

Spectral and Paramagnetic Characterization of Soil Humic Substances Under Different Fertilization Regimes: Implications for Sustainable Grassland Management

Autorzy

Lubica Pospíšilová

Jana Plisková

Maria Jerzykiewicz

Vojtěch Enev

Kristýna Müllerová

Miloslav Pekař

Valerie Vranová

Pavel Nerušil

Ladislav Menšík

Rok wydania

2026

Czasopismo

Sustainability

Numer woluminu

18

Strony

6357/1-6357/15

DOI

10.3390/su18126357

Kolekcja

Naukowa

Język

Angielski

Streszczenie

Sustainable management of permanent grasslands requires evidence-based selection of fertilization practices that support long-term soil organic matter quality and ecosystem function. This study addresses the need to identify optimal agricultural practices in permanent grasslands and the effects of organic and inorganic fertilizers on soil humic substances (HS) composition and stability. Grassland plots were amended after cutting with mineral fertilizer (NPK), farmyard manure (FYM), cattle slurry (CS), or digestate (DIG), and humic acids (HA) were isolated using the standard International Humic Substances Society procedure. The elemental composition, total carbon and nitrogen contents, C/N ratio, and selected biogenic elements were determined using routine laboratory methods, while infrared spectroscopy, fluorescence excitation–emission matrix analysis, and electron paramagnetic resonance spectroscopy were applied to characterize chemical structure and semiquinone radical concentrations. Principal component analysis (PCA) indicated distinct clustering of fertilization treatments, which was supported by a statistically significant effect ($p < 0.05$) based on ANOVA. The results suggest that the fertilization regime was associated with variation in HS composition and radical abundance. DIG and NPK treatments showed lower O/C ratios and radical concentrations, potentially reflecting more reduced humic acids. In contrast, FYM and CS treatments tended to exhibit higher radical concentrations and O/C ratios. These findings highlight the importance of fertilizer type in shaping soil organic matter dynamics in managed grassland ecosystems and provide a scientific basis for the development of sustainable soil management strategies and environmentally sound fertilization practices in permanent grassland systems.

Typ publikacji

Artykuł

Słowa kluczowe

grasslands, humic substances, inorganic and organic fertilizers, sustainable soil management, soil organic matter quality, electron paramagnetic resonance, fluorescence spectroscopy

Licencja otwartego dostępu

CC-BY

Licencja na prawach której można swobodnie kopiować, rozprowadzać, zmieniać i remiksować objęty prawem autorskim utwór (Utwór-przedmiot prawa autorskiego) pod warunkiem podania imienia i nazwiska autora utworu pierwotnego oraz źródła pochodzenia utworu.

Pełny tekst licencji:

<https://creativecommons.org/licenses/by/3.0/pl/legalcode>

Adres publiczny

<http://dx.doi.org/10.3390/su18126357>

Strona internetowa wydawcy

<http://www.mdpi.com/journal/metals>