

THE CHEMICAL COMPOSITION OF THE FORAGE FROM A CULTIVATED MEADOW OF ALFALFA AND ORCHARD GRASS

I.C. Muntianu^{1*}, V. Vîntu¹, C. Samuil¹, Aida Albu¹, M. Stavarache¹, C. Ciobanu¹

¹ University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

Abstract

*Alfalfa and perennial grass mixture fertilized with moderate doses of mineral fertilizers can provide a forage with a better chemical composition compared with the alfalfa forage in pure culture. To emphasize the effects of combined influence of the mixture and fertilization on the chemical composition of the forage there were tested three different mixtures between alfalfa (*Medicago sativa* L.) and orchard grass (*Dactylis glomerata* L.), which were applied to four doses of mineral fertilizers. On cycle I, the highest value of crude protein (CP) content in plants was recorded on alfalfa fertilized with N₁₀₀P₅₀ dose (17.78% CP), with 2.31% CP higher compared to the control (unfertilized alfalfa, 14.77% CP). On cycles II and III, the highest values in CP were obtained from alfalfa unfertilized (control), of 15.32% CP and 17.14% CP, respectively. The highest plant content of neutral detergent fiber (NDF) and acid detergent fiber (ADF) was recorded on all cycles, on the alfalfa 50% + 50% orchard grass mixture, fertilized with N₁₀₀P₅₀ dose.*

Key words: mixture, fertilization, alfalfa, orchard grass, chemical composition

INTRODUCTION

Alfalfa is a leguminous forage plant most often used in animal food recipes [8]. In contrast to pure cultures, mixture of alfalfa with orchard grass provides a better forage quality [5]. These mixtures also offer the possibility of a more successful ensiling, due to a higher content of sugars [13]. At the same time, these mixtures provide better use of nutrients in the soil and more economic efficient production due to reduced use of fertilizers with nitrogen [10].

Because of the ability of fixing atmospheric nitrogen by alfalfa it's also ensured some nitrogen to orchard grass, which can reach up to 80% [1], and consequently reduces the demand for nitrogen fertilizers and reduces the environmental pollution [2].

The chemical composition of the forage is both changed under the influence of the ratio between alfalfa and orchard grass in the mixture structure and under the influence of fertilization with mineral fertilizers, nitrogen being the element that most influences the quality of the forage [6], [11]. In this study, it was monitored

the influence of the combined effect of mixing different proportions of alfalfa with orchard grass and of fertilization with moderate doses of nitrogen per P₅₀ agrofund on the forage chemical composition.

MATERIAL AND METHODS

In order to achieve our objectives it was established an experience on Ezăreni Farm of the Didactic Resort of USAMV Iasi.

The experience is placed on a cambium chernozem soil with pH values between 6.7 and 6.8 and humus content of 2.73-2.93%, 21-25 ppm P_{AL}, 226-232 ppm K_{AL} and 112 - 139 ppm CaO. The present study covers quality data of forages collected on three production cycles of the experimental year 2010.

The studied factors were: Factor A: type of crop, three graduations: a1- *alfalfa 100%* (Mt.), a2- *alfalfa 75% + 25% orchard grass*, a3- *alfalfa 50% + 50% orchard grass*. Factor B: mineral fertilization with four graduations: b1- N₀P₀ (Mt.), b2- N₅₀P₅₀, b3- N₇₅P₅₀, b4- N₁₀₀P₅₀. For sowing it was used mixture of seeds of Romanian alfalfa (*Medicago sativa* L.) Magnat cultivar and seeds of Danish orchard grass (*Dactylis glomerata* L.) Ambassador cultivar.

*Corresponding author: iulianmuntianu@yahoo.com

The manuscript was received: 04.04.2012

Accepted for publication: 06.06.2012

Fertilization was performed only on the establishment of the culture and products used for fertilization were ammonium nitrate ($N_{33.5}$) and nitrogen-phosphorus complex ($N_{20}P_{20}$). During the year, harvesting was performed at different phenophases, as follows: on cycle I, at full bloom of alfalfa and beginning of boot of orchard grass, on cycle II, at full buds of alfalfa and end of boot of orchard grass and on cycle III, at full buds of alfalfa and blossom ear emergence of orchard grass. At harvest time, corresponding to the dose of fertilizer applied (from unfertilized to dose of $N_{100}P_{50}$), the ratio between alfalfa-other plants (%) in the canopy cover structure varied as follows: on cycle I, it was 86:14, 87:13, 89:11 and 91:9, on cycle II, it was 94:6, 97:3, 98:2 and 98:2 and on cycle III, it was 98:2, 98:2, 99:1 and 99:1.

On mixture *alfalfa 75% + 25% orchard grass* according to fertilizer doses applied, the ratios in canopy cover structure (alfalfa-orchard grass-other plants,%) were: on cycle I, 79:13:8, 79:14:7, 78:17:5 and 77:20:3; on cycle II, 82:17:1, 82:18:0, 77:23:0 and 75:25:0, on cycle III, 82:17:1, 82:18:0, 77:23:0 and 75:25:0. On mixture *alfalfa 50% + 50% orchard grass* the canopy cover structure (alfalfa-orchard grass-other plants,%) was: 62:33:5, 61:36:3, 56:42:2 and 52:46:2 on cycle I, on cycle II, 61:38:1, 59:41:0, 55:45:0 and 52:48:0, and on cycle III, 57:42:1, 52:48:0, 46:54:0 and 44:56:0.

Chemical composition of forage was determined using the following methods of analysis: dry matter (DM) by drying at 105°C, total nitrogen by the Kjeldahl method, crude protein (CP) by %Total-N x 6.25, acid detergent fiber (ADF) and neutral detergent fiber (NDF), using Raypa Fiber Test equipment and Van Soest method, hemicellulose (Hem.) by NDF-ADF, crude fiber (CF) using the formula $CF = (ADF \times 0.75) + 3.56$ [3], ash content (Ash) by calcination of forage sample in an oven at 500-600°C.

The statistical interpretation of data was performed by analysis of variance and limit differences calculation using the SPSS - ANOVA (Statistical Package for the Social Sciences) software.

RESULTS AND DISCUSSIONS

The influence of mixture and fertilization upon chemical composition of the forage

Generally, alfalfa has a higher content in protein and lower in cell walls compared to orchard grass and to its mixtures with orchard grass [12]. Changes in forage CP content are positively correlated to participation percentage of alfalfa in the mixture, and NDF content is positively correlated to the percentage of participation in a mixture of orchard grass [4].

Some authors consider that the application of higher doses of fertilizer than N_{90} to the mixtures of alfalfa with orchard grass, generally leads to a decrease of CP content in forage as a result of decrease in the proportion of participation in mixture of alfalfa [1].

However, most research shows that application of increasing doses of nitrogen, even up to N_{210} , leads also to an increase in CP content, on DM basis [6], [2]. NDF in plants, is the amount of cellulose, hemicellulose, lignin and insoluble substances, and it's an indicator of forage fiber easy to consume [2].

Many authors have studied the effect of N fertilizers on NDF content in plants and concluded that it significantly increases with the addition of N fertilizer and is caused by changes in botanical composition of grasslands by reducing the share of leguminous and increasing grasses participation rate that occur as a result of a plus addition of N [1], [9], [2]. ADF, as a measure of the plant energy is not significantly changed under the influence of fertilization with N [7], [9], [2].

On the harvest cycle I (Table 1), in terms of the influence of mixture, the tendency was of increasing the cell walls content of plant and of reducing the plants crude protein (CP) content as the proportion of alfalfa in the canopy cover structure was reduced and increased the share of orchard grass.

In terms of the influence of fertilization, the tendency was of both increasing the protein content and the cell walls content of plant with increasing doses of N.

Thus, due to differences between the two species, the chemical composition of alfalfa forage was characterized by higher values of the parameters DM, CP, Ash., and by lower of the parameters NDF, ADF, CF and Hem.,

compared with the two mixtures, at all doses of fertilizer.

Of the two mixtures, due to higher percentage of participation in mixture of alfalfa, higher values of the parameters CP, Ash., DM and lower of the parameters NDF, ADF, CF, Hem., were recorded on the mixture of *alfalfa 75% + 25% orchard grass*, compared with the mixture of *alfalfa 50% + 50% orchard grass*. On *alfalfa 100%* fertilized with $N_{100}P_{50}$ dose was recorded the highest DM content, of 26.45% DM, and significant differences from unfertilized alfalfa - control (22.26% DM) were obtained at all doses of fertilizer applied, that ranged between 1.78% DM and 4.20% DM. The highest content of the mixture of *alfalfa 50% + 50% orchard grass*, was 25.80% DM on $N_{100}P_{50}$ dose.

The mixture of *alfalfa 75% + 25% orchard grass*, had the highest content of 24.85% DM also on $N_{100}P_{50}$ dose. On dosage of $N_{100}P_{50}$ were recorded the highest protein content in plants.

Thus, *alfalfa 100%* had the highest content and was 17.78% CP and significant differences compared to the control (15.47% CP) were recorded on each of the doses of fertilizer applied (differences of 1.18% CP on $N_{50}P_{50}$ dose, 1.83% CP on $N_{75}P_{50}$ dose and 2.31% CP, respectively, on $N_{100}P_{50}$ dose).

The mixture *alfalfa 75% + 25% orchard grass* highest content in CP was 15.50% CP, without positive significant differences compared to the control. The mixture of *alfalfa 50% + 50% orchard grass* highest content was 15.10% CP and no positive significant differences were obtained from control (Table 1).

Table 1 The influence of mixture x fertilization interaction on the chemical composition of the forage on cycle I, 2010

Variant		DM %	CP ^a %	NDF ^a %	ADF ^a %	CF ^a %	Hem. ^a %	Ash. ^a %
Alfalfa 100%	Mt- unfertilized	22.26	15.47	40.21	32.48	27.92	7.73	13.46
	$N_{50}P_{50}$	24.03*	16.64*	43.27	34.95	29.77	8.32	14.48
	$N_{75}P_{50}$	25.30*	17.29*	44.96*	36.31*	30.79*	8.65	15.04*
	$N_{100}P_{50}$	26.45*	17.78*	46.22*	37.33*	31.56*	8.89*	15.47*
Alfalfa 75% + Orchard grass 25%	Unfertilized	21.98	13.66 ⁰	43.45	32.96	28.28	10.49*	12.29 ⁰
	$N_{50}P_{50}$	23.44	14.21 ⁰	46.96*	35.62*	30.28*	11.33*	13.28
	$N_{75}P_{50}$	24.25*	14.93	49.35*	37.44*	31.64*	11.91*	13.95
	$N_{100}P_{50}$	24.85*	15.50	51.33*	38.94*	32.76*	12.39*	14.51
Alfalfa 50% + Orchard grass 50%	Unfertilized	22.27	13.22 ⁰	45.11*	32.94	28.27	12.17*	11.03 ⁰
	$N_{50}P_{50}$	23.84	13.76 ⁰	49.24*	35.95*	30.52*	13.29*	12.04 ⁰
	$N_{75}P_{50}$	24.91*	14.37 ⁰	52.18*	38.10*	32.14*	14.08*	12.76
	$N_{100}P_{50}$	25.80*	15.10	54.85*	40.05*	33.60*	14.80*	13.41
LSD	0.05	1.6%	0.8%	3.7%	2.1%	1.9%	1.1%	1.1%

^a - contents of dry matter (DM)

The highest content in cell walls was recorded using dose of $N_{100}P_{50}$. Thus, on the mixture of *alfalfa 50% + 50% orchard grass* was recorded the highest content of cell walls, of 54.85% NDF, of 40.05% ADF, 33.60% CF and 14.80% Hem. and significant difference in NDF and ADF content of plants compared to the control (alfalfa unfertilized, 40.21% NDF, 32.48% ADF of DM) were

obtained at all doses of fertilizer applied ranging between 4.90% NDF and 14.64% NDF and between 3.47% ADF and 7.57% ADF, respectively.

The mixture of *alfalfa 75% + 25% orchard grass* values recorded for the content of plant cell walls were lower compared with the mixture of *alfalfa 50% + 50% orchard grass* and higher than those of alfalfa in pure

culture, and ranged between 43.45% NDF, 32.96% ADF (unfertilized) to 51.33% NDF, 38.94% ADF (on N₁₀₀P₅₀ dose). Because of more vigorous root system of alfalfa and better plant development than orchard grass, the ash content was significantly higher than that of mixtures (Table 1). Thus, it varied on *alfalfa 100%* between 13.46% Ash. (control) to 15.47% Ash. (on N₁₀₀P₅₀ dose). On mixture of *alfalfa 75% + 25% orchard grass* it ranged between 12.90% Ash. (unfertilized) to 14.51% Ash. (on N₁₀₀P₅₀ dose), and on mixture of *alfalfa 50% + 50% orchard grass* between 11.03% Ash. (unfertilized) to 13.41% Ash. (on N₁₀₀P₅₀ dose).

On the cycle II of harvesting (Table 2), the tendency was of growing the plant cell walls content with increasing proportion of orchard grass in canopy cover structure and of decreasing the content of plants in CP. Also, from unfertilized variants to variants fertilized with maximum dose of fertilizer (N₁₀₀P₅₀), there was an increase in cell wall content and a decrease in CP content. For DM content of plants, higher values were recorded on N₁₀₀P₅₀ dose of fertilizer. Alfalfa in pure culture had the highest content, ranging from 25.93% DM

(control) to 29.66% DM, followed by *alfalfa 50% + 50% orchard grass* mixture of which values recorded ranged from 24.26% DM to 26.84% DM. Lower values were obtained from the mixture of *alfalfa 75% + 25% orchard grass* and ranged from 24.05% DM to 25.80% DM. The highest plant contents in CP were recorded on unfertilized variants and the lowest on variants that were fertilized with N₁₀₀P₅₀ dose. Alfalfa in pure culture had highest contents in CP and ranged from 15.32% CP (control) to 14.14% CP.

The contents of mixture of *alfalfa 75% + 25% orchard grass* ranged from 14.94% CP (unfertilized) to 12.85% CP (on N₁₀₀P₅₀ dose). The contents of mixture of *alfalfa 50% + 50% orchard grass* ranged from 14.42% CP (unfertilized) to 12.84% CP (on N₁₀₀P₅₀ dose). The mixture of *alfalfa 50% + 50% orchard grass*, fertilized with the highest dose, N₁₀₀P₅₀, had the highest content in cell walls (50.47% NDF, 38.93% ADF, 32.76% CF), and registered significant differences compared to the control (simple alfalfa unfertilized, 39.59% NDF, 31.82% ADF, 27.42% CF) at all doses of fertilizer.

Table 2 The influence of mixture x fertilization interaction on the chemical composition of the forage on cycle II, 2010

Variant		DM %	CP ^a %	NDF ^a %	ADF ^a %	CF ^a %	Hem. ^a %	Ash. ^a %
Alfalfa 100%	Mt- unfertilized	25.93	15.32	39.59	31.82	27.42	7.78	13.33
	N ₅₀ P ₅₀	27.78	15.05	41.08	33.01	28.32	8.07	13.09
	N ₇₅ P ₅₀	28.93*	14.67	42.14	33.86*	28.96	8.28	12.76
	N ₁₀₀ P ₅₀	29.66*	14.14 ⁰	42.90*	34.47*	29.41*	8.43*	12.30
Alfalfa 75% + Orchard grass 25%	Unfertilized	24.05	14.94	42.41	32.13	27.65	10.28*	11.82 ⁰
	N ₅₀ P ₅₀	24.84	14.53	44.88*	34.00*	29.06*	10.88*	11.63 ⁰
	N ₇₅ P ₅₀	25.40	13.60 ⁰	47.95*	36.33*	30.80*	11.62*	11.15 ⁰
	N ₁₀₀ P ₅₀	25.80	12.85 ⁰	49.30*	37.35*	31.57*	11.95*	10.54 ⁰
Alfalfa 50% + Orchard grass 50%	Unfertilized	24.26	14.42 ⁰	44.94*	34.67*	29.56*	10.27*	11.50 ⁰
	N ₅₀ P ₅₀	25.49	14.18 ⁰	48.58*	37.48*	31.67*	11.10*	11.19 ⁰
	N ₇₅ P ₅₀	26.45	13.88 ⁰	49.63*	38.29*	32.27*	11.34*	10.69 ⁰
	N ₁₀₀ P ₅₀	26.84	12.84 ⁰	50.47*	38.93*	32.76*	11.54*	9.89 ⁰
LSD		0.05	0.8%	3.2%	1.9%	1.6%	0.6%	1.4%

^a - contents of dry matter (DM)

The mixture of *alfalfa 75% + 25% orchard grass* recorded for the content of plant cell walls

lower values (average: 46.13% NDF, 34.95% ADF, 29.77% CF) than those of mixture *alfalfa*

50% + 50% orchard grass (average: 48.41% NDF, 37.34% ADF, 31.57% CF) and higher than those of alfalfa in pure culture (average: 41.43% NDF, 33.29% ADF, 28.53% CF), except only for the hemicellulose values which were higher (average 11.18% Hem.) from both the other mixture (average 11.06% Hem.) and from alfalfa in pure culture (average 8.14% Hem.). The two mixtures and the fertilized variants showed significantly lower content in ash than alfalfa in pure culture and unfertilized (Table 2).

Thus, on alfalfa in pure culture it ranged from 13.33% Ash. (control) to 12.30% Ash. (on N₁₀₀P₅₀ dose). On the mixture of *alfalfa* 75% + 25% orchard grass it ranged from 11.82% Ash. to 10.54% and on the mixture of *alfalfa* 50% + 50 % orchard grass between 11.50% Ash. (unfertilized) and 9.89% Ash. (on N₁₀₀P₅₀ dose).

On the cycle III of harvesting (Table 3) there was a certain uniformity between variants fertilized and the only differences were generally caused by mixture with the tendency of increasing plant contents in cell walls and of decreasing the CP content caused by decreasing the proportion of alfalfa in the canopy cover structure and increasing the proportion of orchard grass. Compared with the chemical composition of forage produced from harvesting cycles I and II, the cycle III was harvested at lower content of plants in DM, with lower values for the contents of CP and Ash. to cycle I, but higher compared with the cycle II and lower values for the contents of the NDF, ADF, CF and Hem., compared to both cycles. For DM content of plants, higher values were recorded for alfalfa in pure culture, ranging from 22.22% DM (control) to 24.59% DM (on N₁₀₀P₅₀ dose).

Table 3 The influence of mixture x fertilization interaction on the chemical composition of the forage on cycle III, 2010

Variant		DM %	CP ^a %	NDF ^a %	ADF ^a %	CF ^a %	Hem. ^a %	Ash. ^a %	
Alfalfa 100%	Mt- unfertilized	22.22	17.14	37.14	30.11	26.15	7.03	14.91	
	N ₅₀ P ₅₀	23.46	17.05	37.56	30.46	26.40	7.11	14.83	
	N ₇₅ P ₅₀	24.21*	16.92	37.85	30.69	26.58	7.16	14.72	
	N ₁₀₀ P ₅₀	24.59*	16.73	38.05	30.85	26.70	7.20	14.56	
Alfalfa 75% + Orchard grass 25%	Unfertilized	22.16	15.73 ⁰	39.80*	30.22	26.22	9.58*	12.90 ⁰	
	N ₅₀ P ₅₀	22.37	15.61 ⁰	41.18*	31.26	27.01	9.91*	12.80 ⁰	
	N ₇₅ P ₅₀	22.52	15.25 ⁰	42.15*	32.00*	27.56*	10.15*	12.51 ⁰	
	N ₁₀₀ P ₅₀	22.63	14.74 ⁰	42.47*	32.25*	27.74*	10.22*	12.09 ⁰	
Alfalfa 50% + Orchard grass 50%	Unfertilized	22.22	15.29 ⁰	40.15*	30.21	26.22	9.94*	11.77 ⁰	
	N ₅₀ P ₅₀	22.89	15.02 ⁰	42.75*	32.17*	27.69*	10.58*	11.57 ⁰	
	N ₇₅ P ₅₀	23.36	14.49 ⁰	44.31*	33.34*	28.57*	10.96*	11.16 ⁰	
	N ₁₀₀ P ₅₀	23.51	13.61 ⁰	45.11*	33.94*	29.02*	11.16*	10.48 ⁰	
LSD		0.05	1.3%	1.1%	2.6%	1.6%	0.9%	0.7%	1.1%

^a - contents of dry matter (DM)

The contents in CP were generally lower on variants where fertilizers were applied at culture establishing compared to variants unfertilized and significantly lower on mixtures compared to alfalfa in pure culture.

Thus, alfalfa's in pure culture plants had highest contents in CP and varied between 17.14% CP (control) and 16.73% CP (on N₁₀₀P₅₀ dose). The mixture's of *alfalfa* 75% + 25% orchard grass contents ranged from 15.73% CP (unfertilized) to 14.74% CP (on

N₁₀₀P₅₀ dose). The contents of mixture of *alfalfa* 50% + 50% orchard grass ranged between 15.29% CP (unfertilized) and 13.61% CP (on dose of N₁₀₀P₅₀).

The mixture of *alfalfa* 50% + 50% orchard grass had the highest content in cell walls on the variants that were fertilized with N₁₀₀P₅₀ dose (45.11% NDF, 33.94% ADF, 29.02% CF, 11.16% Hem.) compared to the control (37.14% NDF, 30.11% ADF, 26.15% CF 7.03% Hem.) due to participation in higher proportions in the

mixture of orchard grass compared to alfalfa, followed by the mixture of *alfalfa 75% + 25% orchard grass* (42.47% NDF, 32.25% ADF, 27.74% CF, 10.22% Hem., at a dose of N₁₀₀P₅₀). The on alfalfa in pure culture ash content in plants (Table 3), ranged from 14.91% Ash. (control) to 14.56% Ash. (on N₁₀₀P₅₀ dose). On the mixture of *75% alfalfa + 25% orchard grass* it ranged from 12.90% Ash. (unfertilized) to 12.09% Ash. (on N₁₀₀P₅₀ dose) and on the mixture of *alfalfa 50% + 50% orchard grass* between 11.77% Ash. (unfertilized) and 10.48% Ash. (on N₁₀₀P₅₀ dose).

CONCLUSIONS

On the harvest cycle I, in terms of the influence of mixture, the tendency was of increasing the cell walls content of plant and of reducing the plants crude protein content as the proportion of alfalfa in the canopy cover structure was reduced and increased the share of orchard grass.

In terms of the influence of fertilization, the tendency was of both increasing the protein content and the cell walls content of plant with increasing doses of N.

On the cycle II of harvesting, the tendency was of growing the plant cell walls content with increasing proportion of orchard grass in canopy cover structure and of decreasing the content of plants in CP. Also, from unfertilized variants to variants fertilized with maximum dose of fertilizer (N₁₀₀P₅₀), there was an increase in cell wall content and a decrease in CP content.

On the cycle III of harvesting there was a certain uniformity between variants fertilized and the only differences were generally caused by mixture with the tendency of increasing plant contents in cell walls and of decreasing the CP content caused by decreasing the proportion of alfalfa in the canopy cover structure and increasing the proportion of orchard grass.

On cycle I, the highest value of crude protein (CP) content in plants was recorded on alfalfa fertilized with N₁₀₀P₅₀ dose (17.78% CP), with 2.31% CP higher compared to the control (unfertilized alfalfa, 14.77% CP). On cycles II and III, the highest values in CP were obtained from alfalfa unfertilized (control), of 15.32% CP and 17.14% CP, respectively.

The highest plant content of neutral detergent fiber (NDF) and acid detergent fiber (ADF) was recorded on all cycles, on the alfalfa

50% + 50% orchard grass mixture, fertilized with N₁₀₀P₅₀ dose.

REFERENCES

- [1] Berdahl J., Karn J., Hendrickson J.: Nutritive quality of coolseason grass monocultures and binary grass-alfalfa mixtures at late harvest. *Agron. J.*, 2004, 96 (4): p 951-955.
- [2] Bijelić Z., Tomić Z., Ružić-Muslić D.: The effect of nitrogen fertilization on production and qualitative properties of sown grasslands in the system of sustainable production, *Biotech. in Anim. Husbandry*, 2011, 27 (3): p 615-630.
- [3] Clemson University: Formulas for feed and forage analysis calculations, *Agr. Serv. Lab.*, rev. 8/21/96.
- [4] Deak A., Hall M.H., Sanderson M.A.: Grazing schedule effect on forage production and nutritive value of diverse forage mixtures. *Agron. J.*, 2009, 101: p 408-414.
- [5] Gil J.L., Fick W.H.: Soil Nitrogen mineralization in mixtures of eastern gamagrass with alfalfa and red clover. *Agron. J.*, 2001, 93: p 902-910.
- [6] Komarek P., Nerušil P., Kohoutek A., Odstrčilova V.: The effect of repeated direct sowing of grass-legume seed mixtures into grasslands on forage production and quality. *Grassland Science in Europa*, 2007, 12: p 39-42.
- [7] Kopp J.C., McCaughey W.P., Wittenberg K.M.: Yield, quality and cost effectiveness of using fertilizer and/or alfalfa to improve meadow bromegrass pastures. *Can. J. Anim. Sci.*, 2003, 83: p 291-298.
- [8] Radović J., Sokolović D., Marković J.: Alfalfa-most important perennial forage legume in animal husbandry. *Biotech. in Anim. Husbandry*, 2009, 25 (5-6): p 465-476.
- [9] Salis L., Vargiu M.: Influence of mineral fertilization on production and quality of forage in a Sardinian pasture. *Grassland Science in Europe*, 2008, 13: p 308-310.
- [10] Tekeli S.A., Ates E.: Yield potential and mineral composition of white clover (*Trifolium repens* L.) and tall fescue (*Festuca arundinaceae* Schreb.) mixtures. *Journal of Central European Agric.*, 2005, 6 (1): p 27-34.
- [11] Tomić Z., Bijelić Z., Žujović M., Simić A., Kresović M., Mandić V., Marinkov G.: Dry matter and protein yield of alfalfa, cocksfoot, meadow fescue, perennial ryegrass and their mixtures under the influence of various doses of nitrogen fertilizer. *Biotech. in Anim. Husbandry*, 2011, 27 (3): p 1219-1226.
- [12] Undersander D., Howard W.T., Shaver R.: Making forage analysis work for you in balancing livestock rations and marketing hay. University of Wisconsin – Extension Bulletin A 3325.
- [13] Vintu V., Moisuc A., Motcă Gh., Rotar I.: Cultura pașiștilor și a plantelor furajere. Editura "Ion Ionescu de la Brad", Iași, 2004: p 519-520.