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Impact of Fertilizing with Organic Composted Mixture on the Quality of Natural Grass Stands in the Semi-mountain Regions of Bulgaria

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Abstract. The impact of a composted mixture of *Pteridium aquilinum* L. with cattle manure on the composition and quality of natural grass stand, transitional type *Chrysopogon gryllus-Agrostis capillaris* in the conditions of the Central Balkan Mountain in Bulgaria was observed. Surface treatment with the composted mixture increased the share of useful legumes and grass fodder species. The percentage share of the components in the grass mass increased by 24.15 and 9.00%, respectively. Graphical regression models were developed to predict the amount of calcium, nitrogen, phosphorus and cellulose through the percentage of legumes and grasses in the treated grass stands, which in practice is significantly more economical and fast. Grass stands fertilized with 2000 kg/da composted mixture (with the highest share of legumes) had the highest content of crude protein (with 29.9%), crude fat (with 44.0%) and minerals (with 10.6%). The highest *in vitro* digestibility of the dry matter was observed in the variants treated with 1000 kg/da and 3000 kg/da composted mixture, where the excess in the values of the indicator was from 4.0 to 4.7% compared to the control. A high positive correlation was found between the indicators of dry matter yield with the content of crude protein (r = 0.84), minerals (r = 0.82), calcium (r = 0.96), phosphorus (r = 0.95), nitrogen (r = 0.84) and cellulose (r = 0.93) in the dry matter of the treated grass stands.

Key words: bio-fertilization, *Pteridium aquilinum*, quality and nutritional value of fodder.

Introduction

The biodiversity of natural grass stands is closely linked to the effective management and implementation of agrotechnical events affecting soil fertility and plant development dynamics (Parton, 1993; Mitev et al., 2013; Iliev et al., 2020; 2021). The use of biofertilizers as a substitute for chemicals is at the heart of sustainable agriculture and a good alternative for increasing soil fertility and microbiological diversity (Samadhiya et al. 2013; Yalew et al. 2020). The choice of new ecological products makes it possible to reduce costs (Churkova, 2021), improve productivity and grass composition. Feeding with some organic fertilizers reduces the degree of lignification and provides optimal conditions for obtaining environmentally friendly biomass with improved qualitative indicators (Bozhanska, 2019).

In this context, plant extracts of *Pteridium aquilinum* L. (bracken fern) used as organic products registered a high pesticidal and fungicidal effect (Mala et al., 2019). The biomass of *Pteridium aquilinum* L. is high in nitrogen and potassium, which makes it suitable for composting (Pitman & Webber, 2013). The processes related to the decomposition and preparation of the composted mixture allow to include inoculants to improve the moisture retention capacity and the quality of the peat material (Antonius et al., 2015).

Manure and urea are the main sources of N in the stage of composting and enrichment of the soil with the necessary nutrients. The high temperature in the fermentation process removes toxins from the leaf mass, which makes *Pteridium aquilinum* a potential organic substrate suitable for growing plants (Pitman & Webber, 2013).

The eagle fern is a perennial herbaceous plant, whose stems are modified mainly in underground rhizomes, which inhibits the development of useful grassland (Alexander et al., 2016; Dragicevic, 2019). The yield of dry leaf mass reaches 4-16 t/ha per year. One way to destroy this aggressive weed is through regulated annual mowing (Suazo et al., 2015).

Composting the aboveground mass of *Pteridium aquilinum* L. is used in modern organic agricuture as: herbicide product in some vegetable crops, biostimulator of seed germination of plants, antifungal agent and biofuel (Donnelly et al., 2002). It has also been found that the composition of minerals in the leaf mass of *Pteridium aquilinum* increases the growth and number of nodules in legumes of the genus *Trifolium* (Donnelly et al., 2006).

The aim of the present study was to determine the effect of a mixture of composted plant mass of *Pteridium aquilinum* L. with fresh cattle manure on the composition and qualitative indicators of a fodder from a natural grass stand (transitional type *Chrysopogon gryllus-Agrostis capillaris*) in the the Central Balkan Mountain region.

Material and Methods

The experiment was conducted at the Research Institute of Mountain Stockbreeding and Agriculture, Troyan (Department of Mountain Meadow Farming and Fodder Production) and covered a four-year study period (2016-2019).

The experiment was set up in 2016, on a natural grass stand (transitional type C*hrysopogon gryllus-Agrostis capillaris*), in the Makaravets area, at an altitude of 460 m, by the block method in 4 replications, with a plot size of 5 m^2. Fertilizing with a composted mixture (*Pteridium aquilinum* + fresh cattle manure) was applied annually, on the surface (manually by spraying) before the onset of active vegetation of grass species (in the period 20. February-10. March).

Experimental variants were:

1. Control (not fertilized with composted mixture);
2. Fertilizing with composted mixture at a rate of 1000 kg/da;
3. Fertilizing with composted mixture at a rate of 2000 kg/da;
4. Fertilizing with composted mixture at a rate of 3000 kg/da;
5. Fertilizing with composted mixture at a rate of 4000 kg/da;

The experimental areas were harvested in the phenophase of tasseling - onset of blossoming - ear formation (for grass species).

The composting mixture is prepared by the method of English nurseries and landscape contractors for growing coniferous and deciduous species (*Picea abies*, *Pinus sylvestris*, *Fraxinus excelsior* and *Betula pendula*) in forest nurseries (Pitmen, 1994).

Biomass of *Pteridium aquilinum* was mowed with a hand-held thumb mower in late spring-early summer (May-June) – Fig. 1. The cut fresh mass was cut with a combine twice with a particle size of 20 mm and 6-10 mm, respectively (in 48-50% of the fraction).

The prepared organic matter was placed on a wooden grill (composter made of 20 m^3 branches of *Populus nigra* and *Betula pendula*, sufficient for machine processing). Fresh cattle manure was added (ratio - 50:50) to balance and compensate for the lack of nitrogen in the eagle fern and neutralize some of the toxic alkaloid compounds. After 15 days (incubation period), the mixture was mixed with a power tiller with metal shovels, which continued for 120-140 days (every 20 days). The composted mixture was covered with silage polyethylene.

Fig. 1. Vegetable mass of *Pteridium aquilinum* and composted mixture.

During the first five weeks, the temperature (recorded on a scale of a soil platinum-resistant thermometer located in the center of the bowl) in the compost was 60-62°C, which accelerated the process of degradation of the carcinogen *ptaquiloide*. The critical minimum humidity of 70-75% and the temperature of 45-47°C were the most optimal conditions for the effective aerobic decomposition of the homogeneous mass.

The reaction in the composted heap was monitored with a mobile pH meter (model - ZD-06) (starting value of pH = 5.0-6.0 to pH = 8.0 in the final product).

The composted mixture (after six months) of eagle fern and manure acquired the character of a peat substrate (loose granular fraction) with dark brown to black color.

The following indicators were observed:

Dry matter yield (kg/da) - determined by mowing, weighing of grass in the different replications for each harvest plot followed by drying the samples to a constant weight at 105°C and recalculated for 1 da.

Botanical analysis of grass stand (%) was determined by weight by analysis of grass samples taken immediately before mowing. The percentage share of each species per year from the group of grasses and legumes, motley grasses (total) in both modes of use and their total ratio in the main botanical groups (grasses, legumes and motley grasses) was established.

The chemical composition of dry fodder was analyzed according to *Weende* analysis: Crude protein (CP, g kg^{-1}) according to *Keldahl* (according to BDS/ISO-5983); Crude fiber (CFr, kg 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; Nitrogen-free extractable substances (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 reagent - spectophotometer (*Agilent 8453 UV - visible Spectroscopy System*) that measure in the sphere of 425 ηm.

The fibrous structural elements in the plant cell were analyzed at a laboratory:

Neutral Detergent Fibers (NDF, g kg^{-1} DM); Acid detergent fiber (ADF, g kg^{-1} DM) and Acid detergent lignin (ADL, g kg^{-1} DM) by the Van Soest and Robertson (1979) detergent assay and in vitro dry matter digestibility (IVDMD) according to a two-way pepsin-cellulase method of Aufrere (1982). The polyosides were empirically calculated: Hemicellulose (g kg^{-1} DM) = NDF-ADF and Cellulose (g kg^{-1} DM) = ADF-ADL. The lignification degree is expressed as the percentage of ADL and NDF.

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

Results and Discussion

Botanical composition of natural grass stand treated with a composted mixture of eagle fern and cattle manure

Fertilizing regime and soil composition affect species diversity in natural grass stands, control plant resistance and productivity (Královec et al., 2009; Pavlů et al., 2011; 2012).

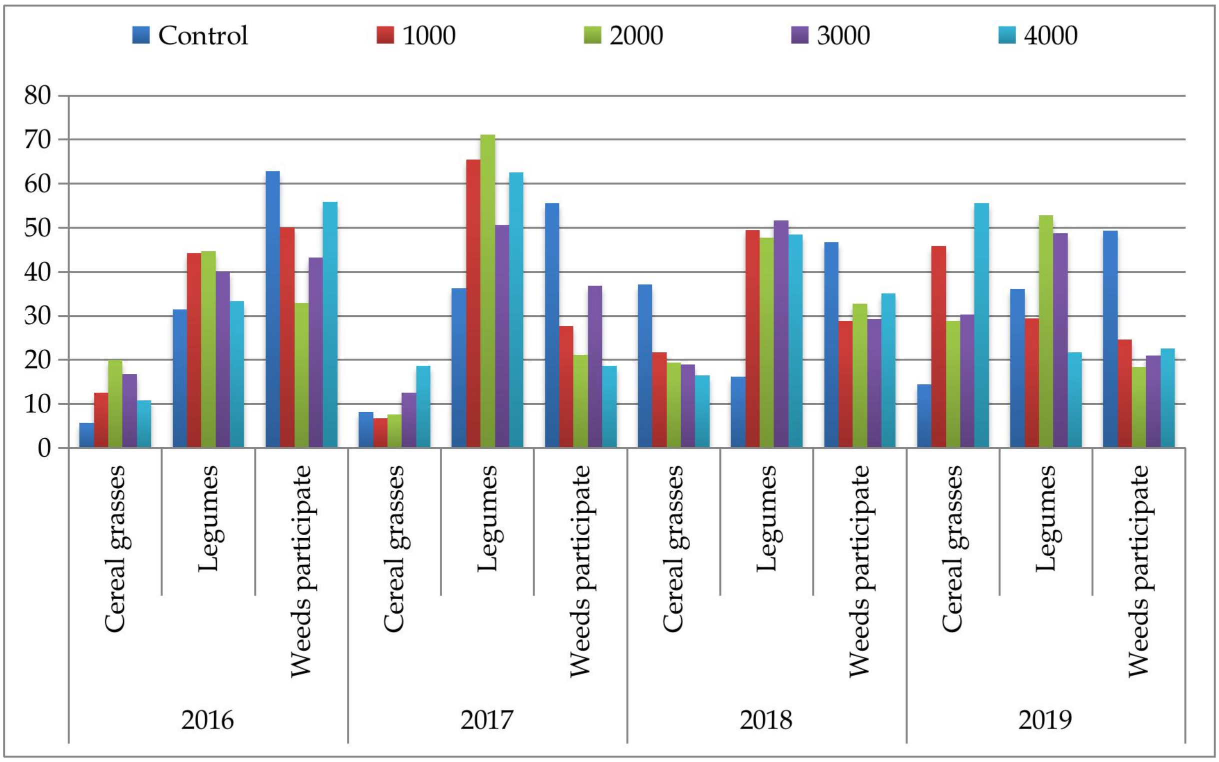

Fig. 2. Botanical composition of natural grass stand, transitional type (*Chrysopogon gryllus-Agrostis capillaris*) treated with composted mixture (%, by groups).

For the four-year test period, the highestshare of legumes and grasses was observed in the grass mass that was treated on the surface with 2000 and 4000 kg/da of composted mixture, respectively (Fig. 2). The excess of the species by groups is by 24.15% (for legumes) and 9.00% (for grasses) compared to the untreated control.

Yalew et al. (2020) report that compost fertilizer proven increases the legume species composition and their ratio in the volume of plant mass.

The results obtained during the study period show that natural grass stands with 2000 and 3000 kg/da of composted mixture imported have a higher presence of legumes than meadow grasses. The ratio of grasses:**legumes** is:

- 20.00:**44.70**% (in the variants with imported dose - 2000 kg/da composted mixture) and 10.80:**33.30** (in the variants with imported dose - 3000 kg/da composted mixture) - first experimental year (2016);
- 7.60:**71.20**% (in the variants with imported dose - 2000 kg/da composted mixture) and 12.60:**50.60**% (in the variants with imported dose - 3000 kg/da composted mixture) - second experimental year (2017);
- 19.40:**47.80**% (in the variants with imported dose - 2000 kg / da composted mixture) and 19.00:**51.70**% (in the variants with imported dose - 3000 kg/da composted mixture) - third experimental year (2017);
- 28.80:**52.80**% (in the variants with imported dose - 2000 kg / da composted mixture) and 30.30:**48.70**% (in the variants with imported dose - 3000 kg/da composted mixture) - fourth experimental year (2019);

During the first three experimental years, the percentage of fodder crops in the legume group in the variants treated with the lowest (1000 kg/da) and highest (4000 kg/da) dose of composted mixture was again higher than that of grasses. An exception is the fourth (last) year, when the share of grasses in the composition of the grass mass was higher by 16.3 to 33.8% compared to that of legumes.

The data from the analysis show that the surface treatment with the composted mixture (plant mass of *Pteridium aquilinum* L. + beef manure) increases the share of useful legumes and cereal feed species and limits that of plants from the group of grasses, which improves productivity and quality of the formed biomass.

Basic chemical composition of natural grass stand treated with composted mixture

The formation of a vegetative mass with a high density of legume components is a major factor in increasing the concentration of crude protein in the dry matter.

The effect of the applied fertilization on the chemical composition of the natural grass cover (transitional type *Chrysopogon gryllus-Agrostis capillaris*) is presented in Table 1. With the highest dry matter content (900.2 g kg^{-1}), crude protein (160.2 g kg^{-1}), crude fats (26.5 g kg^{-1}) and minerals (71.1 g kg^{-1}) are grass fertilizers with 2000 kg/da composted mixture (the variant with the highest share of legumes). The excess in the values of the indicators compared to the untreated control was by 29.9% (for CP), 44.0% (for CF) и 10.6% (for Ash).

Table 1. Basic chemical composition (g kg^{-1}) of natural grassland (transitional type *Chrysopogon gryllus-Agrostis capillaris*) treated with composted mixture (average for the experimental period).

Variants	DM	CP	CF	CFr	Ash	NFE	Ca	P	N
Control	899.9	123.3	18.4	446.4	64.3	247.6	16.9	1.3	17.8
1000	898.0	154.5	17.6	390.2	67.3	268.4	56.9	2.3	22.2
2000	900.2	160.2	26.5	403.1	71.1	239.3	52.5	2.5	21.8
3000	899.9	157.8	25.4	430.0	69.3	217.4	50.2	2.5	20.4
4000	899.7	135.6	21.0	414.2	66.3	262.7	51.7	2.7	19.5
Mean±Sx	***899.5±0.5***	***141.3±4.4***	***21.7±2.0***	***416.8±8.4***	***67.7±1.1***	***252.0±7.8***	***45.6±1.4***	***2.3±0.1***	***20.3±0.6***
SD	***0.9***	***12.6***	***4.0***	***22.1***	***2.6***	***13.8***	***16.2***	***0.6***	***1.8***

The highest content of carbohydrates (268.4 g kg^{-1}), calcium (56.9 g kg^{-1}) and nitrogen (22.2 g kg^{-1}) was observed in the dry matter in the variants treated with 1000 kg/da composted mixture. The results obtained are consistent with those found by Nemera et al. (2018) namely that application of cattle manure in natural pasture exhibited higher ash due to the fact that cattle manure is rich in phosphorous, potassium, magnesium, and calcium.

The maximum dose of composted mixture (4000 kg/da) does not significantly affect the species diversity and quantity of legumes. The grass mass of the variant has the lowest concentration of crude protein (135.6 g kg^{-1}), mineral composition (66.3 g kg^{-1}) and nitrogen (19.5 g kg^{-1}), and the highest content of phosphorus (2.7 g kg^{-1}) in the dry matter compared to the other treated variants.

The grass stand treated with doses of 1000 and 3000 kg/da of composted mixture has the lowest (390.2 g kg^{-1}) and highest (430.0 g kg^{-1}) crude fiber content in the dry matter composition, respectively. In relative terms, the difference in the values of the indicator is from 3.3 to 10.2%.

On average for the test period, the compositions of the composted mixture have a positive effect on the mineral composition and the content of macronutrients (Ca, N and P) in the dry matter, the most significant being the excess in the concentration of the element calcium.

Fibrous structural components of the cell walls of natural grass stand treated with a composted mixture

The grass stands in the fertilizing variants have a lower content of neutral-detergent fibers, neutral-detergent lignin and hemicellulose (Table 2). The values of the indicators vary from 539.3 to 602.4 g kg^{-1} (for NDF), from 97.5 to 171.2 g kg^{-1} (for ADL) and from 173.6 to 199.5 g kg^{-1} (for Hemicellulose). The decrease in concentration compared to the average value of the quality parameters was from 1.3 to 11.6% (for NDF), from 6.9 to 47.0% (for ADL) and from 6.2 to 18.4% (for Hemicellulose).

Table 2. Fiber structural components of cell walls (g kg^{-1}) of a natural grass stand (transitional type *Chrysopogon gryllus-Agrostis capillaris*) treated with composted mixture (average for the experimental period).

Variants	NDF	ADF	ADL	Hemicellulose	Cellulose	IVDMD
Control	610.4	397.7	183.8	212.7	213.9	584.7
1000	544.3	361.8	99.0	182.5	262.8	612.2
2000	573.7	397.0	132.5	176.7	264.5	582.2
3000	539.3	365.7	97.5	173.6	268.2	608.2
4000	602.4	402.9	171.2	199.5	231.7	577.6
Mean±Sx	***574.0±14.6***	***385.0±10.5***	***136.8±17.4***	***189.0±5.8***	***248.2±8.4***	***593.0±8.8***
SD	***32.5***	***19.6***	***40.0***	***16.6***	***24.1***	***16.0***

According to Nemera (2016), the application of organic fertilizer did not significantly affect the NDF content of a natural pasture, but according to Delevatti et al. (2019) fertilizing has a significant effect on the fiber composition of the plant cell in natural grass stands.

The results of the treated variants show that the natural grass mass with imported 2000 and 4000 kg/da composted mixture has a higher concentration of neutral-detergent fibers, acid-detergent fibers and acid-detergent lignin.

The lignin fraction is a major factor influencing the digestibility of grass stand. The higher values of the indicator in the variants treated with 2000 and 4000 kg/da composted mixture also determine the lower *in vitro* digestibility of the dry matter (by 0.4-1.2%) compared to that of the grass stands with imported 1000 and 3000 kg/da composted mixture (although the variants fertilized with 2000 kg/da composted mixture registered the highest share of legumes in grass stands and the highest crude protein content, and fertilizers with a dose of 4000 kg/da composted mixture - the lowest concentration of crude protein). The values for *in vitro* digestibility of the dry matter in variants with 1000 kg/da (612.2 g kg^{-1}) and 3000 kg/da (608.2 g kg^{-1}) exceed the control by 4.0-4.7%.

The cellulose concentration in all fertilizer variants is higher than in the untreated control. The values of the indicator vary from 231.7 g kg^{-1} to 268.2 g kg^{-1}. The excess over the control is from 8.3 to 25.4%.

Compared with cellulose, the content of hemicellulose in the dry matter of the treated grass stands, as well as the degree of lignification indicate a downward trend. The fully digestible polioside (hemicellulose) values were lower by 6.2% (4000 kg/da) to 18.4% (3000 kg/da) compared to the untreated control (212.7 g kg^{-1}). With the highest lignification coefficient (28.40) are the grass stands treated with the maximum dose of composted mixture (4000 kg/da), whereas the lowest one was found in those treated with 3000 and 1000 kg/da (18.23-18.25) in the control variant - 29.17 (Fig. 3).

Correlation and regression dependences of dry matter yield with the botanical and qualitative composition of natural grassland (transitional type Chrysopogon gryllus-Agrostis capillaris) treated with a composted mixture

Table 3 shows the correlation dependences between some key indicators characterizing the productivity and quality of treated biomass.

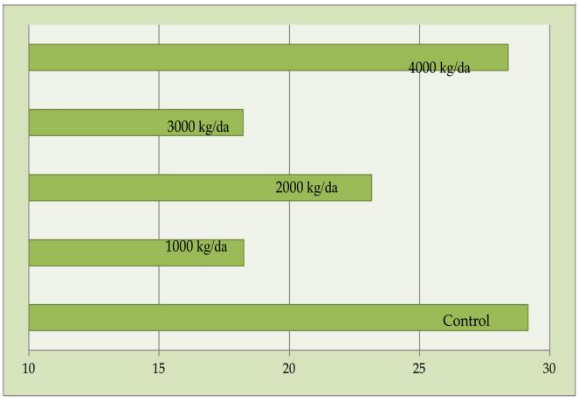

Fig. 3. Degree of lignification (coefficient) of natural grass stands (transitional type *Chrysopogon gryllus-Agrostis capillaris*) treated with composted mixture.

Table 3. Correlation and regression dependences of dry matter yield with the botanical and qualitative composition of a natural grass stand (transitional type *Chrysopogon gryllus-Agrostis capillaris*) treated with a composted mixture. *Legend:* *(P <0.05).

	Grasses	Legumes	Yield dry mass	DM	CP	CF	CFr	Ash	NFE	Ca	P	N	NDF	ADF	ADL	Hemicell	Cellulose	IVDMD
Grasses	1																	
Legumes	0.25	1																
Yield dry mass	0.56	**0.94***	1															
DM	-0.35	-0.07	-0.13	1														
CP	0.27	**0.91***	0.84	-0.46	1													
CF	-0.10	0.67	0.58	0.66	0.30	1												
CFr	-0.52	-0.73	-0.77	0.60	-0.90	-0.01	1											
Ash	0.00	**0.94***	0.82	0.21	0.75	**0.85***	-0.48	1										
NFE	0.60	-0.04	0.14	-0.71	0.27	-0.66	-0.64	-0.34	1									
Ca	0.67	**0.86***	0.96	-0.37	0.86	0.36	-0.84	0.67	0.30	1								
P	**0.73***	**0.81***	0.95	-0.10	0.67	0.53	-0.64	0.67	0.13	0.94	1							
N	0.26	**0.91***	0.84	-0.45	1.00	0.31	-0.90	**0.76***	0.26	0.86	0.67	1						
NDF	-0.51	-0.87	-0.90	0.50	-0.93	-0.29	**0.85***	-0.68	-0.26	-0.96	-0.83	-0.93	1					
ADF	-0.51	-0.56	-0.61	**0.85***	-0.83	0.23	**0.92***	-0.27	-0.67	-0.77	-0.52	-0.83	**0.85***	1				
ADL	-0.74	-0.81	-0.94	0.38	-0.80	-0.32	**0.80***	-0.60	-0.32	-0.99	-0.95	-0.80	**0.94***	**0.75***	1			
Hemicellulose	-0.37	-0.92	-0.92	0.05	-0.77	-0.70	0.56	-0.87	0.19	-0.88	-0.89	-0.77	0.87	0.48	**0.86***	1		
Cellulose	**0.73***	**0.79***	0.93	-0.09	0.65	0.53	-0.61	0.66	0.10	0.93	1.00	0.65	-0.83	-0.51	-0.95	-0.90	1	
IVDMD	-0.07	0.28	0.17	-0.66	0.48	-0.14	-0.26	0.17	-0.06	0.34	0.13	0.47	-0.55	-0.56	-0.33	-0.39	0.16	1

A high positive correlation was found between dry matter yield and crude protein content (r = 0.84), minerals (r = 0.82), calcium (r = 0.96), phosphorus (r = 0.95), nitrogen (r = 0.84) and cellulose (r = 0.93). Correlation coefficients among dry matter yield with crude fiber content (r = -0.77), neutral-detergent fiber (r = -0.90), acid-detergent fiber (r = -0.61), acid-detergent lignin (r = -0.94) and hemicellulose (r = -0.92) were negative.

In the fertilization variants, the increased crude protein content in the dry matter composition strongly correlated with the amount of ash (r = 0.75), Ca (r = 0.86), P (r = 0.67) and N (r = 1.00). The values of the indicator are in strong negative dependence with the amount of crude fiber (r = -0.90) and the structural fiber components of the cell walls (r = from -0.77 to -0.93).

The high negative correlation dependence (r = -0.77 to -0.99) between the concentration of Ca, P and N with the fiber components of the cell walls (NDF, ADF and ADL) allows the amount of macronutrients to be determined with relatively high accuracy by the content of neutral-detergent fibers, acid-detergent fibers and acid-detergent lignin.

Theoretical regression lines and the regression equations between the weight percentage of legumes in the treated grass stands with the yield of dry matter, crude protein, ash and cellulose are presented in Fig. 4.

The equations by which it is possible to predict the amount of these indicators are respectively:

$$Y = 6.6091x + 42.333 \ (R^2 = 0.8827);$$
$$Y = 1.2575x + 85.87 \ (R^2 = 0.8195);$$
$$Y = 0.2736x + 55.58 \ (R^2 = 0.8928);$$
$$Y = 5.0689x + 55.809 \ (R^2 = 0.621).$$

The correlation coefficients between the quantitative share of legumes in the composition of the grass stand and the content of calcium, nitrogen and phosphorus have a high absolute value (r = 0.81-0.91), which corresponds to a strong empirical linear dependence (Fig. 5).

The equations by which it is possible to predict the amount of macronutrients in the composition of the dry matter are:

$$Y = 1.5473x - 22.63 \ (R^2 = 0.7467) \text{ - for Ca;}$$
$$Y = 1.1812x + 12.349 \ (R^2 = 0.8277) \text{ - for N;}$$
$$Y = 0.0494x + 0.0744 \ (R^2 = 0.6491) \text{ – for P.}$$

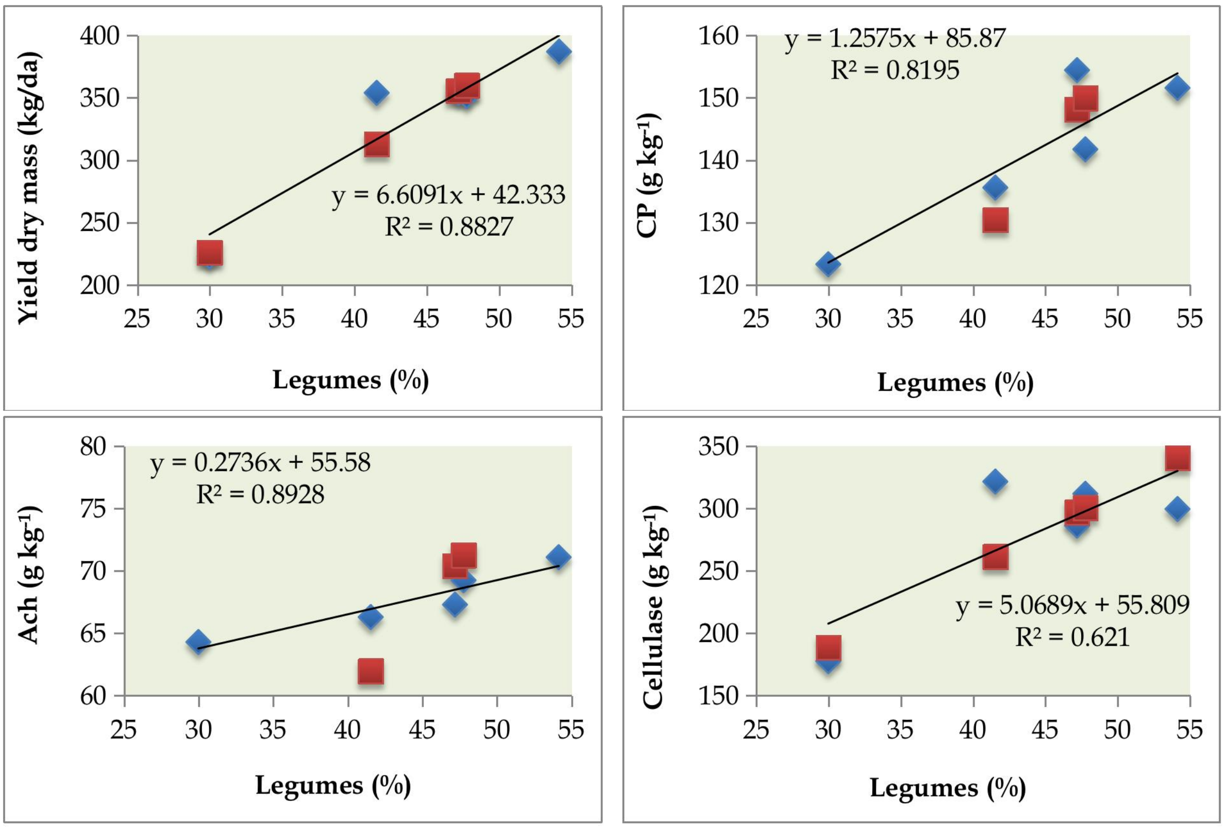

Fig. 4. Regression dependence between the percentage of legumes in grass stand with dry matter yield and the content of crude protein, ash and cellulose.

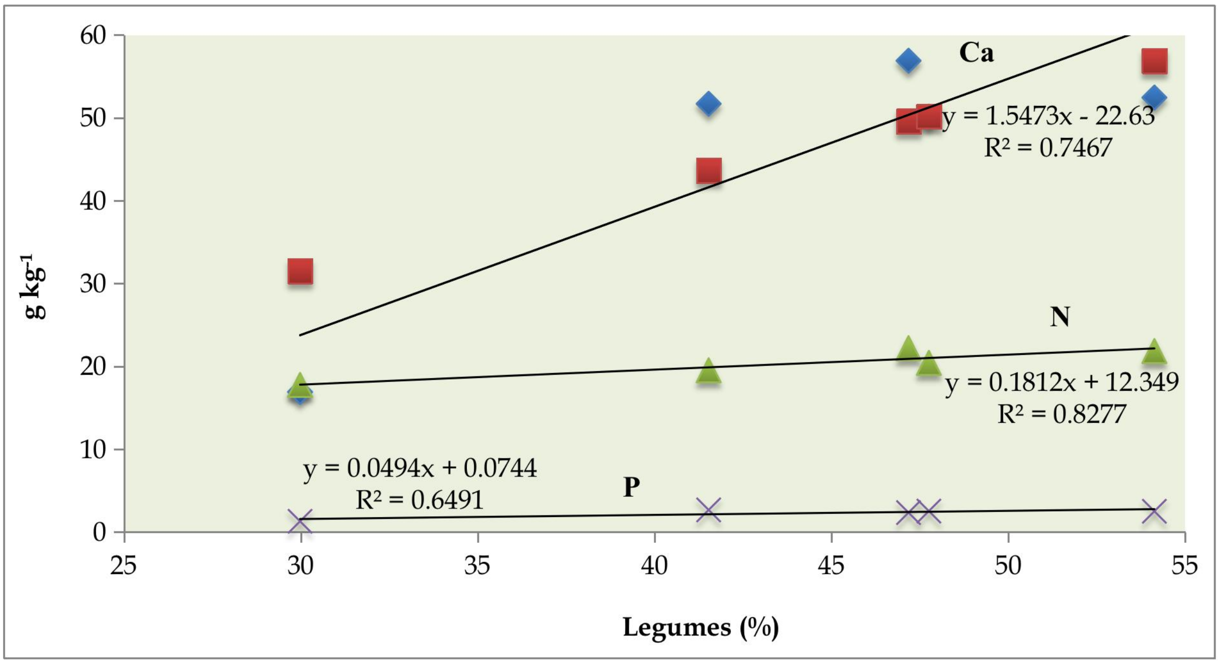

Fig. 5. Regression dependence between the percentage of legumes in grass stand with the content of nitrogen, phosphorus and calcium in the dry matter.

The weight percentage of meadow grasses had the greatest impact on the change in the average values of the element phosphorus and polyoside - cellulose (Fig. 6). The results of the analysis show a high positive correlation (r = 0.73) between the indicators.

The established graphical regression models reveal a good possibility for their approximate determination by the percentage share of grasses in the grassland:

$Y = 0.1207x – 0.2108$ ($R^2 = 0.5326$) - for P;

$Y = 12.667x - 20.683$ ($R^2 = 0.5335$) - for Cellulose.

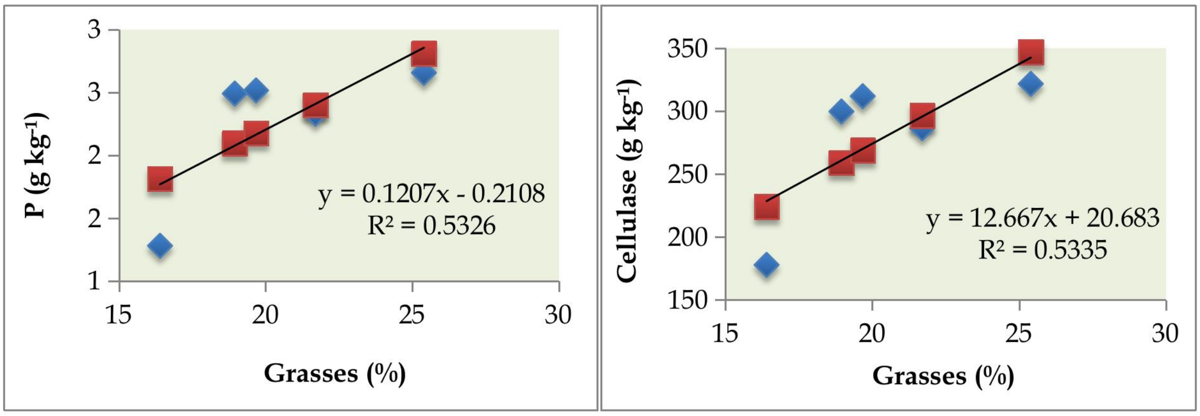

Fig. 6. Regression dependence between the percentage of legumes in grass stand with the content of phosphorus and cellulose in the dry matter.

From the point of view of practice, it will be significantly more economical, quick and easy to determine the estimated amount of calcium, nitrogen, phosphorus and cellulose by the botanical composition (legumes and cereals) of the stand.

Conclusions

The applied surface fertilizing increased the percentage share of useful legumes and grasses in the composition of the grass stand by 24.15 and 9.00%, respectively. The weight percentage of meadow grasses had the greatest impact on the change in the average values of calcium, nitrogen, phosphorus and cellulose in the dry matter of the treated grasses. From the point of view of practice, the developed graphical regression models based on the percentage share of legume and grass components in the amount of the obtained biomass is significantly more economical and fast method for predicting the amount of studied macronutrients and cellulose.

Variants with an imported dose of 2000 kg/da composted mixture registered the highest content of crude protein (160.2 g kg^{-1}), crude fat (26.5 g kg^{-1}) and minerals (71.1 g kg^{-1}). The excess in the values of the indicators compared to the untreated control was respectively 29.9% (for CP), 44.0% (for CF) and 10.6% (for Ash).

The grass stands in the fertilizing variants had a lower content of neutral-detergent fibers (by 1.3 to 11.6%), neutral-detergent lignin (from 6.9 to 47.0%) and hemicellulose (from 6.2 to 18.4%) compared to the untreated control.

The values for *in vitro* digestibility of the dry matter in variants with 1000 kg/da (612.2 g kg^{-1}) and 3000 kg/da (608.2 g kg^{-1}) exceeded the control by 4.0-4.7%.

A high positive correlation was found between dry matter yield and crude protein content (r = 0.84), minerals (r = 0.82), calcium (r = 0.96), phosphorus (r = 0.95), nitrogen (r = 0.84) and cellulose (r = 0.93).

In the fertilizing variants, the increased crude protein content in the dry matter composition strongly correlated with the amount of ash (r = 0.75), Ca (r = 0.86), P (r = 0.67) and N (r = 1.00). The values of the indicator are strongly negatively correlated with the amount of crude fiber (r = -0.90) and the structural fiber components of the cell walls (r = from -0.77 to -0.93).

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