ECOLOGIA BALKANICA
2021, Vol. 13, Issue 1 June 2021 pp. 143-153

Changes in the Composition of Natural Grassland (Chrysopogon gryllus type) in Grazing and Haymaking Mode of Use

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Abstract. The objective of the experiment was to observe the impact of the different management practices applied on natural meadow grassland (*Chrysopogon gryllus* L.) under mountain conditions and their impact on the qualitative composition of the formed biomass. The share of grasses in the composition of natural grassland decreased in grazing (up to 10.3%) and haymaking (up to 14.3%) mode of use from the first to the fifth experimental year. During the last two experimental years, there was a higher share (39.8-55.5% - in grazing and 38.6-52.0% - haymaking mode) of the representatives of genus *Fabaceae*, which is a prerequisite for higher quality and nutritional value of the formed mass for grazin g and hay. The amount of crude protein exceeded by 10.1% (in grazing mode) and by 10.8 to 25.4% (in haymaking mode) the average annual values of the indicator. The amount of crude protein in the dry matter of grassland with pasture management practice was 5.1% higher than that in grassland with haymaking mode. A high positive correlation was found between the percentage share of legumes in the grassland in the pasture mode of use with the concentration of crude protein (r = 0.82) and the gross energy value (r = 0.95) of the feed mass. In hay-making variants, the weight percentage of legumes correlated positively with the indicators characterizing the energy nutritional value (GE - r = 0.81; EE - r = 0.79; FUM - r = 0.77 and FUG - r = 0.69) of the formed aboveground mass.

Key words: *Chrysopogon gryllus* L., natural grassland, chemical composition, yield of crude protein.

Introduction

The quality and nutritional value of pasture and hay are subordinated to the species composition and the quantitative ratio of the individual biological groups in the natural grasslands (Tomović et al., 2014; Aćić et al., 2015). Natural and economic factors have an impact on the changes in floristic composition and reflect differences in yield and quality characteristics of grass biomass in first mowing, early grazing, or late grazing (Tenikecier & Ates, 2018; Iliev et al., 2020). The grass cover of natural meadows and pastures, as a set of diverse plant species, affects the mode of use and taste of the aboveground mass (Sanderson, 2010; Hegedüšová & Senko 2011; Woodward et al., 2013). The development of perennial grasses and legumes for meadows (a major component in the natural grass association), as well as the period of their mowing is a significant factor in obtaining good quality hay (Mitev et al., 2010; 2011; Yavuz & Karadağ, 2016). In the conditions of the Central Balkan Mountain, the maximum accumulation of nutrients in

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Chrysopogon gryllus meadow coincides with the phase of tasseling-beginning of flowering, which determines the optimal harvesting period of the grassland (Iliev et al., 2017). Species of local origin form highly productive and long-lasting grasslands (Naydenova & Mitev, 2008). The chemical composition of the feed mass (the content of proteins, carbohydrates, vitamins, minerals and nitrogen-free extracts) affects the nutritional value of feed and its full absorption by ruminants (Jeranyama & Garcia, 2004; Enchev, 2013; Butnariu et al., 2016; Bozhanska, 2017; Bozhanska et al., 2018).

Grazing use of mode is an economical and environmentally friendly way to meet the food needs of adolescent and highly productive animals (Woyessa et al., 2013; Shapiro et al., 2015). The grazing mode allows the obtained animal production (milk, meat, wool, etc.) to be at a lower cost (Thomas et al., 2010; Pringle et al., 2014). When grazing, animals show selectivity, which leads to changes in the botanical composition and quality of the formed aboveground mass (Luscher et al., 2014). Changes in the values of the main quality indicators in the chemical composition of grassland determine its nutritional value, the degree of digestibility by animals (Getachew et al., 2004; Cho et al., 2012; Tenikecier & Ates, 2019) and their productivity.

The objective of the study was to evaluate the effect of different management practices on the chemical composition of mountain meadow grassland, *Chrysopogon gryllus* L. type.

Material and Methods

The experiment was conducted on a natural grassland, of *Chrysopogon gryllus* type, in mountain conditions (515 m above sea level). The experimental period was five years (2013-2017). The grazing and hay productivity of the grassland in the first regrowth was monitored, with two modes of use and three terms of harvesting (early, medium-early and late at the respective dates).

Variants of pasture harvesting (PH):

1. PH1 - (Control) - from 31st May to 9th June;
2. PH2 - from 10th June to 19th June;
3. PH3 - from 20th June to 29th June.

Variants of hay-making harvesting (HH):

1- HH1 - (Control) - from 30th June to 09th July;
2- HH2 - from 10th July to 19th July;
3- HH3 - from 20th July to 31st July.

During the first three experimental year was used stockpile fertilization with N_6P_6 for the variants. The terms of grazing and mowing were at an interval of a ten-day period (considering the climatic conditions). Fertilization with triple superphosphate (containing 44–48% P_2O_5) was applied once in autumn (September-October), and fertilization with nitrogen fertilizer (NH_4NO_3) once in spring (April).

Climatic characteristics of the area in the experimental period

The highest amount of vegetation and autumn-winter precipitation (1164.9 mm) was in 2014 (second experimental year). The relative difference in the amount of precipitation in 2015 (922.7 mm) and 2017 (983.2 mm), 2013 (807.3 mm) and 2016 (837.0 mm) compared to the maximum value of the characteristic varied from 18.5 to 26.2% and from 39.2 to 44.3%, respectively. The highest average air temperature (11.9°C) and the highest average temperature for the months of July, August and September (22.4°C) was registered in 2015, and the lowest average annual temperature (10.5°C) in 2017 year.

Research indicators:

- Botanical composition of grassland (%) - determined by weight analysis of grass green mass samples taken at each mowing of each variation. Their weighing is carried out in an air-dry state, by weighing the percentage of sown grass species and motley grasses (in total).
- The chemical composition of the dry feed is analyzed according to *Weende* analysis: Crude protein (CP, g kg^{-1}) according to *Kjeldahl* (according to BDS/ISO-5983); Crude fiber (CFr, g kg^{-1}); Crude fat (CF, g kg^{-1}) (according to

BDS/ISO-6492) - by extraction into a *Soxhlet* extractor; Ash (g kg^{-1}) - (according to BDS/ISO-5984) degradation of the organic matter by gradual burning of the sample in a muffle furnace at 550°C; Dry matter (DM, g kg^{-1}) - empirically calculated from % moisture; NFE = 100 - (CP, % + CFr, % + CF, % + Ash, % + Moisture, %) converted to g kg^{-1}; Calcium (Ca, g kg^{-1}) - Stotz (Complexometric) and Phosphorus (P, g kg^{-1}) - with vanadate-molybdate reactive according - spectophotometer (*Agilent 8453 UV - visible Spectroscopy System*) measuring in the area of 425 ηm.

- The nutritional value of the feed was assessed by the Bulgarian system as Feed Unit for Milk (FUM) and Feed Unit for Growth (FUG) and calculated on the basis of equations according to the experimental values of CP, CFr, CF and NFE, recalculated by the coefficients for digestibility by Todorov (2010): Gross energy (GE, MJ/kg DM) = 0,0242*CP + 0,0366*CF + 0,0209*CFr + 0,017*NFE - 0,0007*Zx and Exchangeable energy (EE, MJ/kg DM) = 0.0152*DP (Digestible protein) + 0.0342*DF (Digestible fat) + 0.0128*DFr (Digestible fibers) + 0.0159*DNFE (Digestible Nitrogen-free extractable substances) - 0.0007*Zx.

Statistical data processing includes the analysis product Analysis Toolpak for Microsoft Excel 2010 and analysis of variance (ANOVA).

Results and Discussion

Botanical composition of natural grassland Chrysopogon gryllus L. type in pasture and haymaking harvesting

The mode of use has an impact on the quantitative share and the ratio of plant species in the botanical composition of the grassland (Šantrůček et al., 2002) while genotypic factor successfully determines abiotic restriction and specific adaptation of legumes to environmental conditions (Naydenova & Vasileva, 2019).

The applied mineral fertilization, as well as the modes of use have an impact on the percentage of plant species in the main functional groups in the grassland (Table 1). On average for the first three years (2013, 2014, 2015) of the experimental period, the share of cereal meadow grasses is from 17.4 to 68.7% (for grazing) and from 21.9 to 66.8% (for hay-making harvesting). During the period 2016-2017 (last two experimental years) the percentage share of grass species marked a decreasing trend (up to 10.3% - in the grazing mode and up to 14.3% - in the hay-making mode) in the composition of the studied grassland.

Proper management of pastures and meadows is a key element in maintaining biodiversity and optimal forage productivity in natural grasslands (Talmaci & Miron, 2016; Butnariu, 2018). The data on the species diversity and the quantitative share of legumes in the amount of the formed above-ground mass are opposite to those of grasses. In the period 2013-2015, a slight increase was observed in the average values (1.0-6.6% in the pasture mode and 0.0-9.2% in the hay-making mode) regarding the percentage share of the species of genus *Fabaceae*. In the last two years of the experimental period, legumes registered a higher presence (39.8-55.5% in pasture and 38.6-52.0% - hay-making) in the natural grassland, which is a prerequisite for higher quality and nutritional value of grass biomass used for pasture and hay. The percentage share of the group of weeds varied from 24.7 to 81.7% (in pasture mode) and from 24.0 to 78.1% (in hay-making) in the composition of the grassland.

Basic botanical composition of natural grassland of Chrysopogon gryllus L. type in pasture and hay-making harvesting

Changes in the botanical composition of grassland are associated with changes in the chemical composition and digestibility of feed (Garden et al., 2000). When the experiment was set, grasses predominated in the composition of grasslands with pasture and hay-making mode, and the feed mass had the highest carbohydrate content (PH - 509.3 g kg^{-1} and HH - 470.9 g kg^{-1}) - Tables 2 and 3.Grassland age, species and phenological identity of plants are a prerequisite for the quality and relative forage value of grass areas (Andueza et al., 2010; Grant et al., 2014). The grassland tested in the fifth experimental year (in both modes of use) had the highest average values regarding the amount of crude fiber (PH - 435.8 g kg^{-1} and HH - 437.4 g kg^{-1}).

Table 1. Botanical composition (%) of natural grassland of *Chrysopogon gryllus* L. type in pasture and hay-making harvesting (over the years).

Species	Pasture harvesting				Hay-making harvesting			
Groups	PH1	PH2	PH3	Average	HH1	HH2	HH3	Average
2013								
Grasses	20.5	13.2	18.4	17.4	20.8	21.1	23.9	21.9
Legumes	3.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
Motley grasses	76.8	86.8	81.6	81.7	79.2	78.9	76.1	78.1
2014								
Grasses	49.0	50.5	50.6	50.0	60.9	44.4	46.4	50.6
Legumes	2.3	6.7	5.4	4.8	6.1	13.2	4.9	8.1
Motley grasses	50.1	42.8	44.0	45.6	33.0	42.4	48.7	41.4
2015								
Grasses	77.1	71.0	58.0	68.7	79.2	70.1	51.1	66.8
Legumes	0.0	6.7	13.2	6.6	0.0	5.2	22.3	9.2
Motley grasses	22.9	22.3	28.8	24.7	20.8	24.7	26.6	24.0
2016								
Grasses	19.6	9.9	21.4	17.0	16.0	24.3	17.6	19.3
Legumes	28.6	46.8	44.0	39.8	46.0	34.7	35.2	38.6
Motley grasses	51.8	43.3	34.6	43.2	38.0	41.0	47.2	42.1
2017								
Grasses	15.0	11.6	4.3	10.3	11.1	16.2	15.7	14.3
Legumes	54.5	56.0	56.0	55.5	43.6	59.7	52.8	52.0
Motley grasses	30.5	32.4	39.7	34.2	43.6	59.7	52.8	52.0

Table 2. Chemical composition (g kg^{-1}) of natural grassland of *Chrysopogon gryllus* L. type over the years (pasture harvesting).

Indicators / Variants	CP	CF	CFr	Ash	NFE	Ca	P
2013							
PH1	101.9	18.9	264.1	83.6	536.5	14.0	2.1
PH2	76.9	32.5	307.2	86.7	496.6	21.2	2.3
PH3	71.0	19.4	334.9	80.1	494.6	14.0	1.8
Mean±SD	***83.3±16.4***	***23.6±7.7***	***302.1±35.7***	***83.5±3.3***	***509.3±23.6***	***16.4±4.2***	***2.0±0.2***
2014							
PH1	55.4	9.2	407.3	71.6	456.5	10.0	2.2
PH2	78.9	24.5	399.8	70.0	426.8	8.8	2.0
PH3	80.0	15.1	403.0	66.1	435.8	7.6	2.2
Mean±SD	***71.4±13.9***	***16.2±7.8***	***403.4±3.8***	***69.3±2.9***	***439.7±15.2***	***8.8±1.2***	***2.1±0.1***
2015							

PH1	56.7	20.2	363.9	84.1	475.2	10.9	2.8
PH2	69.5	16.0	344.8	82.9	486.9	12.1	3.0
PH3	71.3	22.6	371.0	87.4	447.7	13.3	2.1
Mean±SD	***65.8±8.0***	***19.6±3.3***	***359.9±13.6***	***84.8±2.3***	***469.9±20.1***	***12.1±1.2***	***2.7±0.5***
			2016				
PH1	120.8	28.9	352.3	67.3	430.6	13.8	1.8
PH2	157.4	34.4	381.8	57.2	369.2	16.3	1.8
PH3	150.5	28.0	390.1	63.8	367.7	15.0	1.7
Mean±SD	***142.9±19.5***	***30.4±3.5***	***374.7±19.8***	***62.8±5.1***	***389.2±35.9***	***15.0±1.3***	***1.8±0.1***
			2017				
PH1	132.9	26.9	430.0	74.2	336.0	15.0	1.4
PH2	157.5	23.4	437.9	72.3	308.9	18.5	1.8
PH3	138.5	26.4	439.5	73.3	322.2	17.4	1.5
Mean±SD	***143.0±12.9***	***25.6±1.9***	***435.8±5.1***	***73.3±1.0***	***322.4±13.5***	***16.9±1.8***	***1.6±0.2***
			2013-2017				
PH1	93.5	20.8	363.5	76.2	447.0	12.7	2.1
PH2	108.0	26.2	374.3	73.8	417.7	15.4	2.2
PH3	102.3	22.3	387.7	74.1	413.6	13.5	1.9
Mean±SD	***101.3±37.8***	***23.1±6.8***	***375.2±49.2***	***74.7±9.1***	***426.1±70.1***	***13.9±3.7***	***2.0±0.4***

In the first experimental year (2013), grassland harvested as a pasture at an earlier date (31.05-09.06.) and fodder used as hay-making in the period - 10.07.-19.07., marked the highest content of crude protein (PH1 - 101.9 g kg^{-1} and HH2 - 86.7 g kg^{-1}). The values of the indicator exceed the average (PH - 83.3 g kg^{-1} and HH - 71.9 g kg^{-1}) by 22.3% and 20.6%, respectively (in both modes of use). In the years with the highest amount of vegetation precipitation (2014) and the highest average annual air temperature (2015), the grassland, which was formed during the third decade of the pasture (20.06.-29.06.) and haymaking (20.07.-31.07.) modes of use, marked maximum values in terms of the amount of crude protein.

Table 3. Chemical composition (g kg^{-1}) of natural grassland of *Chrysopogon gryllus* L. type over the years (hay-making harvesting).

Indicators / Variants	CP	CF	CFr	Ash	NFE	Ca	P
			2013				
HH1	69.0	31.4	335.9	81.5	482.1	16.3	2.0
HH2	86.7	32.8	366.6	74.0	439.9	17.4	1.9
HH3	60.1	16.4	355.9	77.0	490.7	11.3	1.4
Mean±SD	***71.9±13.5***	***26.9±9.1***	***352.8±15.6***	***77.5±3.8***	***470.9±27.2***	***15.0±3.3***	***1.8±0.3***
			2014				
HH1	53.9	10.2	419.0	64.4	452.5	6.3	2.3
HH2	71.2	19.7	402.5	68.7	437.9	8.9	1.9
HH3	87.7	14.7	372.1	70.2	455.3	6.4	2.4
Mean±SD	***70.9±16.9***	***14.9±4.8***	***397.9±23.8***	***67.8±3.0***	***448.6±9.3***	***7.2±1.5***	***2.2±0.3***

2015							
HH1	50.5	15.5	399.2	67.3	467.5	14.5	2.2
HH2	58.7	20.3	462.7	72.8	385.5	13.5	2.9
HH3	81.9	24.0	380.7	76.4	437.0	12.1	2.0
Mean±SD	***63.7±16.3***	***19.9±4.3***	***414.2±43.0***	***72.2±4.6***	***430.0±41.4***	***13.4±1.2***	***2.4±0.5***
2016							
HH1	225.7	33.7	415.3	63.5	261.8	21.3	2.7
HH2	155.8	26.7	384.8	62.8	369.8	15.1	1.5
HH3	158.5	29.1	392.7	65.3	354.4	16.2	1.6
Mean±SD	***180.0±39.6***	***29.8±3.6***	***397.6±15.8***	***63.9±1.3***	***328.7±58.4***	***17.5±3.3***	***1.9±0.7***
2017							
HH1	100.7	23.5	431.0	73.7	371.2	12.3	0.8
HH2	105.9	22.8	425.4	69.0	376.9	13.7	1.1
HH3	80.3	24.1	455.9	71.6	368.0	14.9	0.7
Mean±SD	***95.6±13.5***	***23.5±0.7***	***437.4±16.2***	***71.4±2.4***	***372.0±4.5***	***13.6±1.3***	***0.9±0.2***
2013-2017							
HH1	100.0	22.9	400.1	70.1	407.0	14.1	2.0
HH2	95.7	24.5	408.4	69.5	402.0	13.7	1.9
HH3	93.7	21.7	391.5	72.1	421.1	12.2	1.6
Mean±SD	***96.4±48.5***	***23.0±7.0***	***400.0±35.7***	***70.5±5.4***	***410.0±61.5***	***13.3±4.0***	***1.8±0.6***

The excess in the values of the trait compared to the averages for the vegetation period (PH - 71.4 g kg^{-1} and HH - 70.9 g kg^{-1} in 2014; PH - 65.8 g kg^{-1} and HH - 63.7 g kg^{-1} in 2015) was 12.0% (in pasture mode) and 23.7% (in hay-making mode) in 2014 and by 8.4% (in pasture mode) and 28.6% (in hay-making mode) in 2015. The data of the studied indicators show that the mineral fertilization (with N_6P_6) applied in the first years of the experimental period, together with the practices of grassland use, had a positive effect on the composition and quality of the aboveground mass.

Mineral fertilization significantly increases the share of legume component (*Trifolium pratense, Trifolium repens*) in natural grasslands (Kacorzyk & Głąb, 2017).

According to the results obtained in 2016 and 2017, the amount of crude protein in dry matter is significantly increased in all variants of pasture and hay-making harvestings, namely:

In *pasture harvesting,* the values of the indicator varied from 120.8 to 157.4 g kg^{-1} (2016) and from 132.9 to 157.5 g kg^{-1} (2017). With maximum values of crude protein, the grassland was harvested in the period 10.06.-19.06 The excess in the values of the indicator compared to the averages for the fourth and fifth experimental year was by 10.1%.

In *hay-making harvesting,* the values of the indicator varied from 155.8 to 225.7 g kg^{-1} (2016) and from 80.3 to 105.9 g kg^{-1} (2017). The grassland, with maximum values of crude protein, was harvested in the period 30.06 - 09.07 (in 2016) and 10.07 - 19.07 (in 2017). The excess in the values of the indicator compared to the averages for the fourth and fifth experimental year is from 10.8% to 25.4%.

On average for the period (2013-2017), the highest amount of crude protein (108.0 g kg^{-1}) in grassland with *pasture management practice* was registered in the second decade of June (10.06.-19.06.), and in *hay-making* in the grassland formed in the period from June 30 to July 9 (100.0 g kg^{-1}). Given the average values of the indicator for a five-year period (PH - 101.3 g kg^{-1} and HH - 96.4 g kg^{-1}), we found that grass biomass from the pasture mode had 5.1% higher amount of protein fraction than in grassland with hay-making mode of use.

Correlation and regression dependences between the botanical composition of the grassland and the quality indicators

A high positive correlation was found between the percentage share of legumes in the grassland in the pasture mode of use with the concentration of crude protein (r = 0.82) and the gross energy value (r = 0.95) of the feed mass in *pasture mode* of use (Table 4).

The share of grasses shows a relatively high negative dependences (r = -0.89 - CP and r = -0.74 - GE) to the quantitative form of both indicators. The dependence of the percentage share of the representatives of *Poaceae* family with the amount of minerals (r = 0.69), nitrogen-free extracts (r = 0.73) and phosphorus (r = 0.99) is expressed by high correlation coefficients.

In the variants with *hay-making harvesting,* the weight percentage of legumes correlates positively with the energy nutritional value (r = 0.81 - GE; r = 0.79 - EE; r = 0.77 - FUM and r = 0.69 - FUG) of the formed aboveground mass, and that of cereals is in such a negative dependence (r = -0.65 - GE; r = -0.82 - EE; r = -0.85 - FUM and r = -0.84 - FUG) - Table 5.

For both modes of use, the presence of legume components in the studied natural grassland (type *Chrysopogon gryllus* L.) is negatively correlated with the carbohydrate content (r = -0.89 - PH and r = -0.94 - HH) and in a relatively high correlation with the amount of crude fiber (r = 0.69 - PH and r = 0.79 - HH) in the dry matter.

The theoretical regression line and the equation of the regression dependence between the crude protein content and the weight percentage of legumes (in pasture and hay-making harvesting) are shown in Fig. 1 and 2, namely:

- For pasture harvesting - y = 68.8059 + 1.5057x, with coefficient of determination - R = 0.925 (P <0.00001);
- For hay-making harvesting - y = 68.8059 + 1.5057x, with coefficient of determination - R = 0.925 (P <0.00001).

Conclusion

The applied management practices in natural grassland of *Chrysopogon gryllus* L. type affected the quantitative share of grasses and legume. From the first to the fifth experimental year, the percentage share of grass species in the volume of the formed grassland decreased by up to 10.3% - in the pasture mode of use and by up to 14.3% - in the hay-making mode of use. During the last two years of the experimental period, the presence of the legume component marked an increasing trend (39.8-55.5% in pasture and 38.6-52.0% in hay-making), which is a prerequisite for higher quality and nutritional value of feed.

For the experimental period, the amount of crude protein in the dry matter of grassland with pasture management practice was 5.1% higher than that in grassland with hay-making mode.

In the *pasture mode* of use there is a high positive correlation between the quantitative share of legumes with the concentration of crude protein (r = 0.82) and the gross energy value (r = 0.95) of the feed mass.

In hay-making harvesting, the weight percentage of legumes is positively correlated with the values of gross energy (r = 0.81), metabolic energy (r = 0.79), feed units for milk (r = 0.77) and feed units for growth (r = 0.69).

Table 4. Correlation dependences between botanical composition and some qualitative indicators of a natural grassland of *Chrysopogon gryllus* L. type (in pasture harvesting). Legend: FUM - feed unit for milk - number in kg of dry matter; FUG - feed units for growth - number in kg of dry matter.

	Grass.	Legum.	CP	EE	CF	Ash	NFE	Ca	P	GE	ME	FUM	FUG
Grasses, %	1.00												
Legumes, %	-0.54	1.00											
CP, g kg^{-1}	-0.89	0.82	1.00										
EE, g kg^{-1}	-0.70	0.61	0.86	1.00									
CF, g kg^{-1}	-0.42	0.69	0.46	-0.03	1.00								
Ash, g kg^{-1}	0.69	-0.56	-0.63	-0.41	-0.55	1.00							
NFE, g kg^{-1}	0.73	-0.89	-0.83	-0.46	-0.87	0.62	1.00						
Ca, g kg^{-1}	-0.56	0.31	0.66	0.79	-0.17	0.11	-0.30	1.00					
P, g kg^{-1}	0.99	-0.42	-0.82	-0.61	-0.38	0.61	0.67	-0.57	1.00				
GE, MJ/kg	-0.74	0.95	0.89	0.62	0.76	-0.75	-0.95	0.29	-0.64	1.00			
ME, MJ/kg	0.25	-0.43	-0.20	0.30	-0.92	0.24	0.70	0.21	0.27	-0.48	1.00		
FUM	0.42	-0.60	-0.41	0.09	-0.97	0.40	0.84	0.10	0.41	-0.66	0.98	1.00	
FUG	0.42	-0.66	-0.45	0.04	-0.98	0.40	0.86	0.06	0.40	-0.70	0.96	1.00	1.00

Table 5. Correlation dependences between botanical composition and some qualitative indicators of a natural grassland of *Chrysopogon gryllus* L. type (in hay-making harvesting). Legend: see Table 4.

	Grass.	Legum.	CP	EE	CF	Ash	NFE	Ca	P	GE	ME	FUM	FUG
Grasses, %	1.00												
Legumes, %	-0.54	1.00											
CP, g kg^{-1}	-0.64	0.66	1.00										
EE, g kg^{-1}	-0.52	0.31	0.69	1.00									
CF, g kg^{-1}	-0.16	0.79	0.09	-0.29	1.00								
Ash, g kg^{-1}	0.35	-0.62	-0.72	0.00	-0.40	1.00							
NFE, g kg^{-1}	0.64	-0.94	-0.88	-0.52	-0.54	0.72	1.00						
Ca, g kg^{-1}	-0.31	0.39	0.63	0.95	-0.14	0.01	-0.54	1.00					
P, g kg^{-1}	0.79	-0.48	-0.19	-0.36	-0.37	-0.13	0.40	-0.25	1.00				
GE, MJ/kg	-0.65	0.81	0.98	0.62	0.30	-0.76	-0.96	0.60	-0.27	1.00			
ME, MJ/kg	-0.82	0.79	0.89	0.77	0.27	-0.48	-0.91	0.71	-0.59	0.92	1.00		
FUM	-0.85	0.77	0.88	0.77	0.25	-0.46	-0.89	0.69	-0.62	0.90	1.00	1.00	
FUG	-0.84	0.69	0.89	0.83	0.13	-0.43	-0.85	0.74	-0.58	0.89	0.99	0.99	1.00

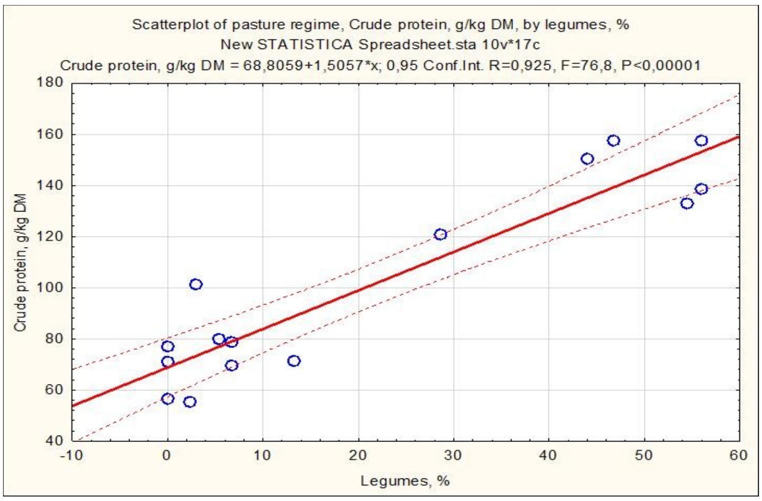

Fig. 1. Regression model for Crude protein (g/kg DM) determination by Legume species participation, % in pasture regime of utilisation of *Chrysopogon gryllus* grass type.

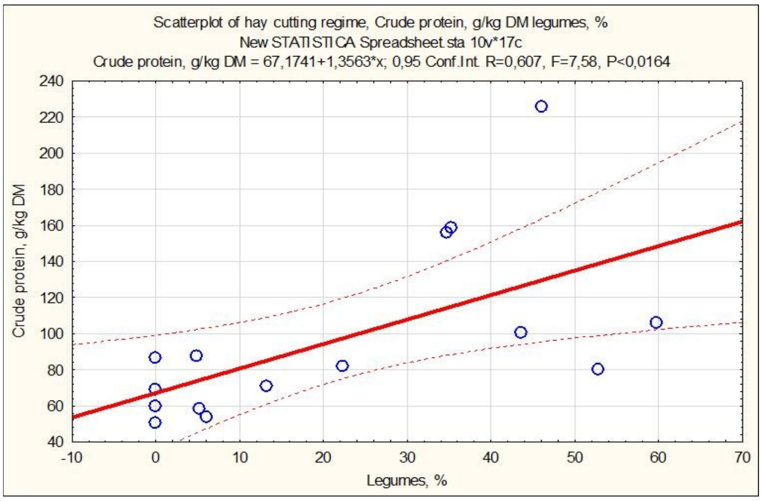

Fig. 2. Regression model for Crude protein, (g/kg DM) determination by Legume species participation, % in hay cutting regime of utilisation of *Chrysopogon gryllus* grass type.

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Received: 13.04.2021
Accepted: 29.05.2021