RECLAMATION OF ARABLE LAND DEGRADED BY GRAVEL MINING BY COMPLEX OF COMPOSTING MICROORGANISMS TO RECOVERY FORAGE PRODUCTION

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ABSTRACT

The aim of the work was to reclaim the degraded area using waste sludge obtained from washing excavated gravel and long-term stored (and therefore biologically minimally active) topsoil treated with compost activated by Bacteriolite. In this way, we aimed to return the anthropogenically physically degraded area to a productive state so that, after reclamation, the land (Anthrozem) would achieve a production capacity similar to the arable Fluvisol on the adjacent control plot, with the potential to apply this reclamation method to other degraded locations if successful. Results showed that after one year of remediation, the total carbon content in Anthrozem increased only slightly but significantly; therefore, it is necessary to continue biological measures to increase the organic matter content in the soil. Maize, sown in the area a year after reclamation, achieved a grain yield of 5.1 t ha^{-1}, which nearly reached the three-year average yield in Slovakia for 2022–2024 (6.5 t ha^{-1}).

Keywords: composting microorganisms, forage production, organic carbon, soil remediation, soil structure

INTRODUCTION

A section of arable land in Horná Seč, covering an area of 3,800 m^2, was temporarily taken out of use and, for 15 years, was used for mining and loading gravel. In Slovakia, according to Government Regulation No. 58/2013, temporarily taken agricultural land must be reclaimed and returned to crop production.

The project aimed to reclaim the degraded area using waste sludge obtained from washing excavated gravel and long-term stored (and therefore biologically minimally active) topsoil treated with compost activated by Bacteriolite. The goal was to return the anthropogenically physically degraded area to a productive state so that, after reclamation, the reclaimed land would achieve a production capacity similar to the arable land on the adjacent control plot, with the potential to apply this reclamation method to other degraded locations if successful.

MATERIALS AND METHODS

The reclamation took place near the village of Horná Seč, in an area of Fluvisols formed on Tertiary sediments (gravel and sand) of the Hron River, unevenly covered with Holocene fluvial flood clays.

The physical part of the reclamation included the excavation and removal of scarp gravel was done from a layer 0–80 cm thick. The resulting depression with compacted original soil parent material was treated by disking. Waste sludge obtained from washing the excavated gravel was used to reconstruct the subsoil, resulting in a total thickness of 0.6 m after soil subsidence. The original topsoil was placed on top, levelled, and loosened in a 0.2 m layer. The biological component of the reclamation involved applying compost made from organic plant matter, activated with the soil aid Bactériolit concentrated (produced by Marcel Mézy Technology, containing an active complex of live composting microorganisms) at a rate of 50 tons per hectare, and adding a legume-cereal mixture. Subsequent appropriate care of the growth included mulching and shallow incorporation into the surface layer of the soil.

Soil sampling and analyses

The first soil sampling was carried out in April 2023, one month after physical reclamation but before the start of biological reclamation. On the reclaimed plot (Anthrozem), a composite soil sample was created by combining seven subsamples. On the neighbouring arable Fluvisol, a composite soil sample was created by combining six subsamples. The control sampling was carried out in April 2024 at the same locations.

Samples were then taken to determine soil structure (0–20 cm) according to the Bakšaev method (Hraško *et al.* 1962), and chemical and biological properties (0–30 cm): soil reaction – potentiometrically in H_2O and 1 M KCl; exchangeable bases (S) and hydrolytic acidity (H) by Kappen's method; carbonate content – volumetrically; total organic carbon (Cox) – oxidimetrically (Hrivňáková *et al.*, 2011); labile carbon (CL) by the method of Loginow *et al.* (1987); and hot water soluble carbon (Chwl) by Körchens and Schulz (1999).

For statistical analysis, one-way ANOVA was used. Differences between Anthrozem and Fluvisol were evaluated using the Tukey test ($P \leq 0.05$).

RESULTS AND DISCUSSION

The residual fine-grained soil material obtained by flushing the excavated stony soil substrate was suitable for subsoil reclamation, as it did not adversely affect plant growth on

Tab. 1: Statistical analysis of soil structure parameters in topsoil of Anthrozem and Fluvisol determined by Tukey's test (significant level $P < 0.05$)

Plot	<0.25 mm dry	MWD_d[1]	K[2]	<0.25 mm wet	MWD_w[3]	K_V[4]	S_W[5]
Anthrozem 2023	10.8^b	1.66^a	3.08^b	15.1^a	0.76^a	2.17^a	1.21^a
Anthrozem 2024	3.67^a	2.43^a	2.49^{ab}	9.00^a	0.83^a	2.92^a	1.30^a
Fluvisol (control)	4.07^a	3.67^b	1.65^a	8.82^a	1.78^b	2.06^a	1.31^a
value P	0.0183	0.0065	0.0250	0.1216	0.0000	0.0454	0.1374
HSD 0,05	± 6.03	± 1.22	± 1.15	± 8.91	± 0.198	± 0.878	± 0.143

Abbreviations: [1]mean weight diameter of structural aggregates dray; [2]Revut structural coefficient; [3]mean weight diameter of water-resistant aggregates wet; [4]vulnerability coefficient of macroaggregates; [5]stability index

https://doi.org/10.11118/978-80-7701-093-1-0110

Tab. 2: Statistical analysis of pH, sorption, and organic carbon values in topsoil of Anthrozem (AM) and Fluvisol (FS) determined by Tukey's test (significant level $P < 0.05$).

Plot	pH_{KCl}	H^3	S^4	V^5	CO_3^{2-6}	$C_{OX}{}^7$	$C_L{}^8$	$C_{hwl}{}^9$	L^{10}
		[mmol/kg]		[%]		[g/kg]			
AM[1] 2023	6.66[ab]	7.47[a]	283[a]	97.3[b]	< 0.3	6.88[a]	0.77[a]	0.23[a]	0.12[a]
AM 2024	6.89[b]	6.53[a]	281[a]	97.7[b]	< 0.3	9.39[b]	0.93[a]	0.29[a]	0.11[a]
FS[2] (control)	6.43[a]	11.20[b]	245[a]	95.6[a]	< 0.3	16.30c	2.34[b]	0.57[b]	0.17[b]
value P	*0.0090*	*0.0006*	*0.0968*	*0.0026*		*0.0000*	*0.0000*	*0.0016*	*0.0008*
SD	± 0.21	± 2.12	± 23.63	± 1.01		± 4.00	± 0.72	± 0.16	± 0.03

[1]Anthrozem; [2]Fluvisol; [3]hydrolytic acidity; [4]sum of base cations; [5]base saturation; [6]carbonates, [7]total organic carbon; [8]labile carbon; [9]hot water soluble carbon; [10]lability of organic carbon

the recultivated land. The water resistance of macroaggregates improved slightly one year after reclamation, especially with biological reclamation, but still did not reach the level of the control Fluvisol. Therefore, it is necessary to improve soil structure, particularly by increasing the supply of organic fertilisers, as organic matter is one of the most important factors in the formation and stabilisation of aggregates (Tab. 1).

The Anthrozem topsoil had significantly lower contents of total organic carbon (C_{OX}), labile carbon (C_L), and hot water-soluble carbon (C_{hwl}) compared to the control Fluvisol (Tab. 2). The total carbon content in Anthrozem increased only slightly, though significantly; therefore, it is necessary to continue biological measures aimed at increasing the organic matter content in the soil (Polláková, 2025). pH values and sorption parameters showed that the Fluvisol topsoil had significantly higher acidity than the Anthrozem topsoil.

Maize, sown in the area a year after reclamation, achieved a grain yield of 5.1 t ha^{-1}, which nearly reached the three-year average yield in Slovakia for 2022–2024 (6.5 t ha^{-1}) (Zelená správa, 2025).

Supporting our research, results obtained in real practice, mainly in France, show that microbial inoculation of livestock effluents and field application of microbial preparations improve not only soil properties but also the chemical and energy quality of forage, particularly protein value, digestibility, and nitrogen efficiency, while maintaining or increasing production levels. These improvements contribute directly to greater feed self-sufficiency, reduced dependence on external inputs, improved nitrogen management, higher milk and meat production potential, and increased farm profitability (SOBAC, 2026).

CONCLUSION

Thanks to concentrated Bacteriolite technology, a farmer can activate manure or compost into an active medium capable of fertilizing even waste sludge from excavated gravel, which can then be used as a subsoil layer.

Acknowledgement

This work was supported by the VEGA 1/0532/24 project.

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