

## The influence of the sowing ratio of common vetch and Italian ryegrass on the yield and quality of forage

### Utjecaj omjera sjetve obične grahorice i talijanskog ljulja na prinos i kakvoću krme

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#### ABSTRACT

Mixing grasses with legume crops is an efficient approach for improving forage production and ensuring the sustainable development of agriculture and livestock. However, the knowledge of the relationship between forage production and interspecific competition in the forage common vetch (*Vicia sativa* L.) and Italian ryegrass (*Lolium multiflorum* Lam.) mixed cropping system is insufficient. A 2-year field study was carried out to determine the dry matter yield and quality of common vetch (*Vicia sativa* L.) and Italian ryegrass (*Lolium multiflorum* Lam.) mixtures at various ratios (100:0, 80:20, 60:40, 40:60, 20:80 and 0:100%). Dry matter yield and crude protein yield, neutral detergent fiber (NDF) and acid detergent fiber (ADF) of the mixtures were determined. Research has shown that the forage yield of common vetch in consociation with Italian ryegrass increased ( $P<0.05$ ) by 7.9-34.9% compared to pure crops. Also, in the consociation, a higher ( $P<0.05$ ) crude protein yield was achieved by 20.7-58.7% compared to pure crops. It was found that the sowing of a consociation of common vetch and Italian ryegrass had a higher dry matter yield and better quality compared to the sowing of Italian ryegrass alone. The highest dry matter yield (8.5 t/ha) and crude protein yield (1.46 t/ha) were obtained from the sowing ratio of 60% common vetch + 40% Italian ryegrass, and a lower share of NDF and ADF was also found compared to pure crops.

**Keywords:** sowing ratio, common vetch, Italian ryegrass, yield, quality

#### SAŽETAK

Sjetva trava s usjevima mahunarki učinkovit je pristup za poboljšanje proizvodnje krme te održivog razvoja poljoprivrede i stočarstva. Međutim, znanje o odnosu između proizvodnje voluminozne krme i međuvrsne konkurencije u konsocijaciji obične grahorice (*Vicia sativa* L.) i talijanskog ljulja (*Lolium multiflorum* Lam.) ostaje još uvijek nedovoljno. Provedeno je dvogodišnje istraživanje kako bi se utvrdio prinos suhe tvari i kakvoća voluminozne krme obične grahorice (*Vicia sativa* L.) u konsocijaciji s talijanskim ljuljem (*Lolium multiflorum* Lam.) u različitim omjerima sjetve (100:0, 80:20, 60:40, 40:60, 20:80 i 0:100%). Utvrđivani su prinosi suhe tvari i sirovih bjelančevina te udio neutralnih deterdžent vlakna (NDF) i kiselih deterdžent vlakana (ADF). Istraživanjima je utvrđeno da se prinos krme obične grahorice u konsocijaciji s talijanskim ljuljem povećao ( $P<0,05$ ) za 7,9-34,9% u odnosu na čiste usjeve. Također, u konsocijaciji je ostvaren veći ( $P<0,05$ ) prinos sirovih proteina za 20,7-58,7% u odnosu na čiste usjeve. Utvrđeno je da je sjetva konsocijacije obične grahorice i talijanskog ljulja imala veći prinos suhe tvari i bolju kakvoću u odnosu na sjetvu samog talijanskog ljulja. Najveći prinos suhe tvari (8,5 t/ha) i sirovih bjelančevina (1,46 t/ha) dobiven je iz omjera sjetve 60% obične grahorice + 40% talijanskog ljulja, a utvrđen je i niži udio NDF-a i ADF-a u odnosu na čiste usjeve.

**Ključne riječi:** omjer sjetve, obična grahorica, talijanski ljulj, prinos, kakvoća

## DETAILED ABSTRACT

Intercropping of grasses and *Leguminosae* has many advantages over pure crops, such as better use of light, water, and nutrients, higher yields than those from legume pure crop, increased feed value, reduced nitrous oxide emissions from soil, and better control of the occurrence of pests and weeds. The crude protein concentration was shown to increase in intercrops due to the legume contribution. One of the most important forage crops is annual ryegrass (*Lolium multiflorum* Lam.), which is a cool-season grass that is suitable for quality herbage production on account of its rich protein, energy, and water-soluble carbohydrate content. It is generally a highly nutritious grass that may be presented as forage for beef cattle through grazing, dried out and fed as hay, or ensiled and fed as silage, and is desirably eaten by livestock, especially in milk production. Vetch (*Vicia sativa* L.) is a legume plant with high forage yield and good nutritional value. The dry forage obtained from vetch dry harvested at the beginning of the flowering contains approximately 12-20% crude protein, 6-10% crude ash, 25-26% crude fiber and 45-46% nitrogen-free extract. Some factors affect the growth of the species used in intercropping, including cultivar selection, seeding ratios, mixture ratios, row spacing and competition between the mixture components, extra work in preparing and planting seed, and crop management practices. In vetch mixtures with cereals or grasses, it is necessary to know the ratios of the vetch and cereal/grass species, because it affects the growth rate of the individual species in the mixtures as well as the forage yield and quality. In the mixtures, for example, an increased proportion of the cereal in its mixture with vetch significantly decreases the stand lodging, and has a positive influence on the forage yield, but the forage is of a poorer quality, because a high cereal ratio in the botanical composition of legume+cereal mixtures causes low protein. A field experiment was carried out during the 2019 and 2020 growing seasons at the experimental field in Oborovo (45°40'54"N, 16°15'12.5"E), Croatia. A 2-year field study was carried out to determine the dry matter yield and quality of common vetch (*Vicia sativa* L.) and Italian ryegrass (*Lolium multiflorum* Lam.) mixtures at various ratios (100:0, 80:20, 60:40, 40:60, 20:80 and 0:100%). Dry matter yield and crude protein yield, neutral detergent fiber (NDF) and acid detergent fiber (ADF) of the mixtures were determined. Research has shown that the forage yield of common vetch in consociation with Italian ryegrass increased ( $P<0.05$ ) by 7.9-34.9% compared to pure crops. Also, in the consociation, a higher ( $P<0.05$ ) crude protein yield was achieved by 20.7-58.7% compared to pure crops. It was found that the sowing of a consociation of common vetch and Italian ryegrass had a higher dry matter yield and better quality compared to the sowing of Italian ryegrass alone. The highest dry matter yield (8.5 t/ha) and crude protein yield (1.46 t/ha) were obtained from the sowing ratio of 60% common vetch + 40% Italian ryegrass, and a lower share of NDF and ADF was also found compared to pure crops.

## UVOD

Uzgoj usjeva žitarica i mahunarki u konsocijaciji ima puno prednosti u odnosu na njihov uzgoj kao pojedinačni usjevi, kao što je bolje korištenje svjetla, vode (Luo i sur., 2016; Tamburini i sur., 2020; Liu i sur., 2023) i biljnih hranjiva, postižu se veći prinosi krme u odnosu na pojedinačni usjev mahunarki, imaju veću kakvoću voluminozne krme (Pinto i sur., 2022), smanjuju emisiju dušičnih spojeva iz tla (Shen i sur., 2018) te je bolja kontrola štetnika i korova u usjevu (Gronle i sur., 2015; Maitra i sur., 2021; Koskey i sur., 2022). Također, utječu i na povećanje sadržaja organske tvari u tlu (Cong i sur., 2014). Utvrđeno je da se povećava i udio sirovih bjelančevina u suhoj tvari voluminozne krme zbog većeg udjela mahunarki u konsocijaciji (Bedoussac i sur., 2015). Jedna od najvažnijih krmnih kultura na oranicama je jednogodišnji ljulj (*Lolium*

*multiflorum* Lam.) koji se uzgaja zbog visokog udjela sirovih bjelančevina, minerala i ugljikohidrata topivih u vodi u suhoj tvari voluminozne krme (Kusvuran i Tansi, 2005; Kusvuran i sur., 2014). Općenito talijanski ljulj je vrlo kvalitetna biljna vrsta koja se može koristiti kao voluminozno krmivo (sijeno, sjenaže i silaža) u hranidbi goveda za proizvodnju mesa ili za proizvodnju mlijeka (Kusvuran, 2011; Durst i sur., 2013). Grahorica (*Vicia sativa* L.) je jednogodišnja biljna vrsta iz porodice mahunarki koja postiže visoke prinose voluminozne krme i dobru kakvoću krme (Sohail i sur., 2021). Voluminozna krma grahorice u fenofazi cvatnje ima udio sirovih bjelančevina od 12 do 20%, 6-10% sirovog pepela, 25-26% sirovih vlakana i 45-46% nedušičnih ekstraktivnih tvari (Sohail i sur., 2021). Puno čimbenika utječe na rast i razvoj biljnih vrsta koje

se koriste u konsocijaciji, uključujući odabir kultivara, omjer sjetve, razmak između redova sjetve, natjecanje između komponenata u konsocijaciji (Dhima i sur., 2007; Akman i sur., 2013), priprema i sjetva te mjere uzgoja usjeva (Lithourgidis i sur., 2011). U konsocijaciji grahorice sa žitaricama ili travama potrebno je poznavati omjere sjetve grahorice i žitarica/trava (Albayarak i sur., 2004; Balabanli i Turk, 2006), jer omjeri sjetve utječu na brzinu rasta pojedinih biljnih vrsta u konsocijaciji kao i na prinos te kakvoću voluminozne krme (Lithourgidis i sur., 2006; Lauk i Lauk, 2009). U konsocijaciji, primjerice, povećani udio žitarice s grahoricom značajno smanjuje polijeganje usjeva i pozitivno utječe na prinos voluminozne krme, ali je zato lošija kakvoća krme (Karagić i sur., 2012), jer visok udio žitarice u botaničkom sastavu u konsocijaciji mahunarka + žitarica uzrokuje nizak udio sirovih bjelančevina u suhoj tvari krme. Mariotti i sur. (2009) utvrdili su da žitarice imaju veću podzemnu konkurentsku sposobnost u odnosu na mahunarke, a mahunarke imaju veću nadzemnu kompetitivnu sposobnost u odnosu na žitarice u konsocijaciji, te da kompetitivna sposobnost biljaka pokazuje razlike između biljnih vrsta. Između biljnih vrsta može postojati nadzemno nadmetanje za svjetlost i prostor, a podzemno nadmetanje za vodu i biljna hranjiva (Mariotte i sur., 2012). Cilj ovog istraživanja bio je utvrditi utjecaj omjera sjetve jare obične grahorice u konsocijaciji s talijanskim ljuljem na prinos suhe tvari i kakvoću krme te projiciranu potencijalnu količinu proizvedenog mlijeka u kg/ha u odnosu na čisti usjev jare obične grahorice i talijanskog ljulja.

## MATERIJAL I METODE

Poljski pokusi provedeni su tijekom vegetacijske sezone u 2019. i 2020. godini na pokusnom polju u Oborovu (45°40'54"N, 16°15'12.5"E). U tablici 1 prikazani su meteorološki podaci za postaju Oborovo. Tip tla na pokusnom polju na lokaciji Oborovo je bio psudoglej na zaravni. Na osnovici kemijske analize tla u osnovnoj i dopunskoj obradi tla ukupno u tlo je unešeno 47 kg/ha N, 119 kg/ha P<sub>2</sub>O<sub>5</sub> i 119 K<sub>2</sub>O kg/ha. Obrada tla obavljena je oranjem na 30 cm dubine u jesen 2018. i 2019. godine.

Predstjetvena priprema tla obavljena je sjetvospremačem u proljeće 2019. i 2020. godine. Tretmani u pokusu su bili slijedeći: čisti usjev jare obične grahorice cv. Hanka (100 kg/ha), čisti usjev talijanskog ljulja cv. Mir (30 kg/ha), 80% jara obična grahorica + 20% talijanski ljulj (80 kg/ha + 6 kg/ha), 60% jara obična grahorica + 40% talijanski ljulj (60 kg/ha + 12 kg/ha), 40% jara obična grahorica + 60% talijanski ljulj (40 kg/ha + 18 kg/ha) i 20% jara obična grahorica + 80% talijanski ljulj (20 kg/ha + 24 kg/ha). Sjetva jare obične grahorice obavljena je u dva koraka zbog različite mase tisuću zrna obične jare grahorice (61 g) i talijanskog ljulja (3,8 g), odnosno prvo je posijana jara obična grahorica, a zatim je posijan talijanski ljulj. Jara obična grahorica i talijanski ljulj posijani su početkom ožujka u 2019. i 2020. godini istraživanja (Tablica 2). Prije sjetve obavljena je predstjetvena bakterizacija sjemena jare obične grahorice cv. Hanka sojem *Rhizobium leguminosarum* bv. viciae komercijalnog pripravka naziva Rizol.

**Table 1.** Mean monthly air temperatures and rainfall during the 2019 and 2020 growing seasons

**Tablica 1.** Srednja mjesečna temperatura zraka i količina oborina tijekom 2019. i 2020. vegetacijske sezone

Month Mjesec	Mean air temperature (°C) Srednja mjesečna temperatura zraka (°C)		Rainfall (mm) Oborine (mm)	
	Year Godina		Year Godina	
	2019	2020	2019	2020
March Ožujak	9.2	8	28.2	32.6
April Travanj	11.9	12.7	76.6	18.9
May Svibanj	13.2	15.2	185.1	94.8
July Lipanj	23.2	19.8	79.4	58.1

U tablici 2 prikazani su prethodni usjevi, rokovi sjetve usjeva te kemijska analiza tla.

**Table 2.** Characteristics of the experimental site, sowing as well as phenological stage BBCH\* scale of crops in the experiment**Tablica 2.** Karakteristike eksperimentalne lokacije, rokovi sjetve te fenološki stadij prema BBCH\* skali usjeva u pokusu

	Year of research Godina istraživanja	
	2019	2020
Preceding winter crop Predkultura	Barley Ječam	Corn Kukuruz
Soil parameters Karakteristike tla		
pH (M-KCl)		4.2
P <sub>2</sub> O <sub>5</sub> (mg/100 g of soil) P <sub>2</sub> O <sub>5</sub> (mg/100 g tla)		4.6
K <sub>2</sub> O (mg/100 g of soil) K <sub>2</sub> O (mg/100 g tla)		20.0
Humus (%)		3.2
Total nitrogen in % Ukupni dušik u %		0.17
Sowing date of vetch and ryegrass Datum sjetve grahorice i talijanskog ljulja	1 March 1. ožujka	2 March 2. ožujka
BBCH* scale for vetch BBCH* skala za grahoricu	60	60
BBCH* scale for ryegrass BBCH* skala za talijanski ljulj	61	61

\* The phenological development of the crops was assessed by determining the developmental stages during the growth of crops according to the BBCH scale (Meier, 2018)

\* Fenološki razvoj usjeva procijenjen je određivanjem razvojnih stadija tijekom rasta usjeva prema BBCH skali (Meier, 2018)

Razmak između redova za jaru običnu grahoricu i talijanski ljulj bio je 25 cm, a dubina sjetve iznosila je za jaru običnu grahoricu 5 cm, a za talijanski ljulj 2 cm. Veličina pojedinačne parcele bila je 10 m dužine x 2.5 m širine za svaki tretman pokusa. Pokus je postavljen kao slučajni blokni raspored s šest tretmana i četiri repeticije. Usjevi su ručno pokošeni na visinu od 5 cm kada je jara obična grahorica dostigla fenofazu stadija prema BBCH skali 60, a talijanski ljulj 61 (Meier 2018.). Dostavna vlaga uzoraka (g/kg svježeg uzorka) je utvrđena sušenjem uzoraka u sušioniku s ventilatorom (ELE International) na temperaturi od 60 °C do konstantne mase uzoraka. Laboratorijska suha tvar je utvrđena sušenjem 5 grama uzorka na temperaturi od 105 °C kroz 4 sata (ISO,

6496:1999). Udio sirovih bjelančevina utvrđen je prema Kjeldahlu (AOAC, 2023), a udio neutralnih i kiselih deterđent vlakna prema Van Soestu i sur. (1991). Na temelju izračunatog udjela sirovih bjelančevina u suhoj tvari jare obične grahorice i talijanskog ljulja utvrđena je projicirana potencijalna količina proizvedenog mlijeka u kg po hektaru. Izračun za projiciranu potencijalnu količinu proizvedenog mlijeka u kg po hektaru je napravljen po DLG-u (DLG-Futterwerttabellen, 1997) sustavu za produktivne potrebe muznih krava za 1 kg mlijeka s 3,4% bjelančevina za što je potrebno obrokom u hranidbi unijeti 86 g sirovih bjelančevina (Tablica 6). Statističke analize: napravljene su analize varijance za parametre prinosa suhe tvari i sirovih bjelančevina te kvalitetu krme ( $P < 0,05$ ),

a za usporedbu srednjih vrijednosti korišten je Tukey test ( $P < 0,05$ ). Podaci su analizirani pomoću statističkog softvera SAS (Statistical Analysis System, 2013).

## REZULTATI I RASPRAVA

Prinosi suhe tvari (Tablica 3) tretmana međusobno su se razlikovali ( $P < 0,05$ ) u dvogodišnjem prosjeku i po godinama. Prinosi suhe tvari kretali su se od 5,4 t/ha tretman (grahorica) do 8,2 t/ha tretman (60% grahorica + 40% talijanski ljulj) u 2019. godini. U slijedećoj vegetacijskoj sezoni u 2020. godini, prinos suhe tvari kretao se od 6,2 t/ha tretman (grahorica) do 8,8 t/ha tretman (60% grahorica + 40% talijanski ljulj).

Najveći prinos suhe tvari utvrđen je u tretmanu s 60% jare obične grahorice + 40% talijanskog ljulja (Tablica 3). Wang i sur. (2021) utvrdili su da je ukupna produktivnost krme u konsocijaciji usjeva u prosjeku 28,7% veća u odnosu na usjev u čistoj sjetvi. Ovi rezultati se mogu pripisati

većoj učinkovitosti u korištenju resursa rasta biljaka kao što su voda, gnojidba i energija zračenja u konsocijaciji usjeva (Gong i sur., 2019). U ovom istraživanju utvrđeno je da je prinos sirovih bjelančevina u tretmanima (80% grahorica + 20% talijanski ljulj i 60% grahorica + 40% talijanski ljulj) bio značajno veći ( $P < 0,05$ ) u odnosu na čisti usjev grahorice i talijanskog ljulja tijekom dvogodišnjeg istraživanja (Tablica 3).

Dosadašnja istraživanja utvrdila su da je uzgoj žitarica i mahunarki u konsocijaciji učinkovit način povećanja prinosa sirovih bjelančevina po hektaru (Hauggaard-Nielsen i sur., 2003; Dordas i sur., 2012). U ovom istraživanju utvrđeno je da je udio sirovih bjelančevina u tretmanima (80%, 60% i 40% grahorica + 20%, 40% i 60% talijanski ljulj) bio značajno veći ( $P < 0,05$ ) u odnosu na čisti usjev talijanskog ljulja tijekom dvogodišnjeg istraživanja (Tablica 4).

**Table 3.** Yield of dry matter and yield of crude proteins (t/ha)

**Tablica 3.** Prinos suhe tvari i sirovih bjelančevina (t/ha)

Treatments Tretmani	Yield of dry matter in t/ha Prinos suhe tvari u t/ha/			Yield of crude proteins in t/ha Prinos sirovih bjelančevina u t/ha		
	Year Godina		Mean Prosjeak	Year Godina		Mean Prosjeak
	2019	2020		2019	2020	
100% common vetch 100% obična grahorica	5.4 <sup>d</sup>	6.2 <sup>d</sup>	5.8 <sup>d</sup>	1.13 <sup>c</sup>	1.23 <sup>c</sup>	1.18 <sup>c</sup>
100% Italian ryegrass 100% talijanski ljulj	5.9 <sup>c</sup>	6.7 <sup>c</sup>	6.3 <sup>c</sup>	0.88 <sup>d</sup>	0.95 <sup>d</sup>	0.92 <sup>d</sup>
80% common vetch + 20% Italian ryegrass 80% obična grahorica + 20% talijanski ljulj	7.1 <sup>b</sup>	8.1 <sup>b</sup>	7.6 <sup>b</sup>	1.31 <sup>b</sup>	1.43 <sup>b</sup>	1.37 <sup>b</sup>
60% common vetch + 40% Italian ryegrass 60% obična grahorica + 40% talijanski ljulj	8.2 <sup>a</sup>	8.8 <sup>a</sup>	8.5 <sup>a</sup>	1.44 <sup>a</sup>	1.48 <sup>a</sup>	1.46 <sup>a</sup>
40% common vetch + 60% Italian ryegrass 40% obična grahorica + 60% talijanski ljulj	6.4 <sup>c</sup>	7.2 <sup>c</sup>	6.8 <sup>c</sup>	1.07 <sup>c</sup>	1.15 <sup>c</sup>	1.11 <sup>c</sup>
20% common vetch + 80% Italian ryegrass 20% obična grahorica + 80% talijanski ljulj	6.7 <sup>b</sup>	7.7 <sup>b</sup>	7.2 <sup>b</sup>	1.06 <sup>c</sup>	1.16 <sup>c</sup>	1.11 <sup>c</sup>
Mean Prosjeak	6.6 <sup>b</sup>	7.5 <sup>a</sup>		1.15 <sup>b</sup>	1.23 <sup>a</sup>	

Different letters in the column indicate a significant difference ( $P < 0.05$ )

Različita slova u stupcu označavaju značajnu razliku ( $P < 0,05$ )

**Table 4.** Content of crude protein and of neutral detergent fiber in g/kg of dry matter**Tablica 4.** Udio sirovih bjelančevina i neutralnih deterdžent vlakana u g/kg suhe tvari

Treatments Tretmani	Content of crude protein in g/kg of dry matter Udio sirovih bjelančevina u g/kg suhe tvari			Content of neutral detergent fiber in g/kg of dry matter Udio neutralnih deterdžent vlakana u g/kg suhe tvari		
	Year Godina		Mean Prosjek	Year Godina		Mean Prosjek
	2019	2020		2019	2020	
100% common vetch 100% obična grahorica	210 <sup>a</sup>	198 <sup>a</sup>	204 <sup>a</sup>	368 <sup>d</sup>	381 <sup>d</sup>	375 <sup>d</sup>
100% Italian ryegrass 100% talijanski ljulj	149 <sup>d</sup>	141 <sup>d</sup>	145 <sup>d</sup>	489 <sup>a</sup>	503 <sup>a</sup>	496 <sup>a</sup>
80% common vetch + 20% Italian ryegrass 80% obična grahorica + 20% talijanski ljulj	185 <sup>b</sup>	177 <sup>b</sup>	181 <sup>b</sup>	415 <sup>c</sup>	454 <sup>c</sup>	435 <sup>c</sup>
60% common vetch + 40% Italian ryegrass 60% obična grahorica + 40% talijanski ljulj	176 <sup>b</sup>	168 <sup>b</sup>	172 <sup>b</sup>	432 <sup>c</sup>	438 <sup>c</sup>	435 <sup>c</sup>
40% common vetch + 60% Italian ryegrass 40% obična grahorica + 60% talijanski ljulj	167 <sup>c</sup>	159 <sup>c</sup>	163 <sup>c</sup>	443 <sup>c</sup>	448 <sup>c</sup>	446 <sup>c</sup>
20% common vetch + 80% Italian ryegrass 20% obična grahorica + 80% talijanski ljulj	158 <sup>d</sup>	150 <sup>d</sup>	154 <sup>d</sup>	451 <sup>b</sup>	479 <sup>b</sup>	465 <sup>b</sup>
Mean Prosjek	174 <sup>a</sup>	166 <sup>b</sup>		433 <sup>b</sup>	451 <sup>a</sup>	

Different letters in the column indicate a significant difference ( $P < 0.05$ )

Različita slova u stupcu označavaju značajnu razliku ( $P < 0,05$ )

Najveći udio sirovih bjelančevina utvrđen je u tretmanu čistog usjeva grahorice (Tablica 4). U usporedbi sa žitaricama, mahunarke imaju relativno veći udio sirovih bjelančevina; stoga se široko koriste za povećanje kakvoće krme u konsocijaciji (Sadeghpour i sur., 2013). U ovom istraživanju utvrđeno je da je udio neutralnih deterdžent vlakana u tretmanima (80%, 60%, 40% i 20% grahorica + 20%, 40%, 60% i 80% talijanski ljulj) bio značajno manji ( $P < 0,05$ ) u odnosu na čisti usjev talijanskog ljulja tijekom dvogodišnjeg istraživanja (Tablica 4).

Neutralna deterdžent vlakna i kisela deterdžent vlakna su važni pokazatelji za procjenu kakvoće krme (Sadeghpour i sur., 2013; Lithourgidis i sur. 2006). Strydhorst i sur. (2008) i Iqbal i sur. (2019) također su utvrdili da mahunarke u konsocijaciji sa žitaricama povećavaju kakvoću krme smanjenjem udjela vlakana u

suhoj tvari krme. U ovom istraživanju utvrđeno je da je udio kiselih deterdžent vlakana u tretmanima (80%, 60%, 40% i 20% grahorica + 20%, 40%, 60% i 80% talijanski ljulj) bio značajno manji ( $P < 0,05$ ) u odnosu na čisti usjev talijanskog ljulja tijekom dvogodišnjeg istraživanja (Tablica 5).

Očekivano, najveći udio neutralnih i kiselih deterdžent vlakana utvrđen je u suhoj tvari kod talijanskog ljulja u čistoj sjetvi. Kako se udio talijanskog ljulja smanjivao u konsocijaciji, udio neutralnih i kiselih deterdžent vlakana u suhoj tvari se također smanjivao. Mahunarke imaju niži udio neutralnih i kiselih deterdžent vlakana u odnosu na trave jer postoje razlike između mahunarki i trava u strukturi tkiva i stanične stijenke (debljina i kemijska struktura) (Önal Aşçı i Eğritaş, 2017).

**Table 5.** Content of ash and of acid detergent fiber in g/kg of dry matter**Tablica 5.** Udio pepela i kiselih deterdžent vlakana u g/kg suhe tvari

Treatments Tretmani	Content of ash in g/kg of dry matter Udio pepela u g/kg suhe tvari			Content of acid detergent fiber in g/kg of dry matter Udio kiselih deterdžent vlakana u g/kg suhe tvari		
	Year Godina		Mean Prosjeak	Year Godina		Mean Prosjeak
	2019	2020		2019	2020	
100% common vetch 100% obična grahorica	7.9 <sup>d</sup>	8.1 <sup>d</sup>	8.0 <sup>d</sup>	293 <sup>c</sup>	301 <sup>c</sup>	303 <sup>c</sup>
100% Italian ryegrass 100% talijanski ljulj	9.2 <sup>a</sup>	9.6 <sup>a</sup>	9.4 <sup>a</sup>	335 <sup>a</sup>	343 <sup>a</sup>	339 <sup>a</sup>
80% common vetch + 20% Italian ryegrass 80% obična grahorica + 20% talijanski ljulj	8.1 <sup>c</sup>	8.3 <sup>c</sup>	8.2 <sup>c</sup>	303 <sup>c</sup>	311 <sup>c</sup>	307 <sup>c</sup>
60% common vetch + 40% Italian ryegrass 60% obična grahorica + 40% talijanski ljulj	8.2 <sup>c</sup>	8.4 <sup>c</sup>	8.3 <sup>c</sup>	310 <sup>b</sup>	319 <sup>b</sup>	321 <sup>b</sup>
40% common vetch + 60% Italian ryegrass 40% obična grahorica + 60% talijanski ljulj	8.3 <sup>b</sup>	8.5 <sup>b</sup>	8.4 <sup>b</sup>	317 <sup>b</sup>	327 <sup>b</sup>	322 <sup>b</sup>
20% common vetch + 80% Italian ryegrass 20% obična grahorica + 80% talijanski ljulj	8.4 <sup>b</sup>	8.6 <sup>b</sup>	8.5 <sup>b</sup>	325 <sup>a</sup>	335 <sup>a</sup>	330 <sup>a</sup>
Mean Prosjeak	8.4 <sup>b</sup>	8.6 <sup>a</sup>		345 <sup>a</sup>	323 <sup>b</sup>	

Different letters in the column indicate a significant difference ( $P < 0.05$ )

Različita slova u stupcu označavaju značajnu razliku ( $P < 0,05$ )

Budakli Carpici i Celik (2014) utvrdili su u svojim istraživanjima da pod sličnim uvjetima rasta mahunarke imaju niži udio NDF-a i ADF-a, dok žitarice imaju veći udio što je u skladu i s ovim istraživanjima. U ovom istraživanju utvrđeno je da je udio pepela u tretmanima (80%, 60%, 40% i 20% grahorica + 20%, 40%, 60% i 80% talijanski ljulj) bio značajno manji ( $P < 0,05$ ) u odnosu na čisti usjev obične grahorice tijekom dvogodišnjeg istraživanja (Tablica 5). Mahunarke sa krmnim sirkom u smjesi značajno povećavaju udio kalija, fosfora, kalcija i magnezija u voluminoznoj krmi (Terzić i sur., 2004; Basaran i sur., 2017; Uher i sur., 2024). Juknevičius i Sabienė (2007) utvrdili su da udio mineralnih elemenata

u biljkama ovisi o vrsti i porodici biljne vrste, odnosno mahunarke (*Fabaceae*) akumuliraju više kalcija i magnezija u suhoj tvari u odnosu na porodicu trava (*Poaceae*). Uher i Horvatić (2023) su u svojim istraživanjima utvrdili da kada se visoki grah sije u većoj gustoći sjetve u konsocijaciji sa kukuruzom, poraste udio kalcija u suhoj tvari voluminozne krme u odnosu na čisti usjev kukuruza. U ovom istraživanju također je utvrđeno da je projicirana potencijalna količina proizvedenog mlijeka u kg po hektaru u tretmanima (80% i 60% grahorica + 20% i 40% talijanski ljulj) bila značajno veća ( $P < 0,05$ ) u odnosu na čisti usjev obične grahorice i talijanskog ljulja tijekom dvogodišnjeg istraživanja (Tablica 6).

**Table 6.** Projected potential amount of milk produced in kg/ha**Tablica 6.** Projicirana potencijalna količina proizvedenog mlijeka u kg/ha

Treatments Tretmani	Milk production in kg/ha Proizvodnja mlijeka u kg/ha		
	Year Godina		Mean Prosjeak
	2019	2020	
100% common vetch 100% obična grahorica	13139 <sup>b</sup>	14302 <sup>b</sup>	13721 <sup>b</sup>
100% Italian ryegrass 100% talijanski ljulj	10233 <sup>d</sup>	11047 <sup>d</sup>	10640 <sup>d</sup>
80% common vetch + 20% Italian ryegrass 80% obična grahorica + 20% talijanski ljulj	15233 <sup>a</sup>	16628 <sup>a</sup>	15931 <sup>a</sup>
60% common vetch + 40% Italian ryegrass 60% obična grahorica + 40% talijanski ljulj	16744 <sup>a</sup>	17209 <sup>a</sup>	16977 <sup>a</sup>
40% common vetch + 60% Italian ryegrass 40% obična grahorica + 60% talijanski ljulj	12442 <sup>c</sup>	13372 <sup>c</sup>	12907 <sup>c</sup>
20% common vetch + 80% Italian ryegrass 20% obična grahorica + 80% talijanski ljulj	12326 <sup>c</sup>	13488 <sup>c</sup>	12907 <sup>c</sup>
Mean Prosjeak	13353 <sup>b</sup>	14341 <sup>a</sup>	

Different letters in the column indicate a significant difference ( $P < 0.05$ )

Različita slova u stupcu označavaju značajnu razliku ( $P < 0,05$ )

## ZAKLJUČAK

Konsocijacija jare obične grahorice sa talijanskim ljuljem značajno je povećala ( $P < 0,05$ ) udio sirovih bjelančevina te smanjila udio neutralnih i kiselih deterđent vlakana u voluminoznoj krmu u odnosu na tretman sa čistim usjevom talijanskog ljulja. Tretman sa 60 kg/ha jare obične grahorice i 12 kg/ha talijanskog ljulja imao je značajno veći ( $P < 0,05$ ) prinos suhe tvari i sirovih bjelančevina te veći projicirani potencijal količine proizvedenog mlijeka u kg po hektaru u odnosu na tretman sa čistim usjevom jare obične grahorice i talijanskog ljulja.

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