INFLUENCE OF ORGANIC INPUTS ON THE QUALITY OF FORAGES PRODUCED ON A GRASSLAND OF *NARDUS STRICTA* L. AND *FESTUCA RUBRA* L

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Abstract

While on permanent grassland of Dorna Depression have been conducted numerous studies to increase their productivity, the studies on the quality of these forages are rather few and incomplete. The study aimed to assess the quality of forages obtained from a permanent grassland of Dorna Depression under the influence of organic fertilization. The experience was monofactorial in three repetitions, located on a grassland of Nardus stricta L. and Festuca rubra L., at an altitude of 940 m and 10% slope, to follow the effect of fertilization with 20-50 t / ha manure, applied annually or every 2 years, on the chemical composition of the forage. Samples were gathered in 2010 and 2011 and were analyzed for dry matter (DM), organic matter (OM), crude fat (GB), crude protein (PB), crude ash (CA), fiber content by treatment with neutral detergent (NDF), fiber content by treatment with acid detergent (ADF), sulphuric lignin content (ADL), total phosphorus and calcium, applying standardized methods. Analyses conducted allowed calculation of parameters to estimate the quality of forages, such as the total digestible nutrients (TDN), net energy (NE) and relative nutritional value (RFV). It was observed that fertilization with manure resulted in an increase in crude protein content and lower NDF and ADF values compared with the control variant, depending on the dose of fertilizer and year of experimentation. Thus, in 2010 PB content increased from 9.79% to 10.11 to 12.72%, NDF and ADF decreased from 54.75% to 53.99-46.57%, and from 50.07 to 39.93-38.07%,respectively, and in 2011 PB increased from 8.83% to 9.23 to 10.50%, while NDF and ADF, decreased from 54.78% to 52.80 – 48.99%, and from 53.96% la 45.18 – 40.11%, respectively. The values of the investigated parameters indicate an improvement in forages quality.

Key words: Fertilization, forages, quality, nutritional value

INTRODUCTION

Romania ranks fifth in Europe in terms of area occupied by permanent grassland. They occupy an area of 4.9 million ha, representing about 32% of the agriculture and 20% of total land. These permanent grasslands are common in very different ecological conditions, from the plain to the alpine area. This leads to the existence of a large variety of types of grassland and therefore need to develop differentiated technologies to improve and use [11].

Permanent grasslands are an important part of Romania's natural resources. These grasslands serve multiple purposes which harmoniously combines many functions that can be used to benefit people and animals: provide habitat and food source for animals, protect soils against erosion, provide biodiversity for at least 70% of all species of plants, make the beautiful environmental and also a great part of the biomass can be converted into unconventional energy [11].

Chemical analysis can provide valuable information about chemical constituents that affect digestion and can help to elucidate important biochemical aspects, thus contributing to a better understanding of factors that may limit animal performance [10]. The methods of chemical characterization do not allow a direct estimate of the nutritional value only in combination with statistical methods to measure digestibility and consumption. Using this statistical combination, characterization of content of fiber, lignin, proteins and other chemical components of feed are increasingly used to predict animal performance [2], [5]. Fertilization is an important factor in improving the production and floristic composition of grasslands. Changes in floristic composition in

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optimum soil moisture conditions depend on the type and amount of fertilizer [4], [9].

Currently agricultural practices recommend reducing the use of chemical fertilizers and promote other sources of fertilizer. In this respect, organic fertilizers can be an alternative, but their effect on the nutritional value of feed is not yet well known [3], [8], [12].

The aim of this study was to evaluate the effect of organic inputs on the nutritional value of forages on permanent grassland of *Nardus stricta L.* and *Festuca rubra L* from Dorna Depression, Romania.

MATERIAL AND METHODS

The research was conducted during 2010 - 2011 on permanent grassland of *Nardus stricta L. and Festuca rubra L.*, located in Dorna Depression, Saru-Dornei village at an altitude of 940 m and slope of 10 degrees.

In this experience was evaluated the influence of 5 different organic fertilizing variants: V1 - unfertilized control, V2 - 20 t ha^{-1} manure applied every year, V3 - 30 t ha^{-1} manure every year, V4 - 30 t ha^{-1} every two years and V5 - 50+0+40+0 t ha^{-1} manure on the quality of forages harvested from such areas.

The experience was monofactorial in 3 repetitions. The surface of each variant of fertilization was 20 m^2 (4 x 5m). The repetition block area was 100 m^2 and the surface of the experience was 300 m^2. Freshly harvested hay samples were dried at room temperature, ground to obtain a homogeneous matrix and analyzed to determine the crude chemical composition: dry matter (DM), crude fat (GB), crude protein (PB), crude ash (CenB) fiber content by treatment with neutral detergent (NDF) fiber content by treatment with acid detergent (ADF), sulphuric lignin content (ADL), and total phosphorus, applying standard methods. The analyses performed allowed the calculation of parameters for assessing the quality of the feed, such as the total digestible nutrients (TDN), net energy (NE) and relative nutritional value (RFV). Calculation of these parameters was performed with the following formulas [1].

$TDN = 82.38 – (0.7515 \times \%ADF)$

$RFV = (DDM \times DMI)/1.29$

$DDM = 88.9 – (0.779 \times \%ADF)$

$DMI = 120/\%NDF$

NE: Mcal/lb = (TDN % x 0.01114) – 0.054

Statistical analysis of results (t-test and principal component analysis) was performed using Statistica 8.

RESULTS AND DISCUSSIONS

Results obtained in accordance with the 2010 and 2011 fertilization variant are presented in table 1. The results show that fertilization leads to increased production from 1.10 t ha^{-1} for the unfertilized variant, to 2.90 - 4.95 t ha^{-1} dry matter, in 2010, and from 1.40 t ha^{-1} to 3.95 - 4.97 t ha^{-1} in 2011 depending on the dose of fertilization. The results are in agreement with other studies in the literature [12].

Organic fertilization of *Nardus stricta L.* grassland using moderate amounts of 20-30 t ha^{-1} manure every year led to an increase in PB content (crude protein) up to 12.72% in 2010 and an increase of up to 10.50% in 2011 compared to the control variant, unfertilized. If the manure was added only every two years there was also a significant increase in PB content up to 11.29% in 2010 and 9.88% in 2011 compared with unfertilized control variant. At the same time there was a significant increase in V5 variant containing 50+0+40+0 t ha^{-1} (from 9.79% to 10.11% in 2010 and from 8.83 % to 10.50 in 2011).

NDF and ADF content on the dried matter also affect the quality of grassland and its effect on animal nutrition. The average content of NDF decreased significantly from 59.15% for the unfertilized control variant to an average of 50.57% - 58.41%, depending on fertilization, in 2010. The average ADF content shows also a significant decrease from 54.10% to 41.20% - 42.11%.

Similar results were obtained in 2011 with a significant decrease in average content of NDF from 59.86% to average values between 57.75% - 53.53%, depending on fertilization and also the ADF average values from 53.96% to 43.75% - 44.53%. In 2010 we obtained a higher crude protein content and lower values of fiber content (ADF and NDF) compared with 2011, including the control variant, suggesting the presence of other factors that could influence the quality of feed, such as climatic conditions.

Phosphorus content increased from 0.17% for control variant to 0.24% - 0.27% depending on the variant of fertilization in 2010. The largest increase was observed for the variant when were applied 50+0+40+0 tons manure per hectare. In the following year, 2011 was a similar increase in phosphorus content from 0.16% in the unfertilized control variant to 0.28% for the variant fertilized with 50+0+40+0 tons manure per hectare.

Table 1 Effect of organic fertilization on the dry matter (t ha^{-1}) and chemical composition of feed produced on permanent grassland in 2010 -2011

Variant	SU/DM (t ha^{-1})	PB (%)	CenB (%)	GB (%)	NDF (%)	ADF (%)	ADL (%)	P (%)
2010								
V1-unfertilized control	1.10	9.79	7.46	1.62	59.15	54.10	10.38	0.17
V2-20 t ha^{-1} manure every year	3.62	11.44***	8.67	1.77	58.41**	42.11***	9.80	0.26***
V3-30 t ha^{-1} manure every year	3.16	12.72***	9.15	2.02	50.57***	41.43***	11.40	0.26***
V4-30 t ha^{-1} manure every two years	2.90	11.29***	9.16	2.11	53.29***	41.20***	9.99	0.24***
V5-50+0+40+0 t ha^{-1} manure	4.25	10.11***	8.77	2.04	53.52***	41.42***	9.51	0.27***
2011								
V1- unfertilized control	1.40	8.83	9.52	1.86	59.86	53.96	10.78	0.16
V2-20 t ha^{-1} manure every year	4.97	9.23***	7.54	2.08	57.75***	43.88***	9.88**	0.21**
V3-30 t ha^{-1} manure every year	4.16	10.50***	7.71	2.10	57.71***	43.75***	11.35***	0.26***
V4-30 t ha^{-1} manure every two years	3.95	9.88***	8.05	1.66	54.51***	46.89***	9.75***	0.26***
V5- 50+0+40+0 t ha^{-1} manure	4.29	10.50***	9.06	1.71	53.53***	44.53***	9.58***	0.28***

SU – dry matter, PB - crude protein; CenB - crude ash, GB - crude fat, NDF- fiber content by treatment with neutral detergent, ADF - fiber content by treatment with acid detergent; ADL - sulphuric lignin content, P - total phosphorus.
*=p< 0.05; **= p< 0.01; ***= p< 0.001.

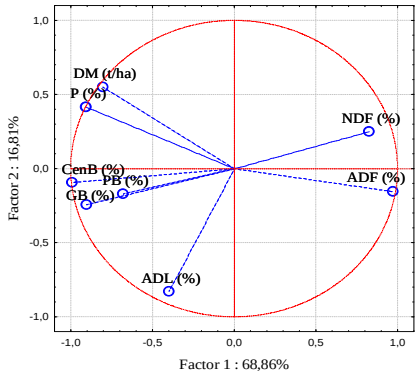
Water, protein and energy are the nutritive elements that are required by the grazing animals in higher quantities for proper growth and production [7]. Often it has been suggested that the quality of feeds depends primarily on the energy content of them and particularly the component of metabolized energy [6]. Thus, the influence of organic inputs on the energy content of feed produced from a permanent grassland *Nardus stricta L.* and *Festuca rubra L* can be observed from the calculated quality parameters for produced forages (Table 2). The total digestible nutrients (TDN), relative nutritive value (RVF) and net energy (NE) increased significantly ($p < 0.001$) both in 2010 and in 2011 compared with unfertilized control variant.

Table 2 The content of total digestible nutrients (TDN) (%), relative nutritive value (RFV) (%) and net energy (NE) (MJ / kg) of forages on fertilized permanent grassland in 2010 and 2011

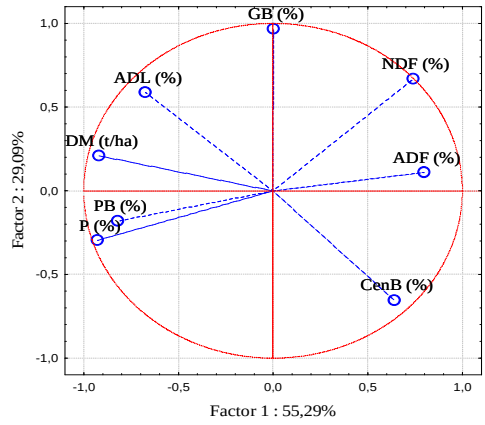
Variant	TDN (%)	RVF (%)	NE (MJ/kg)
2010			
V1-unfertilized control	41.72	73.53	3.79
V2-20 t ha^{-1} manure every year	50.73	89.34	4.72
V3-30 t ha^{-1} manure every year	51.25	104.17	4.77
V4-30 t ha^{-1} manure every two years	51.42	99.15	4.79
V5-50+0+40+0 t ha^{-1} manure	51.25	98.44	4.77
2011			
V1- unfertilized control	41.83	72.83	3.80
V2-20 t ha^{-1} manure every year	49.41	88.15	4.58
V3-30 t ha^{-1} manure every year	45.18	81.14	4.15
V4-30 t ha^{-1} manure every two years	47.14	89.38	4.35
V5- 50+0+40+0 t ha^{-1} manure	48.92	94.20	4.53

From principal component analysis applied to feed samples analyzed for 2010 and 2011 is observed the contribution of two factors that explain about 86% (Fig. 1 a-2010), 84% respectively (Fig. 1 a - 2011) of the total variance of the data set. The difference between the loadings of the two factors in 2010 is given by the insoluble components of plant cell wall, ADF and NDF, and in 2011 besides the cellular insoluble fiber components the crude ash also contribute to significantly differences (Figure 1 a-2010, the -2011).

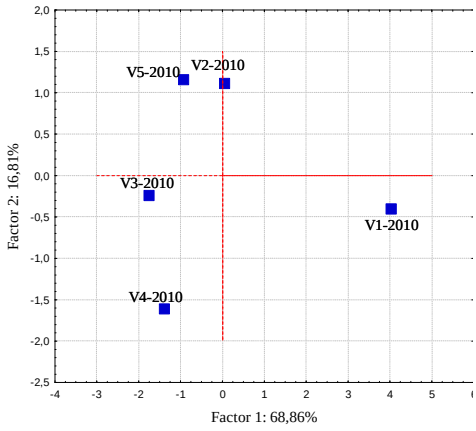
As concern the variants of fertilization with manure there is a clear difference between control variant, unfertilized (V1), along the first factor and the other variants fertilized with different doses of organic fertilizer, both in 2010 and in 2011 (Fig .1 b-2010, b-2011). In 2010 there was a difference between variants V2 (20 t ha^{-1} manure every year) and V5 (50+0+40+0 t ha^{-1} manure) compared to variants V3 (30 t ha^{-1} manure every year) and V4 (30 t ha^{-1} manure every two years) mainly due to the dry matter (DM, t ha^{-1}), total phosphorus, NDF, ADF and sulphuric lignin (ADL) (Fig. 1 b - 2010). In 2011 significant differences were observed between the fertilization variants V2 (20 t ha^{-1} manure every year) and V3 (30 t ha^{-1} manure every year) compared to fertilization variants V4 (30 t ha^{-1} farmyard manure every two years) and V5 (50+0+40+0 t ha^{-1} manure). Difference in this case is given by crude fat (GB), insoluble fiber NDF and ADF, sulphuric lignin (ADL) and crude ash (CenB) (Fig. 1 b-2011).



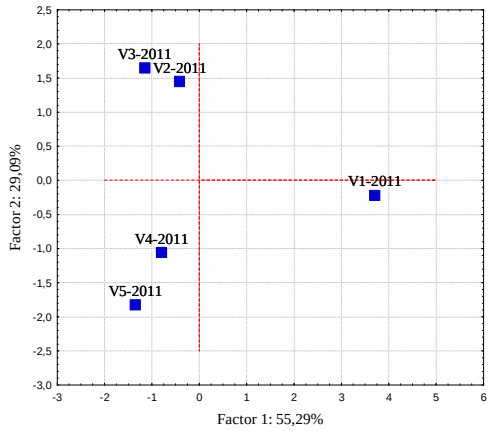
(a-2010)



(a-2011)



(b) 2010



(b) 2011

Fig. 1 Factor loadings for chemical composition (a) and variants of fertilization (b)

CONCLUSIONS

The use of organic fertilizers improves the quality of forages produced on mountain permanent grassland, as evidenced by the values of chemical components and a set of characteristic parameters of forages. Thus, there was a significant increase in dry matter, crude protein and total phosphorus, and a decrease in content of insoluble fibre and acid detergent fibre and of the lignin, respectively.

The results for the relative nutritional value indicate average quality forages produced on the fertilized variants.

Information obtained in this study could be useful in understanding the nutritional potential of the forages, representing basic information in ruminant nutrition.

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