NPK FERTILIZER ADDITION EFFECT ON NARDUS STRICTA TYPE GRASSLAND IN KOPAONIK MOUNTINE

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Abstract: This study examines how the addition of NPK fertilizers impacts the change in *Nardus stricta* type grasslands. The investigation was carried out on the mountain Kopaonik between 2009 and 2012. The effects of four fertilizing treatments: control; N60 (N60P60K60); N90 (N90P60K60); N120 (N120P60K60) on plant species composition, Shannon evenness, and EGQ (evaluation grassland quality index) were researched. The control treatment was dominated by *Nardus stricta* species, while *Festuca rubra* and *Agrostis capillaris* presence was a feature of fertilizing treatments. The highest nitrogen intake (N120) had Shannon evenness that was very similar to that of the control. All fertilizing treatments resulted in increasing forage value.

Keywords: grassland, Nardus stricta, Shannon evenness, forage value

Introduction

The *Nardus stricta* type grasslands are widespread nearly all over the world (Trivedi et al., 2008). In the Balkans, those communities are widespread, especially in mountainous areas. It was mainly created as a result of hundreds of years of regular and low intensity grazing or grazing-hay management (Korzeniak, 2016). High-mountain *Nardus stricta* grasslands are exceptions and regarded as almost climax forms (Galvanék and Janák, 2008). *Nardus stricta* grassland is a uniform community dominated by *Nardus stricta* species (40 to 60%) (Alibegović Grbić et al., 2008).

Fertilization is a key management factor and a prerequisite for successful biomass production in grasslands. Application of mineral fertilizers, especially N, increases herbage yield quickly and changes a grassland vegetation structure (Smits et al., 2008). Addition of N resulted in increase of yield, which is caused by increasing presence of grasses as more productive and stronger competitive species in comparison to others (Wesche et al., 2012). Because of growing

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asymmetry, grasslands have been transformed into homogeneous swards of a few more productive and higher-quality grass species (Zornić et al., 2022).

In this context, the study's objective was to determine how mineral fertilizer s affected the composition of plants, Shannon evenness, and the quality of the grasslands of the *Nardus stricta* type.

Materials and methods

Study site The field experiment was set up at a height of 1550 meters above sea level in Rendara, Serbia, on the mountain Kopaonik. The research was carried out over a four-year period (2009 – 2012). Grassland community was classified as *Nardus stricta* type grassland.

Soil and weather conditions. The soil type at the experimental site was a rendzina. The soil pH (KCl) 3.99, plant-available phosphorus (P) content was 3.1 mg/100 g soil, potassium (K) was 12.9 mg/100 g soil and total humus content was 9.9%.

Experiment. The experiment was established in March 2009, as randomized block design with four replications. Each plot was 4 m × 5 m in size. Four NPK fertilizer treatments were applied: control (unfertilized); N60 (N60P60K60); N90 (N90P60K60); N120 (N120P60K60). The following fertilizers were used: NPK 15:15:15 and calcium ammonium nitrate fertilizer (KAN - 27% N).

Botanical analyses Before mowing, average samples of biomass were collected from each treatment. All plant species in these samples were separated by hand and measured. The biomass proportion of each species was calculated.

Shannon evenness J', was calculated using the data number of species S and Shannon diversity index H': $J' = H' / \ln S$. The Shannon diversity index H' equals to:

$$H' = -\sum_{i=1}^{S} (p_i \times \ln p_i)$$

Where *pi* is proportion of *i* th species in sward.

Individual species forage value (FV) and abundance of species D (%) were used to evaluate grassland quality (EGQ) (Novak, 2004). $E_{GQ}= \Sigma(DxFV)/8$

The influence of the treatments, NPK application and years of investigation at Shannon evenness and EGQ were tested by using main effect ANOVA. Significant differences between the treatments were analyzed by Fisher's LSD test. Species composition change caused by NPK fertilizers was analyzed by direct gradient RDA (redundancy analysis) CANOCO in Windows 4.5 package.

Results and discussion

Based on the RDA analysis (Graph 1), fertilizer treatments affected the percentage of individual plant species on a sward. The effect of fertilizers is related to the studied year. Fertilization promoted grass species such as *Agrostis capillaris, Festuca rubra, Deshampsia flexuosa* and *Poa violacea,* in 2010, 2011 and 2012 year.



Graph 1. Ordination diagram of the results of RDA (redundancy analysis) plant species composition data in 2009, 2010, 2011 and 2012 on *Nardus stricta* type grassland, influenced by fertilizing. Species abbreviations: *Agr cap - Agrostis capillaris, Des fle - Deschampsia flexuosa, Fes rub - Festuca rubra, Nar str - Nardus stricta, Poa vio - Poa violacea.*

Nardus stricta had the highest percent in a treatment with no fertilization. The stronger effect of mineral fertilizers was observed as fertilization was applied for a longer period of time. According to an investigation by Stošić and Lazarević (2007), applications of mineral fertilizers in *Nardus stricta* grassland primarily changed it into an *Agrostis capillaris* and *Festuca rubra* community. The results confirm this hypothesis. Even though those species had always been a less frequent part of swards, their percentage increased in response to the addition of N (Mountford et al., 1996). In fertilized treatments, Samuil et al. (2018), found a decrease in *Nardus stricta* presence and an increase in productive *Arrenatherum elatius* and *Festuca rubra* grassland types.

Shannon evenness increased in treatments N60 and N90, based on the main effect ANOVA (Table 1). The Shannon evenness in treatment N120 was very similar to that of the control. There were no statistically significant differences between research years. After four fertilizing years, treatment N120 had the lowest diversity evenness (Graph 2). Increased soil fertility status increased the percentage presence of species with higher soil nutrient requirements, and thus these species spread on fertilized plots (Samuil et al., 2013).

Table	1.	Main	effect	ANOVA	results	of	influence	NPK	fertilizers	on
Shannon evenness and Ecq in <i>Nardus stricta</i> type grassland										

Tretman	Shannon evenness	Egq		
Control	0.56ab	16.2b		
N60	0.65a	32.7a		
N90	0.64a	35.2a		
N120	0.56b	36.7a		
Investigation years				
2009	0.56a	23.2b		
2010	0.63a	30.5a		
2011	0.62a	33.5a		
2012	0.61a	33.5a		

Values followed by different letters are significantly different (p<0.05) according to the LSD test;

According to Novak (2004), the obtained results classify the initial community into worthless communities based on the quality index. Due to fertilizing and years of research, there was a significant increase in E_{GQ} . (Table 1). Higher E_{GQ} in fertilized plots than control was recorded, during the whole experimental period (Graph 2). Average E_{GQ} in 2010, 2011 and 2012 were significantly higher than in 2009. Application NPK fertuilizers increased grassland quality in grassland comunity *Festuco nardetum subalpinum* in the same area (Zornić et al., 2022). Higher forage values in fertilizing treatments were consistent with the results obtained by Pittarello et al. (2018).



Graph 2. Shannon evenness and E_{GQ} in investigate *Nardus stricta* type grassland during four years fertilizers addition

In general, EGQ and Shannon evenness increased in treatments N60 and N90. In treatments N120, forage values increased while the diversity index remained unchanged when compared to the control.

Conclusion

During the four-year experiment period, significant differences in plant species composition occurred as a result of NPK fertilizer addition. In comparison to low productive *Nardus sticta* species, more productive *Festuca rubra* and *Agrostis capillaris* grasses were stimulated by fertilizer application over a four-year period.

Shannon evenness increased as a result of the NPK fertilizers N60P60K60 and N90P60K60. In terms of grassland diversity, there were no differences between N120P60K60 and the control. The value of forage was significantly increased in NPK treatments.

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