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THE FEATURES OF RADIONUCLEIDES ACCUMULATED BY DISTURBED SEMIPALATINSK TEST SITE VEGETATION ECOSYSTEMS

The ability of plants to accumulate radionuclides, the methods for its quantitative assessment, and dependence on a large number of different factors and conditions that make it possible to control the removal of radionuclides are not well understood. Meanwhile, the results of such studies allow us to draw conclusions about the possibility of botanical rehabilitation (phytoremediation) of territories contaminated during nuclear tests.
These data can be the basis for predicting the content of radionuclides in fodder plants during animal husbandry in contaminated areas, and therefore for predicting radioactive contamination of food products (meat, milk, etc.). When harvesting medicinal raw materials, data on the accumulation of radionuclides in plants are also needed.
The ability of plants to accumulate a radioactive component is assessed by the factor of radionuclide transfer from the soil to the ground part of the plants. The accumulation factor is used to quantify the transition factor. It depends on the type of soil, their physical and chemical properties and mechanical composition of the content of exchangeable potassium, pH of the soil solution, organic matter and biological characteristics of plants, as well as soil moisture. The determination requires data on the nature of the distribution of radionuclides and plant roots in the soil layer.
On the basis of gamma-spectrometric analysis of paired samples «plant-soil» for the first time in 1998 at the Semipalatinsk test site, the values of radionuclide transfer factors for 14 species of higher plants and one species of lichen were obtained. The studies were carried out in the most common communities of the main types of vegetation. Plants are ranked in descending order of their transition factors. The range of transition factors for these plants is significant. The coefficient of accumulation of radiocesium in the studied plants ranges from 0.029 to 3.732. In this paper, the results of research are considered by us in anthropogenically disturbed ecosystems.
In ecosystems disturbed by nuclear explosions, the highest ability to accumulate radiocesium was found in the lichen Parmelia vagans. With a specific activity of Cs137 of 14 470 Bq/kg (in a soil layer of 0-10 cm), it accumulates in lichen up to 54 000 Bq/kg. The accumulation factor is 3.732. The selection of a paired sample "plant-soil» was carried out on a site disturbed by engineering and technical communications irradiated with radiation.
The exposure dose rate (PED) of gamma radiation reached 150-280 μR/h. Anthropogenically disturbed meadow-desert-steppe solonetzes are formed on the leveled area of the gentle slope to the sor depression. The mechanical composition of the soils is heavy loamy. As a result of planning and possibly decontamination works, the suprasolonetz soil horizon has been disturbed. The upper 10 cm layer does not have a complete set of features characteristic of this soil type. Vegetation cover is broken. The total projective cover ranges from 50 to 70%. Of these, 40-50% are occupied by Parmelia vagans.
A significant radiocesium transfer factor was registered in the xeromesophytic dwarf shrub Ephedra distachya. With a specific activity of radiocesium of 51 Bq/kg in a soil layer of 0-5 cm, it accumulates up to 67 Bq/kg in the overground part of the plant. The accumulation factor is 1.314. Paired sampling was carried out on a military-technical facility covered with soil, which rises 1.5 m above the surface of a wide flat inter-hill plain. The soil is gravel-stony, sandy loam, with fragments of building concrete. The total projective cover ranges from 10-15 to 100%. Of these, Ephedra distachya occupies from 9-10 to 95%. The roots are located in a layer of soil 0-5 cm from the surface. Maximum permissible concentration (MPC) of gamma radiation reaches 150 mR/h. Determination of the factor of transfer of radiocesium to aboveground organs in the semishrub Atriplex cana was carried out on a leveled gentle slope to a sor depression in the zone of influence of a power line. MPC of gamma radiation reaches 120-130 Bq/kg. Meadow-desert-steppe solonetzes are formed here. Under these radioecological conditions, sparse communities of Camphorosma monspeliacum with participation of Atriplex cana communities are formed. Of the plants typical for these soils, densely sod grasses have been preserved - the xerophytes Stipa sareptana and Khoeleria cristata, the halomesoxerophytic semishrub Kalidium schrenkianum, and the lichen Parmelia vagans. This community is one of the stages in the restoration of haloxerophytic coenoses typical of meadow-desert-steppe solonetzes. The projective soil cover by plants does not exceed 30-40%. The ground cover is not formed. The penetration depth of Atriplex cana roots reaches 80-85 cm. The specific activity of radiocesium in the soil layer of 0-9 cm is 5 397 Bq/kg. In the above ground part of Atriplex cana, it accumulates up to 2 770 Bq/kg. The accumulation coefficient is 0.513. To determine

the factor of radiocesium transfer from the soil to the aboveground part of the mesophytic perennial Potentilla virgata, an elevated flat area in the central part of the stream valley was selected. In 1992, at the experimental site "Degelen"there was an outpouring of water in 27 adits. 24 estuarine areas were contaminated to some extent with radioactive substances. The PED value reached 1-5 μR/h. There was a migration of radioactive substances with water. Subsequently, their sorption was observed soil and vegetation. Paired samples "plant-soil"were taken on the meadow carbonate steppe, stony soil. Its hydration is superficial. Vegetation cover is represented by mesophytic grass-forb community (Galatella biflora. G. angustissima, Potentilla virgata, P. bifurca, Elytrigia repens, Calamagrostis epigeios, Phragmites australis). This is one of the stages of restoration of this cenosis after periodic burning of the herbage. The projective cover does not exceed 60-70%, ground cover - 5-10%. The depth of penetration of the roots is 90 cm, the soil layer is 0-10 cm most saturated with them (184 g/m2). Activity of radiocesium in the layer 0-6 cm 1 513 Bq/kg in the overground part of Potentilla acaulis accumulates 320 Bq/kg. The accumulation coefficient is 0.212.
Thus, γ - spectrometric analysis (paired samples "soil-plant") of the dominant species of disturbed ecosystems found that all the plants we studied are hyperaccumulators. The highest accumulation coefficients of radionuclides were found in the lichen Parmelia vagans - 3.732 and in the overground part of mesoxerophytic shrub Ephedra distachya –1.314. With a significant projective soil cover by these species, their use in phytoremediation of disturbed ecosystems is possible.

Section

Radiation ecology and methods of analysis (Section 3)

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