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Protein and fiber contents in alfalfa leaves and stems

S. Popovic*, M. Stjepanovic, S. Grljusic*, T. Cupic* and M. Tucak***
*Agricultural Institute Osijek, Juzno predgrade 17, 31000 Osijek, Croatia,
e-mail spopovic@ratar.poljinos.hr
**Faculty of Agriculture, Trg Sv. Trojstva 3, 31000 Osijek, Croatia

SUMMARY – Alfalfa leaves and stems contain different protein and fiber concentration in different stages of growth. The objective of the study was to determine a dynamic of nutrient accumulation in leaves and stems. The experiment was conducted in two consecutive years (1999, 2000) on three cultivars (Slavonka, Vuka and Os-88). Chemical analysis of leaves and stems were obtained from first and second growth. Samples were taken at four growth stages per growth (first growth-plant height: 30, 43, 55, 65 cm, and second growth-plant height: 30, 39, 45, 58 cm). The results of the study indicate high statistical influence of growth stage (plant height), cut and investigated year on protein concentration and high statistical influence of growth stage (plant height) on fiber concentration in alfalfa leaves. Protein and fiber content in stems were highly statistically influenced by year of investigation, cut and growth stage (plant height). Protein concentration in stems decreased by the plant height increasing but a greater decrease occurred in a first growth. Unlike proteins, the fiber content in stems increased by the plant height increasing but a greater increase occurred in a second growth. Cultivars did not significantly influence investigated traits.

Key words: *Medicago sativa* L., growth stage, cut, protein and fiber content.

RESUME – *"La teneur en protéines et fibres dans la feuille et la tige de luzerne". La feuille et la tige de luzerne contiennent différentes concentrations en protéines et fibres à différents stades de croissance. L'objectif de la recherche était de déterminer la dynamique d'accumulation de substances nutritives dans la feuille et dans la tige. L'expérience a été mise en pratique pendant deux ans (1999, 2000) sur trois cultivars (Slavonka, Vuka* et *OS-88). Les analyses chimiques de la feuille et de la tige sont faites dans la première et la deuxième croissance. Les échantillons ont été pris dans les quatre stades de croissance par accroissement (première, la hauteur de la plante : 30, 43, 55, 65 cm, et deuxième croissance, la hauteur de la plante : 30, 39, 45, 58 cm. Les résultats de recherches indiquent la haute importance statistique de l'influence du stade de croissance (la hauteur de la plante), de la fauche et de l'année de la recherche sur la concentration en protéines dans la feuille et la haute importance statistique de l'influence du stade de croissance (la hauteur de la plante) sur la concentration en fibres dans la feuille. La concentration en protéines et en fibres dans la tige a été différente et cela est d'une haute importance statistique selon l'année de recherche, la fauche et le stade de croissance (la hauteur de plante). La concentration en protéines dans la tige était en baisse avec l'accroissement de la hauteur de la plante, mais la plus importante baisse s'est manifestée dans le premier accroissement. Contrairement aux protéines, la teneur en fibres dans la tige augmentait avec l'accroissement de la hauteur de plante, mais elle a été plus grande dans la deuxième fauche. Les cultivars n'ont pas eu d'influence statistiquement significative sur les qualités recherchées.*

Mots-clés : Medicago sativa *L., stade de croissance, fauche, teneur en protéines et fibres.*

Introduction

The assessment of alfalfa quality is usually based on the relationships between digestibility and protein content and phenological stage of the crop (Demarquilly, 1966; Kalu and Fick, 1983). These relationships are indirectly related to leaf/stem (L/S) ratio. Numerous scientists have reported on this ratio (Juan *et al.*, 1993; Kratchunov and Naydenov, 1995; Julier *et al*., 2000; Sheaffer *et al.,* 2000). The general conclusion was that L/S ratio could be the valuable criteria in alfalfa breeding. Johnson *et al.* (1994) pointed out that understanding the relationships between quality and agronomic traits may assist breeding programs. Same authors found significant positive correlation between L/S ratio and crude protein content (0.25-0.46), plant height and cellulose content (0.18-0.72) and plant height and green mass yield, maturity, stem diameter and lodging. They also found significant negative correlation between L/S ratio and cellulose content (-0.47 to -0.76).

The aim of our study was to determine a dynamic of leaves and stems crude protein and fiber accumulation in different growth stages (different heights) during the first and second growth of alfalfa.

Materials and methods

The experiment was conducted in two consecutive years (1999, 2000) on three to four year old stands of cultivars: Slavonka, Vuka and Os-88. Chemical analysis (Weende method; Kjeltec autosampler 1035-Tecator and Fibertec-Tecator machines) of leaves and stems were obtained from first and second growth. The fresh matter samples of 500 g in four replications were taken at four growth stages per growth (first growth-plant height: 30, 43, 55, 65 cm and second growth-plant height: 30, 39, 45, 58 cm). The cutting dates were as follows: (i) 1999: first growth (27.04, 05.05, 14.05 and 26.05), second growth (01.06, 05.06, 10.06 and 21.06); and (ii) 2000: first growth (17.04, 21.04, 25.04 and 28.04), second growth (18.05, 25.05, 29.05 and 31.05).

The results were analyzed by statistical programming system MSTAT.

Results and discussion

Probably as a consequence of cultivar similarity the results did not indicate significant influence of cultivars on investigated traits. Lemaire *et al.* (1994) also found the same. Contrarily, Berardo (1992) pointed out significant differences of protein and fiber content in eight investigated cultivars.

Year of investigation had a high statistical influence on crude protein and fiber contents (Tables 1 and 2). In the first year of investigation crude protein content in leaves and stems was significantly lower but crude fiber content in stems was highly statistical higher than in second year of investigation. A great number of environmental factors influence on L/S ratio. Bula (1972) and Allirand *et al*. (1992) confirmed the impact of climatic conditions on L/S ratio, nutrient and digestibility changes.

Table 1. Influence of investigated years and cuts on stem crude protein and fiber contents (%)

Year	Crude protein			Crude fiber		
	1st cut	2nd cut	Average	1st cut	2nd cut	Average
1	15.47	11.69	13.58	41.50	47.16	44.33
2	17.43	15.83	16.63	32.18	40.60	36.39
Average	16.45	13.76		36.84	43.88	
LSD cut	0.05	0.48		1.50		
Year	0.01	0.64		2.02		
Year cut	0.05	0.67		NS†		
	0.01	0.91		NS		

†NS = non-significant.

Table 2. Influence of investigated year and cuts on leaf crude protein and fiber contents (%)

Year	Crude protein			Crude fiber		
	1st cut	2nd cut	Average	1st cut	2nd cut	Average
1	33.72	34.64	34.18	12.07	12.01	12.04
2	35.64	39.11	37.38	11.78	11.72	11.75
Average	34.68	36.87		11.92	11.86	
LSD cut	0.05	0.85		NS†		
Year	0.01	1.15		NS		
Year cut	0.05	1.20		NS		
	0.01	1.62		NS		

†NS = non-significant.

The second parameter investigated – cut, significantly influenced crude protein and crude fiber content in leaves and stems. In both years of investigation crude protein content in stems was significantly higher (16.45%) and crude fiber content was significantly lower (36.84%) in the first cut. Crude protein content in leaves was significantly higher (36.87%) in the second cut. Leaf crude fiber content was not statistically different for the cuts. Interaction year of investigation cut significantly influenced crude protein content in leaves and stems. Grizzard (1935) found higher crude protein content in leaves and stems in the second cut. Our results are the same for leaves but not for stems.

Growth stage of alfalfa (plant height) was the third statistically significant investigated parameter (Tables 3 and 4). Vodraska (1990), Rotili (1992), Johnson *et al*. (1994) and Julier and Huyghe (1997) found positive correlation between plant height and yield and negative correlation between plant height and quality. Our results were similar to the results of the above-mentioned investigations.

Table 3. Influence of growth stage and cuts on stem crude protein and fiber contents (%)

Year	Crude protein			Crude fiber		
	1st cut	2nd cut	Average	1st cut	2nd cut	Average
1	20.99	16.34	18.66	28.14	36.21	32.18
2	18.49	14.96	16.73	37.36	44.50	40.93
3	13.32	12.45	12.88	39.96	45.42	42.69
4	13.01	11.30	12.15	41.91	49.38	45.64
LSD growth stage	0.05	0.67			2.12	
Cut	0.01	0.91			2.86	
Cut growth stage	0.05	0.95			NS†	
	0.01	1.28			NS	

†NS = non-significant.

Table 4. Influence of growth stage and cuts on leaf crude protein and fiber contents (%)

Year	Crude protein			Crude fiber		
	1st cut	2nd cut	Average	1st cut	2nd cut	Average
1	35.29	38.97	37.13	11.80	10.78	11.29
2	37.41	36.74	37.07	12.39	13.19	12.79
3	33.29	37.54	35.41	11.74	11.57	11.65
4	32.74	34.26	33.50	11.78	11.94	11.86
LSD growth stage	0.05	1.20			0.51	
Cut	0.01	1.62			0.69	
Cut growth stage	0.05	1.70			0.72	
	0.01	2.29			0.97	

Lemaire *et al.* (1994) concluded that crude protein and fiber content were not directly affected by plant phenological development but protein content was directly related to the dynamic of the dry matter accumulation. Interaction cut growth stage had a high statistical influence on crude protein and fiber content in leaves and stems.

We also investigated crude protein and fiber content in petioles and flowers. Petioles had 22% of crude proteins and 25% of crude fiber while the flowers had 26% of crude proteins and 23% of crude fiber.

Conclusion

The results indicate non-statistical influence of cultivars on dynamic of protein and fiber content accumulation in leaves and stems. Years of investigation and cuts had a high statistical influence on crude protein content in leaves and stems and on crude fiber content in stems but did not influence crude fiber content in leaves. Year cut interaction influenced crude protein content in leaves and stems but did not influence crude fiber content. Growth stage of stands (plant height) and growth stage cut interaction had a high statistical influence on investigated parameters but did not influence crude fiber content in stems.

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