Assessment of the availability of heavy metals to plants based on the translocation index and the bioaccumulation factor

Piotr Pachura, Agnieszka Ociepa-Kubicka*, Beata Skowron-Grabowska

Faculty of Management, Czestochowa University of Technology, 42-200 Czestochowa, Poland, Tel. +48608469741; email: agnieszkaociepa22@wp.pl (A. Ociepa-Kubicka)

Received 10 July 2014; Accepted 19 January 2015

ABSTRACT

The bioconcentration factors and the translocation index have been determined for the assessment of the level of phytoextraction in plants. The bioaccumulation factor, determined as the quotient of the content of a given metal of the plant to its content of soil, defines the ability of the plant to accumulate heavy metals. The translocation index, $T_i$, is a measure of the phytoextraction capacity of plants. This index provides a useful means of the quantitative description of relative differences in the biological availability of metals to plants. This paper presents the results of studies on the effect of fertilizing soil on the ability to translocate cadmium, zinc, lead, and nickel from the soil to the roots, and then to the above-ground parts of Virginia fanpetals. The source of the results was a pot experiment conducted under semi-natural conditions from April 2007 to November 2011. The studies described in this paper concern the last year of the experiment (the plant crop in November 2011). Six fertilization combinations plus soil control were used in the experiment, each in three repetitions. Sewage sludge in three doses: 10, 20, and 40 t/ha, and two composts (one made from Dano urban greenery, and one produced from sewage sludge and forest waste) in a dose of 20 t/ha were used for plant cultivation. Great differences in bioaccumulation indices were observed between the above-ground parts and the roots of the plants and between individual metals, while there were small differences between individual fertilization types. The level of translocation of metals from the underground parts to the above-ground ones depended primarily on the kind of metal and fertilization applied. By analyzing the values of the translocation index, $T_i$, for individual metals, the following relationship was obtained. It should be noted that definitely higher $T_i$ index values were obtained for cadmium and zinc than for lead. The zinc translocation amounted to approx. 40–50%, while the translocation of cadmium reached a level of even approx. 70–80%. The lead translocation was very low, amounting to about 10% at the maximum. The low mobility of lead in the root—above-ground part system reduced the phytoextraction process.

Keywords: Heavy metals; Translocation; BFC

*Corresponding author.

Presented at the 12th Scientific Conference on Microcontaminants in Human Environment 25–27 September 2014, Czestochowa, Poland

1944-3994/1944-3986 © 2015 Balaban Desalination Publications. All rights reserved.