High productivity on *Nardus stricta* L. grasslands from the Carpathian Mountains of Romania

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Abstract

In the mountainous region of Romania about 200,000 ha is covered by grassland, which is mainly dominated by *Nardus stricta* L. We have studied the influence of mineral fertilization on productivity, canopy composition and forage quality of *Nardus stricta* L. permanent grassland in the intra-mountainous depression of Vatra Dornei (North-Eastern Carpathians, 820 m.a.s.l.). Fertilisation was applied at rates of $N_{100\text{-}200}$ $P_{100\text{-}200}$ kg ha^{-1} in one or several applications. These mineral fertilizer rates resulted in changes in the dominant species of *Nardus stricta* L. grasslands, by increasing the percentage of *Festuca rubra* L. and *Agrostis capillaris* L. Productivity increased by 119-224%, as well as forage quality compared to the unfertilized control.

Keywords: permanent grassland, mineral fertilization, productivity, forage quality, biodiversity

Introduction

In Romania, the area covered with mountain grassland dominated by *Nardus stricta* L. species is about 200,000 ha, of which 2,000 ha are protected by Natura 2000. Most of it is located in areas where animal rearing represents the main activity for the local population. Within this context, it is necessary to find efficient solutions that will lead to the improvement of productivity of the natural grasslands by ensuring the provision of fodder for the animals. Research on grasslands has emphasised the role of fertilizers, canopy composition, environmental conditions and grassland management on the productivity and quality of fodder, thus ensuring a superior animal productivity (Andueza *et al.*, 2010; Galka *et al.*, 2005; Poetsch *et al.*, 2014; Štýbnarová *et al.*, 2010; Vellinga *et al.*, 2004; Vintu *et al.*, 2008).

This study investigated the rates of mineral fertilizers leading to a high productivity and superior forage quality on the *Nardus stricta* L. grasslands from the Romanian Carpathians.

Materials and methods

A monofactorial experiment was carried out on *Nardus stricta* L. grassland in the Cosna area of the Romanian Carpathians (47°22'36.2'N; 25°11'27.4'E; 840 m elevation) on a soil with 13.6 mg kg^{-1} P and 381 mg kg^{-1} K. The forage from the grasslands in the area is mainly used for feeding dairy cattle. The experiment was laid out in randomized blocks design with three adjacent replicates, and each plot measured 20 m^2, of which the harvestable area was 12 m^2. The influence of nitrogen and phosphorus mineral fertilizers was investigated. Fertilizers were applied either entirely during early spring or in two applications during the year, with the following seven treatments: V_1 – control (unfertilised); V_2 – $N_{100}P_{100}$; V_3 – $N_{140}P_{140}$; V_4 – $N_{200}P_{200}$; V_5 – $N_{100}P_{100}$ + $N_{40}P_{40}$; V_6 – $N_{100}P_{100}$ + $N_{100}P_{100}$; V_7 – $N_{80}P_{80}$ + $N_{60}P_{60}$.

Dry matter (DM) productivity, canopy composition and forage quality were measured. The Kjeldahl method was used to determine crude protein content, the Van Soest method was used for measuring the acid detergent fibre (ADF), neutral detergent fibre (NDF) and acid detergent lignin (ADL), while the vegetation study was conducted by the geobotanical method, using the Braun-Blanquet scale, and the

analysis of biodiversity with the help of the PC-ORD program. The chemical tests for the fodder were conducted on samples from the first cut, at the beginning of July, the data representing the average for the years 2012-2014. The experiment was started in 2009. The statistical interpretation of data was carried out with the analysis of variance (ANOVA) and LSD test (P<0.05-0.001).

Results and discussion

Fertilization of mountain grasslands with mineral fertilizers improved the canopy composition, productivity and forage quality. The $N_{100\text{-}200}P_{100\text{-}200}$ treatment contributed, within the framework of natural factors from the area, to significant yield improvements, with values between 130-224%, when the amount was applied entirely in early spring, and values of 119-141% when applied in several applications, because the first cut represented around 80% of total yield. On average, over three years, values of 1.59 Mg ha^{-1} DM were obtained for the unfertilized control, and statistically higher yields for fertilized treatments of 3.49-5.15 Mg DM ha^{-1} ($N_{80}P_{80}$+$N_{60}P_{60}$, respectively $N_{200}P_{200}$) (Table 1).

Mineral fertilization resulted in significant changes in the chemical composition of the fodder, by increasing the crude protein content and reducing the values for the components of the cell walls (NDF, ADF, ADL), thus improving the forage quality. Fertilizer use led to an increase in crude protein content from 6.69 (control) to 11.62 g kg^{-1} ($N_{100}P_{100}$ + $N_{100}P_{100}$) and a reduction of NDF content from 63.77 to 52.66 g kg^{-1}, ADF from 41.29 to 33.50 g kg^{-1}, and ADL from 10.21 to 9.46 g kg^{-1} (Table 2).

By analysing the effect of fertilizers on canopy composition, represented by a graphic (Figure 1), we noticed significant changes in the fertilized communities. Thus, the canopy composition of the fertilized treatments did not overlap that of the unfertilized control, which proves that their similarity is very low. Furthermore, it can be seen that the treatments V_2 and V_3, respectively, V_4 and V_7, have a rather high similarity, since their overlapping in the graphic is significant. This leads us to conclude that changes in canopy composition depend on the fertilizer application rates and their manner of application.

Conclusions

Fertilization by nitrogen and phosphorus at high application rates caused significant changes in canopy composition by reducing the share of the dominant species *Nardus stricta* L. and increasing the share of species with a higher fodder value, such as *Festuca rubra* L. or *Agrostis capillaris* L. These changes in the vegetation and soil fertilization led to high yields, with rates of 119-224% compared to the unfertilized

Table 1. Influence of fertilization on the *Nardus stricta* L. grassland yield (Mg ha^{-1} dry matter).

Fertilizer rate	Year			Average 2012-2014	
	2012	2013	2014		
	Mg ha^{-1}	Mg ha^{-1}	Mg ha^{-1}	Mg ha^{-1}	%
Unfertilized control	1.88	1.54	1.34	1.59	100
$N_{100}P_{100}$	3.48***	3.59***	3.89***	3.65**	230
$N_{140}P_{140}$	4.16***	4.28***	4.31***	4.25**	267
$N_{200}P_{200}$	4.66***	4.92	5.87***	5.15***	324
$N_{100}P_{100}$+$N_{40}P_{40}$	3.93***	3.43**	3.71***	3.69*	232
$N_{100}P_{100}$+$N_{100}P_{100}$	3.76**	3.32**	4.40***	3.83*	241
$N_{80}P_{80}$+$N_{60}P_{60}$	3.57***	3.14**	3.75***	3.49*	219
* P≤0.05	0.54	1.10	0.62	1.51	
** P≤0.01	0.76	1.54	0.88	2.12	
*** P≤0.001	1.07	2.17	1.23	2.99	

Table 2. Influence of mineral fertilization on forage quality from the *Nardus stricta L.* grassland (g kg^{-1} dry matter).[1]

Fertilizer rate	CP	NDF	ADF	ADL
Unfertilized control	6.69	63.77	41.29	10.21
$N_{100}P_{100}$	7.60	55.15*	33.50**	9.59**
$N_{140}P_{140}$	8.56	56.79*	34.44**	9.75*
$N_{200}P_{200}$	10.35**	55.27*	34.98**	9.43**
$N_{100}P_{100}+N_{40}P_{40}$	10.62**	52.66**	33.77**	9.69*
$N_{100}P_{100}+N_{100}P_{100}$	11.62***	55.01*	34.35**	9.84
$N_{80}P_{80}+N_{60}P_{60}$	10.65**	55.78*	36.92*	9.60**
* $P \leq 0.05$	2.10	6.91	4.40	0.39
** $P \leq 0.01$	3.01	9.72	6.11	0.55
*** $P \leq 0.001$	4.20	13.70	8.63	0.80

[1] CP = crude protein; ADF = acid detergent fibre; NDF = neutral detergent fibre; ADL = acid detergent lignin.

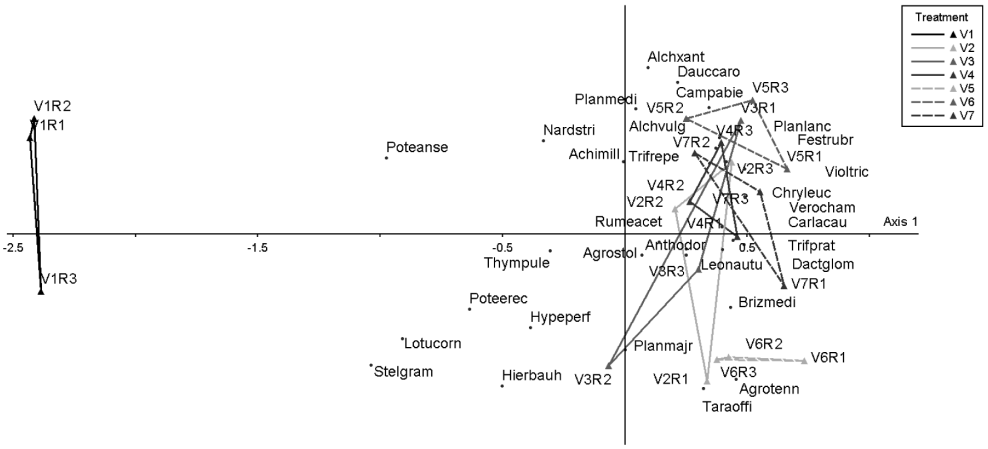

Figure 1. Order of canopy composition influenced by fertilization. (V_1...V_7 – fertilizer rates; R1, R2, R3 – replicates).

control, ensuring the supply of significant quantities of superior quality forage for the development of animal rearing in the mountainous area of the Romanian Carpathians.

References

Andueza D., Cruz P., Farruggia A., Baumont R., Picard F. and Michalet-Doreau B. (2010) Nutritive value of two meadows and relationships with some vegetation traits. *Grass and Forage Science* 65, 325-334.

Galka A., Zarzycki J. and Kopeca M. (2005) Effect of different fertilisation regimes on species composition and habitat in a long-term grassland experiment. *Grassland Science in Europe* 10, 132-135.

Poetsch E.M., Asel A., Schaumberger A. and Resch R. (2014) Impact of climate change on grassland productivity and forage quality in Austria. *Grassland Science in Europe* 19, 139-141.

Štýbnarová M., Svozilová M., Hakl J., Karabcová H., Pozdíšek J. and Otrhálková P. (2010) Effect of different management on the yields, forage quality and botanical composition of permanent grassland. *Grassland Science in Europe* 15, 741-743.

Vellinga T.V., André G., Schils R.L.M. and Oenema O. (2004) Operational nitrogen fertilizer management in dairy farming systems: identification of criteria and derivation of fertilizer application rates. *Grass and Forage Science* 59, 364-377.

Vintu V., Samuil C., Sirbu C., Saghin G. and Iacob T. (2008) The influence of grassland management on biodiversity in mountainous region of NE Romania. *Grassland Science in Europe* 13, 183-185.