WHITE LUPIN AS A FORAGE CROP ON ALKALINE SOILS

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ABSTRACT

White lupin (*Lupinus albus* L.) is not widely known in Serbia. A small-plot trial was carried out during 2006 and 2007 at the Rimski Šančevi Experiment Field of the Institute of Field and Vegetable Crops, on a carbonated chernozem soil with a pH value in H_2O of 7.92. It included twelve white lupin accessions of diverse geographical origin from the Annual Forage Legumes Collection of the Forage Crops Department of the Institute. All accessions were sown in early March, with a crop density of 75-85 viable seeds m^{-2}, and were cut when main stem inflorescences were in full flower. The tallest accession was Termis (120 cm). The greatest number of main stems and first-order branches was in BG-005542 (9.0 plant^{-1}) and BG-002171 (8.7 plant^{-1}), with the former having most leaves as well (59.7 plant^{-1}). Accessions BG-005542 and LUP 261/89 had the highest green forage yields of 53.3 t ha^{-1} and 52.9 t ha^{-1} respectively. The average dry forage matter yield ranged from 4.0 t ha^{-1} in BG-002173 to 8.7 t ha^{-1} in Termis. The greatest dry matter proportion in green forage was in Termis and Siebacher Red (0.19).

KEYWORDS

Lupinus albus, green forage yield, forage dry matter yield, forage yield components

INTRODUCTION

Despite the widely accepted opinion that it was domesticated in southern parts of the Balkan Peninsula (Cowling *et al.* 1998), white lupin (*Lupinus albus* L.) is mostly unknown in Serbia and many other central and northern regions of the Balkan Peninsula (Đukić, 2002). The first attempt to introduce it as a forage and grain legume into Serbian agriculture date occurred just after the Second World War (Popović-Pecija, 1950). The main obstacles to the cultivation of white lupin on chernozem soils, which dominate the plains of the Serbian north, are their alkaline soil reaction and high calcium content, frequently leading to heavy chlorosis and eventually to complete necrosis (Duthion, 1992).

One of the strategic goals of breeding annual legumes in the Institute of Field and Vegetable Crops in Novi Sad is to introduce new species of annual forage and grain legumes. A small white lupin collection was established and first results of the performance of white lupin accessions of diverse geographical origin on chernozem soils were rather encouraging (Mihailović *et al.* 2006).

The aim of this research was to assess the possibility of utilising white lupin as a forage crop on chernozem soils.

MATERIALS AND METHODS

A small-plot trial was carried out during 2006 and 2007 at the Rimski Šančevi Experiment Field of the Institute of Field and Vegetable Crops. It included twelve white lupin accessions of diverse geographical origin from the Annual Forage Legumes Collection (AFLC) maintained in the Forage Crops Department (Table 1).

All accessions were sown in early March, with a plot size of 5 m^2, a crop density of 75-85 viable seeds m^{-2} and a row spacing of 20 cm (Mišković, 1986), on a chernozem soil with a slight alkaline reaction (Table 2). Each accessions were cut when its main stem inflorescences were in full flower (Mejakić and Nedović, 1996).

The following forage yield components were determined from plant samples taken just before cutting: plant height (cm), number of stems and lateral branches (plant^{-1}), number of leaves (plant^{-1}), and green forage yield per plant (g),. Green forage yield per area unit (t ha^{-1}) was calculated on the basis of green forage yield per plot, measured in situ immediately after cutting. Forage dry matter yield, both per plant (g) and per area unit (t ha^{-1}), was calculated from the values of green forage yields and forage dry matter proportion, with the latter being the ratio of forage sample mass after and before drying at room temperature.

Results were processed by analysis of variance (ANOVA) using the computer software MSTAT-C, and means were compared using the Least Significant Difference (LSD) test.

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RESULTS AND DISCUSSION

In both years, all twelve white lupin accessions grew successfully on the chernozem soil, confirming reports that white lupin tolerates alkaline soil reaction up to 8.2 (Duke, 1981).

There were significant differences between accessions in all forage yield components (Table 3). The average plant height varied between 83 cm in landraces BG-001743 and BG-002173 and 120 cm in the landrace Termis. The white lupin accessions were similar in plant height to common vetch cultivars under the same conditions (Mihailović *et al.* 2005). The landrace BG-005542 had the greatest average number of stems and lateral branches (9.0 plant^{-1}), while the landrace LUP 261/89 had the smallest average number of stems and lateral branches (3.7 plant^{-1}). The average number of leaves ranged from 36.7 plant^{-1} in the landrace BG-005573 to 59.7 plant^{-1} in the landrace BG-005542.

There were also significant differences among accessions in green forage and forage dry matter yields, as well as in forage dry matter proportion (Table 4). The average green forage yields varied from 25.35 g plant^{-1} and 21.3 t ha^{-1} in the landrace BG-005573 to 73.06 g plant^{-1} and 53.3 t ha^{-1} in the landrace BG-005542. The green forage yields of the twelve white lupin accessions fall in the range previously reported for this species (Vučković, 1999). The white lupin accessions had higher green forage yields, both per plant and per unit area, than cultivars of grass pea grown under the same conditions (Mihailović *et al*. 2008). The landrace BG-005542 had the highest forage dry matter yield per plant (11.75 g) and the landrace Termis had the highest forage dry matter yield per unit area (8.7 t ha^{-1}). The landrace BG-005573 had the lowest forage dry matter yields (4.27 g and 3.6 t ha^{-1}). Forage dry matter yields in this experiment were lower than in previous research under similar conditions (Mihailović *et al*. 2007), but higher than in faba bean cultivars (Mikić *et al*. 2007). The proportion of dry matter in green forage ranged from 0.14 in the landrace BG-002603 to 0.19 in the landraces Siebacher Red and Termis.

CONCLUSIONS

White lupin can be successfully cultivated on chernozem soils with a slight alkaline reaction and high calcium content. They have considerable potential for both forage and biomass production.

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Table 1. Some passport data of the twelve white lupin genotypes at Rimski Šančevi for 2006 and 2007.

Accession name	Country of origin	Status	Donor*	Number in AFLC
BG-001743	Spain	Landrace	1	LUP 004
BG-002171	Spain	Landrace	1	LUP 006
BG-002173	Spain	Landrace	1	LUP 007
BG-002553	Spain	Landrace	1	LUP 010
BG-002603	Spain	Landrace	1	LUP 012
BG-005542	Spain	Landrace	1	LUP 018
BG-005555	Spain	Landrace	1	LUP 019
BG-005573	Spain	Landrace	1	LUP 020
Siebacher Red	Germany	Cultivar	2	LUP 030
LUP 261/89	Spain	Landrace	2	LUP 031
Termis	Egypt	Landrace	3	LUP 041
LUP 149	Serbia	Line	4	LUP 149

* 1 – National Institute of Agriculture and Food Research (INIA), Spain; 2 – Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), Germany; 3 – National Plant Germplasm System (NPGS), USA; 4 – Institute of Field and Vegetable Crops (IFVCNS), Serbia.

Table 2. Chemical composition of the chernozem soil at Rimski Šančevi during 2006 and 2007.

Ph (H_2O)	N* (%)	P_2O_5** (mg 100^{-1} g^{-1})	K_2O** (mg 100^{-1} g^{-1})	$CaCO_3$ (%)	Humus (%)
7.92	0.196	17.99	21.00	5.61	2,970

* Total soil N.
** Total extractable P and K.

Table 3. Average values of forage yield components in twelve white lupin cultivars at Rimski Šančevi for 2006 and 2007.

Accession	Plant height (cm)	Number of stems and lateral branches ($plant^{-1}$)	Number of leaves ($plant^{-1}$)
BG-001743	83	4.0	39.3
BG-002171	85	8.7	51.7
BG-002173	83	7.3	38.3
BG-002553	106	5.0	48.3
BG-002603	93	4.3	37.3
BG-005542	106	9.0	59.7
BG-005555	104	4.3	39.0
BG-005573	90	4.0	36.7
Siebacher Red	97	7.3	53.3
LUP 261/89	113	3.7	42.7
Termis	120	7.3	52.3
LUP 149	114	5.7	43.0
$LSD_{0.05}$	8	2.4	5.4
$LSD_{0.01}$	11	3.8	7.1

Table 4. Average values of forage yields in twelve white lupin cultivars at Rimski Šančevi for 2006 and 2007.

Accession	Green forage yield (g plant^{-1})	Green forage yield (t ha^{-1})	Forage dry matter yield (g plant^{-1})	Forage dry matter yield (t ha^{-1})	Forage dry matter proportion (t ha^{-1})
BG-001743	63.36	48.8	10.00	7.7	0.16
BG-002171	53.58	43.4	8.50	6.9	0.16
BG-002173	32.09	26.6	4.86	4.0	0.15
BG-002553	63.35	48.1	9.38	7.1	0.15
BG-002603	56.45	44.0	7.80	6.1	0.14
BG-005542	73.06	53.3	11.75	8.6	0.16
BG-005555	42.62	35.0	6.99	5.7	0.16
BG-005573	25.35	21.3	4.27	3.6	0.17
Siebacher Red	53.84	43.1	10.05	8.0	0.19
LUP 261/89	71.48	52.9	11.64	8.6	0.16
Termis	57.51	45.4	10.97	8.7	0.19
LUP 149	67.00	50.3	11.48	8.6	0.17
$LSD_{0.05}$	6.52	5.7	1.82	1.4	0.01
$LSD_{0.01}$	8.11	8.0	2.33	1.9	0.02