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Effect of Liming on Grain Yield of Field Peas

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Abstract

Growing field pea for grain and forage is an integral part of the livestock development strategy, due to its importance as a good source of protein in improving milk and meat production. This is of particular relevance to livestock producers in Central Serbia who experience problems in alfalfa production on acidic soils. As a legume, field pea also plays a valuable role in crop rotations. More recently, field pea has been used as an important crop in organic and sustainable farming systems. Under non-irrigated conditions, grain yield of spring pea *cvs.* 'NS-Junior' and 'Javor' was evaluated in 2011 and 2012 on an acidic soil receiving amendment applications. A field trial was established in Čačak (43°54'39.06" N, 20°19'10.21" E, 246 m a.s.l.) on an alluvial soil acid in reaction (pH_{H2O} 4.8). The experimental field was fertilized with 300 kg ha^{-1} $N_{15}P_{15}K_{15}$. The treatments used included an unfertilized control and liming at 3t ha^{-1} and 6t ha^{-1}. The experiment was laid out in a completely randomized block design with four replications. Plot size was $5m^2$ (1x5m). In both years, the average grain yield of *cv.* 'NS-Javor' was significantly higher than in *cv.* 'Junior'. No significant differences were observed between the control and the lime treatments. Grain yield in both years was significantly below the genetic potential of the cultivars tested, mostly due to deficient rainfall and severe soil and air drought conditions.

Key words: pea, grain, lime, yield

Introduction

Growing field pea for grain and forage is an integral part of the livestock development strategy, due to its importance as a good source of protein in improving milk and meat production. This is of particular relevance to livestock producers in Central Serbia who experience problems in alfalfa production on acidic soils. Along with common vetch, field pea is the main annual forage legume grown in Serbia

(Mihajlović et al., 2004). A major goal of annual forage legume selection programs is to create cultivars adapted to a range of agroenvironmental conditions (Mihajlović and Mikić, 2010).

A distinct advantage of field pea over soybean is the use of its grain without prior heat treatment. All feed pea cultivars developed in Novi Sad are characterized by a low or very low trypsin inhibitor content, which is in accordance with current European Union regulations (Mikić et al., 2009). As a legume, field pea also plays a valuable role in crop rotations for purposes of soil fertility regeneration through a symbiotic relationship with nitrogen-fixing bacteria (Stoddard et al., 2009). The frequent occurrence of arid years in dryland farming requires the use of appropriate crop rotations, along with other cultural practices, in an attempt to reduce the adverse effect of water deficiency in the growing season. Field pea is an important crop in organic and sustainable farming systems as it provides forage rich in crude protein and mineral elements (Ćupina et al., 2004; Corre-Hellou & Crozat, 2005; Lauk & Lauk, 2008). Acidic soils necessitate amendments to improve soil productivity (Dugalić, 1997; Broćić, 1997; Bokan i sar., 2000; Bošković Rakočević, 2003; Bošković Rakočević and Bokan, 2005, Bokan et al., 2010).

Materials and methods

A field trial was established in Čačak (43°54'39.06" N, 20°19'10.21" E, 246 m a.s.l.) on an alluvial soil acid in reaction (pH_{H2O} 4.8), containing 3.18% organic matter, 0% $CaCO_3$, 22.08 mg P_2O_5 and 30.0 mg K_2O 100 g^{-1} soil. The experimental field was fertilized with 300 kg ha^{-1} $N_{15}P_{15}K_{15}$. The trial included an unfertilized control and treatments with 3t ha^{-1} and 6t ha^{-1} lime worked into the soil through secondary tillage using a disk harrow. The experiment was laid out in a completely randomized block design with four replications. Plot size was $5m^2$ (1x5m). Two manual weedings were sufficient to control weeds. No irrigation was used during the growing season.

Two spring field pea cultivars 'NS Junior' and 'NS Javor' were grown. 'NS Junior' is of excellent quality, with a crude protein content of 25-28%. The cultivar is also intended for combined use (green forage and grain). It is the most common field pea cultivar in Serbia, since it produces grain yields of more than 5 t/ha under favorable conditions. 'Javor' is produced for grain, which has an average crude protein content of 24.4%. In a three-year VCU trial, this cultivar gave an average grain yield of 5.41 t/ha (Erić et al., 2007).

Results were subjected to a two-factor analysis of variance (ANOVA) using SPSS 4.5 software. Significant differences between treatment means were assessed by the LSD test.

Climatic conditions

The average temperature in the experimental years was above the long-term average (Table 1). April, June and July in both years were also warmer than average. Total annual rainfall decreased by 222.6 mm and 120.4 mm in the first and second years, respectively, compared to the long-term average. In the Republic of Serbia, 2011

is best remembered for the extremely dry weather. The following year in the Čačak region was marked by a 107.2 mm increase in rainfall and seemed to be somewhat more favorable for the crop. However, only the rainfall during April and May promised a favorable growing season. Total rainfall for June, July and August shows that the year 2011 with 115.5 mm total rainfall received during this period was more favorable in terms of natural water supply to the plants in this period, compared to the rainfall amount of as low as 56.9 mm in 2012. In the Čačak region, August 2012 was recorded dry, whereas September in the same year had 7.8 mm of rainfall.

Tab. 1. Monthly rainfall and temperature in Čačak in 2011 and 2012
Mesečne padavine i temperatura u Čačku u 2011. i 2012. godini

Month *Mesec*	Air temperature (°C) *Temperatura vazduha (°C)*			Rainfall (mm) *Padavine (mm)*		
	2011	2012	Long-term average *Višegodiš. prosek*	2011	2012	Long-term average *Višegodiš. prosek*
January	0.7	0.5	0	18.5	99.4	44.1
February	1.2	–3.9	2.3	50.4	52.9	38.9
March	6.9	8.8	6.8	45.9	25.4	46.2
April	12.2	12.6	11.5	23.5	70.3	51.6
May	15.5	15.9	16.8	83.2	106.8	72.7
June	20.7	22.3	20.0	64.8	11.8	87.3
July	22.3	25.5	21.5	36.0	45.1	79.1
August	23.4	24.5	21.2	14.7	0.0	58.0
September	21.3	21.0	16.7	32.4	7.8	56.2
October	11.3	14.6	11.4	30.9	54.9	51.1
November	3.8	9.5	6.0	1.3	10.8	55.9
December	3.3	0.8	1.4	66.0	94.6	50.4
Mean or total *Srednje ili ukupno*	11.9	12.7	11.3	467.6	579.8	690.2

Results and discussion

The average grain yield in 2011 was 2.66 t/ha (Table 2). Cultivar 'Javor' produced a significantly higher yield (2.78 t/ha) compared to 'Junior' (2.54 t/ha).

In the following experimental year, the average grain yield was 1.65 t/ha (Table 3). 'Javor' was significantly superior in yield (1.93 t/ha) to 'Junior' (1.37 t/ha). This finding suggests consistency with the yield potential and properties of the cultivars tested (Erić et al., 2007).

Tab. 2. Effect of soil liming on grain yield (t ha^{-1}) of pea cultivars 'NS-Junior' and 'Javor' in 2011
Uticaj đubrenja krečom na prinos (t ha^{-1}) sorti graška 'NS-Junior' i 'Javor' u 2011. godini

	'Junior'	'Javor'	$\bar{x}$
Ø	2.55	2.84	2.7
3t	2.51	2.7	2.6
6t	2.57	2.79	2.68
$\bar{x}$	2.54	2.78	2.66
LSD 0.05		Cultivar (A) *Kultivar*	0.234
		Liming (B) *Đub. krečom*	0.286
		A x B	0.485
$\overline{X}$ ± SE		2.66 ± 0.058	
CV (%)		10.6	

Tab. 3. Effect of soil liming on grain yield (t ha^{-1}) of pea cultivars 'NS-Junior' and 'Javor' in 2012
Uticaj đubrenja krečom na prinos (t ha^{-1}) sorti graška 'NS-Junior' i 'Javor' u 2012. godini

	'Junior'	'Javor'	$\bar{x}$
Ø	1.3	1.82	1.56
3t	1.41	2.16	1.78
6t	1.4	1.81	1.61
$\bar{x}$	1.37	1.93	1.65
LSD 0.05		Cultivar (A) *Kultivar*	0.247
		Liming (B) *Đub. krečom*	0.303
		A x B	0.428
$\overline{X}$ ± SE		1.65 ± 0.081	
CV (%)		20.6	

Climatic conditions during the experimental years (Table 1) indicate that 2011 was generally more unfavorable for the crop than 2012. Nevertheless, grain yield was higher in this less favorable year. One of the reasons was that rainfall in 2012 decreased by 53 mm in June, which is a critical period of water demand by the field pea crop for intensive grain filling. At the same time, the soil water deficit during June was accompanied by high mean daily air temperatures. Namely, the mean monthly

temperature for June 2012 was 2.3ºC above the long-term average, and 1.6ºC higher than in 2011. Moreover, under non-irrigated conditions, increasing grain yields require sufficient supplies of available nutrients through fertilization to minimize the impact of drought (Stevović et al., 2000; Bokan et al., 2008).

Tab. 4. Analysis of variance for grain yield of pea at different lime rates in 2011 and 2012
Analiza varijanse za prinos stočnog graška pri različitim nivoima đubrenja krečom u 2011. i 2012. godini

Year *Godina*		2011		2012	
Sources of variation *Izvori varijacije*	Degrees of freedom *Stepeni slobode*	Sum of squares *Suma kvadrata*	P value *vrijed. P*	Sum of squares *Suma kvadrata*	P value *vrijed. P*
Cultivar (A) *Kultivar*	1	0.331	0.449	1.898	<0.001
Liming (B) *Đub. krečom*	2	0.037	0.776	0.219	0.288
A x B	2	0.010	0.933	0.122	0.488

In both years, the use of lime as a soil amendment at the rate of 3 t/ha and 6 t/ha did not improve grain yield in field pea, compared to the control. This confirms that field pea is tolerant of low soil pH, suggesting that this crop can be grown under such soil conditions. Furthermore, lime produces long-term effects in improving soil chemical properties, which did not reflect positively on grain yield in the short term. However, the low grain yield indicates that field pea development is significantly affected not only by soil but also by climatic factors during the growing season. As in other annual forage legumes, rainfall distribution is an important factor in obtaining high grain yields. Given the variable distribution of rainfall across months throughout the experiment, stable production can be ensured through irrigation to be undertaken as an important cultural operation.

Conclusion

In both years, a significantly higher yield was obtained in *cv*. 'NS Javor' than in *cv.* 'NS Junior'. On average, both cultivars gave higher average yields in 2011 due to the highly deficient rainfall and high temperatures in June 2012.

Applications of lime for soil amendment purposes did not have a significant effect on the grain yield of the cultivars tested, which confirms that field pea can be grown on acidic soils.

Much of the increase in grain yield of this annual forage legume under similar growing conditions is expected to come from irrigation, as well as from fertilization based on soil tests and crop nutrient requirements. In the long term, improvement of acidic soils is part of the agricultural development strategy that should be consistently implemented under appropriate organic fertilizer and lime treatments.

Acknowledgments

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Uticaj đubrenja krečom na prinos zrna stočnog graška

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Sažetak

Gajenje stočnog graška u cilju dobijanja zrna i krme je deo strategije razvoja stočarske proizvodnje, jer kao dobar izvor proteina može povećati produkciju mleka i mesa. Ovo je od posebnog značaja za stočare u centralnoj Srbiji, koji na kiselim zemljištima imaju problem sa proizvodnjom lucerke. Kao leguminozna vrsta, krmni grašak ima i važno mesto u plodoredu njivskih biljaka. U novije vreme grašak je veoma važna vrsta u sistemima organske i održive poljoprivrede. U uslovima bez navodnjavanja, na zemljištu kisele reakcije uz mere popravke, analiziran je prinos zrna jarih sorti graška NS-Junior i Javor u 2011. i 2012. godini. Poljski ogled je zasnovan u Čačku (43°54'39.06" N, 20°19'10.21" E, 246m a.s.l.) na aluvijalnom tipu zemljišta, kisele reakcije (pH_{H2O} 4,8). Đubrenje celokupne površine je obavljeno sa 300 kg ha^{-1} $N_{15}P_{15}K_{15}$. Osim kontrolne, u ogledu su bile i varijante đubrene sa 3t ha^{-1} i 6t ha^{-1} kreča. Ogled je postavljen po potpuno slučajnom blok sistemu, u četri ponavljanja. Površina elementarne parcele bila je $5m^2$ (1x5m). U obe godine prosečan prinos zrna sorte NS-Javor bio je značajno veći od prinosa sorte Junior. Razlike između kontrole i varijanti gde je primenjen kreč, nisu bile statistički značajne. U obe godine ostvareni prinos zrna, bio je značajno ispod genetskog potencijala gajenih sorti, što je najvećim delom posledica manjka padavina i izrazite zemljišne i vazdušne suše.

Ključne reči: grašak, zrno, kreč, prinos

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