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INFLUEN F NITROGEN RATE AND TIME USAGE ON E QUALITY OF FODDER KALE

UTICAJ ČINE AZOTA I VREMENA KORIŠĆENJA KVALITET STOČNOG KELJA

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ABSTRACT

A field study in central Srem (valuated during two seasons the effect of nitrogen (N) fertilizer application (50, 100 and 150 kgha^{-1}) and harvest time (fro 0 days after the seeding) on fodder kale quality. Fodder kale was sown as a second crop in the conditions of irrigation. The goal of study was to evaluate the most important parameters of fodder kale quality (raw proteins and raw cellulose) depending on different nitrogen fertilization and harvest time. The average crude protein content increased (20.78-22,85 %) and the crude cellulose content decreased (15.12-13,96 %) as the nitrogen rates increased, directly due to the higher adoption of nitrogen and indirectly, by increasing the proportion of leaf dry matter in the total yield. The plants used in the first time of harvest had the highest leaf proportion and the highest protein content. Such trends changed in the last harvest time (by postponing the usage) when the crude cellulose content increased because of the leaf biomass reduction. The highest crude protein content (23.10 %) and the lowest crude cellulose content (13.63 %) in the fodder kale dry matter were obtained in the first harvest time (70 days after the seeding) using the highest nitrogen rate (150 kgha^{-1}).

Key words: *fodder kale, nitrogen, harvest time, quality.*

REZIME

U radu su izneti dvogodišnji rezultati ispitivanja uticaja različitih količina azota (50, 100 i 150 kgha^{-1}) kroz tri roka korišćenja (od 70 do 110 dana nakon setve) na sadržaj sirovih proteina i sadržaj sirove celuloze u suvoj materiji stočnog kelja, gajenog kao postrni usev u centralnom Sremu, u uslovima navodnjavanja. Cilj istraživanja bio je da se ispita način reagovanja stočnog kelja na različite količine azota u različitim rokovima korišćenja, izraženog preko najvažnijih parametara kvaliteta. Parametri kvaliteta značajno su se menjali u zavisnosti od ispitivanih faktora. Prosečan sadržaj sirovih proteina je rastao (20,78 – 22,85%), a sadržaj sirove celuloze opadao (15,12 – 13,96%) primenom većih količina azotnog đubriva, zbog direktnog uticaja na veće usvajanje azota i indirektno povećanjem udela lisne mase u ukupnom prinosu. Biljke korišćene u prvom roku imale su najveći udeo lišća i najveći sadržaj proteina. Takva kretanja su izmenjena u poslednjim rokovima (odlaganjem korišćenja) kada dolazi do povećanja sadržaja sirove celuloze, zbog smanjenja udela lisne mase. Najveći sadržaj sirovih proteina (24,10%) i najmanji sadržaj sirove celuloze (13,63%) u suvoj materiji stočnog kelja, utvrđeni su u prvom roku korišćenja (70 dana od setve) na varijanti sa primenom najveće količine azota (150 kgha^{-1}).

Ključne reči: *stočni kelj, azot, vreme korišćenja, kvalitet.*

INTRODUCTION

Fodder kale (*Brassica oleracea L. var acephala D.C*) is a forage brassicas, which is used in animal feed as fresh juicy fodder on the food table – manger (*Herbert and Hashemi, 2002*). Fodder kale is one of the forage crop used for the production of forage most commonly used in the world, particularly in Europe. In our country, it is less studied and little is used in animal feed, but it deserves more attention, especially since it can be grown in all production systems (as the mainpostsowing or postharvest crop), with or without irrigation (*Petrović – Tošković, 2001*). Of all the forage brassicas has the longest period of use which can be further extended by the proper combination of planting in several deadlines *(Erić et al.., 1998, Erić et al., 2006)*.

Of all mineral nutrients, nitrogen largely increases the yield and crude protein content. According to the results of *Šoštarić – Pisačić and Štafa (1975), Šoštarić – Pisačić et al. (1978), Mijatović (1978, 1981)*, as well as other domestic and foreign authors, the content of crude protein in the fodder kale dry matter ranges from 13.3 % to 25.8 %. According to the same authors, crude protein content depends on several factors, including: variety, sowing dates and use, soil fertility, the amount of input of nutrients and other (*Zakonović, 1996; Tošković, 1999*). High fodder kale varieties (with a larger proportion of trees and smaller leaves) contain less protein than the low, leafy varieties (*Štafa and Crnobrnja 1983). Ostojić (1989)* examining productivity and chemical composition of main and post sowing fodder kale crop, found a higher content of crude protein in the post sowing (17.03 %) than that of the main crop (14.84 %). *Tošković (1999)* points out that the content of crude protein in fodder kale, among other factors, depends on the vegetation length. When plants are in later phase of development, protein content is lower and cellulose content is higher, because the proportion of trees increases in total yield.

The aim of this study was to determine the basic parameters of fodder kale quality, with varying amounts of nitrogen in various periods of use.

MATERIAL AND METHOD

Test were conducted in the area of central Srem in Veliki Radinci (DP "Mitrosrem") during the 2011 and 2012 year. The

experiment was set up as a two – factor block design with four replications using split plot.

The following factors were examined:

Nitrogen amount (factor A): $\mathbf{A_1}$ – without fertilization; $\mathbf{A_2}$ – $N_0P_{50}K_{50}$; $\mathbf{A_3}$ – $N_{50}P_{50}K_{50}$; $\mathbf{A_4}$ – $N_{100}P_{50}K_{50}$; $\mathbf{A_5}$ – $N_{150}P_{50}K_{50}$.

Time usage (factor B): $\mathbf{B_1}$ – 70 days from sowing; $\mathbf{B_2}$ – 90 days from sowing; $\mathbf{B_3}$ – 110 days from sowing.

Sowing of fodder kale, Novi Sad selection "NS Bikovo", was performed at the beginning of July using standard cultural practices. During testing irrigation was performed only in July and August.

During the tests following parameters of fodder kale quality were followed: the content of crude protein and crude cellulose in dry matter. The crude protein was determined based on the amount of total nitrogen by Kjeldahl method and increased by a factor of 6.25, and crude cellulose content was determined by a modified Heneberg – Stohman's method. Statistical analysis was performed using analysis of variance and the evaluation of significance of differences was determined by LSD test.

Data from the meteorological station in Sremska Mitrovica (Table 1) shows that the average air temperature during the growing season 2011 (18.9 ºC) and the 2012 (20.4 ºC) was more than ten year average (18.0 ºC). In the second year of study higher average air temperature was determined during the growing season, in relation to the first year, especially the warm months were July and August 2012.

Amount of precipitation in the growing season 2011 (143.6 mm) and 2012 (100.2 mm) was lower than ten year average (223.9 mm). During the experiment monthly minimums were recorded in August. Due to higher air temperatures and less precipitation, both years were dry, particularly stood out year 2012.

Table 1. Mean monthly temperatures (℃) and monthly precipitation (mm) amount for growing season of fodder kale in 2011 and 2012 (S.Mitrovica) and irrigation schedule

Year	Sowing date	Parameter	Month				Aver.	Irrigation (mm)
			VII	VIII	IX	X		
2011.	5.VII	Air temp.	22.2	22.5	20.2	10.5	18.9	110 (5)
		Amount preci.	93.4	6.1	17.6	26.5	143.6	
2012.	1.VII	Air temp.	24.5	23.7	19.5	13.7	20.4	140 (6)
		Amount preci.	39.6	0.4	13.2	47.0	100.2	
2000-2009.		Air temp.	22.0	21.9	16.2	12.0	18.0	
		Amount preci.	46.2	62.4	54.6	60.7	223.9	

The experiments were conducted on the soil type chernozem, it is slightly alkaline reaction. According to the humus content it is poorly humic soil (2.56 to 2.65 %) and the total nitrogen content is proportional to the share of humus. In the upper layers the soil is carbonate, which is the main characteristic of typical chernozem of Vojvodina. Soil is medium provided with available phosphorus, and content of available potassium is high. On the whole the soil on which experiment was conducted offer favorable conditions for the cultivation of fodder kale (Table 2).

Table 2. Chemical Properties of the Soil

Depth (cm)	Humus (%)	Total N (%)	Ph		AL mg/100g		$CaCO_3$ (%)
			in H_2O	in KCl	P_2O_5	K_2O	
0 – 20	2.56	0.13	8.25	7.25	12.2	37.3	19.6
20 – 40	2.65	0.13	8.30	7.30	11.9	33.8	20.9

RESULTS AND DISCUSSION

The crude protein content. The two – year study found a significant effect of nitrogen amount and time usage and the impact of their interaction on the content of crude protein in the dry matter of fodder kale. The study results (Tables 3 and 4) show that nitrogen fertilizer has very significant impact on the increase in the crude protein content compared to the variant without fertilization (A1) and variant (A2). The average crude protein content is increased by application of large amounts of nitrogen from 20.67 to 22.74 % in the first year and 20.88 to 22.96 % in the second year of study. The variants A4 and A5 were fertilized with larger quantities of nitrogen (100 to 150 $kgha^{-1}$) had a faster and greater production of the leaves (Table 5), which have achieved a very substantial increase in the protein content compared to the plants of A3 variant with least amount of nitrogen applied (50 $kgha^{-1}$). The amount of 150 $kgha^{-1}$ of nitrogen was not significantly affected by the increase in the protein content, compared to a dose of 100 $kgha^{-1}$ of nitrogen, as determined in both years.

During the period of use from 70 to 110 days after sowing (Tables 3 and 4), the average crude protein content decreased in all versions going from B1 to B3 term. With delay of time usage and extending the growing season, there was a decrease in the share of leaf mass in total yield (Table 5), which resulted in protein content. Highly significant differences in the average protein content were found between all the terms of use. On variants with the application of nitrogen average crude protein content decreased from 23.13 to 20.20 % in the first and from 23.55 to 20.88 % in the second year of study.

Interaction between the amount of nitrogen and time usage was very significant. Starting from B1 variants fertilized with nitrogen stood out (A3, A4 and A5) of which the plants due to a larger share of the leaf mass (Table 5) during the whole period of use had a higher protein content, compared to the control plants and PK variants which was more pronounced in treatments with the application of higher doses of nitrogen (A4 and A5). In the B3 period, in all variants it has been found a very significant reduction in the protein content. Nevertheless, plants fertilized with nitrogen used in B3 term, although older, had a higher protein content than the control plants (A1) and variant (A2) at the beginning of the period of use, the B1 term. Larger amounts of nitrogen (100 and 150 $kgha^{-1}$) was influenced by the plants in variants A4 and A5, in B3 term (although 20 days older) show a similar protein content as well as plants of A3 variant, with the application of a minimum dose of nitrogen (50 $kgha^{-1}$), used in the B2 term. The highest protein content was found in the B1 term, the A5 variant with the application of the highest dose of nitrogen (150 $kgha^{-1}$) and is 24.15 % in the first year and 24.05 % in the second year of study. A very significant and important differences in the protein content (Table 3 and 4) are determined in the variants with the application of nitrogen in relation to the A1 and A2 variant in all three periods of use, as well as the variants A4 and A5 in relation to A3 in B2 term.

According to research of *Šoštarić – Pisačić et al. (1978)*, crude protein content in fodder kale increases with increasing amounts of nitrogen up to a maximum dose of 300 $kgha^{-1}$ and found free of high nitrate levels. *Štafa and Crnobrnja (1983)* found that the content of crude protein, depending on the variety, range from 17.74 to 22.40 %. For variety NS Bikovo they determined the content of 20.53 % protein, which agrees with ours results. *Mijatović and Pavešić – Popović (1985)* obtained slightly higher protein content results. Growing fodder kale variety NS Bikovo as postharvest crop and fertilizing with N150P100K100 determined protein content of 25.7 %.

Zakonović (1991) by examining different ways of production at different levels of nutrition, found an increase in the crude protein content using a large amount of fertilizer, in both modes of production of fodder kale.

Tošković, (1999) in the period of usage of fodder kale from 110 to 200 days after sowing, found that the protein content is constantly decreasing from 110 day, as opposed to the yield proteins, in which the downward trend established from 140 day after sowing. Pejić and Jovanović (1980) examining intensity and increase of the nutritional value of postharvest crop to older kale, over the period from 110 to 160 days after sowing, found a reduction of the protein content from 22.60 to 19.82 %. However, the same authors found that the yield of crude protein increases significantly during the entire period of use, thanks to high levels of dry matter. The highest yield of crude protein was given at the end of the test period, the amount of 3.15 tha^{-1}. In our studies, in the period of use from 70 to 110 days after the sowing, it was also found a reduction of content of crude protein, from 21.62 to 18.67 % in average for two years. Plants used in the beginning of the period, the B1 term, were the youngest and with largest share of the leaves, which have achieved the highest average protein content. During the examination, between all times of use were found highly significant differences in protein content.

Therefore, with use of large amounts of nitrogen, fodder kale can be used for a longer period of time, and that the content of crude protein as an important factor in the quality and in addition to extend the growing season and reducing the share of the leaves of green forage, remain at a satisfactory level.

During the research it was found that the studied factors and their interaction had a significant impact on the content of crude cellulose in the fodder kale dry matter (Tables 3 and 4). The average content of crude cellulose is decreased by the use of large amounts of nitrogen. In the first year it ranged from 15.15 to 13.94 %, in the second year from 15.09 to 13.98 %. The highest content of crude cellulose was found in the variant without fertilization (A1). Larger amounts of nitrogen resulted in the increase in the proportion of leaf mass (Table 5), so that the smallest content of cellulose was in variant A5 with the application of the highest amounts of nitrogen (150 $kgha^{-1}$).

During the period of use from 70 to 110 days after sowing (Tables 3 and 4), the average content of crude cellulose increased with the extension of time usage and the growing season, going from 14.68 to 15.54 % in the first year and from 14.46 to 15.31 % in the second year of study. Plants used in the B5 term were oldest and with largest share of the trees, which have made the greatest cellulose content (average 16.5 %).

In the interaction of both factors, it has been found the following: cellulose content was the highest in all treatments at the end of the period of use, however, the plant variants A4 and A5, with the application of large amounts of nitrogen, even though they were older, had lower cellulose content than control plants and PK variants with the use of minimum amount of nitrogen.

So, with the application of large amounts of nitrogen, fodder kale can be used for a longer period of time, content of crude cellulose does not significantly increases without losing quality of the crop.

Table 3. Crude proteins content and crude cellulose content (% in dry matter) in 2011 year

Variant fertiliz. (A)	Usage time (B)						Average A	
	B_1		B_2		B_3			
	Crudeprotein.	Crude cellulose	Crude protein.	Crude cellulose	Crude protein.	Crude cellulose	Crudeprotein.	Crude cellulose
A_1	18.85	15.25	17.88	15.79	15.03	16.75	17.25	15.93
A_2	19.01	15.21	17.80	15.81	15.50	16.45	17.44	15.82
A_3	22.54	14.78	20.24	15.15	19.24	15.51	20.67	15.15
A_4	22.69	14.50	22.40	14.36	20.30	14.66	21.80	14.51
A_5	24.15	13.61	23.00	13.90	21.07	14.32	22.74	13.94
Average B (A_3,A_4,A_5)	23.13	14.30	21.88	14.47	20.20	14.83	21.74	14.53
Average B	21.45	14.68	20.26	15.00	18.28	15.54	20.00	15.07

	Crude proteins content		Crude cellulose content	
	LSD 5%	LSD 1%	LSD 5%	LSD 1%
A	0.95	1.09	0.58	0.76
B	0.63	0.84	0.44	0.59
AB	1.41	1.88	0.99	1.32

Table 4. Crude proteins content and crude cellulose content (% in dry matter) in 2012 year

Variant fertiliz. (A)	Usage time (B)						Average A	
	B_1		B_2		B_3			
	Crude protein.	Crude cellulose	Crude protein.	Crude cellulose	Crude protein.	Crude cellulose	Crude protein.	Crude cellulose
A_1	19.14	15.15	18.11	15.62	16.10	16.25	17.78	15.67
A_2	19.10	15.18	17.85	15.75	16.58	16.12	17.84	15.68
A_3	23.04	14.51	20.10	15.32	19.50	15.45	20.88	15.09
A_4	23.55	13.83	22.90	14.07	21.10	14.45	22.52	14.12
A_5	24.05	13.65	22.83	14.00	22.01	14.28	22.96	13.98
Average B (A_3, A_4,A_5)	23.55	14.00	21.94	14.46	20.88	14.73	22.12	14.40
Average B	21.78	14.46	20.36	14.95	19.06	15.31	20.40	14.91

	Crude proteins content		Crude cellulose content	
	LSD 5%	LSD 1%	LSD 5%	LSD 1%
A	0.97	1.10	0.81	1.09
B	0.87	1.05	0.63	0.84
AB	1.95	2.21	1.41	1.88

Table 5. Leaf Proportion (%) in Total Forage Yield in 2011 and 2012 years

Variant fertiliz. (A)	Usage time (B)						Average A	
	B_1		B_2		B_3			
	2011.	2012.	2011.	2012.	2011.	2012.	2011.	2012.
A_1	68.13	69.60	67.90	68.03	61.24	62.05	65.75	66.56
A_2	69.80	70.00	69.05	68.90	62.09	63.28	66.98	67.39
A_3	71.47	72.35	70.10	69.20	65.80	65.40	69.12	68.98
A_4	74.06	74.14	71.55	70.86	67.15	68.01	70.92	71.00
A_5	75.02	74.98	72.03	71.50	67.95	68.15	71.67	71.54
Average B (A_3, A_4,A_5)	73.51	73.82	71.23	70.52	66.97	67.19	70.57	70.51
Average B	71.70	72.21	70.13	69.70	64.85	65.38	68.89	69.09

	Leaf proportion in total yield in 2011		Leaf proportion in total yield in 2012	
	LSD 5%	LSD 1%	LSD 5%	LSD 1%
A	1.18	1.57	1.12	1.48
B	1.18	1.57	1.12	1.48
AB	2.64	3.50	2.49	3.31

In the literature, there is little data on the content of crude cellulose in fodder kale. They are often found in studies that examine the effect of different sowing dates and methods of production, productivity and quality of fodder kale. *Šoštarić – Pisačić et al. (1978)* examined the effects of terms of sowing and grow sowing on yield and quality of fodder kale, where they found that the crude cellulose content is lower in the later sowing which agrees with ours results. *Ostojić (1989)* found a higher content of crude cellulose in the main crop fodder kale (21.51 %) than in the post sowing (16.36 %). In our studies lower cellulose content was obtained, which may be explained with post sowing period. *Pejić and Jovanović (1980)* received results similar to those in our study. In postharvest fodder kale, over the period from 110 to 160 days after planting, they found an increase in the content of crude cellulose, from 14.57 to 15.42 % in average for both years.

CONCLUSION

Fodder kale as post sowing crop can be successfully grown in the central part of Srem, in irrigation, and in the period from mid – September to late October it is possible to provide a continuous income of high – quality green fodder in this area.

Quality parameters were significantly changed depending on the studied factors: crude protein content from 20.78 to 22.85 % for different amounts of nitrogen and 23.34 to 20.54 % in different periods of use, a crude cellulose content from15.12 to 13.96 % and 14.15 to 14.78 % in average for two years. The crude protein content is increased and the content of crude cellulose decreased by using larger amounts of nitrogen fertilizer, both because of the direct impact on greater adoption of nutrient elements and indirectly by increasing the share of leaf mass to total yield. These trends have changed in the last period of use due to reduced share of leaf mass.

With use of large amounts of nitrogen, fodder kale can be used for a longer period of time, and content of crude protein, as an important factor in quality and in addition to extend the growing season and reducing the share of the leaves of green fodder yield, remain at a satisfactory level.

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