Why grasslands?

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Volume 29
Grassland Science in Europe

Landolt indicator values changes as result of fertilization in *Danthonia alpina* grassland

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Abstract

On natural grasslands, application of mineral fertilizers increases dry matter yields and also changes the botanical composition of plant communities. The objective of this study is to examine how the *Danthonia alpina* Vest type grassland changed as a result of fertilization in the hilly Balkan region. Unfertilized control and four fertilized treatments P60K60 (PK), N20P60K60 (N20), N80P60K60 (N80) and N140P60K60 (N140), were applied annually during a four-year period were examined. Mean Landolt's ecological indicator values (moisture (F), nutrients (N) and temperature (T)), were calculated for each treatment. The fertilized plots showed higher F and N, but lower T value, and the changes became more evident at the fourth year of application. During the research period, the NxPK treatments had a greater effect than PK treatments. The F was highest in treatments N140 (2,97) four years after fertilizers were applied; Nevertheless, T decreased greatly in the fourth year and ranged from 3,40 (control) to 3,03 (N140). In our experiment, short-term fertilizer application changed Landolt's ecological indicator values, which is the opposite of ongoing climate change effects.

Keywords: grassland, *Danthonia alpina*, Landolt indicator values, nitrogen

Introduction

The plant species that comprise a grassland community are the product of habitat conditions and management practices. Each change in the management methods (e.g. frequency of cutting or fertilization level) has an impact on botanical composition of the sward and habitat itself. Indicator values according Ellenberg or Landolt express plant preferences for temperature, light, continentality, soil moisture, pH, and soil nutrients, and have been largely used to deduce plant communities' environmental characteristics. The environmental indicator values of plant communities indicate mean conditions of the realized niche of every species. On the basis of these indicators, it is possible to make conclusions about habitat changes over time, influenced by fertilizing, frequency of cutting etc. An important question is how the changes connect to climatic changes which are characterized by extreme weather events such as heat waves, droughts, heavy rainfall, hailstorms, and storms. According to current climate research, it can be assumed that by 2050 the annual average air temperature in highland region will rise about +2°C (Gobiet *et al*., 2014). The primary objective of our experiment was to assess the impacts of different fertilization treatments on Landolt ecological indicator values (F, N, T) during four years in the hilly Balkan region.

Materials and methods

Field experiment site

This was located at Mitrovo Polje in the central part of Serbia (43°30′ N, 20°52′ E) on acid soil (pH_{KCl} 4.09). Prior to the trial establishment the soil phosphorus content was 2.65 mg kg^{-1} and potassium content was 7.96 mg kg^{-1}. There was a high level of organic matter (8.96%) in the soil. The community was *Danthonietum alpinae* type grassland.

Experiment

The experimental plots were established in an area with homogeneous vegetation and they were arranged as randomized block system. The plots were 10 m^2 in size, and each treatment replicated four times. The experiment consisted of five treatments: control, N20P60K60 (N20PK), N80P60K60 (N80PK), N140P60K60 (N140PK). Phosphorus and potassium were applied in autumn. Nitrogen was applied in spring, every years in mid-March, as ammonium nitrate (33% nitrogen).

Analyses

Cover-abundance values of individual species was estimated right before first cut, using the 6 classes of Braun–Blanquet scale (+=<1%, 1=1–10%, 2=10–25%, 3=25–50%, 4=50–75%, 5=75–100%). According to Braun–Blanquet, cover values were converted to percentages: +=0.5%, 1=5%, 2=17.5%, 3=37.5%, 4=62.5%, 5=87.5%).The Landolt indicator value (Landolt *et al.*, 2010) for each plot was calculated as the mean of indicator values weighted with cover of each species present in the plot. We calculated the following Landolt indicator values for: nutrients (N), humidity (F) and temperature (T).

Results

Significant dependence of N, F, T values of fertilization treatments on *Danthonia alpina* type grassland was found (Figure 1).

During the first year, no dependence was found between N and the fertilization treatment. The analysis of habitat conditions based on Landolt indicator values shows a considerable fertilizer effect on N in the second year, and the changes became more evident at fourth year of application. The mean ecological indicator values of nutrients gradually rose as applied nitrogen increased. The N was highest in treatments

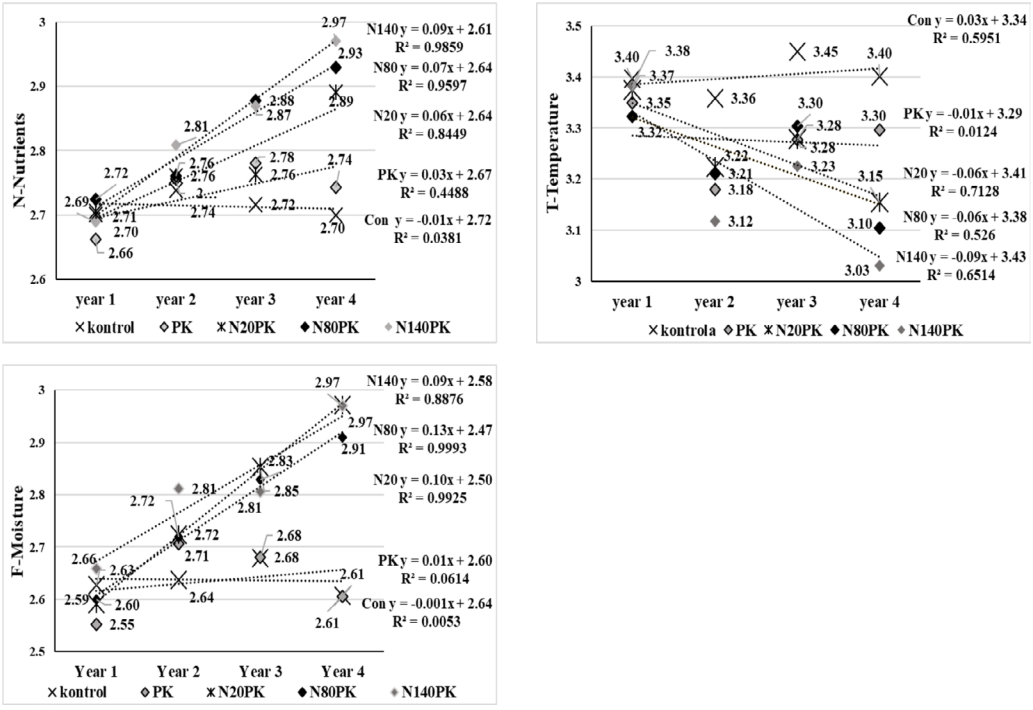

Figure 1. Mean Landolt indicator value for nutrients, temperature and moisture, in fertilized treatment during four years of addition in *Danthonia alpine* grassland (the coefficient of determination is significant at a value of R^2>0.6).

N140 (2.97) compared to the control (2.7) four years after fertilizers were applied. Galka, (2005) discovered similar, that nitrogen addition had a positive impact on N (2005). The N was increased in PK treatments. According to Tiller *et al.* (2021), adding phosphorus to systems where it is the limiting factor leads the nutrients indicator value increase.

T decreased with increasing nitrogen addition. During the four-year period, indicator values for temperature in treatment N140 declined the most (R^2>0.6). The decrease is most expressed in the fourth year, and ranged from 3.40 (control) to 3.03 (N140).

The impact of fertilizer application on F change was similar to that on N. There were no differences among treatments in F during the first year. Changes was more evident in the second, third and fourth years, and the changes became more expressed in the fourth year of application. During research period, treatments with nitrogen had a greater effect than PK treatment. Similar influence of fertilizers on ecological indicator value are detected by Chitry *et al.* (2009).

Conclusion

Mean Landolt ecological value was changed in all fertilized plots and the NxPK treatments had a greater effect than PK treatments. Short-term fertilizers application on *Danthonia alpina* grassland increase N, F, while T decreased. These changes were most pronounced in the treatments where the highest amount of nitrogen was applied.

Acknowledgement

The work was supported by Ministry of Education, Science and Technological Development (Serbia number 47/2023) -01/ 200217.

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