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Yield and Nutritive Value of Double Cropped Soybean

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Abstract: This paper reviews two-year results of studies on yield and forage quality of soybean cultivars Krajina and Jelica (FAO maturity group 00) double cropped at AIC "Bečej" in Bečej and Institute of Field and Vegetable Crops in Novi Sad. With the average crop density of 421,500 plants/ha and irrigation, double cropped soybean produced over 20 t ha⁻¹ of green forage or over 7 t ha⁻¹ of dry matter suitable for ensiling. The average stem height was 68.4 cm, the percentage of dry matter at the time of harvest 30.5%. The proportions of stems, leaves and pods in the total biomass were 25.3%, 26.0% and 48.7%, respectively. The average number of pods per stem was 23.4. The feed dehydrated to 90.55% of dry matter had the following average values of crude proteins, crude cellulose, crude fats, crude ashes and N-free extract: 27.1%, 17.06%, 13.29%, 4.66% and 28.42%, respectively. The average value of the feed was very good: the average NEL and NEM values were 6.80 and 7.03 MJ/kg DM).

Key words: soybean, double cropping, irrigation, forage yield, quality.

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Introduction

Soybean (*Glycina hispida* Max., syn. *Soja hispida* Moench.) is considered a major protein crop on the global scale. According to FAO data, the total soybean acreage in 1998 was around 70 million hectares, with the grain production of about 160 million tons or somewhat above 2 t ha^{-1} . The world's major soybean producers are the USA, which produce a half of the total global production, followed by Brazil (20%), Argentina (12%) and China (9%). The EU countries produce about 1.2 million tons. The major soybean producers in Europe are Italy and France, with the acreages of 240,000 and 100,000 ha, respectively. The soybean acreage in Serbia is around 80,000 ha, with the average grain yield of about 2 t ha^{-1} . Regarding the production of soybean meal for animal feed, the USA covers one third of the global production (35 million tons), followed by Brazil (17 million tons), EU (13 million tons) and Argentina (12 million tons) (Hrustić et al., 1999; Larousse Agricole, 2002).

Regarding the production of soybean biomass for feed for ruminants, yields and quality achieved so far have been modest. Soybean biomass is seldom ensiled alone, mostly because of its bitter taste. When mixed with corn biomass, however, palatable silage of high quality is obtained (Göhl, 1982).

Under the agroecological conditions of our country, very early soybean cultivars (maturity group 00) can be successfully grown in an irrigated double cropping system.

The objective of this study was to assess yield and quality of forage of irrigated soybean with intention of optimizing the exploitation of agricultural land and irrigation systems. Considering the importance of roughage

Material and Method

Field trials to assess the yield and quality of soybean biomass were conducted at "Jezero" experiment field of AIC "Bečej", Bečej, and Rimski Šančevi experiment field of Institute of Field and Vegetable Crops in Novi Sad in the course of 1999 and 2000. Research objects were very early soybean cultivars (FAO maturity group 00) Jelica and Krajina, which are suitable for double cropping.

After spring pea (*Pisum sativum* L.) harvest, the fields were tilled and prepared for planting. Plantings were performed with Nodet pneumatic drills, with the row spacing of 45 cm and in-row spacing from 3.9 to 4.2 cm, on 19 June 1999 and 21 June 2000. The achieved stand densities were 55 viable seeds/m² for Jelica and 50 viable seeds/m² for Krajina.

The cultivars were grown in large-plot trials of 1.0 ha and 0.50 ha/cultivar. The plots received conventional cultural practices but no mineral fertilizers.

In 1999, 85 l m⁻² of water were applied in five turns (20 l m⁻² on 9 July, 15 l m⁻² on 20 July, 15 l m⁻² on 6 August, 20 l m⁻² on 13 August and 15 l m⁻² on 23 August). In 2000, 230 l m⁻² of water were applied in nine turns (20 l m⁻² during primary tillage on 9 June, 17.06. 20 l m⁻² during seedbed preparation on

17 June, 25 l m⁻² on 24 June, 30 l m⁻² on 1 July, 30 l m⁻² on 7 July, 35 l m⁻² on 14 July, 20 l m⁻² on 22 July, 30 l m⁻² on 28 July and 20 l m⁻² on 4 August).

The experiment was harvested on 27 September 1999 and 14 October 2000, at the reproductive stages R₅ and R₆, respectively.

Yield of green forage was assessed for the area of 40 m² (10 m² x 4 replications). Shortly before harvest, samples for morphological study and chemical analysis of dry matter in whole plants were taken from each replication. After drying at 65^oC, proportion of dry matter (%) and yield of dry matter (t ha⁻¹) were measured.

Dry matter (DM) quality was established on the basis of the analyses of crude proteins (CP), crude fats (CF), crude cellulose (CC) and crude ash (CA) conducted by conventional methods.

Based on the results of the chemical analyses of SM, we calculated the proportion of N-free extract (NFE) and the energy value of DM, i.e., the net energy for lactation – NEL (in MJ/kg of feed) (according to the system of Obračević, 1990; Glamočić, 2000). Digestibility coefficients for sheep were used while calculating the energy value of DM (Göhl, 1982)

The results obtained for stem length, green forage yield, dry matter yield, proportion of stems, leaves and pods in total yield of biomass and the number of pods per stem were processed by the analysis of variance (ANOVA). Significance of differences among treatments was determined by the *t*-test.

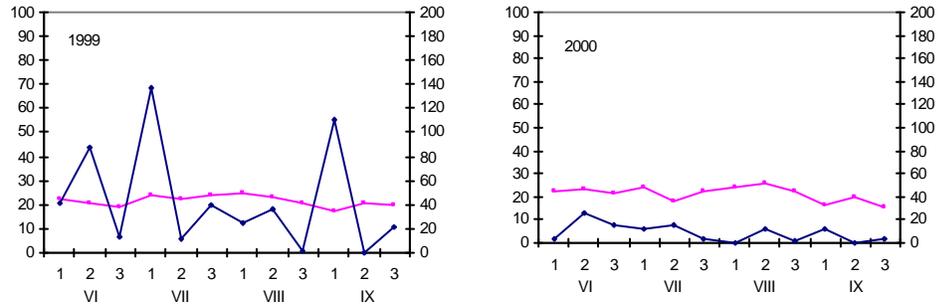
Soil and weather conditions

Soil conditions – Soybean double cropping for biomass production and ensiling was performed on a chernozem soil with good agrochemical properties. According to the results of the soil testing laboratory of AIC "Bečej" in Bečej, the soil layer 0-30 cm is highly calcareous, alkaline (pH >7.2), with high contents of humus (>4%), nitrogen (>0.20%), P₂O₅ and K₂O (Kastori et al., 1991).

Weather conditions - In the period June-September 1999, the rainfall was 526.8 l m⁻² or 57.0% above the long-term average (226.3 l m⁻²). Soil moisture reserves were favorable for soybean double cropping, as the rainfall in June was 143.5 l m⁻² or 43.8% higher than the long-term average (80.7 l m⁻²). Furthermore, the rainfalls in July, August and September exceeded the average figures by 70.8, 20.4 and 69.4%, respectively. Contrary to the situation in 1999, the period June-September 2000 had 101.8 l m⁻² of rain or 45% less than the long-term average. Similarly, the rainfalls in June, July, August and September were lower by 46.1, 47.7, 72.8 and 61.9%, respectively, than the long term averages (Graph 1).

The average air temperature in the period June-September 1999 was 19.3^oC or 0.4^oC above the long-term average (18.9^oC). In June-September 2000, the average temperature was 1.1^oC higher than the long-term average (Graph 1).

Graph 1. Climatograms for 1999 and 2000



Taking into consideration such weather conditions, irrigation was performed in order to provide water needed for the growth and development of double cropped soybean, thus for the production of soybean roughage.

Results and Discussion

The two-year study of soybean yield components showed that an average of 421,500 plants/ha was achieved in double cropping. Stem length ranged from 63.9 cm in Krajina to 72.3 cm in Jelica or 68.4 cm on the average. The differences were significant (Table 1).

Soybeans cut when the average dry matter proportion reached 30.5% produced the plant weight of 53.71 g with the stem and leaf percentage of 25.3 and 26.0%, respectively. The average number of pods per plant was 23.47 while the proportion of pods was 48.7%. The examined cultivars did not differ significantly in plant weight and the proportions of stems, leaves and pods, but the differences in the number of pods were significant (Table 1).

The yield of soybean biomass for ensiling was high, 23.22 t ha⁻¹ of green forage or 7.07 t ha⁻¹ of dry matter on the average. The differences between the cultivars were significant (Table 2).

The average proportion of crude proteins was 271.2 g/kg of dry matter or 27.12%. The proportions of crude cellulose, crude fats and crude ash were 170.6, 132.9 and 46.6 g/kg of DM. Estimated on the basis of the results obtained in this study, the soybean biomass contained a high proportion of crude proteins and low energy value (the average proportion of N-free extract was 284.2 g/kg of DM or 28.42%).

According to Göhl (1982), soybeans grown in Chile had the DM content of 26.1% and the contents of crude proteins, crude cellulose, crude fats, crude ash and N-free extract of 12.2, 34.2, 8.2 and 41.2%, respectively, when the stem height reached 80 cm. In other words, the digestibility for sheep was 77% for crude proteins, 53% for crude cellulose, 83% for crude fats and 67% for N-free extract. Mišković (1986) reported that the contents of crude proteins, crude

cellulose, crude fats, crude ash and N-free extract in soybeans at the stage of early flowering were 19.94, 24.40, 4.00, 10.00 and 37.13%, respectively.

The energy value of dry matter in the studied cultivars was very good - the average NEL and NEM were 6.8 and 7.03 MJ/kg of DM, respectively. The cultivar Krajina had a somewhat higher energy value of dry matter than the cultivar Jelica, resulting from somewhat higher contents of crude proteins and crude fat (Table 2).

Table 1. Number of plants per ha, stem length (cm), plant weight (g), proportions of stems, leaves and pods per plant (in g and %), number of pods per plant, yield of green forage (GF) and dry matter ($t\ ha^{-1}$) and the proportion of DM (%) in soybean cultivars

Cultivar	No. of plants per ha (in 000)	Plant height (cm)	Plant weight (g)	Proportion in GF (g and %)			No. of pods/plant	Yield ($t\ ha^{-1}$)		DM (%)
				Stems	Leaves	Pods		GF	DM	
Jelica	421.0	72.3	52.90	13.58 25.7%	12.65 23.9%	26.67 50.4%	26.10	22.87	6.90	30.2
Krajina	422.0	63.9	54.53	13.56 24.9%	15.35 28.1%	25.62 47.0%	20.85	23.57	7.25	30.8
Average	421.5	68.4	53.71	13.57 25.3%	14.00 26.0%	26.14 48.7%	23.47	23.22	7.07	30.5
LSD 0.05	1.55	1.29	3.18	0.81	1.04	6.49	1.10	1.34	0.40	-
0.01	1.91	1.64	4.04	1.03	1.32	8.22	1.40	1.70	0.51	-

Table 2. Chemical composition of dry matter (in g/kg DM) and proportion of N-free extract in soybean cultivars and energy value of soybean feed (MJ/kg DM)

Cultivar	DM (%)	In g/kg DM				NFE	In MJ/kg	
		CP	CC	CF	CA		NEL	NEM
Jelica	90.2	264.7	179.0	125.7	44.7	287.9	6.52	6.68
Krajina	90.9	277.7	162.2	140.2	48.5	280.4	7.09	7.39
Average	90.5	271.2	170.6	132.9	46.6	284.2	6.80	7.03

Ensiled soybean biomass is a quality feed for ruminants, especially when mixed with biomass of double cropped corn.

High yields of biomass are obtained by double cropping early corn hybrids and early soybean cultivars in irrigation. When these crops are harvested simultaneously (corn at the stage of milk-wax maturity of grain, soybean between the reproductive stages R5 and R6) and their biomass mixed and ensiled, a feed mixture is prepared which combines a high content of crude proteins (soybean) and a high energy value (corn). With the yields of $20\ t\ ha^{-1}$ of corn and $7\ t\ ha^{-1}$ of soybean, an average of $13.5\ t\ ha^{-1}$ of ensiled biomass are obtained, with 11.55% of crude proteins. Such feed significantly improves the quality of nutrition of ruminants.

Conclusion

Following conclusions were drawn on the basis of a two-year study of the yield level and biomass quality in double cropped soybean cultivars.

At the time of soybean harvest for silage, the average stand was 421.5 plants m⁻², the stem length was 68.4 cm and the content of dry matter was 30.5%.

The proportions of stems and leaves (calculated together) and pods in the total yield of biomass were 51.3% and 48.7%. The average number of pods per stem was 23.5.

The average yield of green forage was 23.2 t ha⁻¹, or 7.07 t ha⁻¹ of dry matter.

The quality of feed (at 90.5% dry matter) was very good. The contents of CP, CC, CF, CA and NFE were 271.2, 170.6, 132.9, 46.6 and 284.2 g/ka DM, respectively.

The energy value of the feed was very good. The values of NEL and NEM were 6.8 and 7.03 MJ/kg DM, respectively.

When early corn and early soybean are simultaneously double cropped in irrigation, average yields of dry matter between 13 and 15 t ha⁻¹ can be obtained. Such feed mixture combines a high content of crude proteins (soybean) and a high energy value (corn) and it may significantly improve the quality of nutrition of ruminants.

References

- Glamočić D. (2000): Ishrana preživara, Univerzitet u Novom Sadu, Poljoprivredni fakultet, str. 151.
- Göhl B o (1982): Les aliments du bétail sous tropiques, Collection FAO: Production et santé animales, Rome, B69, 167-168.
- Đukić D., Pejović M., Stevović V., Maksimović Livija, Ilić Olivera (2005): Prinos i kvalitet krme hibrida kukuruza iz postrne setve, Traktori i pogonske mašine, Vol. 10, br. 2, 407-414.
- Hrustić Milica, Vidić M., Miladinović J., Malidža G., Sinđić M., Reljin V. (1999): Soja – priručnik za gajenje, Institut za ratarstvo i povrtarstvo, Novi Sad, Sojaprotein, Bečej, Semenarstvo, Novi Sad, 20 str.
- Kastori R., Ubavić M., Petrović N., Peić A. (1991): Đubrenje ratarskih i povrtarskih biljaka, Poljoprivredni fakultet, Novi Sad, PHI "Zorka" Subotica, str. 87.
- LAROUSSE AGRICOLE – Le monde paysan au XXI^e siècle, sous la direction de Marcel Mazoyer, Paris, 2002.
- Mišković B. (1986): Krmno bilje, Naučna knjiga, Beograd.
- Obračević Č. (1990): Tablica hranljivih vrednosti stočnih hraniva i normativi u ishrani preživara, Naučna knjiga, Beograd.

PRINOS I HRANLJIVA VREDNOST SORTI SOJE IZ POSTRNE SETVE

- originalni naučni rad -

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Rezime

U radu je dat prikaz dvogodišnjih rezultata istraživanja prinosa i kvaliteta krme sorti soje Krajina i Jelica (FAO grupe zrenja 00) gajenih u PIK "Bečej" u Bečeju, i Naučnom institutu za ratarstvo i povrtarstvo u Novom Sadu. Pri prosečnoj gustini useva (421.500 biljaka/ha) i sa navodnjavanjem, u postrojnoj setvi može se ostvariti preko 20 t ha⁻¹ zelene krme, odnosno preko 7 t ha⁻¹ suve materije pogodne za spremanje silaže. Prosečna visina stabljika sorti soje je bila 68,4 cm, a udeo suve materije u vreme košenja 30,5%. U ukupnom prinosu biomase ostvaren je udeo stabljika 25,3%, lista 26,0%, a mahuna 48,7% ili 23,4 mahuna/stabljici. U hranivu sa 90,55% suve materije ostvareno je prosečno 27,1% sirovih proteina, 17,06% sirove celuloze, 13,29% masnih materija, sirovog pepela 4,66% i 28,42% bezazotnih ekstraktivnih materija (BEM). Energetska vrednost hraniva je bila vrlo dobra (prosečno NEL 6,80 ili NEM 7,03 MJ/kg SM).