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Evaluation of PAHs bioaccumulation in spiked Haplic Chernozem soil (on benzo[a]pyrene example)

Svetlana Sushkova (1), Irina Deryabkina (Turina) (1), Abdulmalik Batukaev (2), Elena Antonenko (1), Jana Popileshko (1), Alina Gimp (1), Vishnu Rajput (1), and Tatiana Minkina (1)

(1) Southern Federal University, Rostov-on-Don, Russian Federation (snsushkova@sfedu.ru), (2) Chechen State University, Grozny, Russian Federation

Polycyclic aromatic hydrocarbons (PAHs) are representatives of the most significant environmental contaminants with mutagenic and carcinogenic properties to all living organisms. The assessment of regularities of PAHs biogeochemistry in soil-plant system is one of the major indicators of the environmental monitoring system. Benzo[a]pyrene (BaP) is the main marker of soil-plant system pollution by PAHs. The maximal permissible concentrations (MPC) for BaP is 20 μg kg-1.

The aim of the research was evaluation of PAHs bioaccumulation in spiked Haplic Chernozem soil, on BaP example. Haplic chernozem was spiked with various doses of BaP (20, 200, 400 and 800 μg kg-1) equivalent to 1, 10, 20 and 40 levels of MPC planted with spring barley (Hordeum sativum distichum). The experimental soil samples were planted every spring and incubated outdoor during 4 years. The express-method of subcritical water extraction was used for BaP extraction from samples.

Evaluation of PAHs bioaccumulation in spiked Haplic Chernozem soil was measured by counting the next indicators: The rate constant of BaP degradation in the soil samples (Ks, years-1) was calculated from the equation: Ks = -ln (Ct/Co)/t, where Co and Ct are BaP concentrations in soil: initial and in a point t (years) of incubation respectively. The period of BaP semi-degradation in soil (T50, years) was counted from the equation: T50=0,693/Ks. The bioaccumulation factors for BaP in roots and vegetative part of barley plants (BAFr and BAFv respectively) were counted as a ratio of its concentrations in the respective parts of plant to BaP concentration in soil.

The values of BaP period of semi-degradation in soil (T50, years) contaminated with 10, 20 and 40 MPC deviated from 1.4 to 1.8 years, while these values in low contaminated soils deviated from 2.9 to 5.4 years. The BaP concentrations in plants depended on initial BaP contamination and reduced simultaneously with diminish of BaP concentration in the related spiked samples.

Growing of spring barley in the BaP spiked soils lead to BaP accumulation in the plants. The coefficients BAFr and in roots and BAFv in vegetative part fluctuated within 0.035-0.065 and 0.015-0.025 respectively at the 1st season and then reduced about twice to the 4th season. Meantime those values in control soils vice-versa increased twice from 0.03 and 0.01 respectively. These data can be explained by higher BaP availability in the spiked soil and low availability of the BaP residues after its degradation in soil. Low available original BaP in native Haplic chernozem might become more available during long incubation of the soil in favorable conditions that could bring to deliberation of the native bound BaP from soil humus.

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