POTENTIAL OF ANNUAL LEGUMES FOR FORAGE AND GREEN MANURE PRODUCTION

ПОТЕНЦИЈАЛ ЈЕДНОГОДИШЊИХ МАХУНАРКИ ЗА ПРОИЗВОДЊУ КРМЕ И ЗЕЛЕНИШНОГ ЂУБРИВА

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***Abstract**: A small-plot trial was carried out in 2005 and 2006 at Rimski Šančevi Experimental Field of the Institute of Field and Vegetable Crops. Pea had the highest yields of green forage and forage dry matter (37.6 t ha^{-1} and 8.6 t ha^{-1}), while white lupine had the highest potential yields of forage crude protein and forage nitrogen (2161 kg ha^{-1} and 346 kg ha^{-1}). Among the cultivars, the pea NS-Junior and the faba bean B-413 had the highest green forage yields (41.9 t ha^{-1} and 41.7 t ha^{-1}), the pea Poneka the highest forage dry matter yield (9.9 t ha^{-1}) and the white lupine BL-164 the highest potential yields of forage crude protein and forage nitrogen (2521 kg ha^{-1} and 404 kg ha^{-1}).*

***Сажетак**: Микрооглед је изведен на Огледном пољу Института за ратарство и повртарство на Римским Шанчевима током 2005. и 2006. године. Грашак је остварио највише приносе зелене крме и суве материје крме (37.6 t ha^{-1} и 8.6 t ha^{-1}), док је бела лупина остварила највише потенцијалне приносе сирових протеина крме и азота крме (2161 kg ha^{-1} и 346 kg ha^{-1}). Међу сортама, грашак НС-Јуниор и боб В-413 имали су највише приносе зелене крме (41.9 t ha^{-1} и 41.7 t ha^{-1}), грашак Poneka највиши принос суве материје крме (9.9 t ha^{-1}) и бела лупина BL-164 највише потенцијалне приносе сирових протеина крме и азота крме (2521 kg ha^{-1} и 404 kg ha^{-1}).*

***Key words**: pea, common vetch, faba bean, grass pea, white lupine, yield, green forage, forage dry matter, forage crude protein, forage nitrogen.*
***Кључне речи**: грашак, обична грахорица, боб, састрица, бела лупина, принос, зелена крма, сува материја крме, сирови протеини крме, азот крме.*

INTRODUCTION

Annual legumes represent one of the most significant crops in the global agriculture today, with a prominent place in both animal nutrition and animal feeding. The most important annual legumes are soy bean (*Glycine max* (L.) Merr.) and common bean (*Phaseolus vulgaris* L.), while chickpea (*Cicer arietinum* L.), cowpea (*Vigna unguiculata* (L.) Walp.), pea (*Pisum sativum* L.), pigeon pea (*Cajanus cajan* (L.) Millsp.), lentil (*Lens culinaris* Medik.), faba bean (*Vicia faba* L.), lupins (*Lupinus* spp.) and vetches (*Vicia* spp.) are of a considerable economic importance (MIHAILOVIĆ *ET AL.*, 2006A). Annual forage legumes are traditionally grown in Serbia and other Balkan countries for centuries. The most widely distributed in Serbia are pea and vetches, with a total area of between 30,000 ha and 35,000 ha (MIHAILOVIĆ *ET AL.*, 2005A).

If cultivated for animal feeding, annual legumes can be utilised in diverse forms such as green forage, hay, forage meal, grain, straw, silage and haylage, while vetches can be used for grazing as well (MIKIĆ *ET AL.*, 2006). Due to a rather high crude protein content in both forage and dry matter, annual legumes such as pea, common vetch (*Vicia sativa* L.), faba bean and white (*Lupinus albus* L.) and blue lupines (*Lupinus angustifoilus* L.) are regarded as one of

the least expensive and most quality answers to constant demands for plant protein in animal husbandry (MIHAILOVIĆ *ET AL.*, 2005C).

Apart from their production for food and feed, annual legumes can be cultivated for green manure. Recently, they have become valuable cover crops in modern trends such as organic farming and sustainable agriculture, with a direct and immediate increase of profit for farmers and multifold benefits for the environment (ĆUPINA, 2005). The biomass of annual legumes is considered as more easily degradable in comparison with other crops such as grasses and brassicas, leaving the quantities of available nitrogen for the following crops of up to 100 kg ha^{-1} (ČUVARDIĆ, 2005). The value of annual legumes such as pea and vetches in soil melioration, erosion protection and weed suppression is high (ĆUPINA *ET AL.*, 2004A).

The study was aimed at determining the potential of five annual legume species for forage and green manure production in the prevailing conditions of the northern Serbian province of Vojvodina.

MATHERIAL AND METHOD

A small-plot trial was carried out in 2005 and 2006 at Rimski Šančevi Experimental Field of the Institute of Field and Vegetable Crops, comprising 25 accessions of diverse origin from the Annual Forage Legumes Collection (AFLC) of the Forage Crops Department, namely five pea, five common vetch, five faba bean, five grass pea (*Lathyrus sativus* L.) and five white lupine cultivars (Table 1).

Table 1

Accessions of the five annual legume species included in the trial at Rimski Šančevi in 2005 and 2006

Species	Accession name	Country of origin	Number in AFLC
Pea	NS-Lim	Serbia	PIS 002
	NS-Junior	Serbia	PIS 022
	Nadja	Germany	PIS 041
	Poneka	Germany	PIS 044
	Timo	Sweden	PIS 059
Common vetch	Novi Beograd	Serbia	VIC 003
	Armantes	Spain	VIC 011
	Topaze	France	VIC 012
	Languedoc	France	VIC 150
	Blanchefleur	France	VIC 191
Faba bean	Omar	Slovakia	VIC 207
	Liber	Slovakia	VIC 209
	Nadwislanski	Poland	VIC 228
	B-412	Serbia	VIC 412
	B-413	Serbia	VIC 413
Grass pea	Le Cambou	France	LAT 002
	Parranquet	France	LAT 004
	Faretta	Poland	LAT 010
	PL 114 622	Poland	LAT 011
	Krab	Poland	LAT 019
White lupine	BG-005573	Spain	LUP 020
	Siebacher Red	Germany	LUP 030
	LUP 261/89	Spain	LUP 031
	Termis	Egypt	LUP 041
	BL-164	Serbia	LUP 164

All accessions were sown in late February or early March and were cut at full flowering and when first pods were forming (MIŠKOVIĆ, 1986). All accessions were monitored for green forage yield (t ha^{-1}), forage dry matter yield (t ha^{-1}), potential forage crude protein yield (kg ha^{-1}) and potential forage nitrogen yield (kg ha^{-1}). Green forage yield was measured *in situ* and immediately after the cutting. Forage dry matter yield was determined upon the basis of a sample of green forage yield dried at room temperature until constant mass. Potential forage crude protein yield was calculated by means of forage dry matter yield and the average values of crude protein content for each of the five species, namely 179 g kg^{-1} in pea (PROKOF'EVA, 1985), 212 g kg^{-1} in common vetch (MIHAILOVIĆ *ET AL.*, 2003), 207 g kg^{-1} in faba bean (MIKIĆ *ET AL.*, 2007), 227 g kg^{-1} in grass pea (ČIŽEK, 1964) and 266 g kg^{-1} in white lupine (ĐUKIĆ, 2002). Potential forage nitrogen yield (kg ha^{-1}) was calculated by dividing the potential forage crude protein yield with a coefficient of 6.25.

The study results were processed by analysis of variance (ANOVA) with the Least Significant Difference (LSD) test applied and using the computer software MSTAT-C.

RESULTS AND DISCUSSION

Green forage yield. There were significant differences in green forage yields between both species and cultivars (Table 1). Among the species, the highest green forage yield was in pea (37.6 t ha^{-1}), while the lowest green forage yield was in common vetch (29.4 t ha^{-1}). Among the cultivars, the highest green forage yields were in the pea NS-Junior (41.9 t ha^{-1}) and the faba bean B-413 (41.7 t ha^{-1}).

In average, the five examined spring pea cultivars produced higher green forage yields than the winter ones in the same conditions (MIHAILOVIĆ *ET AL.*, 2006B).

Forage dry matter yield. The average forage dry matter yield in cultivars ranged from 5.2 t ha^{-1} in the white lupine BG-005573 to 9.9 t ha^{-1} in the pea Poneka, while the average forage dry matter yield in species ranged from 6.4 t ha^{-1} in grass pea 8.6 t ha^{-1} in pea., with differences at both levels of significance.

The common vetch and the faba bean cultivars produced higher forage dry matter yields than the pea cultivars in previous research and in the same conditions (MIHAILOVIĆ *ET AL.*, 2005B).

Potential forage crude protein yield. Among the species, white lupine had the highest potential forage crude protein yield (2161 kg ha^{-1}), while grass pea had the lowest potential forage crude protein yield (1457 kg ha^{-1}). In a similar way, among the cultivars, the white lupine BL-164 the highest potential forage crude protein yield (2527 kg ha^{-1}), while the grass pea Krab had the lowest potential forage crude protein yield (1090 kg ha^{-1}). The differences in potential forage crude protein yield were at the levels of both 0.05 and 0.01.

There were cultivars in all five examined species with a potential for higher forage crude protein yield than grain crude protein yield in traditional grain legume species, such as pea or faba bean (MIHAILOVIĆ *ET AL.*, 2007).

Potential forage nitrogen yield. White lupine had a higher potential forage nitrogen yield (346 kg ha^{-1}) at both levels of significance than in faba bean (260 kg ha^{-1}), common vetch (253 kg ha^{-1}), pea (245 kg ha^{-1}) and grass pea (233 kg ha^{-1}). Among cultivars, potential forage nitrogen yield varied between 404 kg ha^{-1} in the white lupine BL-146 and 174 kg ha^{-1} in the grass pea Krab.

All five species, as well as some of their cultivars, are able to produce forage nitrogen yield with values higher the average for each of the species (ĆUPINA *ET AL.*, 2004B), proving a great potential these crops may have in enriching the soil with this element.

Table 2

Agronomic characteristics related to forage and green manure in the five annual legume species included in the trial at Rimski Šančevi in 2005 and 2006

Species	Cultivar	Green forage yield (t ha^{-1})	Forage dry matter yield (t ha^{-1})	Potential forage crude protein yield (kg ha^{-1})	Potential forage nitrogen yield (kg ha^{-1})
Pea	NS-Lim	38.0	7.7	1378	220
	NS-Junior	41.9	8.4	1503	240
	Nadja	35.0	8.1	1449	232
	Poneka	39.2	9.9	1771	283
	Timo	33.9	8.7	1556	249
	Average	37.6	8.6	1531	245
Common vetch	Novi Beograd	34.7	8.7	1843	295
	Armantes	27.0	7.6	1610	258
	Topaze	28.2	7.7	1631	261
	Languedoc	27.3	6.1	1292	207
	Blanchefleur	30.0	7.3	1546	247
	Average	29.4	7.5	1584	253
Faba bean	Omar	35.7	5.6	1158	185
	Liber	36.7	9.3	1918	307
	Nadwislanski	30.0	8.7	1790	286
	B-412	39.9	7.7	1586	254
	B-413	41.7	8.3	1722	276
	Average	34.1	7.8	1622	260
Grass pea	Le Cambou	40.6	8.5	1930	309
	Parranquet	36.4	6.9	1566	251
	Faretta	23.4	6.1	1385	222
	PL 114 622	31.5	5.8	1317	211
	Krab	28.0	4.8	1090	174
	Average	32.0	6.4	1457	233
White lupine	BG-005573	22.3	5.2	1383	221
	Siebacher Red	37.2	9.4	2500	400
	LUP 261/89	38.0	9.4	2500	400
	Termis	35.6	8.5	2261	362
	BL-164	40.3	9.5	2527	404
	Average	33.3	8.1	2161	346
$LSD_{0.05}$		5.2	1.1	373	62
$LSD_{0.01}$		6.9	1.7	501	84

CONCLUSIONS

Both traditional, such as pea and common vetch, neglected or new annual legume species, such as faba bean and grass pea or white lupine, have a prominent place in forage and green manure production. The spring-sown cultivars of all five species are characterised by an ability to produce high yields of both green forage and forage dry matter in a relatively brief period of time. Due to higher forage crude protein content in comparison with other crops, annual legumes have a considerable potential for high forage crude yields, thus providing animal husbandry with quality feed. At the same time, annual legumes forage is proven to represent one of the most abundant sources of nitrogen, having a multiple role in improvement of soils and the whole environment.

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