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Quantitative traits of domestic and foreign alfalfa cultivars

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SUMMARY – In a three-year study, eight genetically divergent alfalfa cultivars produced an average of 16.2 t/ha of dry matter (DM). The highest-yielding genotypes (above 17 t/ha) were the recently developed cultivar Rasinka and the experimental genotype NS 11/4. The cultivars Leninskaja and Sinskaja had highest crude protein concentrations (21.2 and 21.0%, respectively). Although dry matter energy value was fairly uniform, one cultivar, Zarnica, stood out in this regard with net energy of lactation 66 MJ/kg of dry matter, or net energy of maintenance 5.41 MJ/kg of DM. The P and K concentrations were low (0.24 and 1.50%, respectively), while the concentration of Ca was medium (1.65%).

Key words: Alfalfa, crude protein, P, K, Ca.

RESUME – *"La description de caractères quantitatifs de variétés locales et étrangères de luzerne". Huit variétés de luzerne génétiquement différentes ont été étudiées pendant trois années. Ces variétés ont donné un rendement moyen de 16,2 t/ha de matière sèche (MS). Les plus productives ont été les variétés locales Rasinka et un génotype expérimental NS 11/4 (plus de 17 t MS/ha). Les teneurs en protéine ont été supérieures chez les variétés étrangères Leninskaja (21,2%) et Sinskaja (21,0%). Les valeurs énergétiques de la matière sèche ont été presque identiques. Cependant, pour cette propriété, les meilleurs résultats sont apparus chez Zarnica avec 5,66 MJ/kg (NEL) et 5,41 MJ/kg MS (NEM) respectivement. La concentration de phosphore et potasse a été très basse (0,24% et 1,50% respectivement), tandis que la concentration de calcium a été moyenne (1,65%).*

Mots-clés : *Luzerne, protéine, P, K, Ca.*

Introduction

Over the past 50 years, a total of 16 domestic alfalfa cultivars have been developed in Yugoslavia and the Institute of Field and Vegetable Crops in Novi Sad developed nine of them. The most frequent parent materials of these cultivars were local genotypes of the Panonian type of alfalfa (*Medicago sativa* L.). For hybrid, populations of yellow alfalfa (*M. Sativa M. falcata*) were also used.

Under favorable agroecological conditions, the Novi Sad (NS) alfalfa cultivars present very good adaptability and forage yield stability. With a normal rate of utilization and no irrigation, dry matter yields of over 15 t/ha and crude protein (CP) contents from 17 to 20.5% can be obtained in a three-year average.

Due to the importance of alfalfa in the production of quality forage, the objective of this paper was to compare the production and nutritive value of several domestic and foreign cultivars. A more detailed knowledge of quantitative traits of genetically divergent domestic and foreign cultivars will help enlarge the gene pool providing the basis for breeding and developing new alfalfa lines.

Materials and methods

The alfalfa used in this study were the domestic cultivars NS-Backa ZMS, NS-Mediana ZMS II, Rasinka and the experimental genotype NS 11/4, and the foreign cultivars Zarnica, Leninskaja, Sinskaja and Nadezda. The study was conducted from 1993 to1995 at the Institute of Field and Vegetable Crops on a slightly calcareous chernozem with no irrigation.

The statistical design was a randomized block design with four replicates, with an elemental plot size of 5 m^2. In the first (A_1) and second (A_2) year, when crop utilization was normal (four cuttings a year), alfalfa was harvested at initial flowering in the earliest-maturing cultivars. In the third (A_3) year, with only three cuttings, the crop was harvested at flowering stage.

The parameters studied were: (i) annual dry matter (DM) yield and dry matter percentage; (ii) chemical composition – CP, crude fiber (CF), fats, ash and nitrogen-free extract (NFE); and (iii) mineral concentrations of P, K and Ca.

The energy value of dry matter was calculated and expressed as net energy for lactation (NE_l) and net energy for growth maintenance and meat production (NE_m).

The values of chemical composition, energy value, and P, K, and Ca concentration are means of three harvests per year making a total of nine cuttings. Data were processed using analysis of variance (ANOVA).

Results and discussion

Under relatively favorable agroecological conditions for alfalfa growing, the eight cultivars produced a three-year average yield of 16.2 t/ha of DM.

The highest DM were produced by Rasinka, the experimental genotype NS 11/4, and NS-Mediana (17.9, 17.3 and 16.6 t/ha, respectively) and the lowest by Leninskaja and Sinskaja. Differences among the cultivars were significant. Several studies have shown that Yugoslav cultivars have a high potential for forage yield and excellent dry matter quality (Ivanov, 1980; Kruppa *et al.*, 1994). In the present study, the eight cultivars yielded 14.8-17.9 t/ha with an average dry matter contribution of 24.2% (Table 1).

Table 1. Average dry matter (DM) yield, dry matter contents, crude protein (CP), crude fiber (CF), fat, ash, nitrogen-free extract (NFE) and DM energy value of lactation (NE_l) and of maintenance (NE_m)

Variety	DM		CP (%)	CF (%)	Fat (%)	Ash (%)	NFE (%)	NE_l (MJ/kg DM)	NE_m (MJ/kg DM)
	t/ha	(%)							
NS-Backa	16.1	23.9	19.1	25.5	3.9	8.1	43.4	5.38	5.25
NS-Mediana	16.6	24.8	18.8	25.3	3.6	8.1	44.2	5.41	5.35
Rasinka	17.9	24.1	19.3	26.6	3.6	8.4	42.1	5.33	5.21
NS 11/4	17.3	24.0	20.0	26.2	3.9	7.9	42.0	5.39	5.26
Zarnica	15.8	24.3	20.4	25.4	3.8	8.5	41.9	5.66	5.53
Leninskaja	14.8	23.9	21.2	25.9	3.8	8.3	40.8	5.37	5.25
Sinskaja	14.9	24.4	21.0	25.1	3.7	8.3	41.9	5.39	5.26
Nadezda	16.1	24.4	19.7	26.1	3.6	7.8	42.8	5.39	5.27
Average	16.2	24.2	19.9	25.8	3.7	8.2	42.4	5.41	5.30
$LSD_{(0.05)}$	0.9	–	0.6	0.8	0.1	0.8	–	–	–
$LSD_{(0.01)}$	1.4	–	1.0	1.1	0.2	1.2	–	–	–
CV (%)	6.6	1.3					2.5	1.87	1.91

Crude protein concentration is one of the best indicators of alfalfa quality. The highest CP content was obtained by Leninskaja (21.2%) and Sinskaja (21.0%), followed by Zarnica and NS 11/4, and the lowest by NS-Mediana (18.8%), showing significant differences between cultivars. Four of the eight cultivars had high CP concentrations above 20%, while the rest had medium concentrations, above 18%, with a global average of 19.9%. According to Kruppa *et al*. (1994), the largest CP contribution among eight alfalfa cultivars was that of cultivar NS-Mediana with 22.4%.

The contents of CF is one of the main factors indicating quality of alfalfa because the CF contents as well as the CP are affected by a number of factors such as stage of plant development at cutting, leaf to stem ratio, etc. In the present study, the average CF contribution was 25.8%, whereas the percentage contents of fat was 3.7% and that of ash 8.2%.

Although alfalfa has a number of agricultural important properties, one of the main disadvantages is its low energy value. In the present study, the average energy value for NE_l and NE_m ranged from 5.33 to 5.66 MJ/kg DM, and from 5.21 to 5.53 MJ/kg DM, respectively. The energy value of the cultivars was rather uniform with average values for NE_l and NE_m of 5.41 and 5.30 MJ/kg DM, respectively. Journet (1992) argued that alfalfa energy value increases with an increase of its CP content. With a CP contents of 17 to 25%, the energy value of this crop species increases in a linear fashion. Further, Emile *et al.* (1993) and Emile *et al.* (1997) reported a pronounced genetic variability for alfalfa nutritive value resulting from an increased contribution of the leaves to total biomass yield, higher stem digestibility, etc.

The concentrations of Ca, P and K obtained in the present study, essential elements for a proper nutrition of domestic animals are presented in Table 2.

Table 2. P, K and Ca concentrations (% of dry matter)

Cultivar	Backa	NS-Mediana	Rasinka	NS 11/4	Zarnica	Leninskaja	Sinskaja	Nadezda	Average	$LSD_{(0.01)}$
P	0.25	0.22	0.24	0.25	0.25	0.24	0.23	0.21	0.24	0.04
K	1.49	1.40	1.52	1.43	1.52	1.60	1.53	1.50	1.50	0.26
Ca	1.65	1.62	1.43	1.52	1.73	1.68	1.88	1.72	1.65	0.33

The average concentration of P was of 0.21-0.25% and that of K 1.40-1.60%. There were significant differences for P and K concentrations among cultivars but the variations were smaller than those of Ca, which ranged between 1.43% (Rasinka) and 1.88% (Sinskaja) and also showed differences among cultivars.

McDonald *et al.* (1975) reported that alfalfa hay with 88% of dry matter and a ash content of 8% had 0.23% of P and 1.43% of Ca, which translates into a Ca to P ratio of 6.2:1. According to Mauries (1994), the normal average concentrations of Ca, P and K are 1.1-1.9, 0.20-0.35, and 1.2-2.3%, respectively.

In order to illustrate the high quality of alfalfa for livestock nutrition, Antongiovanni and Bruni (1994) refer to studies, who reported that the CP concentration from bud stage until full flowering ranged from 18.3 to 25.2%. In other words, dehydrated alfalfa had 14.3 to 22.3% CP, 20.8-26.2% CF, 2.3 to 3.1% fat and 10.5 to 12.2% ash. The concentration of Ca was of between 1.49 to 1.61% and that of P from 0.24 to 0.25%. Therefore, the results of the present study coincide with values presented by other authors in other areas of the world (McDonald *et al*., 1975; Mauries, 1994).

Conclusions

Eight genetically divergent alfalfa cultivars produced an average annual DM yield of 16.2 t/ha with a DM concentration of 24.2%.

Nine cuttings produced high and/or medium high percentages of CP, with an average of 19.9%. The average CF, fat, ash and NFE contents were of 25.8%, 3.7%, 8.2% and 42.4%, respectively. The DM energy value was uniform (Ne_l of 5.41 or Ne_m of 5.30 MJ/kg of DM).

The forage dry matter had a low concentration of P (0.24%) and K (1.50%) and a medium Ca concentration (1.65%). P and K concentrations varied less than that of Ca.

The highest DM yields were produced by Rasinska and the genotype NS 11/4 (over 17 t/ha), while the best cultivars in terms of CP contribution were the foreign introductions Leninskaja and Sinskaja (21.2 and 21.0%, respectively). The cultivar Zarnica had the highest energy value (NE_l of 5.66, or NE_m of 5.42 MJ/kg of DM).

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