Phytoremediation of radionuclide-contaminated soil - long-term trial in sunflower cultivation

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1 Introduction

The last nuclear power plant in Germany was shut down on 15 April 2023. In addition to contaminated construction waste, significant quantities of contaminated soil must also be disposed of during decommissioning. In order to avoid expensive disposal of these soils in deep geological repositories, concepts for volume reduction and decontamination are being investigated. One of these is phytoremediation, a technique we are focusing on in this paper. In particular, we investigate the potential of sunflowers for radionuclide uptake from contaminated soil in order to optimize efficiency and time.

2 Material and methods

The soil originates from the site of the former Dresden Rossendorf reactor operated from 1957 to 1991 [1]. Due to the extended time period since decommissioning, the radionuclides reached a chemical equilibrium state. This state is difficult to reproduce on short time scales by spiking uncontaminated soils. Therefore, plants are grown in soils from the contaminated sites. Before planting, the soil is sieved to 2 mm to remove concrete particles. The experiment is carried out in plant pots (Ø x H: 18 cm x 17 cm) in a climate chamber with optimized growth conditions. Small sunflowers, Helianthus annuus, are planted. These have delivered promising results in inactive preliminary trials. In order to support the growth of the plants, Hoagland solution was used for irrigation [2]. The growth of the sunflowers are analyzed every month. Three pots are harvested per month and the plants are divided into their stem, leaf and flower components. The specific gamma activity of each of these samples is measured by using an HPGe detector. Soil to plant transfer factors are finally calculated using the previously measured specific activity of the soil.

3 Results and discussion

The experiments indicate that the transfer factor for both Cs-137 and Co-60 in the stems and leaves is already at its maximum after the second month and that the largest proportion of radionuclide uptake therefore occurs in the second month. The development of the transfer factor for Cs-137 is shown in Figure 1. It is related to the growth phases of the sunflower: between the first and second month, the plants grow in length [3]. This ends in the third month. The transfer factors for the nuclides become smaller again in the third month. This work shows that the uptake of Cs-137 and Co-60 depends on the growth phases of the sunflowers.

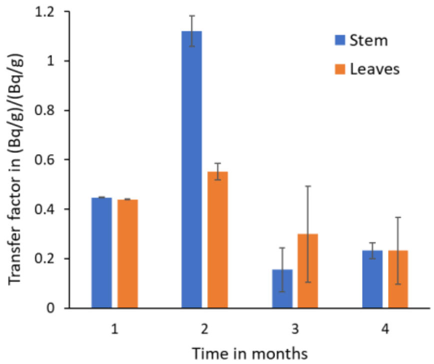

Fig. 1: The diagram shows the temporal development of the transfer factor for Cs-137 in stems and leaves of sunflowers in the first few months.

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