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IMPACT OF CONVENTIONAL AND ORGANIC FERTILIZATION ON THE QUALITY AND NUTRITIONAL VALUE OF DEGRADED MOUNTAIN PASTURES

Biser BOZHANSKI, Minko ILIEV, Magdalena PETKOVA, Tatyana BOZHANSKA

Agricultural Academy, Research Institute of Mountain Stockbreeding and Agriculture, 281 Vasil Levski Street, 5600 Troyan, Bulgaria

Corresponding author email: bbozhanski@gmail.bg

Abstract

It was found that the dry mass of grasslands with organic fertilizing was by 2.0% higher in vitro digestibility of dry matter, higher content of CP (by 0.1%), CFr (by 1.7%) and N (by 0.1%), and a lower concentration of cellulose (by 0.3%) compared with of the mineral fertilizing variants, which led to a more in the concentration of NFE (by 1.2%), NDF (by 2.9%), hemicellulose (by 2.8%), Ca (by 0.3%) and P (0.2%). The energy nutritional value of fodder with of the mineral fertilizing of exceeded that of control with 0.4-2.8% and at organic fertilizing with 0.5-0.8%. A high correlation was found between the nitrogen content and CP ($r = 1.0$) of the grasslands with mineral fertilizing. The theoretical regression line and the equation of the regression dependence between the values of the indicators show $y = 7.2224x - 0.4841$ at a high coefficient of determination ($R^2 = 0.9988$). For the variants with manure, the concentration of CP registered proven correlation ($r = 1.0$) and regression dependence with the nitrogen content: $y = 6.9861x - 0.0815$ at $R^2 = 0.9999$ ($P<0.05$).

Key words: *mineral fertilizing, natural grassland, chemical composition.*

INTRODUCTION

Natural and semi-natural ecosystems are integrated communities in which through ecological continuity they lead to optimal stability and development of plant species (grasses, legumes, motley grasses). They are the main source of food for farm animals in Bulgaria and their condition significantly affects the productivity and nutritional value of the formed grassland.

Highly efficient agrotechnologies and systems improve the biological diversity of meadow phytocenoses and limit the spread of harmful invasive species. Desired changes in the individual groups and species of the botanical composition of the pastures were observed (Iliev et al., 2021). Changes in the botanical composition of grassland affect fodder yield and quality (Oelmann et al., 2011; Melnyk, 2014; Veklenko et al., 2015, Naydenova & Vasileva, 2019).

Mineral fertilizing provides a good nutritional balance of plants and significantly affects the dry matter yield in the composition of meadow and pasture grasslands (Chintala et al., 2012; Kacorzyk & Głąb, 2017). Nitrogen and phosphorus fertilizing stimulates growth and increases the percentage of legumes, and potassium improves biodiversity in the composition of natural grasslands (Liebisch et al., 2013). A high regression dependence (R^2 = 0.80-0.95) was found between the yield and the applied nitrogen fertilizing in the natural grasslands (Valkama et al., 2016). The generalized multifactor analysis shows a relatively high regression dependence (R^2 = 0.7-0.8) between the productivity of natural biomass with applied fertilizing and the climatic conditions of the region (April - July are critical for Bulgaria), which allows for an approximate forecast of fodder yield (Iliev et al., 2020). Annual fertilizing of natural meadows with the combination N_6P_6 leads to a proven increase in the amount of crude protein, crude fat, minerals and phosphorus in the dry matter of the harvested grassland. The values of the indicators exceed the untreated control by 52.3% (CP), 31.1% (CF), 3.1% (Ash) and 81.2% (P), respectively (Iliev et al., 2019).

Replacing mineral fertilizers with microbiological ones is one of the good practices set in the European programs and strategies for development in the field of environment and agriculture. In mountain regions, the use of organic fertilizers is an economically driven practice (as a source of nutrients in the soil) for the production of organic products (Demyanchik, 2012; Kurgak, 2013; Vasileva, 2015; Hynes et al., 2018). Fertilizing with organic fertilizer increases the productivity of dry matter and positively affects the botanical composition (significantly increases the share of grasses and motley grasses, reduces that of legumes) in natural grasslands (Iliev et al., 2017; Iliev, 2018). The ecological balance and the rich floristic composition of the natural grasslands contribute to the formation of an above-ground mass with higher nutritional value, rich in protein, energy, minerals (P, K, Ca, Mg) and with high digestibility of dry matter (Lemaire & Belanger, 2020; Churkova & Churkova, 2020; Churkova & Churkova, 2021).

The aim of the present study is to establish the impact of the annual mineral organic surface fertilizing on the quality and nutritional value of degraded natural grassland in the region of the Central Balkan Mountain.

MATERIALS AND METHODS

The experiment was conducted at the Research Institute of Mountain Stockbreeding and Agriculture, Troyan (Bulgaria) in the period 2016-2019, on degraded grassland, in the conditions of the Central Balkan Mountain. The experiment was based on the block method, in 4 replications with the size of the harvest plot - 5 m^2. Variants in the study were:

Mineral fertilizing

1. Control (untreated)
2. N_8P_8 (annual combined fertilizing - from March 20 to April 10);
3. $N_{10}P_{10}$. (annual combined fertilizing - from March 20 to April 10);
4. N_8P_8 (annual combined fertilizing - from March 20 to April 10);
5. N_7/I P_7/II P_7/III/N_7/IV (individual fertilizing with N_7 - first and fourth experimental years and individual fertilizing with P_7 - second and third experimental years);
6. P_6/I N_6/II P_6/III/ N_6/IV (individual fertilizing with P_6 - first and third experimental years and individual fertilizing with N_6 - second and fourth experimental years).

For variants 5 and 6, fertilizing with double superphosphate and ammonium nitrate was performed once in autumn (September-October) and spring (April).

***Legend:** I -first experimental year; II - second experimental year; III - third trial year and IV - fourth trial year.

Fertilizing with manure

1. Control (untreated)
2. 10 t ha^{-1};
3. 20 t ha^{-1};
4. 30 t ha^{-1};
5. 40 t ha^{-1}.

The manure treatment was applied annually and once, every year, manually, by spraying, before the onset of active vegetation in the grass cover. The experimental areas were harvested in the phenophase of tasseling/ear formation (for grass species) until the beginning of the phenophase of flowering.

Studied indicators

- Crude protein (CP,%) according to Kjeldahl (according to BDS/ISO-5983); Crude fiber (CFr, %); Crude fats (CF, %) (according to BDS/ISO-6492) - by extraction in an extractor type Soxhlet; Ash (%) - (according to BDS/ISO-5984) decomposition of organic matter by gradual combustion of the sample in a muffle furnace at 550°C; Dry matter (DM, %) - empirically calculated from % of moisture; NFE (%, DM) = 100 - (CP, % + CFr, % + CF, % + Ash, % + Moisture, %); Calcium (Ca,%) - complexometrically and Phosphorus (P,%) - with vanadate-molybdate reagent - spectophotometer (Agilent 8453 UV - visible Spectroscopy System), measuring in the range 425 ηm.
- Neutral detergent fibers (NDF, %); Acid detergent fibers (ADF, %) and Acid detergent lignin (ADL, %) according to the detergent analysis of Van Soest & Robertson (1979).
- *In vitro* dry matter digestibility (IVDMD, %) bythe two-stage pepsin-cellulase method of Aufrere (1982), which includes two stages: I - Pre-treatment with pepsin / 200 FIB-U g-1 /, Merck 7190, in 1 N hydrochloric acid for 24 hours (for protein digestion) and II - Treatment in acidic medium with the enzyme cellulase

"Onozuka R-10" isolated from *Trihoderma viride* /Endo-1.4 -β-glucanase; 1.4- (1.3:1.4) - β-D glucan-4-glucan hydrolase / with enzymatic activity 1.2 U g-1, 1 g 1L in 0.05 M acetate buffer pH 4.6 for 24 hours at 40°C (for cellulose digestion).

- Empirical calculation of: Hemicellulose (%) = NDF - ADF and Cellulose (%) = ADF - ADL and the degree of lignification (coefficient) - percentage of ADL and ADF (Akin & Chesson, 1990).
- The nutritional value of the fodder 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, CF, Cft and NFE, recalculated by the coefficients for digestibility by Todorov (2010): Gross energy (GE, MJ/kg) = 0.0242*CP + 0.0366*Cft + 0.0209*CF + 0.017*NFE – 0.0007*Zx and Exchangeable energy (EE, MJ/kg) = 0.0152*DP (Digestible protein) + 0.0342*Dft (Digestible fat) + 0.0128*DF (Digestible fibers) + 0.0159*DNFE (Digestible Nitrogen-free extractable substances)-0.0007*Zx.

The results were analyzed by the method of analyzing the variance of a single-factorial trial (ANOVA) using the SPSS 4.5 software. The significance of differences in mean values of the treatments was tested by the LSD test.

RESULTS AND DISCUSSIONS

Quality and nutritional value of degraded grass feed after applied mineral and organic fertilization

Mineral fertilizing

Productivity and quality composition of grassland in natural meadows and pastures are related to environmental conditions, use regime, type and norms of applied fertilizing (Kesting et al., 2009; Pasho et al., 2011; Sîrbu et al., 2012). In the variants with mineral fertilizing (exception is P_6/I N_6/ II P_6/III / N_6/IV) the content of crude protein exceeds the control by from 5.2% ($N_{10}P_{10}$) to 28.4% (N_8P_8) (Table 1). The annual import of the combination of $N_{12}P_{12}$ increased the highest concentrations of calcium (3.2%) and phosphorus (0.5%). The excess in the values of the indicators compared to the untreated control was by 2.1% (Ca) and 0.3% (P), respectively. The variants with alternative alternation of nitrogen and phosphorus (N_7/I P_7/II P_7/III / N_7/IV) registered the lowest content of crude fiber (34.1%) and the highest concentration of nitrogen-free extractable substances (34.1%) in the dry matter. The harvested biomass from the variant with $N_{12}P_{12}$ had a maximum content of dry matter (90.1%), crude fiber (44.9%) and the lowest concentration of NFE (22.1%).

Table 1. Basic chemical composition (%) of dry matter of degraded mountain grassland, after mineral and organic fertilizing

Variants	DM	CP	CF	CFr	Ash	NFE	Ca	P	N
Mineral fertilizing									
Control	90.0	11.6	3.1	37.3	6.9	31.1	1.1	0.2	1.7
$N_{12}P_{12}$	90.1	13.6	3.0	44.9	6.6	22.1	3.2	0.5	2.0
$N_{10}P_{10}$	90.0	12.2	2.7	40.5	7.2	27.3	1.7	0.4	1.8
N_8P_8	88.9	14.9	2.2	42.3	6.6	22.8	1.9	0.4	2.1
N_7/I P_7/IIP_7/III/ N_7/IV	89.9	13.4	1.8	34.1	6.7	34.1	1.8	0.3	1.9
P_6/I N_6/IIP_6/III/ N_6/IV	90.0	11.6	1.9	42.0	6.7	27.8	1.8	0.3	1.7
Average	***89.8***	***12.9***	***2.5***	***40.2***	***6.8***	***27.5***	***1.9***	***0.4***	***1.8***
SD	***0.5***	***1.3***	***0.6***	***3.9***	***0.2***	***4.6***	***0.7***	***0.1***	***0.2***
$LSD_{0.05}$	***0.9***	***2.2***	***1.1***	***7.2***	***0.4***	***8.4***	***3.2***	***0.1***	***0.3***
Organic fertilizing									
Control	89.9	12.5	2.3	38.8	6.5	29.7	1.6	0.2	1.8
10t ha^{-1}	90.1	12.0	2.4	42.8	6.8	26.0	1.8	0.2	1.7
20t ha^{-1}	90.0	14.1	2.0	41.3	6.6	26.1	1.5	0.1	2.0
30t ha^{-1}	90.2	12.0	1.4	44.4	7.0	25.5	1.6	0.1	1.7
40t ha^{-1}	90.0	14.4	2.3	42.0	7.2	24.1	1.6	0.1	2.1
Average	***90.0***	***13.0***	***2.1***	***41.9***	***6.8***	***26.3***	***1.6***	***0.2***	***1.9***
SD	***0.1***	***1.1***	***0.4***	***2.0***	***0.3***	***2.1***	***0.1***	***0.1***	***0.2***
$LSD_{0.05}$	***0.3***	***0.7***	***0.7***	***4.4***	***0.5***	***4.5***	***0.3***	***0.1***	***0.4***

Organic fertilizing

The dry matter content (90.0-90.2%) in the stands with applied manure was higher by 0.1-0.3% compared to the control. The annual treatment of the natural mass with a dose of 40 t ha^{-1} most significantly affects the content of: crude protein (14.4%), minerals (7.2%) and nitrogen (2.1%).

The values of the indicator exceeded the control by 1.9% (CP), 0.7% (Ash) and 0.3% (N), respectively. With the lowest concentration of the protein fraction (12.0%) and respectively the highest fiber are the grasslands in the variants with imported 10 t ha^{-1}(CFr - 42.8%) and 30 t ha^{-1} (CFr - 44.4%) manure. The content of the macroelement Ca in the treated grasses varies from 1.5% (20 t ha^{-1}) to 1.8% (10 t ha^{-1}).

On average for the period, the dry mass of stands with organic fertilization has a higher content of crude protein (13.0%), crude fiber (41.9%) and nitrogen (1.9%) compared to those with mineral fertilization. The excess in the average values of the indicators by 0.1%, 1.7% and 0.1%, respecttively. Feeding the grassland with N and P (annually combined and successively alternating) increased the concentration of carbohydrate components (to 27.8%) and the content of macronutrients Ca (to 1.9%) and P (to 0.4%). Compared to the variants with imported manure, the excess in the average values of the traits is respectively by 1.2%, 0.3% and 0.2%.

Floristic composition influences the assessment of the nutritional value in the pastures. The dynamics of development during the vegetation, changes in the chemical composition and digestibility of individual plant species are indicators related to the uptake and assimilation of feed by ruminants (Andueza et al., 2010; Dale et al., 2012).

Grasslands with applied mineral fertilization are characterized by a higher content of neutral and acid-detergent fibers compared to the untreated control (Table 2). The excess in the values of the indicators varies from 3.1% to 7.2% (for NDF) and from 0.4% to 3.4% (for ADF). The data from the study show that the dry mass of the variants with annual combined fertilization and self-fertilization with N_7 (first and fourth experimental years) and P_7 (second and third experimental years) has a high concentration of acid-detergent lignin. The excess over the control was 1.2% ($N_{12}P_{12}$), 3.4% ($N_{10}P_{10}$) and 10.5% (N_7/I P_7/II P_7/III N_7/IV).

Table 2. Main structural fiber components (%) of cell walls and in vitro digestibility of dry matter of degraded mountain grassland, after applied mineral and organic fertilization

Variants	NDF	ADF	ADL	Hemicel	Cellul	IVDMD
Mineral fertilizing						
Control	59.0	39.4	12.2	19.6	27.2	58.8
$N_{12}P_{12}$	66.2	42.8	13.4	23.4	29.4	43.3
$N_{10}P_{10}$	62.8	39.8	15.6	22.9	24.3	58.7
N_8P_8	62.1	40.5	10.2	21.6	30.3	58.2
N_7/IP_7/IIP_7/III/ N_7/IV	62.7	41.4	22.7	21.3	18.7	57.8
P_6/I N_6/IIP_6/III/ N_6/IV	65.3	41.9	10.9	23.4	31.0	56.7
Average	***63.0***	***41.0***	***14.2***	***22.0***	***26.8***	***55.6***
SD	***2.6***	***1.3***	***4.6***	***1.5***	***4.7***	***6.1***
$LSD_{0.05}$	***6.9***	***3.8***	***9.5***	***4.1***	***7.8***	***3.0***
Organic fertilizing						
Control	56.9	39.0	12.5	17.9	26.5	59.1
10t ha^{-1}	56.1	38.4	11.8	17.8	26.6	60.1
20t ha^{-1}	56.7	34.3	10.1	24.4	24.2	63.2
30t ha^{-1}	62.3	41.7	22.3	20.6	19.4	57.3
40t ha^{-1}	68.5	53.0	25.9	15.5	27.1	48.5
Average	***60.1***	***41.2***	***16.5***	***19.2***	***24.7***	***57.6***
SD	***5.1***	***7.1***	***7.1***	***3.4***	***3.2***	***5.5***
$LSD_{0.05}$	***10.2***	***13.1***	***12.1***	***6.5***	***5.3***	***5.9***

The values of the indicator are lower in the variants treated with reduced doses of macronutrients, imported in combination (N_8P_8 -10.2%) and alone (P_6/I N_6/II P_6/III N_6/IV - 10.9%). The amount of fully digestible by farm animals polioside - hemicellulose is higher in all treated grasses compared to that of untreated. The excess in the values of the attribute is from

1.7% (N_7/I P_7/II P_7/III N_7/IV) to 3.8% ($N_{12}P_{12}$ and P_6/I N_6/II P_6/III N_6/IV) compared to that of the control (19.6%). The dry matter of self-fertilized stands of N_7 (first and fourth years) and P_7 (second and third experimental years), and those with self-fertilization of P_6 (first and third years) and N_6 (second and fourth years) is respectively with the most low (18.7%) and highest (31.0%) cellulose content, at a control (27.2%). The analyzed data show lower *in vitro* digestibility (43.4-58.7%) of the stands formed in the variants with mineral fertilization at a standard control (58.8%).

The variants with lower doses of manure (10 and 20 t ha^{-1}) are characterized by reduced content of neutral detergent fibers (by 0.2-0.8%), acid detergent fibers (by 0.6-4.7%) and acid detergent lignin (by 0.7-2.4%), which determines the sufficiently high *in vitro* digestibility of dry matter for obtaining quality fodder for ruminants (60.1% and 63.2%). The one-time application of manure (dose 20 and 30 t ha^{-1}) before the onset of active vegetation for the species in the natural grasslands had a positive effect on the concentration of hemicellulose in the dry matter. The excess in the values of the indicator compared to the control is from 2.7% to 6.5%. Grasslands treated with higher doses of organic fertilizer (30 and 40 t ha^{-1}) showed a higher fiber content of basic structural fiber components (NDF, ADF and ADL) in the cell walls and lower digestibility of the dry matter. Empirically calculated values of cellulose varied from 19.4% (30 t ha^{-1}) to 27.1% (40 t ha^{-1}) in the control variant - 26.5%.

On average for the period, the grasslands of the variants with organic fertilizing were characterized by 2.0% higher *in vitro* digestibility of the dry matter and 2.1% lower concentration of cellulose (polyoside - partially digestible by animals) compared to the variants treated with different doses of N and P. The dry mass of the variants with mineral fertilizing has a higher content of neutral detergent fibers (by 0.7%) and hemicellulose (by 2.8%) compared to that of the variants fertilized with manure.

The quality of plant matter is closely dependent on the biological process of lignification - a major factor limiting the nutritional value of fodder and inhibiting digestibility (Casler & Jung, 2006). The lignification coefficient in the studied degraded mountain grassland, after applied mineral fertilizing varied from 13.8 ($N_{12}P_{12}$) to 32.9 (N_7/I P_7/II P_7/IIIN_7/IV) (Figure 1). Variants with $N_{12}P_{12}$, N_8P_8 and P_6/I N_6/II P_6/III N_6/IV had a lower degree of lignification compared to the control by 6.8%, 4.1% and 3.8%, respectively.

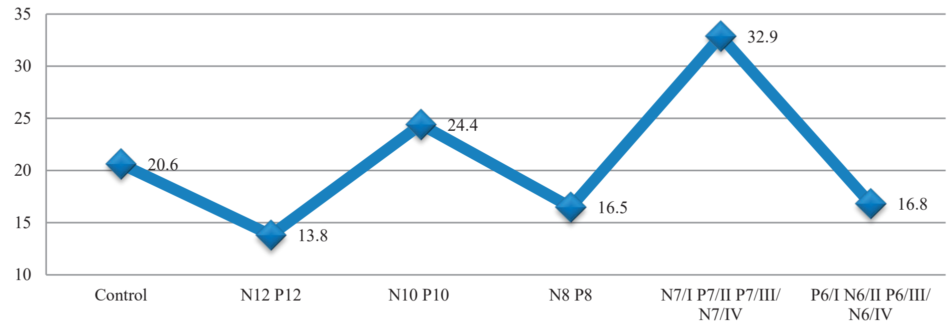

Figure 1. Degree of lignification of degraded mountain grassland after mineral fertilizing (coefficient)

In the variants with organic fertilizing (10 and 20 t ha^{-1}) the values of the lignin coefficient were reduced by 0.9 to 4.7% (Figure 2). The grasslands with higher doses (30 and 40 t ha^{-1}) of organic fertilizer register higher lignification coefficient (35.8 and 37.8) compared to the control (21.9).

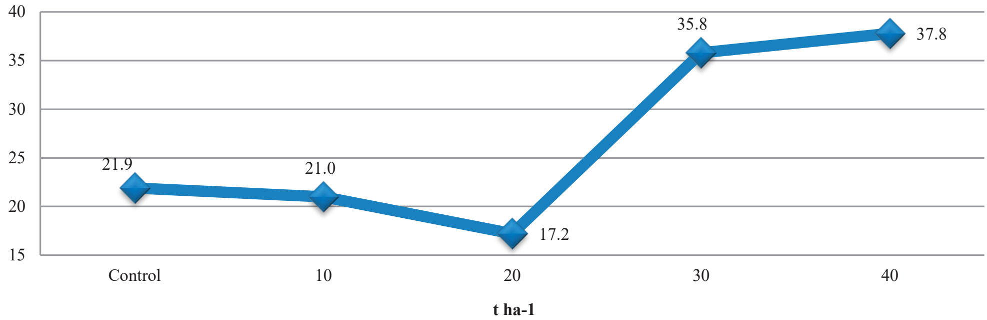

Figure 2. Degree of lignification of degraded mountain grassland after applied organic fertilizing (coefficient)

The biological value of fodder largely depends on the energy nutritional value and some other characteristics that affect the productivity of animals. The diversity and changes in the botanical composition of natural grasslands, as a result of the agrotechnical events, affect the amount of gross and metabolic energy, as well as the number of forage units in the dry matter of the grass matter treated with mineral and organic fertilizers.

The total energy value of the plant matter from the variants with annual combined fertilizing of N and P exceeds that of the untreated control by 0.4% ($N_{10}P_{10}$), 2.1% (N_8P_8) and 2.8% ($N_{12}P_{12}$) (Table 3).

Only the individual fertilizing with N_7 (first and fourth years) and P_7 (second and third years) registered higher values of exchange energy (8.04 MJ/kg DM) and feed units (FUM - 0.74 pieces in DM and FUG - 0.67 pieces in DM) compared to the control.

Table 3. Potential energy nutritional value of degraded mountain grassland, after applied mineral and organic fertilizing

Variants	**GE**	**EE**	**FUM**	**FUG**
Mineral fertilizing				
Control	18.91	7.86	0.72	0.64
$N_{12}P_{12}$	19.44	7.47	0.67	0.59
$N_{10}P_{10}$	18.98	7.63	0.69	0.61
N_8P_8	19.30	7.56	0.68	0.60
N_7/IP_7/IIP_7/III/ N_7/IV	18.67	8.04	0.74	0.67
P_6/I N_6/IIP_6/III/ N_6/IV	18.90	7.56	0.69	0.61
Average	***19.03***	***7.69***	***0.70***	***0.62***
SD	***0.28***	***0.22***	***0.02***	***0.03***
Organic fertilizing				
Control	18.96	7.79	0.71	0.63
10t ha^{-1}	19.06	7.53	0.68	0.60
20t ha^{-1}	19.09	7.64	0.69	0.61
30t ha^{-1}	18.86	7.38	0.67	0.58
40t ha^{-1}	19.11	7.54	0.68	0.60
Average	***19.02***	***7.58***	***0.69***	***0.61***
SD	***0.10***	***0.15***	***0.02***	***0.02***

GE - Gross energy (MJ/kg DM); ME - Metabolizable energy (MJ/kg DM); FUM - Feed unit for milk (pieces in DM); FUG - Feed units for growth (pieces in DM); ($P<0.05$)

In grasslands with organic fertilizing, a more significant effect of the applied treatment was observed on the amount of gross energy. The values of the indicator exceed the untreated control by 0.5% (10 t ha^{-1}), 0.7% (20 t ha^{-1}) and 0.8% (40 t ha^{-1}), respectively. The effect of manure does not lead to significant changes in the empirically calculated content of metabolic energy and feed units in the dry matter composition.

Correlation and regression dependences between basic qualitative indicators of natural grasslands treated with mineral and organic fertilizers

A high correlation dependence was found (Table 4) between the nitrogen content and the amount of crude protein (r = 1.0) in the dry matter of the grasslands with mineral fertilizing. The theoretical regression line and the equation of the regression dependence between the values of the indicators are shown in Figure 3, where y = 7.2224x - 0.4841 at high coefficient of determination - R^2 = 0.9988 (P <0.05).

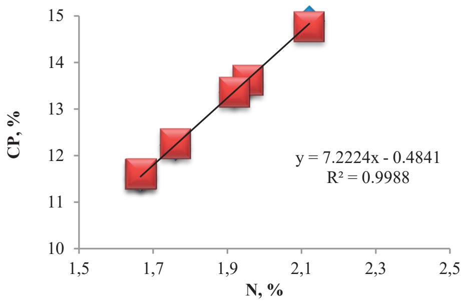

Figure 3. Regression dependence between the amount of nitrogen (%) and the content of crude protein (%) in dry matter of degraded mountain grassland, after applied mineral fertilizing

The effective utilization of natural grasslands and their nutritional value are closely related to the analysis of the basic chemical composition and the composition of the components of the cell walls. The amount of crude fiber is very well correlated with the empirically calculated values of hemicellulose (r = 0.7) cellulose (r = 0.9), and the content of nitrogen-free extracts and acid-detergent lignin with indicators characterizing the energy nutritional value (r = 0.9 for EE, FUM and FUG) of mountain grassland. Correlation dependences of the above features are completely opposite for the variants with organic fertilizing (Table 5). The concentration of the fiber fraction (CFr) strongly correlates with the values of hemicellulose (r = -0.2), cellulose (r = -0.7), gross energy (r = -0.9), exchange energy, FUM and FUG (r = -1.0). This tendency is maintained with regard to the dependence of lignin with the energy indicators of the dry fodder mass (r = from -0.6 to -0.3). In the variants with imported manure, the concentration of crude protein is in a very good correlation (r = 1.0) and regression dependence with the percentage of the macroelement nitrogen at a high coefficient of determination (R^2 = 0.9999) and a statistically proven equation: y = 6.9861x - 0.0815 (P <0.05) (Figure 4).

Table 4. Correlation dependences among main qualitative indicators of natural grasslands, treated with mineral fertilizers

	DM	CP	CF	CFr	NFE	Ca	P	N	NDF	ADF	ADL	Hemi	Cellul	GE	EE	FUM	FUG
DM	1																
CP	-0.8	1															
CF	0.2	0.1	1														
CFr	-0.1	0.1	0.7	1													
NFE	0.3	-0.4	-0.7	-0.9	1												
Ca	0.2	0.3	0.6	0.6	-0.6	1											
P	0.1	0.1	**1.0***	0.7	-0.7	0.5	1										
N	-0.7	**1.0***	0.1	0.1	-0.4	0.3	0.1	1									
NDF	0.6	-0.4	0.4	0.6	-0.3	0.7	0.2	-0.4	1								
ADF	0.4	-0.1	0.1	0.3	-0.2	0.8	-0.2	0.0	**0.9***	1							
ADL	0.4	-0.1	-0.3	-0.9	0.8	-0.2	-0.4	0.0	-0.3	-0.1	1						
Hemicellulose	0.6	-0.6	0.5	0.7	-0.4	0.4	0.5	-0.6	0.8	0.4	-0.5	1					
Cellulose	-0.3	0.1	0.3	**0.9***	-0.8	0.3	0.3	0.0	0.5	0.3	-1.0	0.5	1				
GE	-0.3	0.5	0.7	**0.9***	-1.0	0.7	0.7	0.5	0.3	0.3	-0.7	0.3	0.7	1			
EE	0.1	0.0	-0.6	-1.0	**0.9***	-0.5	-0.7	0.0	-0.5	-0.2	**0.9***	-0.7	-0.9	-0.8	1		
FUM	0.1	0.0	-0.7	-1.0	**0.9***	-0.5	-0.7	0.0	-0.5	-0.2	**0.9***	-0.7	-0.9	-0.8	**1.0***	1	
FUG	0.1	-0.1	-0.7	-1.0	**0.9***	-0.5	-0.7	-0.1	-0.5	-0.2	**0.9***	-0.7	-0.9	-0.9	**1.0***	**1.0***	1

(P<0.05)

Table 5. Correlation dependences among main qualitative indicators of natural grasslands, treated with organic fertilizers

	DM	CP	CF	CFr	Ash	NFE	Ca	P	N	NDF	ADF	ADL	Hemi	Cellu	DMD	GE	EE	FUM	FUG
DM	1																		
CP	-0.9	1																	
CF	-0.6	0.3	1																
CFr	**1.0***	-0.8	-0.6	1															
Ash	0.0	0.2	0.1	0.3	1														
NFE	0.3	-0.5	-0.2	0.0	-0.9	1													
Ca	0.3	-0.5	0.5	0.3	0.2	0.0	1												
P	0.1	-0.5	0.6	0.0	-0.2	0.4	**0.9***	1											
N	-0.9	**1.0***	0.3	-0.8	0.2	-0.5	-0.5	-0.5	1										
NDF	-0.3	0.5	-0.1	0.0	**0.9***	-1.0	-0.3	-0.6	0.5	1									
ADF	-0.2	0.4	0.2	0.1	1.0	-1.0	0.2	-0.3	0.4	**0.9***	1								
ADL	0.1	0.2	-0.3	0.4	**0.9***	-0.9	0.0	-0.5	0.2	**0.9***	**0.9***	1							
Hemicell	0.0	0.0	-0.5	-0.2	-0.8	0.7	-0.7	-0.3	0.0	-0.5	-0.8	-0.6	1						
Cellulose	-0.7	0.5	**1.0***	-0.7	0.2	-0.3	0.4	0.5	0.5	0.1	0.3	-0.1	-0.5	1					
DMD	0.2	-0.4	-0.2	-0.1	-1.0	**1.0***	-0.2	0.3	-0.4	-0.9	-1.0	-0.9	0.8	-0.3	1				
GE	-0.9	0.7	**0.9***	-0.9	-0.1	-0.2	0.1	0.2	0.7	0.0	0.1	-0.3	-0.2	**0.9***	-0.1	1			
EE	-0.9	0.7	0.6	-1.0	-0.4	0.2	-0.2	0.1	0.7	-0.2	-0.3	-0.6	0.3	0.6	0.3	**0.9***	1		
FUM	-0.9	0.7	0.6	-1.0	-0.5	0.2	-0.3	0.1	0.7	-0.2	-0.3	-0.6	0.3	0.6	0.3	**0.9***	**1.0***	1	
FUG	-0.9	0.7	0.6	-1.0	-0.5	0.2	-0.3	0.1	0.7	-0.2	-0.3	-0.6	0.4	0.6	0.3	**0.9***	**1.0***	**1.0***	1

(P<0.05)

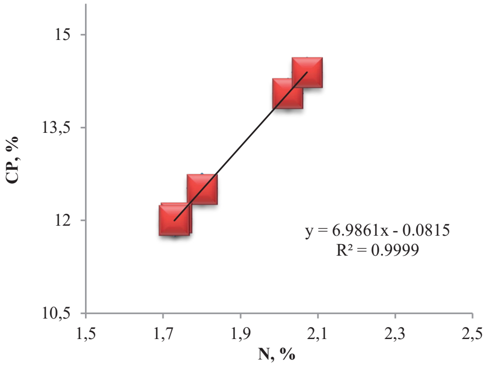

Figure 4. Regression dependence between the amount of nitrogen (%) and the content of crude protein (%) in dry matter of degraded mountain grassland, after applied organic fertilizing

A high correlation was found between the dry matter content in the fodder (treated with manure) and the amount of crude fiber (r = 1.0) and strongly negative with the content of GE, EE, FUM, FUG, crude protein and nitrogen (r = -0.9).

The values of the indicators (GE, EE, FUM and FUG) influencing the potential energy nutritional value of the grass mass are in good correlation (r = 0.7) with the concentration of crude protein and nitrogen.

The amounts of fully digestible polyoside - hemicellulose and partially digestible polyoside - cellulose are positively correlated respectively with the digestibility of the dry matter (r = 0.8) and the total energy value (r= 0.9) of the biomass treated with bovine manure.

CONCLUSIONS

On average for the period, the dry matter of the grasslands with organic fertilizing had a lower concentration of cellulose (by 0.3%), higher content of CP (by 0.1%), CFr (by 1.7%), N (by 0.1%) and higher *in vitro* dry matter digestibility (by 2.0%) compared to the variants with mineral fertilizing. Increase in the concentration of carbohydrate components (by 1.2%), neutral detergent fibers (by 2.9%), hemicellulose (by 2.8%), Ca (by 0.3%) and P (0.2%) was observed in the dry matter of the stands with annual combined and alternating fertilizing with nitrogen and phosphorus.

The energy nutritional value of the fodder, after annual combined fertilizing with N and P, exceeded that of the untreated control by 0.4% ($N_{10}P_{10}$), 2.1% (N_8P_8) and 2.8% ($N_{12}P_{12}$). The organic fertilizing had a greater effect on the amount of gross energy. The values of the indicator exceeded the untreated control by 0.5% (10 t ha^{-1}), 0.7% (20 t ha^{-1}) and 0.8% (40 t ha^{-1}), respectively.

In the stands with mineral fertilization and organic fertilization, the content of N and CP are in proven high correlation (r = 1.0) and regression (R^2 = 0.9988-0.9999) dependence.

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