

## EFFECTS OF LIME ON ALFALFA CULTIVARS YIELD ON ACIDIC SOIL

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**Abstract:** Soil acidity limits the cultivation of alfalfa and the effecting of high yields. The experiment was set up on acidic soil to determine the effect of lime (0, 1 t ha<sup>-1</sup>, 2.5 t ha<sup>-1</sup>) on forage yield of alfalfa cultivars (K-28, Zuzana, NS-Nijagara) in the year of establishment. The yield of the liming variants was higher in all three cut and total yield, compared to the control. The significant differences in yield were only in the third cut, where the K-28 (4.76 t ha<sup>-1</sup>) and NS-Nijagara (4.46 t ha<sup>-1</sup>) had a higher yield compared to the Zuzana (3.65 t ha<sup>-1</sup>). Interaction cultivar/lime was significant only in the first cut, while in the other two cuts and in the total yield it wasn't.

**Keywords:** acidic soil, alfalfa, cultivars, lime, yield

### Introduction

Alfalfa (*Medicago sativa* L.) is one of the most important forage crops, cultivated on over 33 million hectares worldwide, due to its high nutritional value and high yield (Radović et al., 2009). In the Republic of Serbia, the total growing area in 2021 was 106.340 ha, with an average hay yield of 5.1 t ha<sup>-1</sup> (Statistical yearbook of the Republic of Serbia, 2022). The alfalfa dry matter yield in the Republic of Serbia in drought conditions varies between 24 - 30 t ha<sup>-1</sup> (Milić et al., 2014). Alfalfa has high soil requirements (Jakšić, 2014), and the main limiting factors for cultivation are the soil acidity and the toxicity of the Al<sup>3+</sup> ions (Khu et al., 2012). Soil acidity is a major issue in the Republic of Serbia, around 60% of the arable land has moderately to extremely acidic soil, with a pH range of 4.5 to 6.0 (Dugalić et al., 2012). It has a negative impact on the emergence of seedlings, their early growth, and overall biomass production (Stevović et al., 2010). One of the ways to increase the area to growing alfalfa in our production conditions can be effected by calcification (Stevović et al., 2012),

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with regular application of organic and mineral fertilizers before sowing (Stojiljković et al., 2021). The most commonly used materials are ground limestone (50-55% CaO), dolomite (30% CaO), calcium oxide (70-90% CaO), hydrated lime (60-70% CaO), saturation mud (22% CaO), and other industrial by-products (Katić et al., 2007).

Different cultivars react differently to soil acidity and choice of tolerant cultivars should be considered as a factor in overcoming acidity issues (Stevović et al., 2012). According to Grewal and Williams (2003), there is a variation in alfalfa cultivars reaction to high soil acidity.

This research was aimed to evaluate the effect of soil calcification on forage yield in three cultivars of alfalfa in the year of establishment.

### **Materials and methods**

The experiment was conducted in the locality of Mačkovac, (municipality Kruševac 43°33'563" N, 21°13'608" E; 247 m). The soil is eutric cambisol, very acidic chemical reaction  $\text{pH}_{\text{KCl}}$  4.55, (exchangeable acidity is 2.28 m.e/100g of soil), the content of mobile aluminum is 9.45 mg/100g of soil. Soil had high content of nitrogen 0.25%, moderately provided by phosphorus 11.06 mg/100g, potassium 13.28 mg/100g, humus 2.83% and low carbonate content 1.4% CaO. The experiment was set up as a split plot design with four replications. Hydrated lime (70% CaO) was utilized in amounts of 0 (control), 1 and 2.5 t ha<sup>-1</sup> for calcification, five months before the sowing. This material is spread across the surface and plowed to a depth of 20 cm. Used three cultivars: K-28, Zuzana and NS-Nijagara. Sowing rate was 20 kg ha<sup>-1</sup>. In the year of establishment three cuts were made in the flowering phase, and the forage yield was measured. The data were processed by two-factor analysis of variance (ANOVA)(Statistica 12 StatSoft), and the least significant differences were determined by the LSD test.

### **Results and discussion**

In the year of establishment, in the first two cuts, the cultivars did not show significant differences in yield, while in the third cut, the K-28 and NS-Nijagara cultivars effected a significantly higher yield compared to the Zuzana (Tabel 1.). There was no significant difference in yield between the cultivars K-28 and NS-Nijagara. Stevović et al. (2010a) have also reported that the K-28 cultivar had a significantly higher yield than the other cultivars in the first year of cultivation.

In the total forage yield (Tabel 1.), the K-28 cultivar had significant higher forage yield compared to the Zuzana, but not than NS-Nijagara. The differences in the total yield between Zuzana and NS-Nijagara are not significant.

Table 1. Forage yield in the first year (t ha<sup>-1</sup>)

	I cut	II cut	III cut	Total yield
CULTIVAR				
NS-Nijagara	7.69a	12.32a	4.46a	24.47ab
Zuzana	7.51a	12.24a	3.65b	23.40b
K-28	7.67a	12.64a	4.76a	25.07a
LIME				
Control	6.25 c	11.08b	3.76b	21.10b
1 t ha <sup>-1</sup>	7.97 b	12.96a	4.53a	25.19a
2.5 t ha <sup>-1</sup>	8.65 a	13.42a	4.58a	26.65a
ANOVA				
Cultivar	<b>ns</b>	<b>ns</b>	*	*
Lime	*	*	*	*
Cultivar x lime	*	<b>ns</b>	<b>ns</b>	<b>ns</b>

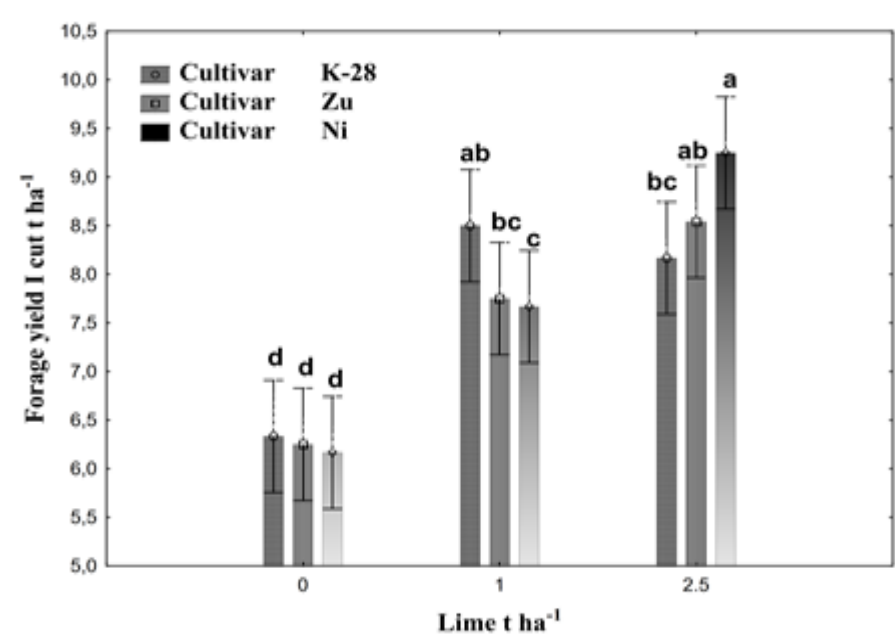
Values in columns with a different letter are significantly different based on the LSD test (R<0.05)

\*F-test significant at R≤0.05; ns-not significant

The application of 1 t ha<sup>-1</sup> and 2.5 t ha<sup>-1</sup> CaO increased the alfalfa yield in all three cuts and the total yield compared to the control (without lime) in the year of establishment of alfalfa. In the first cut on the variant with a higher dose of lime, 2.5 t ha<sup>-1</sup>, a significantly higher yield was effected compared to 1 t ha<sup>-1</sup> (Tabel 1.). Similar results were reported by other authors, where calcification also affected significantly higher alfalfa biomass yields in the year of establishment compared to the control (Dugalić et al., 2012; Stevović et al., 2004, 2010, 2010a). Katić et al. (2006) also reported a significant increase in yield on pseudogley soil, active acidity 4.79, with the application of 3 t ha<sup>-1</sup> and 6 t ha<sup>-1</sup> powdered lime (70% CaO) in the first year. However, Popović et al. (2007) did not see significant variations in yield in the first year, using different doses of dolomite (56% CaO) on soil pH<sub>KCl</sub> 4.60. The authors reported that the weak effects of lime in the first year are attributed to the lime material (dolomite) which is less soluble than powdered lime. Also, Hendry et al. (2018) in their research did not find significant differences in alfalfa yield in the first year of the trial.

Cultivars reacted differently to the introduction of lime into the soil. The cultivar/lime interaction showed that a significantly higher alfalfa forage yield was observed only in the first cut (Graph 1). In the control treatment, the

differences between the cultivars were not significant. With the addition of 1 t ha<sup>-1</sup> lime K-28 had a higher forage yield than NS-Nijagara, but the differences in yield between Zuzana and NS-Nijagara and between K-28 and Zuzana are not significant. Applying 2.5 t ha<sup>-1</sup> of lime significantly increased the forage yield of the NS-Nijagara variety compared to K-28, while there was not difference in yield between Zuzana and NS-Nijagara, nor between K-28 and Zuzana. In the other two cuts, significant.



Graph 1. Forage yield cultivars/lime in the first cut (t ha<sup>-1</sup>)

Stevović et al. (2010a) have calculated the degree of tolerance to acidity of alfalfa cultivars Banat, NS-Medijana, K-28, Sinaskaja and OS-66. The authors reported that in the year of establishment of the control treatments, there was no difference between the cultivars, and that increasing the amount of CaO to 1.5 t ha<sup>-1</sup> and 3 t ha<sup>-1</sup> led to an increase in yield in all cultivars. The best reaction was observed in the cultivar K-28, while the other cultivars showed a weaker reaction to the application of an increased amount of CaO.

## **Conclusion**

The application of different doses of lime led to an increase in the alfalfa yield in all three cuts and the total forage yield.

In the third cut, the cultivars K-28 and NS-Nijagara achieved a significantly higher yield compared to Zuzana. Also, in the total yield, the cultivar K-28 had a significantly higher yield than Zuzana, but not than NS-Nijagara.

The cultivar/lime interaction shows that the cultivars reacted to different amounts of lime only in the first cut.

For growing alfalfa in acidic soil, it is recommended to increase the amount of lime to 2.5 t ha<sup>-1</sup> and select cultivars such as K-28 and NS-Niagara. More precise research results will be confirmed in the coming years.

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