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Variability and Correlation of Yield and Forage Quality in Alfalfa Varieties of Different Origin

Ratibor STRBANOVIC[a], Rade STANISAVLJEVIC[a], Lana DUKANOVIC[a], Dobrivoj POSTIC[a], Jordan MARKOVIC[b], Veljko GAVRILOVIC[a], Nenad DOLOVAC[a]

[a]*Institute for Plant Protection and Environment, 11040 Belgrade, Teodora Drajzera 9, SERBIA*

[b]*Institute for Forage Crops, Kruševac, 37251 Globoder, SERBIA*

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Corresponding Author: Ratibor ŠTRBANOVIC, E-mail: ratibor.strbanovic@yahoo.com, Tel: +381 (62) 880 89 29
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ABSTRACT

Alfalfa is the most important forage plant species. There are numerous alfalfa varieties in the world with improved yield potential and forage quality. Many of them have also been created in the region of Southeast Europe, using various breeding techniques. This investigation was carried out in central Serbia and it included 15 alfalfa varieties of different origin (nine from USA and six from Europe). The objective was to determine their yield in each cut and total dry matter yield (TDMY) in the second (A1) and third (A2) year of exploitation, as well as forage quality: the content of mineral matter (MM), crude protein (CP), crude fiber (CF), crude fat matter (CFM) and nitrogen-free extract (NFE). Investigated varieties exhibited high total variability in dry matter yield (DMY) (A1: CV= 13.19%; A2: CV= 9.33%). DMY variability was higher with the varieties from USA (A1: CV= 13.65%; A2: CV= 9.92%) than with those from Europe (A1: CV= 6.67%; A2: CV= 8.01%). Varieties from USA also proved more variable in crude protein (CP) content than European varieties (CV= 6.27% and CV= 2.68%, respectively). Differences between the investigated varieties (genotypes) also influenced total variability of forage quality parameters, with total CV ranging from 5.07% for CP to 10.48% for CF. Dry matter yield (DMY) had significant positive correlation with CP (r= 0.344), CF (r= 0.342) and CFM (r= 0.306), and the strongest correlation, although negative, was between CF and NFE (r= -0.917).

Keywords: Alfalfa; Varieties; Dry matter yield; Forage quality; Variability

Farklı Orijinlere Sahip Yonca Genotiplerinin Verim ve Ot Kalitesindeki Değişimler ve Korelasyonları

ESER BİLGİSİ
Araştırma Makalesi
Sorumlu Yazar: Ratibor ŠTRBANOVIC, E-posta: ratibor.strbanovic@yahoo.com, Tel: +381 (62) 880 89 29
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ÖZET

Yonca önemli bir yem bitkisi türüdür. Dünyada, yüksek verim ve ot kalitesine sahip çok sayıda yonca çeşidi vardır. Farklı ıslah yöntemleriyle Güneydoğu Avrupa'da ıslah edilmiş yonca çeşitleri de vardır. Orta Sırbıstan'da yapılmış olan bu çalışmada farklı orijinlere sahip (9 adedi Amerika ve 6 adedi Avrupa) 15 yonca çeşidi kullanılmıştır. Bu çalışmanın amacı; tesisin ikinci (A1) ve üçüncü (A2) yılında her biçimde yonca genotiplerinin verim ve toplam kuru madde verimi (TKMV) yanında mineral madde (MM), ham protein (HP), ham lif (HL), ham yağ madde (HY) ve azotsuz ekstrakt (AE) içeriklerini belirlemektir. Yonca genotipleri kuru madde verimleri (KMV) açısından yüksek toplam değişkenlik göstermişlerdir (A1: CV= % 13.19; A2: CV= % 9.33). KMV değişkenliği, Amerika orijinli genotiplerde (A1: CV= % 13.65; A2: CV= % 9.92) Avrupa orijinli genotiplere (A1: CV= % 6.67; A2: CV= % 8.01) göre daha yüksek olmuştur. Amerika orijinli genotipler, ham protein (HP) açısından da Avrupa orijinli genotiplere gore daha yüksek değişkenlik göstermişlerdir (sırasıyla CV= % 6.27 ve CV= % 2.68). Genotipler arası farklılık; HP için toplam CV % 5.07'den HL için % 10.48'e değişecek şekilde ot kalitesindeki toplam değişkenliği de etkilemiştir. Kuru madde verimi (KMY) ile HP (r= 0.344), HL (r= 0.342) ve HYM (r= 0.306) arasında önemli olumlu ilişki belirlenirken HL ile AE (r= -0917) arasında önemli olumsuz ilişki belirlenmiştir.

Anahtar Kelimeler: Yonca; Genotip; Kuru madde verimi; Ot kalitesi; Değişkenlik

1. Introduction

Alfalfa is grown in all agricultural regions in more than 80 countries on all continents, on an area of over 33 million hectares (Ivanov 1988). In the Northern hemisphere, it is grown up to 69 ºN latitude (Scandinavian countries), and up to the latitudes of 45 ºS (New Zealand) and 55 ºS (Argentina and Chile) in the Southern hemisphere (Ivanov 1988). In addition to high alfalfa forage yield, its advantage lies in different possibilities of exploitation: as fresh, hay, silage, haylage and/or for grazing. Regardless of the way of use, it retains its high nutritive value. All of this gives it the epithet of "the queen of forage crops". Alfalfa is a perennial, pollinated plant species with high genetic complexity, which complicates its breeding (Brummer 2004; Robins et al 2008). Creation of new alfalfa varieties is a very time-consuming process of selecting plants with improved qualities in several cycles, in order to produce varieties significantly better than others (resistance to cold or drought, higher yield, better nutritive value). There are numerous varieties in the world, created with one or several positive characteristics, but they often have different adaptability to environmental conditions. In the region of Southeast Europe, adequate methods of selection and breeding have created many alfalfa varieties with great genetic yield potential and other positive characteristics (Nešić et al 2005; Schitea et al 2007; Tucak et al 2008; 2009; Radović et al 2009; Petcu et al 2009). However, the main testing of each alfalfa variety takes place on individual farms, resulting in the spread or reduction of its growing area. Some varieties have been completely pushed out of production after a very short time, while others have been produced for decades.

The main objective of this study was testing of 15 alfalfa varieties of different origin (USA and central and southeast Europe), during the most productive years of their exploitation (the second and third), to find their potential for dry matter yield (DMY) and five most important parameters of forage quality. The other objective was to determine the correlation between the examined characteristics.

2. Material and Methods

The trial was set up in central Serbia (43º34' N, 21º12' E, 150 m a.s.l.) in April 2005 (year A0), by conventional sowing of alfalfa in soil suitable for its growth (pH 6.95, 3.4% humus, 0.21% total nitrogen). The soil was also well supplied with phosphorus (21.2 mg 100 g^{-1} of soil) and potassium (25.2 mg 100 g^{-1} of soil). The trial was carried out using the conventional method of completely randomized block system in four replications (the cultivars were sown at spacing: 20 cm-10 rows per plot 4×2 m in size). During the second (2006-A1) and third (2007-A2) year of their exploitation, 15 alfalfa varieties of different origin (nine from USA and six from central and southeast Europe, Table 1) were tested for green forage yield per each cut in a basic plot, which was then recalculated into dry matter yield (DMY, t ha^{-1}). The trial was carried out in dry-land conditions and the mowing of each cut was performed when 20-30% of alfalfa plants were in the flowering stage (Stanisavljević 2006). For each investigated variety, the quality of forage dry matter was determined using Weende system of analysis, in four cuts (I-IV) of each investigation year (A1 and A2). The following quality parameters were determined. Mineral matter (MM, g kg^{-1}), using the dry ashing method at 550 ºC. Crude proteins (CP, g kg^{-1}), using the Kjeldahl method (AOAC 1990), crude fiber (CF, g kg^{-1}), using the Weende method (AOAC 1990), crude fat matter (CFM, g kg^{-1}), using the Soxhlet extraction method (AOAC 1990), nitrogen-free extract (NFE, g kg^{-1}), by subtraction the values of previous parameters from 100 (AOAC 1990).

Table 1- Origin of investigated alfalfa varieties (*Medicago sativa* L.)

Çizelge 1- Çalışmada kullanılan yonca (Medicago sativa L.) genotiplerinin orijinleri

Variety	*Origin*
Mecca III	USA
Dynamic	USA
Pointer	USA
Weston-4	USA
DKA 50-18-4	USA
WL-625 HQ	USA
Tru test	USA
Ameri stand	USA
Integrity	USA
K-22	Europe-Serbia
K-28	Europe-Serbia
Pop. Užice	Europe-Serbia
Vali	Europe-Slovakia
Synteza 1	Europe-Slovakia
OS-95	Europe-Croatia

Obtained results were analyzed by ANOVA (Analysis of Variance). Medium effect of factors (year, genotype, cut and their interaction) was assessed by F-test. Tukey's multiple range test and coefficients of variation (CV, %) were used for detection of differences between treatments. Correlation between investigated parameters was determined by Pearson correlation coefficients (r). Data were processed by program STATISTICA, version 8 (StatSoft Inc, Tulsa, OK, USA).

3. Results and Discussion

3.1. Dry matter yield (DMY)

It was determined by statistical analysis that all three factors (year, variety-genotype and cut) had significant influence (P≤0.001) on dry matter yield (DMY). The following significant interactions were also determined; variety×cut (P≤0.001), as well as year×variety, year×cut and year×variety×cut (P≤0.01) (Table 2).

For significant impact year and cut and their interactions on DMY of alfalfa indicate (Albayrak & Turk 2013). During the two years of the trial, the amount of precipitation and air temperature greatly varied (Table 3 and 4). This was especially evident during the growth of each year's second cut, when the varieties responded differently. It was indicated by significant interactions; variety×year and variety×cut. Therefore, there is the possibility of choosing a variety according to agro-ecological conditions.

Average dry matter yield (DMY) in the first cut was higher by 2.83 t ha^{-1} in the year A1 than in the year A2. Contrary to that, DMY in the second cut was higher by 2.94 t ha^{-1} in the year A2 than in the year A1 (Table 5). This difference can be attributed to the influence of precipitations, which is in accordance with the results obtained by (Delić et al 2007). In the third and fourth cut of the year A2, DMY was respectively lower by 0.18 and higher by 0.80 t ha^{-1} than in the third and fourth cut in the year A1. This also indicates the influence of weather conditions on yield generation and its distribution between cuts (Table 3, 4 and 5). DMY variations, dependent on different variety genotypes, in four cuts of each of the two years (A1 and A2) were as follows: A1: I-3.64 t ha^{-1}, II-1.46 t ha^{-1}, III-1.30 t ha^{-1} and IV-1.10 t ha^{-1}, and A2: I-2.79 t ha^{-1}, II-2.42 t ha^{-1}, III-1.76 t ha^{-1} and IV-2.22 t ha^{-1}. High variability

Table 2- F-test statistical probabilities for medium effect of three factors on yield and forage quality

Çizelge 2- Verim ve ot kalitesine genotip, biçim ve yıl etkisine ilişkin F-test sonuçları

Source (factors)	df	DM yield	Forage quality (g kg^{-1} DM)				
			MM	CP	CF	CFM	NFE
Year	1	***	ns	ns	ns	ns	ns
Variety (genotype)	14	***	*	*	*	*	*
Cut	3	***	ns	ns	ns	ns	ns
Year×variety	14	**	ns	ns	ns	ns	ns
Year×cut	3	**	ns	ns	ns	ns	ns
Variety×cut	42	***	ns	ns	ns	ns	ns
Year×variety×cut	42	**	ns	ns	ns	ns	ns

ns, not significant; *, significant at P≤0.05; **, significant at P≤0.01; ***, significant at P≤0.001

Table 3- Precipitation for central Serbia (mm)

Çizelge 3- Orta Sırbistan'ın yağış durumu (mm)

Year	Months												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
2006	37	44	146	58	34	71	20	76	45	37	24	60	652
2007	30	54	54	3	107	66	8	62	89	117	114	41	745
1968-2008	38	36	43	57	70	76	60	47	51	50	55	53	636

Table 4- Mean monthly air temperatures for central Serbia (ºC)

Çizelge 4- Orta Sırbistan'ın aylık ortalama sıcaklık durumu (ºC)

Year	Months												Annual average
	1	2	3	4	5	6	7	8	9	10	11	12	
2006	-2.0	1.4	5.4	12.8	16.3	19.9	22.4	20.9	17.8	12.9	6.5	2.3	11.4
2007	5.0	6.0	9.2	12.4	18.3	22.6	24.9	23.4	15.5	10.7	4.0	0.5	12.7
1968-2008	-0.1	2.1	6.8	11.6	16.4	19.9	21.6	21.3	16.8	11.5	6.4	1.4	11.3

of DMY is also indicated by its dependence on the variety genotype, taking into account both years of exploitation-total CV ranged from 11.37% (II cut) to 28.38% (IV cut) (Table 5).

It is in accordance with the results obtained by Stanisavljević et al (2012) on DMY variability in two localities during four-year period (CV= 17.1% and 25.7%). In those parts of the years with more favourable agro-ecological conditions (I and II cut in both A1 and A2), the following varieties exhibited an increased DMY potential: Vali (24.58 t ha^{-1}), Synteza 1 (24.19 t ha^{-1}), K-22 (23.78 t ha^{-1}), Integrity (23.43 t ha^{-1}) and OS-95 (23.02 t ha^{-1}), which makes them more suitable for use in May, June and July. In periods of worse agro-ecological conditions (precipitation amount and temperature), (III and IV cut of both A1 and A2), the increased DMY potential was recorded in varieties: Vali (10.73 t ha^{-1}), WL-625 HQ (10.58 t ha^{-1}) and Weston (10.17 t ha^{-1}) (Table 5). Yield distribution between cuts is also very important, especially if alfalfa forage is used immediately after mowing. On annual basis, all the investigated varieties (genotypes) had an influence on high DMY total variability (A1: CV= 13.19%, A2: CV= 9.33%). DMY variability in the varieties from USA was higher (A1: CV= 13.65%,

Table 5- DMY (t ha^{-1}) of alfalfa varieties in four cuts of the years A1 and A2

Çizelge 5- Yonca genotiplerinin yıllara (A1 ve A2) ve biçim dönemlerine göre kuru madde verimleri (t ha^{-1})

Year	*Variety*	*Cut*			
		I	*II*	*III*	*IV*
A1	Mecca III	5.49 f*	2.69 e-g	2.77 bc	1.27 d-f
	Dynamic	5.35 f	2.63 fg	2.80 a-c	1.44 c-e
	Pointer	5.65 f	2.82 ef	2.32 bc	1.12 ef
	Weston	5.45 f	2.60 fg	2.42 bc	1.57 b-d
	DKA 50-18	6.17 ef	3.01 d-f	2.82 a-c	1.12 ef
	WL-625 HQ	5.40 f	3.05 c-f	2.69 bc	1.53 b-d
	Tru test	6.95 de	2.35 g	2.98 a-c	1.63 b-d
	Ameri stand	7.89 bc	3.47 ab	2.84 a-c	1.83 a-c
	Integrity	7.55 cd	3.74 ab	3.51 a	2.11 a
	K-22	7.48 cd	3.81 a	2.49 bc	1.50 b-e
	K-28	7.49 cd	3.35 bc	2.21 c	1.01 f
	Pop Užice	8.47 ab	3.45 a-c	2.81 a-c	1.36 d-f
	Vali	8.99 a	3.36 bc	3.01 ab	1.88 ab
	Synteza 1	7.75 b-d	3.63 ab	2.59 bc	1.48 b-e
	OS-95	8.06 bc	3.51 ab	2.76 bc	1.50 b-e
	Average	7.94	3.16	2.73	1.49
	Total CV (%)	17.94	14.58	11.55	20.07
A2	Mecca III	4.25 de	5.71 c-f	1.72 e	1.87 ef
	Dynamic	4.80 c-e	5.26 ef	2.24 de	1.39 f
	Pointer	4.47 de	5.41 d-f	2.10 e	1.98 d-f
	Weston	4.88 c-e	5.07 f	2.81 b-d	3.37 ab
	DKA 50-18	4.39 de	5.75 c-f	3.48 a	2.31 c-e
	WL-625 HQ	3.95 e	5.45 d-f	3.47 a	2.89 a-c
	Tru test	6.24 a	5.24 ef	3.21 ab	3.58 a
	Ameri stand	5.67 a-c	5.79 c-f	2.84 bc	2.09 d-f
	Integrity	5.62 a-c	6.52 bc	2.29 cd	1.76 ef
	K-22	6.14 ab	6.35 bc	2.09 e	2.20 c-e
	K-28	5.11 b-d	5.92 c-e	1.73 e	1.36 f
	Pop. Užice	4.14 de	7.49 a	2.04 e	2.41 c-e
	Vali	5.54 a-c	6.69 b	3.08 ab	2.76 b-d
	Synteza 1	6.74 a	6.07 b-d	2.17 e	1.88 ef
	OS-95	4.73 c-e	6.72 b	3.01 ab	2.48 c-e
	Average	5.11	6.10	2.55	2.29
	Total CV (%)	16.54	11.37	23.73	28.38

*, means followed by the same letter are not significantly different at P≤0.01

A2: CV= 9.92%) than in the varieties from Europe (A1: CV= 6.67%, A2: CV= 8.01%) (Table 6 and Figure 1). The highest average DMY (of A1 and A2) was recorded in Vali variety (17.66 t ha^{-1}). It was followed by varieties: Integrity, OS-95, Ameri stand, Synteza 1, Užice, Tru test and K-22, with the most difference in average DMY of only 0.52 t ha^{-1}. Investigating 17 alfalfa varieties and populations, Radović et al (2009) reported on the difference in DMY of 6.27 t ha^{-1}, which is in accordance with our results. Contrary to that Tomić et al (2005) did not find any significant difference in DMY between investigated alfalfa varieties, but all of them were of blue Pannonian-type and therefore in closer genetic relation than the varieties investigated in this study. Higher DMY was in correspondence with higher content of CP, CF and CFM (r= 0.344, r= 0.342, r=0.306; P≤0.001), while it was in negative correlation with MM (r= -0.510, P≤0.001). According to Tucak et al (2008), there was not a significant correlation between DMY and CP content (r= 0.04) as there was between DMY and CP yield (r= 0.91, P≤0.001).

Table 6- Annual DMY (t ha^{-1}) in alfalfa varieties

Çizelge 6- Yonce genotiplerinin yıllara gore kuru madde verimleri (t ha^{-1})

Variety	*A1*	*A2*	*Average (A1, A2)*
Mecca III	12.22 e*	13.55 e	12.89 c
Dynamic	12.22 e	13.69 d-e	12.96 c
Pointer	11.91 e	13.96 b-e	12.94 c
Weston	12.04 e	16.13 a-e	14.09 bc
DKA 50-18	13.12 c-e	15.93 a-e	14.53 bc
WL-625 HQ	12.67 d-e	15.76 a-e	14.22 bc
Tru test	13.91 b-e	18.27 a	16.09 ab
Ameri stand	16.03 a-c	16.39 a-c	16.21 ab
Integrity	16.91 ab	16.19 a-d	16.55 ab
CV (%)	13.65	9.92	10.14
K-22	15.28 a-e	16.78 a-c	16.03 ab
K-28	14.06 b-e	14.12 c-e	14.09 bc
Pop. Užice	16.09 a-c	16.08 a-e	16.09 ab
Vali	17.24 a	18.07 a	17.66 a
Synteza 1	15.45 a-d	16.86 ab	16.16 ab
OS-95	15.83 a-d	16.94 a	16.39 ab
Average	14.33	15.91	15.13
CV (%)	6.67	8.01	7.13
Total CV (%)	13.19	9.33	10.11

*, means followed by the same letter are not significantly different at P≤0.01

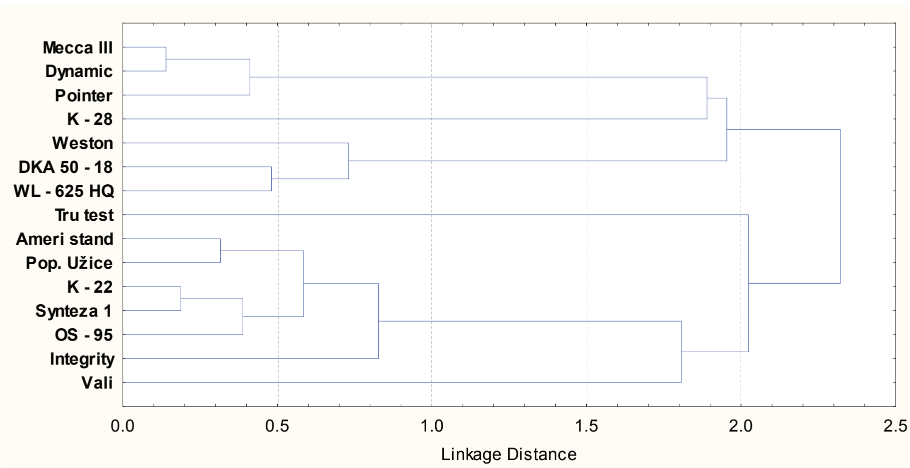

Figure 1- Dendrogram of total dry matter yield of alfalfa varieties

Şekil 1- Yonca genotiplerinin toplam kuru madde dendrogramı

3.2. Forage quality

The variety (genotype) factor had significant effect on forage quality parameters (P≤0.05) (Table 2, Figure 2), which were not significantly affected by the other factors or their interactions (Table 2). There are many reports on the potentialities of breeding in improving the alfalfa forage quality (Ridy & Brummer 2002; Lamb et al 2006; Štrbanović 2010; Milić et al 2014). Average mineral matter content (MM) of 85.8 g kg^{-1} DM was determined by analysis. Depending on the variety, MM content ranged from 82.8 g kg^{-1} DM (Synteza 1) to 104.6 g kg^{-1} DM (Integrity), so it differed most by 21.8 g kg^{-1} DM (total CV= 8.09%). Mineral matter had significant correlation, although negative, only with CF (r= -0.364, P≤0.001).

By decomposing MM into components (Hintz et al 1985) determined correlation between calcium and CP (r= 0.40, P≤0.01) and between phosphorus and CP (r= 0.26), which was positive, but not significant. The highest recorded CP content was 215 g kg^{-1} DM (Tru test and Pointer), and the lowest was 174 g kg^{-1} DM (Mecca III). Depending on the variety, CP content varied most by 41 g kg^{-1} DM, and the varieties from USA exhibited higher variability (CV= 6.27%) than those from Europe (CV= 2.68%). According to Keskin et al (2009) the biggest difference in CP content between 12 investigated varieties was 37 g kg^{-1} DM. Altinok & Karakaya (2002) reported it was 30 g kg^{-1} DM between eight investigated varieties and Geleti et al (2014) reported the biggest difference in CP content of 14.1 g kg^{-1} DM between five investigated varieties. A little higher difference recorded in this study could be attributed to greater heterogeneity of the investigated varieties (Table 7 and 8). Crude protein (CP) was in negative correlation (r= -0.393, P≤0.001) with crude fiber (CF) and in positive (r= 0.424, P≤0.001) with crude fat matter (CFM) (Table 8), which is in accordance with the results obtained by (Katić et al 2005). Stanisavljević (2006) also reported on negative correlation between CP and CF (r= -0.409, P≤0.05). Differences in CF content caused by different variety genotypes ranged to the maximum of 99 g kg^{-1} DM, so that total variability of this parameter was high (CV= 10.48%). Average CF content was 275 g kg^{-1} DM, while according to (Heuze et al 2013), CF content ranged from 201 to 315 g kg^{-1} DM, depending on plant phenophase. The strongest correlation, although negative (r= -0.917) was between CF and NFE, which is in accordance with the results obtained by Stanisavljević (2006) (r= -0.607). Negative correlation was also determined

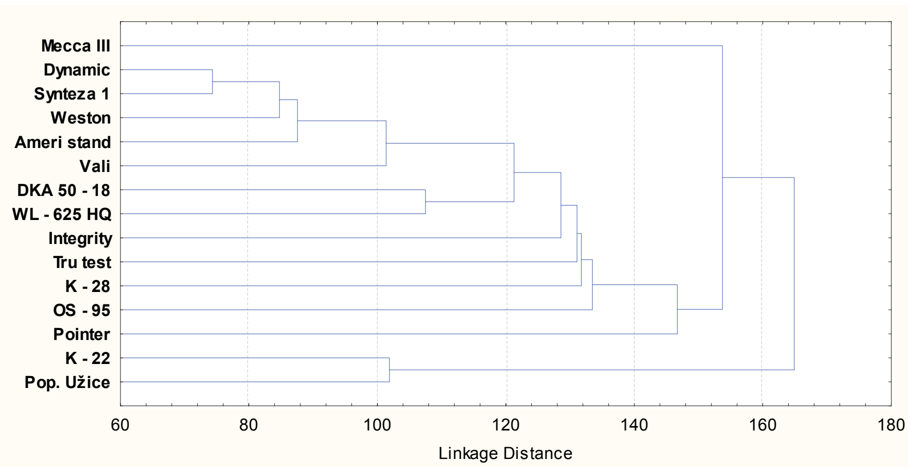

Figure 2- Dendrogram of forage quality of alfalfa varieties

Şekil 2- Yonca genotiplerinin ot kalitesi dendrogramı between CF and CFM (r= -0.227, P≤0.05). Investigated varieties had the average CFM content of 24.3 g kg^{-1} DM. This is in accordance with the results obtained by (Marković et al 2008), although the results obtained by (Katić et al 2005) indicated that there was not any significant difference in CFM content between varieties. Considering similar agro-ecological conditions, these contradictory results could be explained by different variety genotypes. Maximum difference in NFE content between the investigated varieties was 101 g kg^{-1} DM, with variability of this parameter of 6.74% (total CV). Stanisavljević (2006) determined the maximum difference in NFE content of only 2.9 g kg^{-1} DM between three domestic (NS-H-11, NS Slavija and ZA-83) and one French variety (Europe), which could also be explained by the influence of genetic constitution of investigated varieties.

Table 7- Forage quality parameters for different alfalfa genotypes; average of A1 and A2 (I-IV harvests each)

Çizelge 7- Yonca genotiplerinin 2 yıl (A1 ve A2) ve 4 hasat (I-IV) ortalaması olarak ot kalite özellikleri

Varieties	*MM*	*CP*	*CF*	*CFM*	*NFE*
Mecca III	85.8 bc*	174 e	301 a-c	19.2 b	407 a-d
Dynamic	89.8 bc	201 a-d	271 c-e	25.9 a	413 b-d
Pointer	100.4 ab	215 a	225 g	23.0 ab	437 ab
Weston	98.6 a-c	196 b-d	260 d-f	26.7 a	418 bc
DKA 50-18	94.4 a-c	198 b-d	272 c-e	23.1 ab	413 bc
WL-625 HQ	103.8 a	196 b-d	244 e-g	25.5 a	431 a-c
Tru test	84.1 c	215 a	282 ed	23.2 ab	396 de
Ameri stand	90.7 a-c	199 b-d	289 b-d	25.3 a	396 de
Integrity	104.6 a	210 ab	259 d-f	24.2 a	403 cd
CV (%)	8.01	6.27	8.70	9.36	3.47
K-22	87.0 bc	201 a-d	229 fg	25.1 a	458 a
K-28	83.9 c	193 c-d	285 bc	24.4 a	404 cd
Pop. Užice	89.0 a-c	203 a-d	316 ab	25.3 a	362 f
Vali	87.1 bc	206 a-c	297 a-c	26.0 a	369 ef
Synteza 1	82.8 c	200 b-d	277 cd	24.8 a	406 cd
OS-95	98.6 a-c	191 d	324 a	22.7 ab	357 f
Average	85.8	200	275	24.3	405
CV (%)	5.92	2.68	10.97	4.21	8.95
Total CV (%)	8.09	5.07	10.48	7.66	6.74

*, means followed by the same letter are not significantly different at P≤0.01

Table 8- Coefficients of correlation (r) between investigated parameters (n= 120; 2 years; 15 varieties; four cuts)

Çizelge 8- İncelenen özellikler arası (n= 120, 2 yıl, 15 genotip, 4 biçim) ait korelasyon katsayıları (r)

DMY (t ha^{-1})	*Forage quality parameters (g kg^{-1} DM)*				
(I)	*MM (II)*	*CP (III)*	*CF (IV)*	*CFM (V)*	*NFE (VI)*
I	-0.140 ^{ns}	0.344***	0.342***	0.306***	-0.510***
II		0.160 ^{ns}	-0.364***	0.099 ^{ns}	0.151 ^{ns}
III			-0.393***	0.424***	0.068 ^{ns}
IV				-0.227*	-0.917 ***
V					0.043 ^{ns}

ns, not significant; *, significant at P≤0.05; ***, significant at P≤0.001

4. Conclusions

In this two-year trial, conducted in central Serbia, the investigated varieties originated from different regions of USA and Europe. Several varieties from each region had superior potential for high dry matter yield (DMY): Vali, Integrity, Ameri stand, OS-95, Synteza 1, Užice, Tru test and K-22, with DMY ranging from 16.03 to 17.66 t ha^{-1}. Varieties from USA exhibited higher DMY variability (A1: CV= 13.65% and A2: CV= 9.92%) than European varieties (A1: CV= 6.67% and A2: CV= 8.01%). Variability of crude protein content (CP), the most important parameter of forage quality, was also higher in USA varieties than in those from Europe (CV= 6.27% and CV= 2.68%, respectively). Total variability of forage quality parameters ranged from 5.07% (CV) for crude protein (CP) to 10.48% (CV) for crude fiber (CF). The strongest correlation, although negative (r= -0.917), was between CF content and nitrogen-free extract (NFE), while DMY was in significant positive correlation with CP (r= 0.344), CF (r= 0.342) and crude fat matter content (CFM) (r= 0.306). The obtained results could be helpful when choosing alfalfa varieties, in this or similar region, for conventional growing and/or for selection and breeding of varieties with good potential for high dry matter yield (DMY) and forage quality.

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