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EVALUATION OF THE QUALITY OF GREEN FODDER OBTAINED FROM MIXTURES OF NARROWLEAF LUPIN WITH SPRING TRITICALE

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Abstract. The aim of the study was to evaluate the influence of the share of components in the mixture of narrowleaf lupin with spring triticale and the harvest stage on the quality of green fodder for livestock. Two factors were analysed in a three-year experiment: Share of components in the mixture at sowing narrowleaf lupin + spring triticale (seed·m^{-2}): 120 + 0, 90 + 150, 60 + 300, 30 + 450, 0 + 600, harvesting stage: I – narrowleaf lupin flowering stage, II – narrowleaf lupin flat green pod stage. The most favourable quality of green fodder was obtained from narrowleaf lupine, while among the mixtures from the mixture with the highest share of narrowleaf lupine at seed sowing. These crops were characterised by the lowest concentration of crude fibre and its fractions and the highest digestibility, dry matter intake and relative feed value. The harvesting of mixtures at the narrowleaf lupin flowering stage proved to be more favourable in terms of the quality of the green fodder obtained. In order to obtain valuable fodder for livestock, the cultivation of mixtures with a seed share at sowing of 90 + 150 of narrow-leafed lupine and spring triticale, respectively, should be recommended.

Key words: narrowleaf lupin, spring triticale, green fodder, crude fiber, digestibility.

INTRODUCTION

According to United Nations estimates, the world population will reach nearly 10 billion by 2050, thus there will be an increase in demand for food (UN 2017). Projections indicate that global meat demand will increase by about 73% by 2050, while dairy production will increase by 58% (FAO 2011). Consequently, global livestock production will face the challenge of meeting the increasing demand for animal protein in the years ahead. Animal nutrition will therefore play a significant role in meeting the mentioned needs. High livestock productivity is closely linked to livestock nutrition. Livestock nutrition can be a constraint to productivity, especially in cases where on-farm feed resources are insufficient in terms of quantity and quality (Karydogianni et al. 2022). According to Tona (2018), inadequate forage quality and quantity

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limits livestock productivity. In addition, declining agricultural land due to urbanisation, farmers interest in high-income-generating crops and a changing climate are causing deterioration in forage production (Ahmad et al. 2007). As a result, the increase in demand for livestock products which is associated with an increase in the demand for feed requires the search for sources of high quality feed that are at the same time safe for livestock. According to Soufan and Al-Suhaibani (2021), growing a mixture of legumes and cereals can serve as a strategy to cope with the challenges of forage scarcity, poorer forage quality and deteriorating soil fertility. Growing legume-cereal mixtures has many advantages such as soil conservation, more efficient use of land and available resources (Xu et al. 2020). Legume-cereal mixtures additionally generally yield better than monoculture crops, and are an important source of protein in green fodder (Javanmard et al. 2020). Mixtures of legumes and cereals can be used for seed, green fodder or silage (Księżak et al. 2023). According to Kumar et al. (2017), growing fodder crops for green fodder can provide significant benefits in terms of farm feed security due to the production of a large quantity of good quality biomass. The feed provided to livestock should have high intake, digestibility and efficient utilisation (Begna et al. 2021). According to Umesh et al. (2022), legumes have a higher protein content and lower fibre content compared to cereals. Neutral detergent fibre (NDF) is a measure of the total cell wall fraction, while acid detergent fibre (ADF) is responsible for the indigestible fraction of the feed. According to Giannoulis et al. (2022), protein, crude fibre (CF) and its fractions, and digestibility are the primary indicators of feed suitability for livestock. The authors also mention the significant influence of the vegetative stage of the crop at harvest on the mentioned traits. In order to obtain good quality fodder, in addition to the appropriate harvest date, the proper selection of components and their interrelationships are also important. According to Księżak et al. (2023), appropriate plant selection will avoid excessive competition between the components of the mixture. According to Yu et al. (2016), the predominance of a legume or cereal crop in a sown mixture may improve some yield traits and cause deterioration of others. Additionally, the most optimal mixture compositions for a given region of the world, may respond differently to different climatic conditions in other regions of the world (Soufan and Al-Suhaibani 2021). Due to the changing climate and inconclusive literature reports on the proportion of individual components in mixtures, there is a need for new research on the cultivation of legume-cereal mixtures in target regions. A hypothesis was put forward that the share of components in the mixture of narrowleaf lupin with spring triticale and the phase of harvesting could influence forage quality and green forage digestibility. The aim of the study was to evaluate the level of crude fiber, neutral detergent fiber, acid detergent fiber, acid detergent lignins, hemicellulose, cellulose, dry matter digestibility, organic matter digestibility, dry matter intake and relative feed value of green forage obtained from mixtures of narrowleaf lupin with spring triticale different proportions of components at different harvest stages.

MATERIALS AND METHODS

The field experiment was conducted in 2016–2018 at the Agricultural Experimental Station in Zawady belonging to the University of Natural Sciences and Humanities in Siedlce. The field experiment was established on soil according to the World Reference Base for Soil Resources (WRB) classification, was Stagnic Luvisols. The content of available mineral nutrients in the soil was: P 81.0 mg·kg^{-1}, K 122.0 mg·kg^{-1}, Mg 52.0 mg·kg^{-1} and humus content was 1.39%. The experiment was conducted in a split-block design, in three replications. Two factors were considered in the study: the proportion of components in the mixture at sowing (M) (Table 1) and the harvest stage (H): I – narrowleaf lupin flowering stage (BBCH 65), II – narrowleaf lupin flat green pod stage (BBCH 79).

Table 1. The proportion of components in the mixture of narrowleaf lupin with spring triticale at sowing

Mixtures	Narrowleaf lupin + spring triticale	
	sedds·m^{-2}	kg·ha^{-1}
M1	120 + 0	240 + 0
M2	90 + 150	180 + 55
M3	60 + 300	120 + 110
M4	30 + 450	60 + 165
M5	0 + 600	0 + 220

In October, phosphorus and potassium fertilizers were applied at rates depending on soil abundance, i.e. 34.8 kg·ha^{-1} P and 99.2 kg·ha^{-1} K. In April, nitrogen fertiliser was applied at a rate of 30 kg N·ha^{-1} on all sites, except narrowleaf lupin grown in pure sowing, before seed sowing. In May, 50 kg N·ha^{-1} was applied under spring triticale and 30 kg N·ha^{-1} under mixtures. Sowing was done in the first decade of April. Mechanical tillage treatments, i.e. harrowing twice before and once after crop emergence with a medium harrow, were applied to control weeds. Crop harvesting was carried out according to the second factor of the experiment. While the harvesting of mixtures from each field, the fresh matter of 1 kg was acquired (the sample) for the chemical analysis. The sample was shredded and dried in the room with free air flow of ambient temperature. After drying the following estimates were made: crude fibre (CF), neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignins (ADL), dry matter digestibility (DDM) and organic matter digestibility (DFM) the determination method used was near infrared spectroscopy (NIRS) and the spectrometer was a NIR Flex N-500. Hemicellulose and cellulose were then calculated: hemicellulose (Hem) = NDF-ADF and cellulose (Cel) = ADF-ADL, as described by Javier-Astete et al. (2021). Dry matter intake (DMI) and relative feed value (RFV) were calculated according to the following formula adopted by Horrocks and Vallentine (1999): Dry matter intake (DMI) (% body weight) = 120/NDF (%) on a dry matter basis; Relative feed value (RFV) (%) = % DDM × % DMI × 0.775.

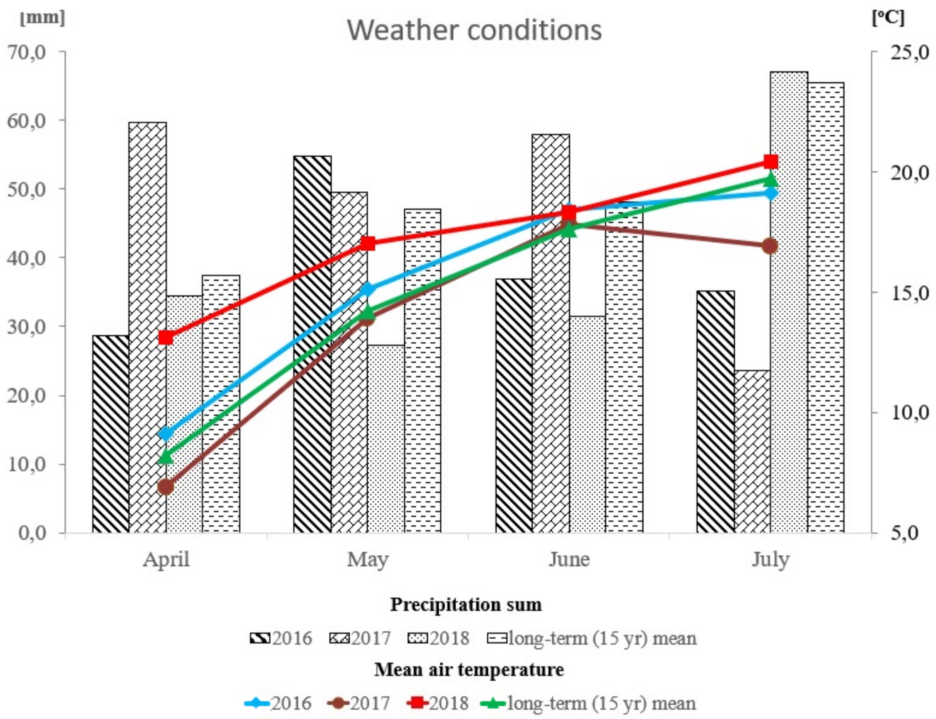


Fig. 1. Weather conditions during the growing season in the mixture of narrowleaf lupin with spring triticale according to the Zawady Meteorological Station

Data for each characteristic studied were analysed by means of ANOVA suitable for the split-block arrangement. Comparison of means for significant sources of variation was achieved by means of Tukey test at a significance level of $p \leq 0.05$. Due to the lack of interaction of factors with years, means of years and means of factors for study years are presented. For interactions between factors studies, presented only for features whose interaction was significant ($p \leq 0.05$). The strength of the relationship between the analysed characteristics was assessed by calculating Pearson's correlation coefficients. All the calculations were performed in Statistica, version 13.3 (Hamburg, Germany).

Temperature and precipitation conditions in the years of the study were varied (Fig. 1).

During the years of the experiment, the highest average temperature was recorded in 2018, equal to 17.2°C. While the lowest average temperature during April–July was recorded in 2017. The highest precipitation sum was recorded in 2017. A lower precipitation sum of 30.2 mm during the mixed crop was recorded in 2018. While the lowest was in 2016, this growing season mixture precipitation sum was 35 mm lower compared to 2018.

RESULTS

Statistical analysis showed a significant effect of growing season conditions, share of components in the mixture and harvest stage on the content of CF and its fractions in the green forage of mixtures of narrowleaf lupin with spring triticale (Table 2).

Table 2. Contents of CF, NDF, ADF, ADL, Cel and Hem in the green forage of mixtures of narrowleaf lupin with spring triticale, $g \cdot kg^{-1}$ DM

Effect	CF	NDF	ADF	ADL	Cel	Hem
Year (Y)						
2016	262^{b}	492^{b}	338^{b}	51.69^{b}	286^{b}	154^{a}
2017	248^{c}	445^{c}	320^{c}	49.59^{c}	271^{c}	124^{b}
2018	277^{a}	511^{a}	350^{a}	55.2^{a}	295^{a}	162^{a}
Mixture (M)						
M1	250^{c}	424^{e}	313^{e}	49.55^{e}	263^{e}	111^{d}
M2	253^{c}	451^{d}	322^{d}	50.26^{d}	272^{d}	129^{c}
M3	262^{b}	477^{c}	334^{c}	51.52^{c}	283^{c}	142^{bc}
M4	269^{b}	494^{b}	347^{b}	53.68^{b}	293^{b}	147^{b}
M5	278^{a}	568^{a}	363^{a}	55.8^{a}	308^{a}	204^{a}
Harvest stage (H)						
I	249^{b}	442^{b}	319^{b}	50.29^{b}	269^{b}	124^{b}
II	275^{a}	523^{a}	353^{a}	54.03^{a}	299^{a}	170^{a}

CF – crude fibre; NDF – neutral detergent fibre; ADF – acid detergent fibre; ADL – acid detergent lignins; Cel – cellulose; Hem – hemicellulose; I – narrowleaf lupin flowering stage (BBCH 65); II – narrowleaf lupin flat green pod stage (BBCH 79).
Main effect means within a column followed by the same small letter do not differ significantly at $p \leq 0.05$.

The lowest contents of CF, NDF, ADF, ADL, Cel and Hem were determined in mixtures harvested in 2017. Growing the mixtures in the 2016 and 2018 growing seasons resulted in an increase in the analyzed traits. The CF content in the green forage of mixtures increased by 5.6% in 2016, and by 11.7% in 2018. The concentration of the NDF, ADF and ADL increased in 2016 by 10.6%, 5.6% and 4.2%, respectively. In 2018, on the other hand, by 14.8%, 9.4% and 11.3%, respectively, in relation to the green forage of mixtures harvested in 2017. An analogous relationship was found in Cel and Hem content. In the case of Cel, a higher content of 5.5% was found in 2016 and 8.9% in 2018. Hem content in 2016 increased by 24.2% while in 2018 it increased by 30.6% compared to 2017. Additionally, no significant difference was found between Hem content in 2016 and 2018.

The lowest content of CF, NDF, ADF, ADL, Cel and Hem was found in the green forage obtained from narrowleaf lupin, while significantly the highest content was found from spring triticale grown in pure sowing (Table 2) The addition of spring triticale during seed sowing to narrowleaf lupin resulted in an increase in the content of the analyzed green forage quality traits. Thus, with increasing the proportion of spring triticale seed in the sown mixture, the content of CF, NDF, ADF, ADL, Cel and Hem increased.

Harvesting mixtures of narrowleaf lupin with spring triticale at an earlier of the analyzed developmental phases made it possible to obtain green fodder with lower contents of CF, NDF, ADF, ADL, Cel and Hem (Table 2). Harvesting mixtures at the flat green pod stage of narrowleaf lupin resulted in an increase in CF content by 10.4%, NDF content by 18.3%, ADF content by 10.7% and ADL content by 7.4% compared to harvesting at the flowering stage of narrowleaf lupin. The Cel content of the green forage mixtures increased by 11.2% and Hem by 37.1% as a result of harvesting the mixtures at the later of the narrowleaf lupin development stages analyzed.

In the experiment conducted, the interaction of the share of components in the mixture and the harvesting stage was shown in relation to the content of NDF, ADF, Cel and Hem in green forage (Fig. 2).

I – narrowleaf lupin flowering stage (BBCH 65); II – narrowleaf lupin flat green pod stage (BBCH 79)

Fig. 2. Interaction of share of components in the mixture and harvest stage of green forage of mixtures of narrowleaf lupin with spring triticale for NDF, ADF, Cel and Hem

It was shown that regardless of the sown mixture, harvesting green forage at the later of the analyzed phases resulted in a significant increase in the content of NDF, ADF, Cel and Hem. In the case of NDF content, the highest increase of 21.5% was recorded in the green forage of spring triticale. The highest increase of 13.2% in ADF content was shown when growing the M2 mixture in which the most narrowleaf lupine was sown among the mixtures. The highest increase in Cel content in green fodder was revealed in the narrowleaf lupine crop and the M2 mixture, both of which showed a 14.0% increase. Spring triticale proved to be the most sensitive crop to an increase in Hem with a delay in the harvesting stage. The green fodder obtained from this crop showed a 52.5% increase in Hem.

The DDM, DFM, DMI and RFV were significantly differentiated by growing season conditions, proportion of components of mixture and mixture harvest stage (Table 3).

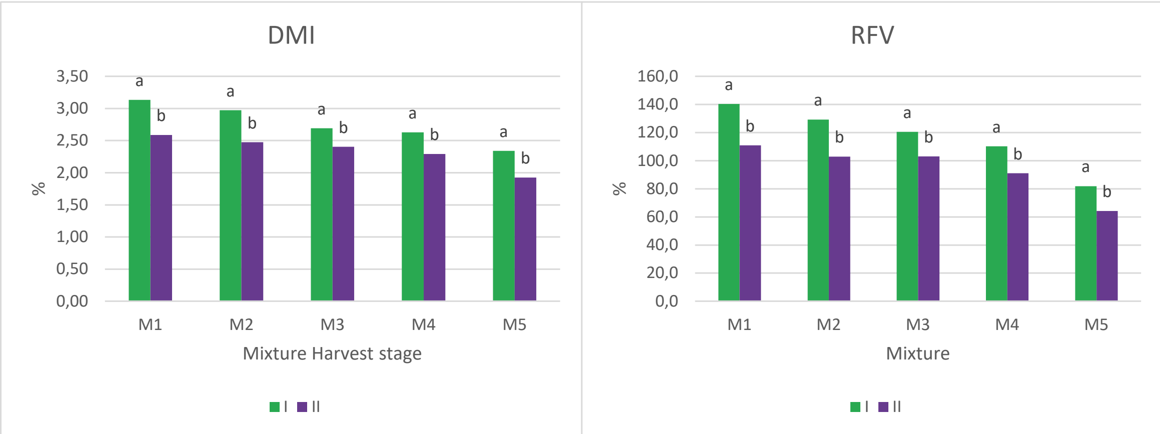
Table 3. The DDM, DFM, DMI and RFV of green forage of mixtures of narrowleaf lupin with spring triticale, %

Effect	DDM	DFM	DMI	RFV
Year (Y)				
2016	52.5[b]	50.03[b]	2.49[b]	102.1[b]
2017	56.21[a]	53.34[a]	2.76[a]	121.8[a]
2018	49.63[c]	47.44[c]	2.38[c]	92.4[c]
Mixture (M)				
M1	56.42[a]	53.05[a]	2.86[a]	125.6[a]
M2	54.57[b]	52.05[b]	2.72[b]	116.1[b]
M3	56.35[a]	53.17[a]	2.55[c]	111.8[b]
M4	52.49[c]	50.85[c]	2.46[c]	100.6[c]
M5	44.06[d]	42.22[d]	2.13[d]	73.1[d]
Harvest stage (H)				
I	54.05[a]	51.5[a]	2.75[a]	116.4[a]
II	51.51[b]	49.04[b]	2.34[b]	94.4[b]

DDM – dry matter digestibility; DFM – organic matter digestibility; DMI – dry matter intake; RFV – relative feed value; I – narrowleaf lupin flowering stage (BBCH 65); II – narrowleaf lupin flat green pod stage (BBCH 79).
Main effect means within a column followed by the same small letter do not differ significantly at $p \leq 0.05$.

Significantly the highest values of DDM, DFM, DMI and RFV were shown in the green forage of mixtures harvested in 2017. Mixtures grown in the 2016 growing season showed lower values of DDM by 6.6%, DFM by 6.2%, DMI by 9.8% and RFV by 16.2% in relation to 2017. Significantly the lowest values of the analyzed traits were revealed in 2018. In relation to 2017 they were lower: DDM by 11.7%, DFM by 11.1%, DMI by 13.8% and RFV by 24.1%. The highest DDM and DFM were revealed in the green forage of narrowleaf lupin and the M2 mixture (Table 3). In the other mixtures, forage digestibility was significantly lower. The green forage obtained from spring triticale cultivation had the lowest DDM and DFM. The green fodder of narrowleaf lupin showed the highest DMI and RFV. The cultivation of the analyzed mixtures was characterized by lower values, but these were nevertheless higher than the significantly lowest DMI and RFV of spring triticale. The highest values of DDM, DFM, DMI and RFV were revealed in the green forage of mixtures harvested at the flowering stage of narrowleaf lupin (Table 3). Harvesting mixtures at a later developmental stage of narrowleaf lupin caused a significant reduction in the analyzed yield traits. A reduction in DDM by 4.7%, DFM by 4.8%, DMI by 14.9% and RFV by 18.9% was revealed.

In the experiment conducted, the interaction of the share of components in the mixture and the harvest stage was shown for DMI and RFV values (Fig. 3).



I – narrowleaf lupin flowering stage (BBCH 65); II – narrowleaf lupin flat green pod stage (BBCH 79).

Fig. 3. Interaction of share of components in the mixture and harvest stage of green forage of mixtures of narrowleaf lupin with spring triticale for DMI and RFV

Regardless of the sown mixture, harvesting the green forage at the later of the analyzed developmental phases of narrowleaf lupin caused a significant reduction in DMI and RFV. The greatest reductions in DMI and RFV were revealed in the green forage of spring triticale, by 17.7% and 21.6%, respectively. The lowest reduction in DMI AND RFV depending on the stage of harvesting was carved by the M3 mixture, 10.8% and 14.4%, respectively.

Correlation analysis revealed a positive significant relationship between CF, NDF, ADF, ADL, Cel and Hem (Table 4).

Table 4. Correlation coefficients (n = 90) between the feature of the mixture of narrowleaf lupin with spring triticale

Feature	CF[1]	NDF	ADF	ADL	Cel	Hem	DDM	DFM	DMI
NDF	0.834**	–	–	–	–	–	–	–	–
ADF	0.875**	0.917**	–	–	–	–	–	–	–
ADL	0.863**	0.867**	0.942**	–	–	–	–	–	–
Cel	0.868**	0.916**	0.999**	0.923**	–	–	–	–	–
Hem	0.750**	0.974**	0.804**	0.762**	0.803**	–	–	–	–
DDM	−0.689**	−0.820**	−0.810**	−0.849**	−0.795**	−0.767**	–	–	–
DFM	−0.688**	−0.819**	−0.804**	−0.841**	−0.790**	−0.768**	0.973**	–	–
DMI	−0.867**	−0.977**	−0.911**	−0.855**	−0.910**	−0.943**	0.785**	0.785**	–
RFV	−0.846**	−0.958**	−0.919**	−0.898**	−0.913**	−0.911**	0.906**	0.893**	0.971**

Significance: p ≤ 0.05 *; p ≤ 0.01**

[1] See table 2 and 3.

In contrast, a significant negative association was revealed between CF, NDF, ADF, ADL, Target, Hem and DDM, DFM, DMI and RFV. The highest negative association was revealed between DDM and DFM showed NDF, ADF and ADL fibre fractions. In contrast, NDF showed the highest negative association with DMI and RFV. The analysis also revealed a significant positive correlation between DDM, DFM, DMI and RFV. The highest correlation coefficient was revealed between DDM and DFM and DMI and RFV.

DISCUSSION

In our own research, the cultivation of mixtures of narrowleaf lupin with spring triticale during the growing season with the highest total precipitation and the lowest average temperature made it possible to obtain green fodder with the most favorable chemical composition and the highest digestibility. Lower water availability during the growing season of the mixtures in the other years of the study resulted in poorer green forage quality. Also, studies conducted by Giannoulis et al. (2022) and Sohail et al. (2021) on other legume-cereal mixtures showed higher CF, ADF and NDF contents in a year that had lower total precipitation. According to Sorieul et al. (2016), plant fibre is part of the cell wall whose function is to mechanically support the plant and the vascular system in which nutrients are transported. According to Ricardi et al. (2014), increased cellulose synthesis may be a mechanism that guarantees the maintenance of cell wall integrity and cell turgor pressure, thus enabling continuous cell growth at low water potential. In addition, significant changes in lignin content and structure in plants occur as a result of biotic stresses (Moura et al. 2010). According to Le Gall et al. (2015), phenylalanine ammonia-lyase (PAL) is an intermediate compound at the intersection of phenyl and lignin synthesis pathways. According to these authors, PAL, catalyses the deamination of phenylalanine to trans-cinnamate and is up-regulated after exposure to stress. In a study by Terzi et al. (2013), the authors showed a 16-fold increase in PAL following drought stress, resulting in a significant increase in lignin content. As a result of the increase in crude fibre content and its fraction, there is a decrease in the digestibility of green forage (Piltz et al. 2021). This relationship is also confirmed in the authors own studies. According to Aşcı and Eğritaş (2017), legumes contain lower amounts of crude fibre due to their thinner cell wall compared to cereal crops. This finding is consistent with the results of our own study in which lower concentrations of CF, NDF, ADF, ADL, Cel and Hem were found in the green forage obtained in narrowleaf lupin with respect to spring triticale. As a result of this relationship, increasing the share of spring triticale in the sown mixture resulted in an increase in the concentration of the quality traits in question. Analogous relationships were also shown by other authors in their studies (Soufan and Al-Suhaibani 2021; Kahraryan et al. 2021). The cell walls of Cel and ADL-based green forages are referred to as ADF, while the NDF value illustrates the ADF and Hem fractions (Giannoulis et al. 2022). In the rumen of livestock, Cel and Hem is partially digested, while ADL is an indigestible fibre (Moore and Jung 2001). The ability of livestock to digest and take up feed is largely characterized by the aforementioned traits. In our own research, the highest DDM, DFM, DMI and RFV were revealed in the green forage of narrowleaf lupin, while the lowest in spring triticale, which reflects the fibre content. The obtained relationship is also confirmed by the results of studies conducted by Kahraryan et al. (2021), Yilmaz et al. (2015) and Kallida et al. (2022). According to Giannoulis et al. (2022), mainly ADF influences feed digestibility. The high correlation of ADF and ADL on feed digestibility is confirmed by the high negative correlation values between ADF, ADL and DDM obtained by the authors in their study. According to Prajapati et al. (2018), legumes have lower fibre content, indicating higher palatability and digestibility, leading to higher DMI. This is confirmed by the results obtained in the authors own study. Analogous relationships between legumes and cereals were also obtained in an experiment conducted by Manoj et al. (2021). RFV is an important indicator used to determine forage quality, which depends to a large extent on NDF and ADF content (Matías et al. 2021). Similar to the study by Qu et al. (2022), the authors own results confirm this relationship as a result of the highest negative correlation values between NDF, ADF and RFV. A study by Riga et al. (2021) showed an increase in NDF, ADF and ADL content with a delay in lupin harvest date. Similar relationships in growing mixtures of vetch with cereals were revealed by Piltz et al. (2021). The correlations obtained by other authors are consistent with those obtained in our own study, which showed an increase in CF, NDF, ADF, ADL, Cel and Hem content with the harvest of mixtures at the flat green pod stage of narrowleaf lupin. The previously mentioned negative correlation between the content of the given traits and DDM, DFM, DMI and RFV explains their decrease with harvesting at a later developmental stage. Also, a study by Turk and Albayrak (2012) revealed lower DDM and RFV in pea greens harvested at the later of the developmental stages analyzed.

CONCLUSIONS

Cultivation of mixtures of narrowleaf lupin with spring triticale makes it possible to obtain green fodder of high quality useful for livestock feeding. The most favorable, in terms of quality and digestibility, green fodder among mixtures was obtained when growing a mixture with M2, in which the most narrowleaf lupine was sown (90 seed·m^{-2}). In order to obtain better quality green fodder, it should be recommended for agricultural practice to harvest it at the flowering stage of the narrowleaf lupin. The cultivation of mixtures based on narrowleaf lupine and spring triticale proved to be sensitive in terms of quality reduction to moisture deficiency during the growing season.

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OCENA JAKOŚCI ZIELONKI UZYSKANEJ Z MIESZANEK ŁUBINU WĄSKOLISTNEGO Z PSZENŻYTEM JARYM

Streszczenie. Celem badań była ocena wpływu udziału komponentów w mieszance łubinu wąskolistnego z pszenżytem jarym oraz fazy zbioru na jakość zielonki dla zwierząt gospodarskich. W trzyletnim doświadczeniu analizowano dwa czynniki: udział komponentów w mieszance przy siewie łubinu wąskolistnego + pszenżyta jarego (nasion·m^{-2}): 120 + 0, 90 + 150, 60 + 300, 30 + 450, 0 + 600; faza zbioru: I – faza kwitnienia łubinu wąskolistnego, II – faza płaskiego zielonego strąka łubinu wąskolistnego. Najkorzystniejszą jakość zielonki uzyskano z łubinu wąskolistnego, a spośród mieszanek – z mieszanki o największym udziale łubinu wąskolistnego w wysiewie nasion. Rośliny te charakteryzowały się najniższą koncentracją włókna surowego i jego frakcji oraz najwyższą strawnością, pobraniem suchej masy i względną wartością pokarmową. Zbiór mieszanek w fazie kwitnienia łubinu wąskolistnego okazał się korzystniejszy pod względem jakości uzyskanej zielonki. W celu uzyskania wartościowej paszy dla zwierząt gospodarskich należy zalecać uprawę mieszanek z udziałem w zasiewie odpowiednio 90 + 150 nasion łubinu wąskolistnego i pszenżyta jarego.

Słowa kluczowe: łubin wąskolistny, pszenżyto jare, zielona pasza, włókno surowe, strawność.