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Biochar and Microorganism-Mediated Enhancement of Barley Growth in Spolic Technosols Ecosystems

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ABSTRACT

Polycyclic aromatic hydrocarbons (PAHs) are among the most hazardous environmental pollutants. Among PAHs, 16 compounds are classified as the most dangerous contaminants, including benzo(a)pyrene (BaP), which exhibits mutagenic and teratogenic effects on living organisms. The challenge lies not only in monitoring the release of these organic pollutants into the environment but also in rehabilitating contaminated areas, which requires the selection of optimal remediation approaches and methods. The objective of this study was to evaluate the effects of biochar and microorganisms on the growth characteristics of barley grown on Spolic Technosols. To study the effectiveness of the combined application of biochar and PAH-degrading microbial strains on polyarene decomposition in soil, a model vegetation experiment was established. The experimental soil, a Spolic Technosols, was collected from the former Atamanskoye Lake area in the Rostov region, which had long served as a reservoir for industrial wastewater from a chemical plant. The experimental design included the following treatments: 1. Control; 2. Technosols; 3. Technosols + 5% biochar; 4. Technosols + bacteria; 5. Technosols + 5% biochar + bacteria. The control soil was a meadow-chernozem soil located 1.5 km away from Atamanskoye Lake. The PAH-degrading bacterial consortium consisted of *Rhodococcus erythropolis* and *Pseudomonas putida* applied at a dose of 10×10^8 CFU/kg. Statistical analysis was performed using Statistica 7 software. One-way ANOVA revealed significant differences in the morphometric parameters of barley grown in soils from different experimental treatments. The root and stem length of barley in the control group measured 14.9 cm and 30.4 cm, respectively. Tukey's test ($p < 0.05$) demonstrated that plants cultivated in Spolic Technosols exhibited significantly reduced root and shoot length compared to the control, with average differences of 5.4 cm and 5.8 cm, respectively. Thus, the applied remediation methods effectively reduced the toxicity of Spolic Technosols. The most significant improvement was achieved through the combined application of biochar and bacteria to the Spolic Technosols. In this treatment, the observed mean values of morphometric parameters approached those of the control group, with no statistically significant differences detected between plants grown in treated Spolic Technosols and control soils.

Keywords: PAHs, pollution, Spolic Technosols, biochar, *Rhodococcus erythropolis*, *Pseudomonas putida*

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