High productivity of perennial grasses with alfalfa mixtures in North-Eastern Romania

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Abstract

The current tendency is for intensification of livestock farming, pursuing continuous improvement of quantitative and qualitative performance of products. Intensification of meadows can be achieved through the use of valuable species, highly productive varieties of perennial grasses and legumes, by cultivating perennial grasses and legumes in mixtures and by proper management of meadows. Unlike pure cultures, mixing alfalfa with orchard grass provides a more balanced energy-protein feed, while providing the opportunity of ensiling alfalfa in good condition due to the contribution of soluble carbohydrates provided by the orchard grass. The purpose of this research was the capitalization of pure-crop alfalfa and mixed crop of alfalfa with orchard grass as succulent fodder packed in bales. Objectives and activities are represented by quantifying the quantitative elements which express the quantitative value, as well as the elements which express the qualitative value of fodder. The highest average yields achieved over three years, for all three mixtures tested, were obtained by fertilizing with $N_{100}P_{50}$ kg ha^{-1}. The quality of the fodder was influenced by the proportions of the two species in the mixture and by the level of fertilisation.

Keywords: ensiled fodder, fertilization, production, wilting, quality

Introduction

Intensification of meadows can be achieved through the use of valuable species, highly productive varieties of perennial grasses and legumes, by cultivating perennial grasses and legumes in mixtures, by agrotechnical measures and by proper management of meadows. Unlike pure cultures, alfalfa with orchard grass provides a more balanced energy-protein feed, while providing the opportunity of ensiling alfalfa in good condition due to the contribution of soluble carbohydrates from the grass. The idea of approaching the performance of temporary meadows established on the basis of mixtures of perennial grasses and legumes on various agricultural fields was imposed by the need to supplement the production of fodder obtained from permanent grasslands. Alfalfa is widely used in mixtures, because it yields high quality crops, even in less favourable climatic conditions (Nyfeler *et al.*, 2008; Smit *et al.*, 2008; Thumm 2008; Vrotniakiene and Jatkauskas, 2010). This paper presents the results for three alfalfa-orchard grass mixtures used for the production of ensiled forage, cropped under differentiated fertilization, in terms of dry matter production and fodder quality.

Materials and methods

The experiment was set up on the Ezareni farm in the spring of 2010. It was located on a field with a slope of 10°, an altitude of 107 m, on a cambic chernozem soil, with a pH value of 6.7-6.8, and 2.73 to 2.93% content of humus, 21-25 mg l^{-1} P_{AL}, 226-232 mg l^{-1} K_{AL} and 112-139 mg l^{-1} CaO. The weather conditions during the experiment were characterized by an average annual temperature of 9.5 °C and annual rainfall of 552.4 mm. In all experimental years, the distribution of rainfall during the vegetation period was extremely irregular, which presented problems concerning grass growth and recovery after harvest. The experiment was bifactorial, arranged in a split-plot design, in four replicates, plot size of 19 m × 5 m. The main experimental factor was represented by the type of species mixture, whereas the second factor was represented by fertilization. Were tested alfalfa-orchard grass mixtures, with varying degrees of participation: a_1 – alfalfa 100%, a_2 – alfalfa 75% + orchard grass 25%; a_3 – alfalfa 50% + orchard grass

50%. Fertilization treatments were as follows: b_1 – unfertilized control, b_2 – $N_{50}P_{50}$ kg ha^{-1}; b_3 – $N_{75}P_{50}$ kg ha^{-1}; b_4 – $N_{100}P_{50}$ kg ha^{-1}. The sampling depended on the mixture and rate of fertilizers. The mixtures were harvested during the flowering stage of the alfalfa. The yields obtained were weighed and biomass samples were harvested in order to determine the dry matter (DM) content and to perform chemical analyses of the forage. The data on yield and chemical composition were analysed by ANOVA and by comparison with the Least Significant Differences.

Results and discussion

Production and chemical composition of herbage before ensiling are presented in Table 1. Mixing alfalfa with orchard grass without fertilization decreased both the fresh fodder crude protein (CP) content and the yield of CP, but for fertilization treatments of $N_{75}P_{50}$ and $N_{100}P_{50}$ both mixtures of species showed significant increases compared to the control. Production mean values were between 8.2 and 9.2 Mg DM ha^{-1} for a_1, 8.0 and 8.4 Mg DM ha^{-1} for a_2, 7.3 and 8.2 Mg DM ha^{-1} for a_3. The quality of feed was influenced by the species components, their proportions in the mixture, and the type and level of fertilization (Table 1). The crude protein content of the fodder increased with increasing percentage contribution of alfalfa, especially when combined with fertilizer application. The mixture consisting of alfalfa 75% with 25% orchard grass showed an average total yield of CP ranging between 1,279 kg ha^{-1} and 1,372 kg ha^{-1} being close to that of the control (1,385 kg ha^{-1}). Total average CP yields recorded for the mixture consisting of 50% alfalfa with 50% orchard grass ranged between 1,186 kg ha^{-1} in the absence of fertilization and 1,225 kg ha^{-1}, when fertilized with $N_{100}P_{50}$. The Ca/P ratio was good for all the fodder mixtures, and all four types of fertilization, and did not drop below the minimum threshold of 2.8. The content of neutral detergent fibre and acid detergent fibre was influenced by the percentage contribution of alfalfa in the fodder mixture and by the rate of fertilization.

The quality of ensiled feed was influenced by the species components, their proportions in the mixture and the type and level of fertilization (Table 2). For the mineral content in fresh fodder, higher values of Ash, Ca and Mg were recorded in pure-crop alfalfa fertilized variants, followed by lower fertilized variants

Table 1. Production and chemical composition of the fodder before silaging.[1]

Mixture[2]	Fertilisation[3]	DM (Mg ha^{-1})	CP (kg ha^{-1})	CP (g kg^{-1})	NDF (g kg^{-1})	ADF (g kg^{-1})	Ca (g kg^{-1})	P (g kg^{-1})	Mg (g kg^{-1})	Ca/P
a_1	b_1	8.2	1,385	178.1	397.3	317.3	124.2	27.4	28.1	4.5
	b_2	8.5	1,434	181.5	424.3	339.2	127.1	29.1	28.7	4.4
	b_3	8.7	1,463	184.4	440.6	352.3	129.4	30.1	29.3	4.3
	b_4	9.2	1,486	187.8	458.7	366.3	131.3	30.8	29.5	4.3
a_2	b_1	8.0	1,279	169.1	128.7	327.1	113.4	28.4	27.7	4.0
	b_2	7.9	1,305	172.3	161.0	353.4	106.7	29.8	27.1	3.6
	b_3	8.3	1,324	175.8	485.7	372.2	100.1	30.6	26.2	3.3
	b_4	8.4	1,327	178.2	508.2	389.5	97.3	31.2	25.1	3.1
a_3	b_1	7.3	1,186	160.4	449.4	332.9	111.3	29.3	27.4	3.8
	b_2	7.7	1,201	163.3	488.0	362.3	102.9	30.7	26.3	3.4
	b_3	8.0	1,220	167.9	518.4	385.6	94.3	31.6	25.2	3.0
	b_4	8.2	1,225	171.4	545.1	405.5	89.4	32.1	24.4	2.8
LSD 0.1%		1.1	50	4.6	27.4	22.8	6.7	1.7	1.3	

[1] DM = dry matter; CP = crude protein; NDF = neutral detergent fibre; ADF = acid detergent fibre; LSD = least significant difference.

[2] Mixture: a_1 – alfalfa 100%, a_2 – alfalfa 75% + orchard grass 25%; a_3 – alfalfa 50% + orchard grass 50%.

[3] Fertilization treatments: b_1 – unfertilized control; b_2 – $N_{50}P_{50}$ kg ha^{-1}; b_3 – $N_{75}P_{50}$ kg ha^{-1}; b_4 – $N_{100}P_{50}$ kg ha^{-1}.

Table 2. Chemical composition and fermentation parameters of grass-legume silage.[1]

Mixture[2]	Fertilisation[3]	CP (g kg^{-1})	NDF (g kg^{-1})	ADF (g kg^{-1})	Ca (g kg^{-1})	P (g kg^{-1})	Mg (g kg^{-1})	pH	Acetic acid (g kg^{-1})	Lactic acid (g kg^{-1})	Butyric acid (g kg^{-1})	Total acids (g kg^{-1})
a_1	b_1	164.2	413.7	339.1	116.5	25.9	26.1	4.6	26.7	39.6	1.5	67.8
	b_2	167.6	441.6	361.3	118.8	27.4	26.3	4.7	27.1	36.7	2.2	66.0
	b_3	170.1	459.2	375.0	120.6	28.0	26.6	4.8	27.5	33.5	3.1	64.1
	b_4	172.4	478.5	389.4	121.8	28.4	26.3	4.8	28.2	30.6	3.8	62.6
a_2	b_1	157.4	444.2	348.8	105.9	26.8	25.9	4.5	26.3	44.8	0.8	71.9
	b_2	162.7	475.1	374.7	99.8	28.4	25.5	4.3	24.5	47.6	0.1	72.2
	b_3	167.9	498.9	393.3	93.4	29.6	25.0	4.3	21.2	51.8	0.1	73.1
	b_4	172.4	520.0	410.2	91.2	30.3	24.2	4.2	18.6	54.9	0.1	73.6
a_3	b_1	150.4	463.7	354.3	103.9	27.8	25.7	4.4	24.1	47.6	0.6	72.3
	b_2	155.0	501.0	383.4	96.6	29.4	24.9	4.2	21.3	51.8	0.0	73.1
	b_3	160.7	530.4	406.3	88.5	30.6	24.2	4.1	18.5	55.6	0.0	74.1
	b_4	165.7	555.3	425.5	84.2	31.5	23.8	3.9	16.7	59.7	0.0	76.4
LSD 0.1%		4.0	32.1	22.4	5.5	1.5	1.1	0.3	2.1	3.1	0.8	3.6

[1] CP = crude protein; NDF = neutral detergent fibre; ADF = acid detergent fibre; LSD = least significant difference.

[2] Mixture: a_1 – alfalfa 100%, a_2 – alfalfa 75% + orchard grass 25%; a_3 – alfalfa 50% + orchard grass 50%.

[3] Fertilization treatments: b_1 – unfertilized control; b_2 – $N_{50}P_{50}$ kg ha^{-1}; b_3 – $N_{75}P_{50}$ kg ha^{-1}; b_4 – $N_{100}P_{50}$ kg ha^{-1}.

of the mixture of alfalfa 75% with 25% orchard grass. For the content of P, higher values were recorded for the mixture 50% alfalfa + 50% orchard grass, in the fertilized variants, followed by fertilized variants of the mixture 75% alfalfa + 25% orchard grass. Therefore, the mixture type 75% alfalfa + 25% orchard grass was the most balanced in mineral components of the feed. Following the silaging process of the fodder, small losses were recorded for contents of Ca, P and Mg.

Conclusions

Regardless of the mixture type, the highest yields were obtained by the fodder mixture in which alfalfa was the dominant species (a_1). The highest average yields achieved in the three years were obtained by fertilizing with $N_{100}P_{50}$ kg ha^{-1} (b_4) for all three mixtures. The quality of the fodder was influenced by the proportions of the two species in the mixture and by the level of fertilisation. For fresh fodder production it is recommended to use the mixture with alfalfa 100% (a_1) and for silage production the best mixture is a_3. For a very good preservation of silage and good DM yields the recommendation is to use the type 50% alfalfa + orchard grass 50% fertilized with higher rates of mineral fertilizer.

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