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THE EFFECT OF SHARE OF COMPONENTS IN THE MIXTURE AND HARVEST DATE ON CALCIUM AND MAGNESIUM CONTENT OF MIXTURES OF FIELD PEA AND SPRING TRITICALE IN SUSTAINABLE AGRICULTURE

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Abstract. The cultivation of mixtures of legumes and cereals contributes to biodiversity and can provide good-quality roughage for direct feeding of livestock. The purpose of the study was to evaluate the effect of the share of components in a mixture of pea and spring triticale and the timing of harvesting on the calcium and magnesium content of green mass. The field experiment was conducted in 2016–2018 and two factors were studied: I. The proportion of components in the mixture: field pea – 100%, spring triticale – 100%, field pea 75% + spring triticale 25%, field pea 50% + spring triticale 50%, field pea 25% + spring triticale 75%. II. Harvesting date: flowering stage of field pea, flat green pod stage of field pea. The highest content of calcium and magnesium was found in field pea, while among the mixtures, in the one with 75% of field pea and 25% of spring triticale. A higher content of the mineral elements in question was found in mixtures harvested at the field pea flowering stage compared with mixtures harvested at the stage of the flat green pod of field pea. Due to the mass relationship between macronutrients, the green mass of mixtures of pea and spring triticale should not be the only feed for livestock.

Key words: calcium, magnesium, field pea, spring triticale, mixtures, harvest date.

INTRODUCTION

Directions in the development of European agriculture have important implications for the environmental and climate problems that are increasingly occurring. As a result of the deteriorating state of the environment within the European Union, and the intensifying effects of climate change, in December 2019 the European Commission published the European Green Deal (European Commission 2019). One of the important Green Deal policies related to agriculture is the protection, restoration of ecosystems and biodiversity (European Commission 2020). The activities carried out are also aimed at reducing the negative impact of agriculture on the environment. To this end, special attention is paid to minimizing the use of mineral fertilizers and plant protection products, which contributes to reducing the load of nutrients leached into waterways and limits the degree of

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soil acidification (Wiśniewski and Marks-Bielska 2022). In addition, mineral fertilizers can contain heavy metals (Thomas et al. 2012; Qaswar et al. 2020). Thus, intensive use of mineral fertilizers can contaminate soils. A factor in favor of reducing the use of mineral fertilizers is also the significant increase in their prices, which translates directly into an increase in the cost of cultivation.

The implementation of the Green Deal policy should be carried out gradually in a way that does not cause, or minimizes, a reduction in yield and quality of obtained crops (Wiśniewski and Marks-Bielska 2022). Opportunities for such measures while increasing crop biodiversity are provided by the cultivation of legumes and their mixtures with cereals. The ability of legumes to symbiosis with bacteria of the genus Rhizobium that convert atmospheric nitrogen into organic form in the roots of crops is well known (Jensen et al. 2020; Amine-Khodja et al. 2022). According to Swarnalakshmi et al. (2020), this nitrogen can be made available to host plants or released into the soil, so crops grown in mixture with legumes can also benefit from it. It should also be noted that the use of large amounts of mineral fertilizers reduces the phenomenon of biological nitrogen fixation (Vejan et al. 2016). A phenomenon additionally supporting the introduction of legume-legume mixtures into cultivation is also the improvement of the exploitation and protection of abiotic environmental resources (Jaskulska et al. 2022) in particular the positive effect on the chemical (Postma and Lynch 2012) and physical (Layek et al. 2018) properties of the soil. According to other authors (Florence et al. 2019; Carton et al. 2020), the cultivation of legume-cereal mixtures as an effective non-chemical method of reducing weed infestation and the occurrence of crop-damaging organisms. Therefore, in the cultivation of legume-cereal mixtures, it is possible to reduce or completely abandon the use of chemical pesticides and mineral fertilizers, which is certainly in line with the European Green Deal Policy. Currently, about 80% of arable land is used for livestock feed (FAO 2017). Crops intended for animal feed, in addition to high and stable yields, should also be characterized by high quality. As reported by many authors, the cultivation of mixtures of legumes with cereals makes it possible to obtain stable yields of high quality (Bacchi et al. 2021; Hwan et al. 2021; Sohail et al. 2021). Among the legumes recommended for growing in mixtures, pea, faba bean and lupins are the most important for animal nutrition reasons (Sońta and Rekiel 2020). Pea is ranked among the most valuable components because it provides good quality feed with high protein and mineral content (Serafin-Andrzejewska et al. 2021). According to Grela et al. (2017), pea contained comparably high phosphorus and potassium contents with respect to other legumes. The authors also showed a high variability in calcium and magnesium content depending on the species and cultivars of the analysed legumes. Pea cultivar mature on a similar date to spring cereals and are characterised by relatively low transpiration rates (Karkanis et al. 2016), little shading of the lower parts and good canopy stability when grown with cereals. Spring triticale is a cereal with very high yield potential, low soil requirements and relatively high disease resistance (Mergoum et al. 2019). Also Oettler (2005) points out the high adaptability, better nutrient content and higher yield compared to other cereals. In addition, according to Myer and Lozano del Rio (2004), spring triticale, together with the legume components of mixtures, provides good quality fodder for livestock both in the form of green fodder and grain or silage. According to Biel et al. (2020), triticale has higher phosphorus and potassium contents compared to wheat, barley and oats, lower magnesium and comparable calcium contents to wheat and barley. Despite the lower contents of some minerals, spring triticale can be a valuable component of a mixture for cultivation with legumes. Spring triticale, as a species recently introduced to cultivation in Poland, needs to be tested in mixtures with legumes grown for green matter, especially with pea. These mixtures can be grown on the light soils prevalent in Poland, where farmers face a shortage of roughage for cattle. The feed provided to ruminants should take up adequate amounts of minerals. Mineral disorders can lead to lower milk yields in cattle (Hadžimusić and Krnić 2012), and therefore to lower profitability of herd breeding (Thilsing-Hansen et al. 2002). Calcium is the macronutrient found in the body in the highest amounts. It is one of the basic components of bone, and is found in all animal tissues. Calcium is essential for many processes in the body such as ossification, blood clotting, control of heart rhythm, permeability of cell membranes, nerve and muscle stimulation, activation and secretion of hormones and enzymes (Soetan et al. 2010). In turn, magnesium plays a key role in most physiological processes. In addition, magnesium activates nearly 30 enzymes and is involved in carbohydrate and protein metabolism (Radwińska and Żarczynska 2014). According to Zimmermann et al. (2000), magnesium and calcium are in dynamic equilibrium, and a higher intake of magnesium than calcium can inhibit bone growth. According to Lutnicki et al. (2015), abnormal concentrations of calcium and magnesium can cause diseases of the nervous system and locomotor system in cattle, and negatively affect fertility. In the evaluation of feed intended for livestock nutrition, it is important not only the content of the given macronutrients but also the correct proportions between them (Szpunar-Krok et al. 2009). It was hypothesised that the proportion of components in the mixture and the harvest date of the pea and spring triticale mixtures differentiated the calcium and magnesium content of the green matter. This will allow us to evaluate the differences and select the mixture with the highest calcium and magnesium content useful for livestock nutrition.

The aim of this study was to evaluate the effect of the share of components in a field pea/ spring triticale mixture and the harvest date on the calcium and magnesium content of the green matter.

MATERIAL 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 terrain was flat, water erosion did not occur. In terms of agricultural usefulness, the soils were classified as very good rye complex, IVb class, with slightly acidic to neutral pH. The content of available mineral elements in the soil was: P 8.1 mg·100 g^{-1}, K 12.2 mg·100 g^{-1}, Mg 5.2 mg·100 g^{-1}. The humus content was 1.39%. The experiment was set up in split-block design in three replications. Two factors were studied in the experiment. I. The proportion of components in the mixture II (field pea – 100%, spring triticale – 100%, field pea 75% + spring triticale 25%, field pea 50% + spring triticale 50%, field pea 25% + spring triticale 75%). Harvesting date: flowering stage of field pea (BBCH 65), flat green pod stage of field pea (BBCH 79). In third decade of October phosphorus and potassium fertilizers were applied in doses depending on the soil chemical composition, i.e. 34.8 kg·ha^{-1} P in the form of 46% triple superphosphate and 99.2 kg·ha^{-1} K in the form of 60% potassium salt. In the first decade of April, nitrogen fertilizers in the form of ammonium nitrate 34% were applied before sowing seeds. On all treatments, with the exception of field pea grown in pure sowing, 30 kg N·ha^{-1} was applied. At the stalk shooting stage, an additional 50 kg N·ha^{-1} was applied for spring triticale and 30 kg N·ha^{-1} for mixtures of field pea with spring triticale. The seeds of field pea (Roch cultivar) and spring triticale (Milewo cultivar) were sown in the 1st decade of April according to the first experimental factor. The pea cultivar Roch is characterised by its high yield potential, high plant height, high uniformity of maturity and early ripening. The average protein content, important for animal nutrition, of this cultivar is around 24%. The cultivar is therefore recommended for production for green fodder used in animal feed. Seed pea of the Roch cultivar are recommended for cultivation on soils of classes III to V. The length of the vegetation period is about 104 days, while the length of the flowering phase is up to 17 days. The spring triticale cultivar Milewo is characterised by its very good yield potential, early earing and maturity. This cultivar is additionally characterised by increased resistance to soil acidity and low soil requirements. It shows good resistance to lodging and medium protein content. The Milewo cultivar is recommended for cultivation in mixtures with legumes plants. The plants were harvested according to the second factor of the experiment: field pea flowering stage (3rd decade of June) and field pea flat green pod stage (1st decade of July). During the harvest of mixtures, fresh weight samples were collected from each plot for chemical analyses. In the collected plant material, Ca and Mg contents in dry matter were determined by the inductively coupled plasma excitation-optical detector (ICP – OES) emission method using a Perkin Elmer Optima 8300 emission spectrometer. From the results of another manuscript by the authors (Górski et al. 2021) the Ca/P and K/(Ca + Mg) ratios were additionally determined.

Each of the studied characteristics was subjected to analysis of variance according to the split-block design scheme. In case of significant sources of variability, detailed comparison of means was made with the use of Tukey's Test.

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

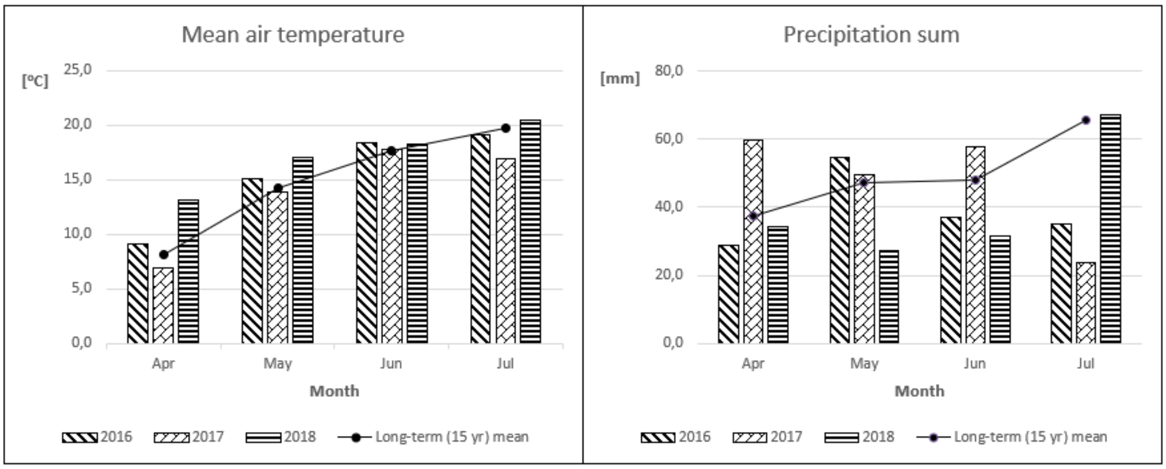

Fig. 1. Weather conditions during the growing season of field pea/spring triticale mixtures according to the Zawady Meteorological Station

In the period from April to July 2016 an average temperature of 0.5°C higher than the multi-year average was recorded. In the months of April, May and June 2016, the average air temperature was higher than the multi-year average by 0.8°C, 0.9°C and 0.8°C respectively. In 2016, only in July was the average temperature lower than the multi-year average by 0.6°C. During the entire period, precipitation was more than 40 mm lower compared to the multi-year total. In April, June and July 2016, precipitation totals were below the multi-year total. April recorded precipitation totals 8.7 mm lower than the multi-year total, June 11.2 mm lower, and July 30.3 mm lower. In 2016, only May recorded precipitation totals higher than the multi-year total by 7.7 mm. In the period from April to July 2017, the average temperature in this period was 1°C lower than the multi-year average. This year, only June recorded an average temperature slightly higher than the multi-year average. In the other months of the analysed period, the average temperature was lower compared to the multi-year average. In April, the average temperature was 1.3°C lower, in May 0.3°C lower and in July 2.8°C lower than the multi-year average. Total precipitation in the analysed period of 2017 was slightly lower, by 7.5 mm, than the multi-year total. In the months of April to June, precipitation totals in each month were higher than the multi-year total. In April, precipitation totals were 22.2 mm higher than the multi-year total, in May by 2.4 mm and in June by 9.8 mm. In 2017, only July recorded a lower precipitation totals than the multi-year total by 41.9 mm. The average temperature recorded during the analysed period in 2018 was more than 2°C higher than the multi-year average. In all analysed months of 2018, the average temperature was higher than the multi-year average. The average temperature in April was 4.9°C higher, in May by 2.8°C, in June and July by 0.7°C. In contrast, total precipitation was 38 mm lower than the multi-year total. Total precipitation in the months of April to June 2018 was lower than the multi-year total. April recorded a precipitation total 2.9 mm lower, May 19.8 mm lower and June 16.6 mm lower. In 2018, only July recorded a precipitation total higher than the multi-year total by 1.6 mm. Legumes and cereals plants show the highest demand for water and nutrients between mid-May and June. During the highest water demand, precipitation totals in 2016 were 3.5 mm lower than the multi-year total, 12.2 mm higher in 2017 and 36.4 mm lower in 2018.

RESULTS AND DISCUSSION

The content of calcium and magnesium in the green mass of field pea/spring triticale mixtures was significantly differentiated by weather conditions, the proportion of components in the mixture, the date of harvesting the mixtures and their interaction. The highest Ca content of 11.50 $g \cdot kg^{-1}$ DM and Mg content of 1.61 $g \cdot kg^{-1}$ DM were found in mixtures harvested in 2018 (Table 1).

Table 1. Calcium and magnesium content in field pea/spring triticale mixtures according to component share in the mixture in 2016–2018, $g \cdot kg^{-1}$ DM

Composition of mixture [%] (A)		Ca				Mg			
		years (Y)			means	years (Y)			means
field pea	spring triticale	2016	2017	2018		2016	2017	2018	
100	0	12.85	12.36	14.54	13.25	1.38	1.36	1.83	1.52
75	25	11.74	11.35	13.50	12.19	1.31	1.26	1.73	1.43
50	50	9.93	9.61	11.59	10.37	1.26	1.15	1.61	1.34
25	75	8.12	7.63	9.77	8.51	1.17	1.05	1.51	1.24
0	100	6.43	5.94	8.09	6.82	1.07	0.95	1.37	1.13
Means		9.81	9.38	11.50	–	1.24	1.15	1.61	–
$LSD_{0.05}$		Y – 0.23; A – 0.35; Y × A – 0.60				Y – 0.07; A – 0.11; Y × A – 0.19			

This year was characterized by the highest average temperature during plant vegetation and a rainfall total lower by 37.7 mm than the multi-year total. The cultivation of mixtures in the year with the highest precipitation sum and the lowest average temperature among the analyzed period revealed the lowest concentration of Ca and Mg in the green mass of field pea/spring triticale mixtures. Analogous relationships of Ca and Mg content in relation to atmospheric conditions were obtained by Gill and Omokanye (2018) and Turan et al. (2020) in a study conducted on other legume-cereal mixtures. A study conducted by İleri and Erkovan (2021) on pea-cereal mixtures also found significantly higher Ca concentrations in mixtures grown in years with lower total precipitation and average temperature. However, the same authors study found no significant differences in Mg content depending on growing season conditions. The higher Ca and Mg content in the dry matter of the mixtures may be due to the fact that the mixtures produced less biomass as a result of reduced water availability. Thus, the dilution of mineral substances will be higher in plants grown under favourable weather conditions compared to plants grown under water-stressed conditions (Alghamdi 2009). In our study, the highest Ca content of 13.25 $g \cdot kg^{-1}$ DM was found in field pea, while the lowest was in spring triticale (6.82 $g \cdot kg^{-1}$ DM). In the case of Mg in the conducted experiment, the highest concentration was revealed in field pea and in a mixture with a component share of 75 + 25% in field pea and spring triticale, respectively. In turn, the lowest content was found in spring triticale and a mixture with a 25% share of spring triticale and 75% of field pea. According to Asci et al. (2018), legumes uptake higher amounts of Ca and Mg compared to cereals. Therefore, higher Ca and Mg concentrations were expected in the green matter of pea compared to the green matter of spring triticale. Also other authors (Turan 2020; Hansen et al. 2021; Zaeem et al. 2021; Dobrowolska-Iwanek et al. 2022; Jakubus and Graczyk 2022; Le Cadre et al. 2022) in their studies revealed higher Ca and Mg concentrations in legumes compared to cereals. In our study, the addition of field pea to a mixture with spring triticale resulted in an increase in Ca and Mg content in the biomass obtained. The obtained relationship is analogous to the results obtained by other authors (Mut et al. 2017; Asci et al. 2018; Kaymak et al. 2021; Domagała-Świątkiewicz and Siwek 2022). In our study, among the analyzed mixtures, the highest content of Ca (12.19 $g \cdot kg^{-1}$ DM) and Mg (1.43 $g \cdot kg^{-1}$ DM) was shown in a mixture with 75% of field pea and 25% of spring triticale. However, in the case of Mg content, a mixture with a 75 + 25% share of the components of pea and spring triticale, respectively, did not differ significantly from a mixture with an equal share of both components. The study showed an interaction from which it follows that, among the mixtures, the highest Ca and Mg concentrations were characterized by mixtures with a component share of 75 + 25% of field pea and spring triticale, respectively, harvested in 2018.

The content of calcium and magnesium in the green matter of field pea/spring triticale mixtures was also significantly differentiated by the harvest date of the mixtures (Table 2).

Table 2. Calcium and magnesium content of field pea/spring triticale mixtures depending on harvest date (means across 2016–2018), $g \cdot kg^{-1}$ DM

Composition of mixture [%] (A)		Ca		Mg	
		harvest date (B)		harvest date (B)	
field pea	spring triticale	I	II	I	II
100	0	14.58	11.92	1.63	1.37
75	25	13.65	10.74	1.58	1.34
50	50	11.52	9.23	1.47	1.21
25	75	9.61	7.40	1.39	1.10
0	100	7.69	5.95	1.26	1.00
Means		11.41	9.05	1.46	1.20
$LSD_{0.05}$		B – 0.22; A × B – 0.40		B – 0.06; A × B – 0.11	

I – flowering stage of field pea (BBCH 65), II – flat green pod stage of field pea (BBCH 79).

In our study, the highest content of Ca (11.41 $g \cdot kg^{-1}$ DM) and Mg (1.46 $g \cdot kg^{-1}$ DM) was revealed in mixtures harvested at the flowering stage of field pea. Delaying the harvesting date to the flat green pod stage of field pea resulted in a significant reduction in the concentration of Ca and Mg in the biomass obtained. According to Kebede et al. (2014) as the plant mature, mineral content declines due to a natural dilution process and the translocation of nutrients to the root system. A study by Asci et al. (2018) also showed a reduction, along with the delay of the harvest date, in the Ca and Mg content of mixtures of different field pea varieties with triticale. An analogous relationship of lowering Ca and Mg content with successive stages of plant maturity was also confirmed by Serbester et al. (2015) over other legume-cereal mixtures. Our own study revealed an interaction from which the highest Ca and Mg contents were recorded in field pea harvested at the flowering stage. In the case of Mg, there was additionally no significant difference between field pea and a mixture of field pea and spring triticale with a component share of 75 + 25%, respectively. Among the analyzed mixtures, the highest contents of the analyzed macronutrients were found in mixtures with a share of 75% field pea and 25% spring triticale harvested at the flowering stage of field pea. It was also found that mixtures of field pea and spring triticale with a share of components of 75 + 25%, respectively, and mixtures with an equal share of both components harvested at the flowering stage of field pea contained comparable, not significantly different, contents of Mg.

According to Szpunar-Krok et al. (2009), in assessing the suitability of feed for livestock, it is not only the content of individual macronutrients that is important, but also their proper proportions. According to Madibela and Modiakgotla (2004) and Kumar and Soni (2014), the metabolism of Ca and P in animals is related to each other, and Mg is related to the functions of Ca and P in the animal body. Based on the presented research results and those of another study by the authors (Górski et al. 2021), the macronutrient ratios in mixtures of field pea and spring triticale were calculated (Table 3).

Table 3. Mass ratios of macronutrients in field pea/spring triticale mixtures (means across 2016–2018)

Composition of mixture [%]		Ca/P			K/(Ca + Mg)		
		harvest date		means	harvest date		means
field pea	spring triticale	I	II		I	II	
100	0	2.76	2.66	2.71	2.53	2.45	2.49
75	25	2.78	2.62	2.70	2.56	2.58	2.57
50	50	2.67	2.62	2.65	2.70	2.64	2.67
25	75	2.59	2.52	2.56	2.90	2.91	2.90
0	100	2.56	2.73	2.63	3.14	3.16	3.15
Means		2.69	2.63	–	2.72	2.69	–
Optimum[a]		1.8–2.1			1.9–2.2		

I – flowering stage of field pea (BBCH 65), II – flat green pod stage of field pea (BBCH 79).
[a] Wasilewski (1997).

The highest Ca/P ratio was obtained in the field pea crop. For the mixtures analyzed, the addition of spring triticale to the field pea mixture resulted in a lower Ca/P ratio. The lowest Ca/P ratio was obtained from a mixture with a 25 + 75% component share of field pea and spring triticale, respectively. Harvesting mixtures at the flat green pod stage of field pea caused a lower Ca/P ratio compared to mixtures harvested at the flowering stage of field pea. In all analyzed trials, the Ca/P ratio was higher than optimal. Also, a study by Turan et al. (2020) showed higher than optimal Ca/P ratios in vetch-barley mixtures. According to other authors (Albu et al. 2012; Başbağ et al. 2018; Özyazıcı and Açıkbaş 2019), long-term feeding of animals with feeds with Ca/P ratios higher than optimal can lead to health disorders. Additionally, according to Acikgoz (2001), feeding animals with feeds with Ca/P ratios above 5 can lead to milk fever. In our study, the lowest K/(Ca + Mg) ratio was obtained in field pea crops, while the highest was obtained in spring triticale. The addition of spring triticale to the field pea mixture caused an increase in the K/(Ca + Mg) ratio. An analogous relationship was also shown by Asci et al. (2018) in their study. Among the analyzed mixtures, the lowest K/(Ca + Mg) ratio was revealed in a mixture with 75% of field pea and 25% of spring triticale. Delaying the harvest date from the flowering stage of field pea to the flat green pod stage of field pea resulted in a lower K/(Ca + Mg) ratio in the green mass of the mixtures. All tested trials of mixtures of field pea and spring triticale, and monoculture crops of field pea and spring triticale were characterized by a K/(Ca + Mg) ratio higher than the optimum. These results are consistent with those obtained in a study by Turan et al. (2020). According to Crawford et al. (1998), feeding animals with too high a K/(Ca + Mg) ratio increases the risk of hypomagnesemia.

CONCLUSIONS

The highest Ca and Mg contents were characterized by green mass field pea, while the lowest were those of spring triticale. Among the mixtures analyzed, the highest Ca and Mg contents were revealed in the mixture with a component share of 75% field pea and 25% spring triticale, respectively. Harvesting the green mass of mixtures of field pea with spring triticale at the flowering stage of field pea yields a higher concentration of Mg and Ca, compared to harvesting at the stage of the flat green pod of field pea. Field pea/spring triticale mixtures grown in the year with the lowest rainfall total had the highest Ca and Mg contents among the study years analyzed. In order to obtain forage with high Ca and Mg content, it should be recommended to grow a mixture with a component ratio of 75 + 25% of field pea with spring triticale, respectively, and harvest it at the flowering stage of field pea. Due to higher than optimal Ca/P and K/(Ca + Mg) ratios, mixtures of field pea with spring triticale should not be the only feed fed to livestock.

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WPŁYW UDZIAŁU KOMPONENTÓW W MIESZANCE I TERMINU ZBIORU NA ZAWARTOŚĆ WAPNIA I MAGNEZU W MIESZANKACH GROCHU SIEWNEGO Z PSZENŻYTEM JARYM W ROLNICTWIE ZRÓWNOWAŻONYM

Streszczenie. Uprawa mieszanek roślin bobowatych i zbóż przyczynia się do zwiększenia bioróżnorodności i może być źródłem dobrej jakości pasz objętościowych do bezpośredniego żywienia zwierząt. Celem badań była ocena wpływu udziału komponentów w mieszance grochu siewnego i pszenżyta jarego oraz terminu zbioru na zawartość wapnia i magnezu w zielonej masie. Doświadczenie polowe przeprowadzono w latach 2016–2018 i badano dwa czynniki: I. Udział komponentów w mieszance: groch siewny – 100%, pszenżyto jare – 100%, groch siewny 75% + pszenżyto jare 25%, groch siewny 50% + pszenżyto jare 50%, groch siewny 25% + pszenżyto jare 75%. II. Termin zbioru: faza kwitnienia grochu siewnego, faza płaskiego zielonego strąka grochu siewnego. Największą zawartość wapnia i magnezu stwierdzono w grochu siewnym, a spośród mieszanek w mieszance z udziałem 75%

grochu siewnego i 25% pszenżyta jarego. Wyższą zawartość omawianych składników mineralnych stwierdzono w mieszankach zbieranych w fazie kwitnienia grochu siewnego w porównaniu z mieszankami zbieranymi w fazie płaskiego zielonego strąka grochu siewnego. Ze względu na stosunki masowe między makroelementami zielona masa mieszanek grochu siewnego i pszenżyta jarego nie powinna być podawana jako jedyna pasza dla zwierząt.

Słowa kluczowe: wapń, magnez, groch siewny, pszenżyto jare, mieszanka, termin zbioru.