Investigation of the aftereffects of organic fertilization in a solonetz soil type in a near-natural grassland community

Asbolt Gergő[1, 2] – Czimbalmos Róbert[1] – Csízi István[1]
Magyar Agrár- és Élettudományi Egyetem
[1]Karcagi Kutatóintézet, Karcag
[2]Növénytudományi Doktori Iskola, Karcag
Csizi.Istvan@uni-mate.hu

ABSTRACT

In the autumn of 2021, we examined the residual effects of applied granular sheep manure in a saline habitat, transitional grass association, in the spring of 2024. Three years after the application of organic fertilizer doses (10-15-20 t/ha), we measured the dominance of Alopecuretum pratensis as the dominant grass species in the treatments, while in the control, Festuca pseudovina became the dominant associate. The composition of the plant community influenced yield levels, with the 20 t/ha manure treatment yielding 110.6% more than the control. In terms of species diversity, the treatments that received manure showed higher values.

Keywords: *nature-related grassland, sheep manure, aftereffects, coenology*

INTRODUCTION

It is a fundamental fact that if the biomass generated on a given pasture is regularly removed and there is no nutrient replenishment, the phytomass yield decreases, becoming unpredictable depending on the year. Since grassland management in Hungary primarily operates within an environmental support framework, one requirement of which prohibits the replenishment of nutrients in pastures, the degradation of Hungarian grasslands is continuous. In years with a favourable climate index, certain sites may yield silage from the grass, but in most cases, these areas are only suitable for grazing.

Researchers focusing on nutrient replenishment for grasslands, acknowledging the prohibition of chemical use, have sought to explore the potential of using locally produced manure as a traditional-new alternative in today's climatic conditions. In our brief manuscript, we aimed to highlight relevant articles from the literature over the past two decades due to rapidly changing agricultural practices. Kádár et al. (2007) observed a yield increase of 1-1.5 tons/ha and an increase in plant species numbers following the application of 10 tons/ha of sheep manure to a clayey pasture in Bakonszeg in April. Similarly, Szewczyk et al. (2007) applied 10 tons/ha of sheep manure to mountain grasslands and, on average over three years, recorded increased yields and greater cover values for valuable forage grasses and legumes compared to controls. Török et al. (2013) highlighted an increase in cover of economically valuable plant groups and a reduction in invasive weed species during their study on organic fertilization of grasslands. Tasi et al. (2013) reported an increase in the cover of forage-worthy species in grasslands following organic fertilization. de Sainte Marie (2014) also reported increased species diversity when analysing the effects of manure application on grasslands. Díaz et al. (2018) recommended composted sheep manure for grassland fertilization, as its chelated nutrients are washed into the soil with minimal loss. In their summary of organic fertilization research, Tasi et al. (2022) emphasize the growing importance of using organic materials for sustainable nutrient replenishment. Csizi et al. (2023) recommend 20 t/ha manure application in late autumn.

MATERIAL AND METHOD

We conducted our experiment from 2021 to 2024 on grassland with medium meadow solonetz soil characteristics on the land marked with plot number 01710/1 of MATE Agrárcsoport Ltd. Before setting up the experiment, the average soil sample analysis was performed by the accredited laboratory of the Research Institute, with the following results: pH (KCl) 4.48, Clay content (KA) 44, Total soluble salts 0.03 m/m%, Carbonate 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, Manganese content 324.25 mg/kg.

The 30-year average precipitation is 539 mm. The meteorological data of the experimental area are presented in *Table 1*.

The area's association represents a transition between the Achilleo-Festucetum pseudovinae and the Alopecuretum pratensis communities. Since 2015, the land has been used as a mowed meadow, previously it was utilized as pasture. Since 1997, the area has not received any chemicals or organic fertilizers, overseeding, lawn aeration, or irrigation. The experiment was established on October 22, 2021, with three organic fertilizer dosage levels (0-10-15-20 t/ha), four replications, a net plot size of 30 m^2, and 0.5 m wide access paths (T0-T3). Since most grasslands in this region are located in nitrate-sensitive areas, we used small fertilizer amounts. The organic fertilizer applied in the experiment was mature, deep-litter sheep manure processed twice with the T088 organic manure spreader. The nutrient content of the applied sheep manure was as follows: humus: 8.69%; dry matter: 127.11%; ignition loss: 8.69; TOC (total organic carbon): 5.04; phosphate content: 20163 mg/kg; potassium content: 46580 mg/kg; zinc content: 46.5 mg/kg; copper content: 7.75 mg/kg; iron content: 158 mg/kg; manganese: 186 mg/kg.

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 vegetation inventory was conducted using the Balázs square method on May 9, 2024 (Balázs, 1960), where the area covered by the given plant species is indicated by the Balázs dominance value (DB). The classification of plant species names was based on Király (2009). On the same day after the inventory, the plots' green yields were cut with a motorized trimmer and weighed on-site. The data measured in g/30 square meters were converted to kg/ha units.

The data recorded and compiled during the experiments, as well as the processing and evaluation of the results obtained, were carried out using Microsoft® Office Excel. For data analysis, we employed one-way analysis of variance (ANOVA). In the statistical evaluation, we used the p-value from the elements of the analysis of variance at a significance level of 5%.

RESULTS

A total of 26 species were recorded during the phytosociological study in the experimental area. In the control area (T0), there were 16 species; in the T1 area, 16 species; in the T2 area, 14 species; and in the T3 area, 21 species were found. Except for the control area, the dominant grass species was *Alopecurus pratensis*, with cover percentages of 39.45% in T1, 57.42% in T2, and 70.31% in T3. In the control area, *Festuca pseudovina* had the highest coverage at 45.70%. *Plantago lanceolata* was recorded in all plots of the experiment, showing cover values between 1.56% and 3.62% in 2024, which we attribute to annual effects. All treatments, except for T2, recorded bare areas, with the smallest bare patch observed in T3 (0.78%). The recorded plants were classified into different ecological indicator groups (water requirement, nitrogen requirement, light requirement) as well as Borhidi's Social Behavior Types.

The coverage of plants in the WB 2 category did not change compared to the control in the T1 treatment, increased by 20.00% in the T2 treatment, and decreased by 20.00% in the T3 treatment. The coverage of plants in the WB 3 category decreased by 36.89% in the T1 treatment, by 46.72% in the T2 treatment, and by 75.41% in the T3 treatment compared to the control. The coverage of plants in the WB 4 category decreased by 30.65% in the T1 treatment, by 62.90% in the T2 treatment, and by 80.65% in the T3 treatment compared to the control. The coverage of plants in the WB 5 category decreased by 28.57% in the T1 treatment, by 57.14% in the T2 treatment, and by 35.71% in the T3 treatment compared to the control. In contrast, the coverage of plants in the WB 6 category increased by 169.23% in the T1 treatment, by 289.74% in the T2 treatment, and by 402.56% in the T3 treatment compared to the control. The WB 7 category saw an increase in plant coverage of 200.00% in the T1 treatment, 100.00% in the T2 treatment, and 50.00% in the T3 treatment compared to the control.

The coverage of plants in the NB 1 category did not change in T1 and T2 compared to the control, while it decreased by 60.00% in the T3 treatment. In the NB 2 category, plant coverage decreased by 26.67% in T1, 80.00% in T2, and 86.67% in T3 compared to the control. For the NB 3 category, coverage decreased by 32.77% in T1, 45.38% in T2, and 80.67% in T3 compared to the control. In the NB 4 category, plant coverage increased by 33.33% in T1, 16.67% in T2, and 233.33% in T3 compared to the control. The coverage of plants in the NB 5 category decreased by 22.92% in T1, 47.92% in T2, and 58.33% in T3 compared to the control. Finally, the coverage of plants in the NB 7 category increased by 105.88% in T1, 196.08% in T2, and 266.67% in T3 compared to the control.

The coverage of plants in the LB 6 category increased by 250.00% in the T1 treatment, 400.00% in the T2 treatment, and 700.00% in the T3 treatment compared to the control. The coverage of plants in the LB 7 category increased by 61.8% in the T1 treatment, 93.26% in the T2 treatment, and 123.6% in the T3 treatment compared to the control. The coverage of plants in the LB 8 category decreased by 31.03% in the T1 treatment, 58.62% in the T2 treatment, and 34.48% in the T3 treatment compared to the control. The coverage of plants in the LB 9 category decreased by 39.52% in the T1 treatment, 50.00% in the

T2 treatment, and 83.87% in the T3 treatment compared to the control.

The coverage of plants classified into Social Behavior Types (SBT) can be seen. In category RC-2, plant coverage increased by 100.00% in treatment T1 compared to the control, decreased by 100.00% in treatment T2, and increased by 300.00% in treatment T3. For category W1, coverage decreased by 58.82% in treatment T1, by 47.06% in treatment T2, and increased by 5.88% in treatment T3 compared to the control. In category DT2, coverage decreased by 22.92% in T1, by 50.00% in T2, and by 70.83% in T3 compared to the control. For category G4, coverage increased by 23.53% in T1, decreased by 23.53% in T2, and increased by 11.76% in T3 compared to the control. In category C5, coverage increased by 12.18% in T1, by 32.69% in T2, and by 26.92% in T3 compared to the control. In category S6, coverage decreased by 20.00% in T1, by 40.00% in T2, and by 80.00% in T3 compared to the control.

The ANOVA did not show significant differences in the comparison of the repetitions of treatments, as the plots of the individual treatments exhibited uniformity in all respects.

The very dry first quarter of the third year of organic fertilizer application negatively affected the phytomass yields of the grass community. Since only forage-appropriate grass biomass developed in the control plots, we present the green yield values in this brief report. The average green yield of plots that received 0 t/ha of fertilizer was 940 kg/ha, while plots that received 10 t/ha had an average green yield of 1390 kg/ha, those with 15 t/ha yielded 1576 kg/ha, and the application of 20 t/ha resulted in a green yield of 1980 kg/ha. Notably, the average green yield of the plots treated with 20 t/ha of ground deep litter sheep manure exceeded the control plot average by 110.6% three years after application. However, it should also be considered that the fertilizer cannot be incorporated into the grass sward, so the rate of nutrient leaching depends on the amount of precipitation. Successive dry years are likely to prolong the duration of fertilizer effectiveness.

DISCUSSION

The aftereffects of applying ground deep-litter sheep manure to a grassland were still evident three years post-application. Notably, in terms of the plant species composition of the grass sward, the dominant grass species in treatments receiving different organic fertilizer doses was *Alopecurus pratensis*, which is more suitable for mowing utilization. In contrast, the dominant grass species in the control plots was *Festuca pseudovina*, which, due to the examined vintage, was only suitable for grazing even though the land use mode was intended for mowing. The differences in the dominant grass species could have been a key factor in the development of yield levels.

The degree of diversification was higher in the treatments that received manure dosing, similar to the relevant literature references (Kádár et al., 2007; Szewczyk et al., 2007; de Saint Marie, 2014).

REFERENCES

Balázs F. (1960): A gyepek botanikai és gazdasági értékelése. A Keszthelyi Mezőgazdasági Akadémia Kiadványai 8. Mezőgazdasági Kiadó, Budapest, 28.

Csízi I.-Varga K.-Halász A. (2023): Szervestrágyázás hatása extenzív gyep növényállomány szerkezetére és hozamára. Gyepgazdálkodási Közlemények 21(2): 23-28.

de Sainte Marie, C. (2014): Rethinking agri-environmental schemes. A results – oriented approach tot he management of species – rich grasslands in France. Journal of Environmental Planning and Management 57: 704-719.

Díaz F. D.-Varga K.-Csízi I. (2018): Bio komposztadagok hatása egy arid termőhelyű ősgyep első növedékének hozamaira. Gyepgazdálkodási Közlemények 16(1): 11-17.

Kádár I.-Ragályi P.-Semán L.-Márton L.-Nagy S. (2007): NPK műtrágyázás és foltszerű trágyaterhelés hatásának vizsgálata legeltetett ősgyepen. Gyepgazdálkodási Közlemények 5(1-2): 16-25.

Király G. (2009): Új magyar füvészkönyv. Magyarország hajtásos növényei. Határozókulcsok. Aggteleki Nemzeti Park Igazgatóság, Jósvafő, 616.

Szewczyk, W.-Kasperczyk, M.-Kacorzky, P. (2007): Effect of fertilization scheme on grassland production and water environment. In: de Vliegher, A.-Carlier, L. (eds): Permanent and temporary grassland: plant, environment and economy. Proceedings of the 14th Symposium of the European Grassland Federation, Ghent, Belgium, 3-5 September 2007. 12: 359-362.

Tasi J.-Pencz P.-Török G. (2013): Egy dombvidéki gyep istállótrágyázásának első eredményei. AWETH, Gödöllő 9(1): 61-75.

Tasi J.-Csízi I.-Lepossa A.-Bajnok M.-Halász A. (2022): Szakirodalmi összeállítás a gyepek istállótrágyázásáról. Gyepgazdálkodási Közlemények 19(2): 39-41.

Török G.-Bakos Gy. M.-Kasperné Szél Zs.-Béres A.-Tasi J. (2013): Túlérett kecsketrágyával végzett szervestrágyázás a vegetációs idő alatt. Gyepgazdálkodási Közlemények 11(1-2): 57-62.