Humic acids use to reduce the tailing dump toxicity in Primorsky region, Russia

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Samples from four toxic tailing dumps in the Primorsky region were used to assess the humic acids (HA) ability to bind toxic elements and to determine the optimal methods for their application and doses. The possibility of improving the conditions for the plants growth (using oats as an example) on the tailing dump upper layer under the humic acids action isolated from low-lying peat was studied. In laboratory experiments the possibility of binding toxic elements of HA, a decrease in the general toxicity of tailing dumps, as well as the efficiency of HA use for plant growth were determined. We used both aqueous solutions of HA preparations when watering planted seeds, and adding their dry powder into the surface layer before or after planting plants. The toxic elements were determined by the XRF-SR (storage ring VEPP-3, BINP SB RAS).

The laboratory experiment had six options for growing oats on dump samples: I - non-germinated seeds (control 1, without HA); II – the seeds with sprouted roots (control 2, without HA); III – the seeds with sprouted roots and watering with a solution with a HA concentration of 0.01%; IV - the same, with a HA concentration of 0.005%; V – the seeds with sprouted roots with the addition of HA dry powder to the dump after planting oats; VI - the same before planting oats.

It was revealed that the surface layer of tailings, among a wide range of microelements, contains a number of highly toxic elements, such as arsenic, copper, nickel, cobalt, cadmium, the concentration of which exceeds the permissible norms by 1-3 orders of magnitude. Only an insignificant part of the pollutant total pool can be inhibited by HAs located directly in the sediments. Without exception, all HA from peat, introduced into the tailing dump sediments, increased their saturation with toxic elements several times (from 1.5 to 5 and more times). The duration of exposure to HA had a directional effect on the amount of sorbed elements in the case of chromium, nickel, copper, and cobalt, but did not have a clear direction in the case of arsenic, zinc, and molybdenum. However, in both cases, the concentration of all elements increased significantly.

When HA interact in the form of different concentration solutions with tailings sediments, no pronounced relationship between the content of bound toxic elements and the concentration of HA solutions was revealed for the options considered.

It was shown that the toxic effect on oat plants when added to the surface layer of HA in the form of a powder was significantly reduced in both variants (5 and 6) even after exposure for 7 days; however, the best effect was obtained by adding HA in the form of a dry powder before planting hatched oat seeds (Variant 6).

Our study confirmed the perspectivity for the development of the direction associated with the use of HA, obtained from the lowland peat soils, to enhance the protective functions of tailings dumps, which leads to a decrease of their toxicity and increase the positive effect on the plant growing.