Experiences with grassland aerator with blades in Karcag

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ABSTRACT

In 2023-24, we examined the effects of a lawn aerator with blades on plant structure, nitrogen, and total organic carbon content in a near-natural grass association in Karcag, characterized by saline soil. Following the aeration in October, by the following May, the nitrogen and total organic carbon content of the grass soil decreased. There was a decline in species diversity and the cover value of leguminous grass species. In contrast, the cover proportion of moderately oligotrophic, community-forming Festuca pseudovina increased. Additionally, the cover value of the dominant grass species, Alopecurus pratensis, also rose due to the two-time intervention with the blade roller. Summarizing our results, the application of lawn aeration in sensitive plant structures of near-natural grass associations is justified with great care.

Keywords: *lawn aeration, lawn aerator with blades, and plant structure*

ÖSSZEFOGLALÁS

Gyepszellőztető késes henger növényszerkezetre, valamint nitrogén és összes szerves széntartalomra gyakorolt hatását vizsgáltuk 2023-24-ben, Karcagon, szolonyec talajadottságú, természetközeli gyepasszociációban. Az októberi gyepszellőztetés hatására, a következő év májusára csökkent a gyep talajának nitrogén és összes szerves szén tartalma. Csökkent a fajdiverzitás, és a pillangós virágú gyepalkotó fajok borítási értéke. Nőtt a mérsékelten oligotróf, társulásalkotó, a Festuca pseudovina borítási részaránya. Kétszeri késes hengerrel történő beavatkozás hatására, nőtt a domináns pázsitfűfaj, az Alopecurus pratensis borítási értéke is. Eredményeinket összegezve, nagyon körültekintő módon indokolt a gyepszellőztetés alkalmazása természetközeli gyeptársulások érzékeny növényszerkezetében.

Kulcsszavak: *gyepszellőztetés, késes henger, növényszerkezet*

INTRODUCTION

In accurately determining the spatial-temporal variability of grassland degradation and in grassland restoration, identifying the causal factors is crucial (Li et al., 2012; He et al., 2015), along with addressing the key issues that must be resolved for effective ecological restoration measures (Gang et al., 2014; Zhan et al., 2017). According to Kelemen et al. (2010, 2016) and Valkó et al. (2010), the rehabilitation of grasslands has gained renewed importance today as some low-quality arable lands have become fallow (Cramer et al., 2008; Komoly et al., 2012). These areas provide an excellent opportunity for the restoration of former grasslands (Török et al., 2011a; Uj et al., 2013), their improvement (Török et al., 2010, 2011b, 2012; Valkó et al., 2016), as well as their mechanical maintenance (Barcsák et al., 1978).

Barcsák et al. (1978) recommend scarification to alleviate the compaction of the topsoil, as it improves the physical state of the soil during pasture aeration, thereby enhancing the air and water retention in the soil. Through scarification, molehills can be leveled, which might harbour invasive ruderal weeds, increasing the degradation of the plant community and reducing the forage value of the pasture. Scarification also plays a role in removing dried plant material from the grassland. Furthermore, it enhances the nutrient supply capability of the grass, leading to increased yield. The aim of pasture aeration is to improve soil oxygen availability and water infiltration, as soil covered by grass often becomes compacted, making it difficult for oxygen, water, and nutrients to reach the roots (Halász, 2023). A knife roller is also recommended for aerating grasslands. Fülöp et al. (1975) favor the knife roller due to its low working depth, around 8-12 cm, which corresponds to the grass root zone. This tool can improve the soil's water retention and even prepare a seedbed for overseeding pastures (Szabó, 1973). Using a subsoil loosener allows improvements in the water management of deeper soil layers as well as soil aeration (Barcsák et al., 1978). It is advisable to perform pasture aeration in mid-autumn, for example in October, when the soil is not yet saturated, preventing any compaction damage from heavy machinery (Gyepgazdálkodási Műhely, 2021).

According to the research of Apáti (2003) and Huisz et al. (2006), aeration of the root zone improved soil water and air management in compacted, anaerobic soils. Bajnok et al. (2019) reported that aeration conducted at the root zone depth caused water loss, as the coverage by legumes and indifferent dicotyledonous turf species decreased, while grass species showed little growth. In their 2023 study, Bajnok et al. compared the effects of knife roller and subsoil loosening combined with fertilization, finding that the only knife roller treatment led to a decrease in species richness on the turf, whereas the coverage of plants in moderately oligotrophic sites (NB3) increased.

The aim of our study is to investigate vegetation changes in an experiment set up on dry grassland, as well as to create a database using the Tango FT-NIR device to track the changes in nitrogen and total organic carbon content resulting from the treatment.

MATERIAL AND METHOD

Our experiment was conducted on the grassland area with medium meadow solonetz soil characteristics, on the land marked with plot number 01710/1 of MATE Agrárcsoport Ltd., during 2023-2024. Prior to setting up the experiment, an average soil sample analysis was carried out by the accredited laboratory of the Research Institute, yielding the following results: pH (KCl) 4.48, Soil Binding (KA) according to Arany 44, total soluble salts 0.03 m/m%, carbonated lime content 0.05 m/m%, humus 3.98 m/m%, nitrogen content 2.33 mg/kg, phosphorus pentoxide content 84.50 mg/kg, potassium oxide content 309.25 mg/kg, sodium content 569.50 mg/kg, magnesium content 533.00 mg/kg, sulfate content 14.18 mg/kg, zinc content 3.75 mg/kg, copper content 10.50 mg/kg, and manganese content 324.25 mg/kg.

The 30-year average precipitation is 501 mm. The meteorological data of the experimental area are presented in *Table 1*.

Table 1.

The meteorological data of the experimental area

Year(1)	Month(2)	Temperature(3) (°C)	Precipitation(4) (mm)
2023	September	20,72	53,34
2023	October	14,50	47,24
2023	November	6,17	120,40
2023	December	2,44	36,32
2024	January	0,72	19,05
2024	February	8,06	10,67
2024	March	9,50	19,30
2024	April	14,11	44,96
2024	May	18,06	45,97

1. táblázat: A kísérleti terület meteorológiai adatai
Év(1), hónap(2), hőmérséklet(3), csapadék(4)

The area is an association transition between the *Achilleo-Festucetum pseudovinae* and *Alopecuretum pratensis* associations. Since 1997, it has been utilized as a meadow without the application of chemicals or organic fertilizers, overseeding, lawn aeration, or irrigation. The experiment was set up on October 17, 2023, in collaboration with the Department of Agricultural Engineering at the University of Debrecen, using a 12 cm working depth knife roller for control, single, and double knife roller treatments.

The vegetation survey was conducted using the Balázs square method on May 9, 2024 (Balázs, 1949), where the area of grassland covered by a given plant species is indicated by the Balázs dominance value (DB). The classification of plant species names was based on Király (2009).

We took a soil sample and analyzed the nitrogen content and total organic matter content of the soil samples using the TANGO FT-NIR spectrometer developed by Bruker.

The recording and aggregation of data collected in the experiments, as well as the processing and evaluation of the results obtained, were carried out using Microsoft® Office Excel. We used one-way analysis of variance (ANOVA) for data analysis. For the statistical evaluation, we utilized the p-value from the elements of the ANOVA at a 5% significance level.

RESULTS

During the ecological survey, we recorded 14 species. In the control area, there were 14 species, in the area with single lawn aeration, there were 11 species, and in the area with double lawn aeration, there were 10 species. The dominant species in all three treatments was *Alopecurus pratensis*, with an average coverage of 46.875%. The recorded plant species were classified into Borhidi's ecological indicator groups (water requirement, nitrogen requirement, light requirement) as well as into Social Behavioral Types: *Alopecurus pratensis* (WB6, NB7, LB7, C5), *Artemisia absinthium* (WB4, NB7, LB9, W1), *Bromus hordeaceus* (WB5, NB5, LB7, DT2), *Cardaria draba* (WB3, NB4, LB8, W1), *Cerastium vulgare* (WB5, NB5, LB7, DT2), *Festuca pseudovina* (WB3, NB3, LB9, C5), *Lepidium perfoliatum* (WB4, NB3, LB9, DT2), *Matricaria chamomilla* (WB6, NB4, LB8, G4), *Plantago lanceolata* (WB4, NB5, LB7, DT2), *Podospermum canum* (WB4, NB2, LB8, G4), *Trifolium angulatum* (WB2, NB1, LB8, S6), *Trifolium repens* (WB5, NB7, LB8, DT2), *Veronica persica* (WB5, NB7, LB6, W1), *Vicia tetrasperma* (WB5, NB4, LB6, DT2).

The cover of plants in category WB 2 decreased by 75.00% compared to the control in the single aeration treatment. The cover of plants in category WB 3 did not change compared to the control. In category WB 4, the plant cover increased by 12.50% compared to the control in the single aeration treatment, while it decreased by 37.50% during the double aeration treatment. For category WB 5, the plant cover decreased by 14.29% compared to the control in the single aeration treatment, while it did not change during the double aeration. In category WB 6, the plant cover decreased by 6.90% in the single aeration treatment compared to the control, but increased by 34.48% during the double aeration treatment.

The coverage of plants in the NB 1 category decreased by 75.00% compared to the control in the single aeration treatment. The coverage of plants in the NB 2 category decreased/increased by 50.00% compared to the control in both single and double aeration treatments. The coverage of plants in the NB 3 category increased by 60.00% compared to the control in the single aeration treatment, while in the double aeration treatment it doubled. The coverage of plants in the NB 4 category increased by 33.33% compared to the control in the single aeration

treatment, while it decreased by 16.67% in the double aeration. The coverage of plants in the NB 5 category increased by 35.71% compared to the control in the single aeration treatment, whereas it decreased by 28.57% during double aeration. The coverage of plants in the NB 7 category decreased by 16.13% compared to the control in the single aeration treatment, while it increased by 19.35% during double aeration.

The coverage of plants in the LB 6 category did not change compared to the control in the single aeration treatment, while it increased by one and a half times during the double aeration. The coverage of plants in the LB 7 category increased by 4.76% compared to the control in the single aeration treatment, while it increased by 11.90% during double aeration. The coverage of plants in the LB 8 category decreased by 21.43% compared to the control in the single aeration treatment and decreased by 57.14% during double aeration. The coverage of plants in the LB 9 category increased by 33.33% compared to the control in the single aeration treatment, while it increased by 66.67% during double aeration.

The coverage of plants in category W 1 increased by 16.67% compared to the control in the single aeration treatment, while it decreased by 66.67% in the double aeration treatment. The coverage of plants in category DT 2 increased by 23.53% compared to the control in the single aeration treatment, while it increased by 11.76% in the double aeration treatment. The coverage of plants in category G 4 decreased by 20.00% compared to the control in both treatments. The coverage of plants in category C 5 decreased by 3.13% in the single aeration treatment and changed by 34.38% in the double aeration treatment. The coverage of plants in category S 6 decreased by 75.00% after the single aeration.

The ANOVA did not show significant differences during the comparison of treatments.

The total organic carbon (TOC) and nitrogen (N) content decreased as a result of the treatments. In the control area, the nitrogen content was 0.36%, while it was lower in the single and double knife roller treatments (0.32% and 0.31%, respectively).

We observed the same trend in the measurement of total organic carbon, with the control area at 12.42%, the single knife roller treatment at 11.76%, and the double knife roller treatment at only 11.42%. The decrease in these measured parameters may have caused the reduction in species richness in the single and double knife roller treatments, as well as the increase in coverage of moderately oligotrophic species (NB3).

DISCUSSION

The results obtained from investigating the effects of single and double lawn treatment with a scarifying roller were fundamentally defined by the decrease in nitrogen and total carbon content resulting from the interventions. Similar to the findings of Bajnok et al. (2019), the coverage value of leguminous grass species decreased. Additionally, the species diversity index declined in the treated areas, but the area covered by moderately oligotrophic grass species (*Festuca pseudovina*) increased, and the coverage value of *Alopecurus pratensis* also rose due to the double scarifying intervention, echoing the research results by Bajnok et al. (2023) that reported an increase in the coverage value of economically beneficial turf grasses as a result of lawn aeration.

A persistent problem in our clayey fractional grasslands is soil anaerobiosis. Soil aeration can improve aeration levels down to the depth of loosening, but careful interventions, performed at a biological optimum, are necessary to preserve the structure of the plant community and maintain the soil's organic matter reserves.

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