0	13.9	66.2	51.2	76.2	87.8		
	60	47.2	71.2	16.4	15.5	66.7	34.8	63.7	66.6		
	120	52.8	70.5	19.5	10.2	57.6	24.2	55.6	65.6		
	180	45.6	68.5	18.8	20.9	54.2	22.9	51.6	60.3		
	mean średnia	50.6	66.1	16.2	15.1	61.2	33.3	61.8	70.1		

\* in the sowing year doses of nitrogen fertilization didn't differ – w roku siewnym dawki nawozu azotowego nie różniły się

The studied experiment factors did not significantly influence chemical composition and nutritive value of the feed in the sowing year, thus, these results were not presented in this study. No interaction was proved between studied factors, therefore the results were presented in the form of mean values from respective years of production.

Percentage of seeds of the mixtures components, in general, significantly differentiated the content of chemical constituents in the dry mass of plants (Table 3). Increase of clover percentage in the sowing mixture caused the increase of the content

of total protein and crude fibre, however the content of crude fat and nitrogen-free extracts decreased in the dry mass of plants. The content of crude fibre was optimum in every mixture [Falkowski et al. 1990]. In comparison with sole-crop sowing, the mixtures accumulated on average from 8 to 27% more total protein than festulolium in the first year of production and from 10 to 15% more in the second year. The content of crude fibre and festulolium in mixtures was similar in the first year and on average by 5 to 8% lower in mixtures in the second year of production. Obtained results are confirmed in the research of Sowiński et al. [1998], Staniak and Księżak [2008] as well as Ścibior and Gaweł [2004], who proved positive influence of the high percentage of red clover in the mixture canopy on the quality of feed, especially on the increase of protein content and on the decrease of fibre content. The content of nitrogen-free extracts was the lowest in clover from pure sowing (on average 465 g·kg<sup>-1</sup>), and the greatest in sole-crop sowing of festulolium (on average 488 g·kg<sup>-1</sup>). Inverse proportions were noted in the case of crude ash. Mixtures were characterized by mean content of these components. Similar dependences were proved by Nowak and Sowiński [2007].

Table 3. Mean contents of organic and mineral components in dry matter yield of mixtures, g·kg<sup>-1</sup>  
Tabela 3. Średnia zawartość związków organicznych i mineralnych w suchej masie mieszanki, g·kg<sup>-1</sup>

Factor Czynnik	Level of factor Poziom czynnika	Total protein Białko ogólne	Crude fibre Włókno surowe	Crude fat Tłuszcz surowy	Crude ash Popiół surowy	N-free extracts Związki bezażotowe wyciągowe
The first year of production (mean from 2006-2007) – Pierwszy rok użytkowania (średnia z lat 2006-2007)						
Percentage of red clover, % Udział koniczyny łąkowej, %	40	127.8 a*	240.8 a	39.5 a	95.0 a	497.0 a
	60	128.5 ab	247.4 ab	38.1 a	96.6 a	489.4 ab
	80	150.1 b	234.6 b	37.2 a	101.8 b	476.2 b
Nitrogen dose Dawka azotu kg·ha <sup>-1</sup>	0	147.7 a	232.8 a	36.6 a	98.0 ab	484.9 a
	60	131.4 a	238.5 ab	36.4 a	95.0 a	498.7 a
	120	126.1 a	248.3 b	39.1 ab	98.1 ab	488.3 a
	180	136.6 a	244.0 b	41.0 b	100.0 b	478.5 a
Festulolium 100%		118.0	242.0	40.7	101.8	497.5
Red clover 100%						
Koniczyna łąkowa 100%		183.0	209.5	38.2	103.2	466.1
The second year of production (mean from 2007-2008) – Drugi rok użytkowania (średnia z lat 2007-2008)						
Percentage of red clover, % Udział koniczyny łąkowej, %	40	162.8 a	229.2 a	38.7 a	91.2 a	478.1 a
	60	163.2 a	230.8 a	32.3 b	90.5 a	483.2 a
	80	172.0 a	234.8 a	34.1 b	93.8 b	465.3 b
Nitrogen dose Dawka azotu kg·ha <sup>-1</sup>	0	174.2 a	224.7 a	33.8 a	94.2 a	473.1 a
	60	160.8 a	231.3 a	35.4 a	90.1 b	482.3 b
	120	164.7 a	235.5 a	35.3 a	92.3 ab	472.2 a
	180	164.3 a	234.8 a	35.7 a	90.7 b	474.4 ab
Festulolium 100%		148.5	245.0	39.0	89.7	477.8
Red clover 100%						
Koniczyna łąkowa 100%		191.0	216.5	31.6	97.4	463.5

\* numbers in columns denoted by the same letters do not differ significantly – liczby w kolumnach oznaczone takimi samymi literami nie różnią się istotnie

Nitrogen fertilization in general had a weak influence on the content of basic nutrients in the dry mass of mixtures (Table 3). The greatest content of total fibre, in both years of production, was characteristic of mixtures not fertilized with nitrogen, where differences were not statistically proved. Those mixtures were distinguished by the lowest content of crude fibre. The greatest amount of crude fibre and fat was accumulated by mixtures fertilized with nitrogen at a dose of 120 and 180 kg·ha<sup>-1</sup>, with significant differences noted only in the first year of production. Weak influence, not confirmed statistically, of nitrogen fertilization on the protein content in mixtures of red clover with various grasses was found by Nowak and Sowiński [2007] as well as by Ciepiela et al. [2008]. Bałuch-Małecka and Olszewska [2007] proved that the greatest yield of protein was obtained from legume-grass mixtures not fertilized with nitrogen, compared with those fertilized with the doses of 60 and 120 kg·ha<sup>-1</sup>. It should be emphasized that mixtures without nitrogen fertilization accumulated on average by 21% more total protein in the dry mass yield than festulolium in pure sowing, fertilized with nitrogen at a dose of 180 kg·ha<sup>-1</sup>. Roberts et al. [1989] emphasize that legume-grass mixtures, without nitrogen fertilization, allowed forage to obtain better quality parameters than grasses fertilized with nitrogen at a dose of 340 kg·ha<sup>-1</sup>, while silage formed from it contained more protein and minerals.

The content of macroelements in the dry mass of mixtures formed indirectly in relation to sole-crop sowing (Table 4). Mixtures were richer in Ca and Mg, however more deficient in P, K than festulolium. Increase of nitrogen dose caused the increase of the content of P and K, whereas the content of Ca slightly decreased. Falkowski et al. [2000] report that a positive dependence occurs between the content of phosphorus and nitrogen in plants. Festulolium in the sole crop sowing was fertilized with nitrogen at a dose of 180 kg·ha<sup>-1</sup>, whereas clover was not fertilized at all, which could affect greater accumulation of phosphorus by grass. Greater content of K and P in grasses Kasperczyk [1994] explains with a strong penetration of the surface soil layer, rich in those elements, by the root system of grasses. According to Harkot and Trąba [1998] diversified absorption of potassium by plants in successive years of research may also be caused by weather conditions. The consequence of light rainfall is the slow passing of potassium from fertilizers into deeper soil layers and its greater absorption by plants. On the other hand, large content of Ca in legumes Pharis et al. (source: Kasperczyk [1994]) connect to their specific mechanism of nourishing on nitrogen. In legumes reduction of atmospheric nitrogen into the ammonium form is stimulated by nitrate reductase, whose effectiveness is positively related to the content of Ca in a plant. To enable the normal course of the process, legumes must absorb greater amounts of calcium. A good feed for ruminants should contain: 3-4 P, 17-20 K, 7 Ca, 2 Mg g·kg<sup>-1</sup> [Grzegorzczak 1999, Falkowski et al. 2000, Kasperczyk and Jančovič 2000]. Feed from the studied mixtures was characterized by the optimum content of P and Mg as well as by too high content of K and Ca, where the content of K in the second year of production decreased, whereas Ca increased. Greater content of potassium in legume-grass mixtures is a frequent phenomenon as it is an element absorbed as a luxury by plants, therefore most often it occurs in excess [Nowak and Sowiński 2007]. Moreover, fertilization with nitrate nitrogen, compared to the ammonium form of nitrogen, increases the content of potassium in plants. The content of minerals is also a species trait. According to Falkowski et al. [2000], *Festuca pratensis* and *Lolium multiflorum* may have potassium content reaching even up to 4 g·kg<sup>-1</sup> in the dry mass.

Table 4. Mean contents of macroelements in dry matter yield of mixtures, g·kg<sup>-1</sup>  
 Tabela 4. Średnia zawartość makroelementów w plonie masy suchej mieszanek, g·kg<sup>-1</sup>

Factor Czynnik	Level of factor Poziom czynnika	P	K	Ca	Mg	K : Ca	K : (Ca + Mg)	Ca : P
The first year of production (mean from 2006-2007) – Pierwszy rok użytkowania (średnia z lat 2006-2007)								
Percentage of red clover, % Udział koniczyny łąkowej, %	40	3.1 a*	31.4 ab	8.9 a	2.0 a	2.5 a	3.0 a	2.9 a
	60	3.2 a	30.5 a	9.5 a	2.2 b	2.0 b	2.6 a	3.0 a
	80	3.0 a	32.0 b	11.1 a	2.2 b	1.9 b	2.4 a	3.7 a
Nitrogen dose Dawka azotu kg·ha <sup>-1</sup>	0	3.0 a	29.9 a	10.9 a	2.2 a	2.0 a	2.3 a	3.6 a
	60	3.0 a	30.7 a	9.7 a	2.0 a	2.1 a	2.7 a	3.2 a
	120	3.1 ab	31.5ab	9.2 a	2.1 a	2.0 a	2.8 a	3.0 a
	180	3.2 b	33.2 b	9.5 a	2.1 a	2.3 a	2.9 a	2.9 a
Festulolium 100%		3.5	36.4	7.2	1.8	5.0	4.0	2.1
Red clover 100%		2.8	31.2	15.2	3.0	2.0	1.7	5.4
Koniczyna łąkowa 100%								
The second year of production (mean from 2007-2008) – Drugi rok użytkowania (średnia z lat 2007-2008)								
Percentage of red clover, % Udział koniczyny łąkowej, %	40	3.2 a	28.4 a	12.4 a	2.4 a	2.3 a	1.9 a	3.8 a
	60	3.2 a	27.6 a	14.0 ab	2.7 a	2.0 ab	1.7 a	4.4 a
	80	3.2 a	28.2 a	15.2 b	2.6 a	1.9 b	1.6 a	4.8 a
Nitrogen dose Dawka azotu kg·ha <sup>-1</sup>	0	3.1 a	28.0 a	15.5 a	2.6 a	1.8 a	1.6 a	5.0 a
	60	3.1 a	27.5 a	13.4 ab	2.5 a	2.1 a	1.7 a	4.3 a
	120	3.2 a	28.1 a	14.0 ab	2.5 a	2.0 a	1.7 a	4.5 a
	180	3.4 a	28.5 a	12.5 b	2.6 a	2.3 a	1.9 a	3.7 a
Festulolium 100%		3.6	31.1	9.0	2.1	3.5	2.8	2.5
Red clover 100%		3.0	26.6	17.8	3.0	1.5	1.3	5.9
Koniczyna łąkowa 100%								

\* for explanations, see Table 3 – objaśnienia pod tabelą 3

In ruminant feeding a significant issue is proper selection of proportions of minerals in mixtures as well as their equivalence ratio, allowing the feed to obtain closest to optimum content of elements [Jankowski and Ciepiela 2000, Kasperczyk and Jančovič 2000]. According to Falkowski et al. [2000] ratio of K : (Ca + Mg) and K : Ca should not be over 2.0. Studied mixtures were characterized by slightly wider ratio of K : (Ca + Mg) in the first year of production and by optimum ratio in the second year. The increase of percentage of clover seeds affected lowering of this ratio and the improvement of the feed value, which was also proved by Ciepiela et al. [1998]. The ratio of K : Ca may be considered as proper in mixtures in which percentage of clover seeds was 80 and 60%. According to Płodzik [1996], optimum range of molar ratio of K : (Ca + Mg) may be obtained from mixtures in which clover percentage is over 45%. Weight ratio value of Ca : P in food doses for ruminants should oscillate between 1 and 3. In studied mixtures, from the point of view of ruminant needs, the ratio value was optimum in the first year of production, whereas in the second year the high content of calcium in clover raised this ratio.

Changes in the chemical content affected the protein and energy value of the feed from studied mixtures (Table 5). Calculated according to the INRA system [Normy... 1998] the amount of total protein actually digested in the intestine, was correlated to the



total protein content in mixtures. Together with the increase of the percentage of red clover seeds in the mixture increased protein value of the feed expressed in PDIF and PDIN units. Similar correlations were proved by Grzegorzczuk [1999], Staniak [2009] and Szyszkowska et al. [1997].

Table 5. Protein and energy value of fodder in the years of production (the first cut), g·kg<sup>-1</sup> DM  
Tabela 5. Wartość białkowa i energetyczna paszy w latach użytkowania (pierwszy pokos), g·kg<sup>-1</sup> s.m.

Factor Czynnik	Level of factor Poziom czynnika	PDIF BTJP	PDIN BTJN	PTIE BTJE	UFL JPM	UFV JPŻ
The first year of production (mean from 2006-2007) – Pierwszy rok użytkowania (średnia z lat 2006-2007)						
Percentage of red clover, % Udział koniczyny łąkowej, %	40	25.08	70.06	86.96	0.86	0.80
	60	25.55	71.37	80.99	0.80	0.75
	80	27.68	77.34	87.14	0.79	0.74
Nitrogen dose Dawka azotu kg·ha <sup>-1</sup>	0	29.75	83.11	82.32	0.81	0.76
	60	24.77	69.20	88.17	0.82	0.77
	120	24.01	67.07	83.86	0.83	0.77
	180	25.89	72.32	85.78	0.82	0.77
Festulolium 100%		22.59	63.10	85.98	0.89	0.84
Red clover 100%		47.16	131.75	102.05	0.79	0.73
Koniczyna łąkowa 100%						
The second year of production (mean from 2007-2008) – Drugi rok użytkowania (średnia z lat 2007-2008)						
Percentage of red clover, % Udział koniczyny łąkowej, %	40	26.55	74.18	82.71	0.81	0.76
	60	27.38	76.50	82.92	0.78	0.73
	80	29.38	84.57	81.81	0.79	0.74
Nitrogen dose Dawka azotu kg·ha <sup>-1</sup>	0	33.23	92.83	86.42	0.78	0.73
	60	27.65	77.24	82.15	0.79	0.74
	120	26.71	74.62	80.15	0.79	0.74
	180	23.50	68.98	81.19	0.80	0.75
Festulolium 100%		21.12	58.10	78.69	0.83	0.77
Red clover 100%		42.15	117.75	92.05	0.79	0.74
Koniczyna łąkowa 100%						

PDIF – BTJP – protein digested in the small intestine –białko trawione w jelicie cienkim

PDIN – BTJN – 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 – białko trawione w jelicie pochodzące z paszy plus białko trawione w jelicie cienkim pochodzenia mikrobiologicznego odpowiadające ilości białka paszy ulegającego rozkładowi w żwaczu

PTIE – BTJE – 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 – białko trawione w jelicie cienkim pochodzące z paszy plus białko trawione w jelicie cienkim pochodzenia mikrobiologicznego, odpowiadające ilości masy organicznej paszy fermentującej w żwaczu

UFL – JPM – feed unit for lactation – jednostka paszowa produkcji mleka

UFV – JPŻ – feed unit for maintenance and meat production – jednostka paszowa produkcji żywca

The highest protein value was characteristic of the feed made of sole clover, and the lowest value from the sole crop of festulolium, where neither the first nor the second feed was properly balanced. Nitrogen fertilization weakly influenced the protein value

of mixtures. More protein was found in mixtures not fertilized and in them occurred the smallest difference between PDIN and PTIE, which testifies to a better balance of protein and energy ingredients in such a feed than from the sole-crop sowing. However, nitrogen dose did not have an influence on the protein value expressed in PDIF, PDIN and PTIE units. Beneficial influence of legumes on the food value of the feed is indicated by animal productivity. Mikołajczak and Warda [1997], citing research results of other authors, point to visible dependence of cow productivity on the legume percentage in the feed. As the amount of clover in the sward was increasing, cows' milking productivity increased as well, while feeding with concentrates could be significantly limited without lowering the milk productivity.

In INRA system [Normy... 1998] energy value of feeds is expressed in feed units for lactation (UFL) and feed units for maintenance and meat production (UFV). The greatest energy value of feed was obtained from pure sowing of festulolium, however as the percentage of red clover in the mixture increased, this value decreased. The lowest energy value of the feed, expressed in feed units for lactation and maintenance and meat production (UFL, UFV), was obtained from the feed of sole clover. Nitrogen fertilization did not have an influence on the energy value of the feed from studied mixtures, which is confirmed by the results of Wolski and Szyszkowska [1998].

## CONCLUSIONS

1. Percentage of components in the mixture of red clover with festulolium generally differentiated the content of organic substances in the dry mass of plants. Mixture with 80% part of legume plant seeds was characterized by the greatest content of total protein and ashes, by the optimum content of crude fibre and the smallest amount of fat and nitrogen-free extracts compared to mixtures with 40 and 60% part of red clover.

2. The increase of the part of red clover seeds in the mixture up to 80% positively influenced the content of Ca in the dry mass as well as the decrease of molar ratio of K: (Ca + Mg), which improved the nutritive value of the feed.

3. Mixtures without nitrogen fertilization were characterized by the greatest content of total protein and the smallest content of crude fibre. The nitrogen doses (60, 120 and 180 kg·ha<sup>-1</sup>) did not have a significant influence on the content of basic nutrients in the dry mass.

4. Compared to the pure sowing of festulolium in mixtures were found on average up to 27% more protein and up to 8% less crude fibre and more optimum, from the point of view of ruminant needs, the content of macroelements.

5. In conditions of conducted research, the feed from a mixture with 80% part of red clover seeds at sowing, not fertilized with nitrogen, proved to have a more beneficial chemical composition and was better balanced regarding protein and energy, compared to mixtures with 40 and 60% part of legume seeds. Increase of the nitrogen dose did not contribute to the feed quality improvement.

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**WARTOŚĆ PASZOWA MIESZANEK *Festulolium braunii* (K. RICHT.)  
A. CAMUS Z *Trifolium pratense* L.  
W ZALEŻNOŚCI OD NAWOŻENIA AZOTEM**

**Streszczenie.** Celem badań była ocena wpływu dawki nawożenia azotem oraz różnego udziału komponentów na zawartość składników organicznych i mineralnych oraz wartość pokarmową mieszanek festulolium z koniczyną łąkową. W doświadczeniu uwzględniono dwa czynniki – udział nasion koniczyny w mieszance (40, 60 i 80%) oraz poziom nawożenia azotem (0, 60, 120, 180 kg·ha<sup>-1</sup>). Wykazano, że mieszanka z 80% udziałem nasion rośliny motylkowatej charakteryzowała się największą zawartością białka ogólnego i składników popielnych oraz optymalną zawartością włókna surowego. Zwiększenie udziału nasion koniczyny w mieszance wpłynęło dodatnio na zawartość Ca oraz na obniżenie stosunku molowego K : (Ca + Mg), poprawiając wartość pokarmową paszy. Mieszanki nie nawożone azotem charakteryzowały się większą zawartością białka i mniejszą włókna oraz były lepiej zbilansowane pod względem białkowym i energetycznym niż mieszanki nawożone. Wielkość dawki azotu nie miała znaczącego wpływu na jakość paszy.

**Słowa kluczowe:** festulolium, jednostka paszowa produkcji mleka, jednostka paszowa produkcji żywca, koniczyna łąkowa, mieszanka motylkowato-trawiasta, wartość białkowa paszy, wartość energetyczna paszy

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