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Influence of humic substances on enhanced remediation of soil polluted by a copper-nickel smelter

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The problem of technogenic contamination through the anthropogenic activity is quite urgent nowadays. Long-term air pollution with sulphur dioxide and heavy metals (HM) by injuring vegetation and inhibition of plant and soil microorganisms growth and activity causes appearance of the barren areas – highly damaged eroded ecosystems requiring remediation. There are a lot of remediation ways, but an appropriate restoration method, which does not expensive, does not demand special technical support and corresponds to the natural conditions of soil development is still open to question.

We suggest application of exogenous humic substances as the possible environmentally friendly solution of HM toxicity problem and soil health restoration. Using of humates can result in the improvement of soil properties, localization of contamination by decreasing of HM mobility and bioavailability through binding them in relatively immobile complexes, and in stabilization of organic pool. But practice of scientific society as well as our previous investigations demonstrates ambiguous influence of exogenic humic substances on the behavior of HM depending on origin, doses, molecular weight of organic matter and state of microorganisms.

In this research we have provided series of short-term (45 days) experiments dedicated to the evaluation of suitable doses of humates of different origin – coal and peat - inoculated by nitrogen fixers and mycorhizae-forming fungi in comparison with lime and NPK-fertilizer on the properties of contaminated soil and mobility of HM. The object of investigation was Al-Fe-humus abrazems from the vicinity of mining-and-metallurgical integrated work located in the Kola Peninsula, Russia. This soil is characterized by the absence of vegetation, complete loss of the organic horizon in result of the erosion processes, low pH (pH H_2O 4.1-5.0), low exchangeable acidity (0.8–1.6 cmolc/kg), and depletion of organic mater (content of total carbon is 0.3-0.5%). The main pollutants are Ni and Cu. The efficiency of the proposed method was estimated by state of test-culture, native for the object in undisturbed conditions, and by the dynamics of microbiological activity (measurements was taken during the whole time of experiment). Experiments were provided in the climatic chamber in typical for summer period in the Kola sub-Arctic region conditions.

The obtained data show that peat-humates in chosen doses without combination with lime and NPK-fertilizer have no influence on pH, HM mobility, dissolved organic carbon concentrations and microbiological activity, but favorable for test-culture growing. Coal-humates application in chosen doses raises pH to 5.5-6.0, decreases HM mobility (from 4 mg/kg and 12 mg/kg to 1 mg/kg and 2 mg/kg for Ni and Cu accordingly) , does not require lime application and has positive influence on test-culture growing and microbiological activity. Inoculation of humates by nitrogen fixers has no effect while mycorhizae-forming fungi positively work in combination with coal-humates and cause development of root system of test-culture.

Promising results obtained in short-term experiments should be supported by further investigations.