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INFLUENCES OF LIMING ON YIELDS OF ALFALFA HAY

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SUMMARY

Alfalfa is the most important forage legume on cultivated fields in Croatia (about 45000 ha of growing area – status 2003). The field experiment with application of four dolomite (Agrovapno MgO: 56% CaO and 40% MgO) rates (0, 10, 20, 30 and 40 tha^{-1}) were conducted in autumn of 2004. The experiment was conducted by randomized block design in four replicates. Alfalfa (cultivar Osječanka 88 of the Agricultural Institute Osijek, Croatia) was sown on March 25, 2005. Four cuttings / year were made. Fresh mass of alfalfa (cutting area 0.25 m^2) was oven-dried at 65 ^{o}C. Year was the most influencing factor of alfalfa hay yields (13.03, 28.63, 29.43 and 32.77 tha^{-1}, for 2005, 2006, 2007 and 2008, respectively). Liming resulted in low increases of yields up to 5% only. We presume that possible high tolerance of Osječanka 88 cultivar to soil acidity could be the main reason of low effects of liming on alfalfa yields.

Key-words: alfalfa, dolomite, hay yield, liming, Osječanka 88 cultivar

INTRODUCTION

Alfalfa is the most important forage legume on cultivated fields. A number of scientists from different regions of the world emphasized a problem of susceptibility of alfalfa to soil acidity.
They attempted to solve the problem by liming (Brauer et al., 2002), and breeding, i.e. creation of germplasm tolerant to low pH (Campbell et al., 1993; Dallagnol et al., 1996; Grewal and Williams, 2003).
The aim of the study was testing effects of liming on yields of alfalfa cultivar Osječanka 88. Choice of this cultivar is based on our estimations that two alfalfa cultivars (Osječanka 88 and OS 66) participate in about 70% of alfalfa growing area in Croatia (100% = 45 000 ha according Statistički ljetopis, 2003).

MATERIAL AND METHODS

The field experiment with application of dolomite (Agrovapno MgO: product of Kamen-Sirac, d.d. Sirac, Croatia) containing 56% CaO and 40% MgO was conducted in September 23, 2004 on acid soil of Bjelovar-Bilogora County (locality Pavlovac, municipality Veliki Grdjevac). Choice of the experimental plot was made based on previous soil test (Table 1). Nutritional status of the soil was made by extractions with AL-solution. The total amount of P and K in the samples was measured by the ICP-AES technique after their microwave digestion using concentrated HNO_3+H_2O_2. The analyses were done in the laboratory of the Research Institute for Soil Science and Agricultural Chemistry (RISSAC), Budapest, Hungary.
Four rates of dolomite and control (0, 10, 20, 30 and 40 tha^{-1}) were applied.

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Table 1. Agrochemical test of the experimental soil (spring 2004)
Tablica 1. Agrokemijska analiza tla (proljeće 2004.)

pH		mg 100 g^{-1} (AL-method) *(AL – metoda)*		Organic matter *Organska tvar*	Hydrolytical acidity *Hidrolitička kiselost*
H_2O	KCl	P_2O_5	K_2O	(%)	(cmol kg^{-1})
5.61	4.60	15.8	17.71	1.70	4.42

The experiment was conducted by randomized block design in four replicates (basis experimental plot 20.0 m^2). The statistical analysis were made according to Mead (1996) as three-factorial experiment (A = growing season; B = cutting; C = liming rate).

Table 2. Terms of alfalfa cutting in the experiment
Tablica 2. Vrijeme košnje lucerne u poljskom pokusu

Cutting (c) for the 2005 growing season *Otkos (o) za vegetacijsko razdoblje 2005. Godine*				Cutting for the 2006 growing season *Otkos (o) za vegetacijsko razdoblje 2006. godine*			
1st c - *1. o*	2nd c - *2. o*	3rd c - *3. o*	4th c - *4. o*	1st c - *1. o*	2nd c - *2. o*	3rd c - *3. o*	4th c - *4. o*
June 23 *Lipanj 23*	July 22 *Srpanj 22*	Sept. 01 *Rujan 01*	Oct. 19 *Listopad 19*	May 19 *Svibanj 19*	June 26 *Lipanj 26*	Aug. 18 *Kolovoz 18*	Oct. 17 *Listopad 17*
Cutting (c) for the 2007 growing season *Otkos (o) za vegetacijsko razdoblje 2007. godine*				Cutting for the 2008 growing season *Otkos (o) za vegetacijsko razdoblje 2008. Godine*			
1st c – *1. o*	2nd c – *2. o*	3rd c – *3. o*	4th c – *4. O*	1st c – *1. o*	2nd c – *2. o*	3rd c – *3. o*	4th c – *4. o*
May 15 *Svibanj 15*	June 26 *Lipanj 26*	Aug. 17 *Kolovoz 17*	Oct. 10 *Listopad 10*	May 15 *Svibanj 15*	July 02 *Srpanj 02*	Aug. 22 *Kolovoz 22*	Oct. 30 *Listopad 30*

Alfalfa (cultivar Osječanka 88 of Agricultural Institute Osijek, Croatia) was sown in March 25, 2005. Four cuttings of alfalfa were realized of each testing year (Table 2). For determination of hay yields, fresh mass of alfalfa was weighed from each basic plot (cutting area 0.25 m^2). Fresh mass was oven-dried on 65 ^oC.
Meteorological data for the study period (2005, 2006, 2007, 2008) as well as 30-year average at experimental location are presented in Table 3.
In this study, effects of liming on yields of alfalfa hay in the fourth year of growing was shown.

Table 3. Meteorological data
Tablica 3. Meteorološki podatci

Precipitation (mm) and mean air-temperatures (^oC) for four growing seasons and long-term means (LTM): 1961-1990) – Bjelovar* Weather Bureau
Oborine (mm) i srednje mjesečne temperature zraka (^oC) za četiri vegetacijska razdoblja te višegodišnji prosjeci (LTM): 1961.-1990.) – Bjelovar Meteorološka postaja*

	2005		2006		2007		2008		LTM: 1961-1990	
Month - *Mjesec*	mm	^oC	mm	^oC	mm	^oC	mm	^oC	mm	^oC
May - *Svibanj*	81	16.6	108	16.0	53	18.3	24	17.8	79	15.6
June - *Lipanj*	82	19.7	46	20.3	60	22.4	138	21.2	96	18.7
July - *Srpanj*	123	21.4	21	24.0	50	23.2	59	21.9	78	20.4
August - *Kolovoz*	141	19.0	144	19.0	60	21.6	77	21.7	82	19.5
September - *Rujan*	61	16.8	56	17.7	144	14.5	50	15.1	65	15.8
October - *Listopad*	5	11.6	31	13.1	83	9.9			55	10.4
Total / Mean - *Ukupno / Prosjek*	493	17.5	406	18.4	450	18.3			455	16.7

* Air-distance from the experimental field: 25 km in NW direction - *Zračna udaljenost pokusnog polja: 25 km u jugozapadnom smjeru*

RESULTS AND DISCUSSION

High yield of hay (13.03 – 32.77 tha^{-1}) was found in all years of the investigation (Table 4). Similar results have been reported by a number of scientists (Smith et al., 1991; Paoletti et al., 1999; Tucak, 2003). The growing season was the most influencing factor of alfalfa hay yield because in the first year of testing it was by 55% lower compared to the next year. The 2008 growing season was more favorable for alfalfa growing and mean yield of hay was by 11% higher in comparison with 2007, 14% with 2006 and 61% with 2005.

Hay yields were close related to cutting terms and they were linear decreased from the first to fourth cutting. Differences between hay yields of first, second, third and fourth cut were expected due to weather conditions (Table 3). For example, the fourth cutting had 45% lower hay yield compared to the first cutting (Table 4).

Yields of alfalfa hay was mainly not depended on liming, although general opinion is that alfalfa is susceptible to soil acidity. High yield potential and favorable performances under different agroecologfical conditions in Croatia (high content of proteins, persistence and satiable seed production etc.) of Osječanka 88 are indications for its tolerance to soil acidity (Tucak et al., 2007; Popović et al., 2008).

Liming influenced either less or more or by non-significant differences on nutritional status of alfalfa hay (Popović et al., 2007). For example, by testing of the second cutting for the 2005 growing season, similar values for phosphorus, potassium, magnesium and copper were found. By using lime amounts 20 and more tha^{-1}, S concentrations were significantly increased by 9% (mean 0.423% S) compared to the control. Also, Ca concentrations were significantly increased by 10% using 20 and more lime tha^{-1}. However, zinc, manganese and iron concentrations in hay were decreased due to liming.

Concerning this, by application of the lowest rate of lime Zn was decreased by 30% compared to the control and by increasing of lime rates it was decreased additionally by 7% only.

Mn concentrations in hay were decreased up to 21% after liming and these effects were found by using the lowest lime rate (mean 39.9 mg Mn kg^{-1} with non-significant differences among limed treatments). Only application of the highest lime rate had significant influences on iron status (25% reduction) in alfalfa hay (Popović et al., 2007).

Table 4. Yield of alfalfa hay
Tablica 4. Prinos sijena lucerne

Response of alfalfa to liming – Pavlovac experiment: influences of growing season (year = factor A), cutting (factor B) and lime rate (factor C) on alfalfa hay yield (tha^{-1}) *Reakcija lucerne na kalcizaciju – pokus u Pavlovcu: utjecaj vegetacijskog razdoblja (godina = faktor A), otkosa (faktor B) i doze vapna (faktor C) na prinos sijena lucerne (tha^{-1})*							
Factor A	Factor B	Factor C (lime rates: tha^{-1}) – *Faktor C (doza vapna: tha^{-1})*					
Year *Godina*	Cut *Otkos*	0	10	20	30	40	Mean A *Prosjek*
		Interaction AC – *Interakcija AC*					A
2005		13.48	12.76	12.64	13.56	12.68	*13.03*
2006		27.60	27.64	28.60	29.04	30.28	*28.63*
2007		30.48	30.28	29.24	30.08	29.20	*29.43*
2008		31.76	31.48	32.84	32.32	35.44	*32.77*
	Mean C *Prosjek C*	*25.84*	*25.54*	*25.83*	*26.25*	*26.90*	Mean B *Prosjek*
		Interaction BC - *Interakcija BC*					B
1st cut – *1. Otkos*		31.98	30.88	31.88	32.16	32.56	*31.87*
2nd cut – *2. Otkos*		28.76	27.96	28.88	30.08	28.12	*28.75*
3rd cut – *3. Otkos*		24.64	22.80	24.32	23.80	25.24	*24.25*
4th cut – *4. Otkos*		18.04	16.52	18.28	19.16	19.28	*18.99*
		Interaction AB - *Interakcija AB*					
		1st cut – *1. otkos*		2nd cut – *2. otkos*		3rd cut – *3. otkos*	4th cut – *4. otkos*
2005		2.86		4.28		3.91	1.98
2006		8.51		7.22		7.29	5.61
2007		10.81		8.24		5.04	5.34
2008		9.69		9.01		8.01	6.06
		Statistical analysis (LSD-values) – *Statistička analiza (LSD-vrijednosti)*					
		A	B	C	AB	AC	BC
	LSD 5%	0.84	0.92	1.0	1.36	1.68	1.08
	LSD 1%	1.56	1.28	ns	1.76	2.24	1.56

CONCLUSION

In general, effects of liming on yields of alfalfa hay were low. We presume that used cultivar Osječanka 88 is relative tolerant to soil acidity. It is the most spread cultivar of alfalfa on arable lands in Croatia because of high-yield potential and hay quality under different soil conditions including also acid soils which prevail in middle and north western part of the continental part of the country.

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UTJECAJ KALCIZACIJE NA PRINOS SIJENA LUCERNE

SAŽETAK

Lucerna je najznačajnija krmna leguminoza na oranicama u Republici Hrvatskoj (zasijana je na oko 45000 ha – stanje 2003.). U jesen 2004. godine postavljen je poljski pokus s četiri doze (0, 10, 20, 30 i 40 tha^{-1}) vapna (Agrovapno MgO: 56% CaO and 40% MgO). Pokus je postavljen po shemi slučajnoga bloknoga rasporeda u četiri ponavljanja. U proljeće 2005. godine zasijana je lucerna (Osječanka 88, sorta Poljoprivrednog Instituta Osijek). Ostvarena su po četiri otkosa u svakoj godini istraživanja. Svježa masa lucerne (površina košnje 0,25 m^2) sušena je u sušioniku na 65 ^oC. Najveći utjecaj na prinos sijena lucerne imala je godina istraživanja (13,03; 28,63; 29,43 i 32,77 tha^{-1}, za 2005., 2006., 2007. i 2008. godinu). Kalcizacija je rezultirala slabim povećanjem prinosa, koji je iznosio svega 5%. Pretpostavljamo da je najvjerojatnije visoka tolerantnost sorte Osječanka 88 na kiselost tla mogla biti glavni razlog slaboga djelovanja kalcizacije na prinose lucerne.

Ključne riječi: lucerna, vapno, prinos sijena, kalcizacija, sorta Osječanka 88

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