植物学报 CHINESE BULLETIN OF BOTANY
ISSN 1674-3466
CN 11-5705/Q

植物学报 » 2011, Vol. 46 » Issue (4) :425-436 DOI: 10.3724/SP.J.1259.2011.00425
研究报告

植物对土壤中铀的吸收与富集

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Uranium Uptake and Accumulation in Plants on Soils

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摘要 核工业发展导致重金属铀排放和扩散, 并造成了地表土壤的污染, 对人类的生存环境产生了极其不利的影响。如何修复铀污染土壤成为亟待解决的问题。近年来发展起来的植物修复技术以其成本低廉、安全和环保的特点成为修复铀污染土壤的新选择。寻找理想的铀富集植物是这一技术的基础和关键。该文通过实验模拟铀污染的土壤(土壤中铀的浓度为100 mg·kg^{-1}), 进行一次和二次铀污染土壤的植物修复后, 从4个方面对植物修复铀污染土壤效果进行评估, 即富集铀的浓度、生物提取量、生物富集系数(BFS)和转运系数(TFS)。实验结果表明: 第1次修复时, 四季香油麦菜(*Lactuca dolichophylla*) 地上部富集铀的浓度为1.67×10^3 mg·kg^{-1}, 生物富集系数和转移系数均大于3; 第2次修复时, 麦冬(*Ophiopogon japonicus*) 富集铀的浓度与第1次修复相比变化不大, 而吊兰(*Chlorophytum comosum*)、四季豆(*Phaseolus vulgaris*)和艾蒿 (*Artemisia lavandulaefolia*)富集铀的浓度与第1次修复相比均减少4–8倍; 施加土壤改良剂鸡粪肥、海藻肥和柠檬酸后发现海藻肥和柠檬酸能够增强植物对铀污染土壤的修复; 对两次修复土壤中铀的形态进行对比分析, 发现二次修复时土壤中生物有效态铀的含量降低, 造成第2次修复的难度增加。

关键词: 富集 添加剂 植物修复 土壤 铀

Abstract: With the development of the nuclear industry, heavy metal uranium (U) emissions and diffusion have led to U contamination of surface soils, which have had a great impact on society and the environment. How to remedy U-contaminated soils is a difficult problem. Phytoremediation is welcomed for cleanup because of its low cost, safety and environmental friendliness. Searching for accumulators for U is the key to this technology. We designed simulation experiments for soil contaminated with 100 mg·kg^{-1} U for first and second phytoremediation. The effects of phytoremediation were evaluated in terms of U concentration in shoots and roots of plants, U export, bioaccumulation factors (BFS) and translocation factors (TFS). The first phytoremediation indicated that BFS ($[U]_{plants}/[U]_{soils}$) and TFS ($[U]_{shoots}/[U]_{roots}$) of *Lactuca dolichophylla* are more than 3, and U concentration in shoots reached 1.67×103 mg·kg^{-1}. The second phytoremediation showed that the U concentration of *Chlorophytum comosum*, *Phaseolus vulgaris*, *Artemisia lavandulaefolia* but not *Ophiopogon japonicus* decreased by 4- to 8-fold. Amendments with seaweed fertilizer and citric acid could help remediate U-contaminated soil. The available U for the second phytoremediation on soil was decreased, which made the second phytoremediation more difficult.

Keywords: accumulation amendment phytoremediation soil uranium

Received 2010-10-20; published 2011-07-01

Fund:

螯合诱导植物修复土壤中的铀

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引用本文:
万芹方, 陈雅宏, 胡彬等.植物对土壤中铀的吸收与富集[J] 植物学报, 2011,V46(4): 425-436

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Qinfang Wan, Yahong Chen, Bin Hu etc.Uranium Uptake and Accumulation in Plants on Soils[J] , 2011,V46(4): 425-436