

THE USE OF CONIFEROUS PLANTS AS PHYTOREMEDIATORS OF TECHNOSOIL IN UKRAINIAN STEPPE

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In the process of coal mining, particularly under conditions of operation of mines, significant disturbance and pollution of land occurs, being especially relevant for agricultural lands. Arboreous vegetation that grows in poly-elemental man-made anomalies conditions primarily serves as a mechanical barrier for aerogenic migration of metals. Soil and plant objects are involved in all processes of transformation and migration of substances occurring in the biosphere. The state of assimilation apparatus of arboreous plants can be used as an object of environmental monitoring, which is associated with assessment of their environment stabilizing role as a mediator of pollutants spreading into the environment. The purpose of this research was studying peculiarities of accumulation of elements of the heavy metals group in assimilation apparatus of coniferous tree species, which grow under conditions of mining rock.

Sample plots for the research were established on the forest reclamation site of mine "Pavlohradsk" in Dnipropetrovsk region, Steppe zone of Ukraine. Samples of vegetal material were taken from plants, which were growing on mine rock (technosoil). The object of the study was represented by foliage biomass (needles) of Crimean pine (*Pinus pallasiana* L.) trees.

Mine rock was defined as heavy loam, light and middle clays and characterized by adverse water-physical properties. The sulfur content in mine rocks indicated that the amount of pyrite was changing from 1.8 to 3.3%. Acidity (pH) was 4.8.

Determination of metals concentrations in mine rock and vegetal material was carried out by the method of plasma-optical emission spectrometry (ICP-OES) using Technologies 5100 (Agilent) spectrometer with inductively coupled plasma (University of Girona, Spain).

The comparative analysis of compliance with the maximum permissible concentrations (MPC) norms has demonstrated absence of excess for only one among the nine substances under research – Manganese. The results of analysis of other inorganic contaminants in mine rock have exceeded the MPC values for chemical substances in soil to various extent: Pb – 1.3; Zn – 2.5; Sb – 9.0; Cu – 9.2; Ni – 10.8; As – 12.9; Cr – 15.7; Sn – 20.3 times.

The studied chemical substances in the assimilating fraction of above-ground live biomass of investigated species were divided into 3 groups of concentration (mg/kg of dry mass): 1) substances with excess concentration (113.7–510.6) – *Mn*; medium concentration (41.5– 69.2) – *Pb*, *Zn*; low concentration (0.8–11.9) – *Sb*, *Cr*, *As*, *Cu*, *Ni*, *Sn*.

To characterize remediation potential for the investigated species, the coefficient of biological accumulation of metals by foliage fraction of their above-ground live biomass was calculated. Thus, the leaves fraction of the Crimean pine aboveground phytomass per unit area is able to accumulate the inorganic contaminants, ranging from 1.46 to 2134.35 kg·ha⁻¹.

It was determined that the lowest accumulation in Crimean pine foliage biomass is characteristic for such metals as *Sb* and *As*. Translocation of manganese occurs most intensively. The second position in terms of gross content in foliage fraction is presented by lead and zinc, which are elements with synergistic action when accumulated in soils. An average content of lead included in this research is 209.11 kg·ha⁻¹. For Crimean pine needles it was found that zinc is accumulated in lower quantities – 125.38 kg·ha⁻¹. According to the results of our research it was found that for Crimean pine processes of translocation of such metals as *As*, *Sb*, *Ni* to assimilation apparatus are slowed down as compared to *Cr*, *Mn*, *Zn*.

Determination of content of heavy metals in mine rock and foliage biomass Crimean pine needles shows stabilization of content of heavy metals in the substrate. According to bioaccumulation coefficient, Crimean pine can be considered a hyperaccumulator of lead, which substantiates its use as a phytoremediation agent.

Key words: Coal mining, Coniferous Tree Species, Phytoremediation