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SA Shafiei Darabi[1], A Almodares[1]* and M Ebrahimi[2]

[1]Department of Biology, Faculty of Science, University of Isfahan, Isfahan, Iran
[2]Department of Bioinformatics and Department of Biology, University of Qom, Qom, Iran

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***Corresponding author:** A Almodares, Department of Biology, Faculty of Science, University of Isfahan, Isfahan, Iran, E-mail: aalmodares@yahoo.com

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Research Article

Phytoremediation Efficiency of *Sorghum bicolor* (L.) Moench in Removing Cadmium, Lead and Arsenic

Abstract

Heavy metals are a significant problem in municipal wastewater, in soil accumulation and are costly to remove in order to facilitate water use in irrigation. Wastewater, with three heavy metal cations and an anion, was employed in irrigation during the *Sorghum bicolor* (L.) Moench growth period. Results show that the absorption coefficient or bioaccumulation ability of *Sorghum bicolor* (L.) Moench is relegated to certain heavy metals and their concentrations, but not at all to plant tissues in dry ash weight (DAW) scale. Heavy metals absorption was determined in the following order: cadmium = lead > arsenic, and while tissue accumulation based on DAW was equal for cadmium and lead, based on dry weight (DW) all three ions differed. The soil's ability to accumulate heavy metal ranked as follows: cadmium > lead > arsenic by wastewater quality in this experimvent. These results change many previous ideas about decreasing the transportation of heavy metals from root to shoot or other organs in plants. With low cadmium and lead concentration in irrigation, sorghum is a good plant for remediation; however, in high concentration this plant benefits from arsenic remediation. Soil is a critical parameter for wastewater phytoremediation. This topic merits further research.

Introduction

Wastewater is a new water resource for agriculture and green space. However, wastewater carries pollution of many types, such as heavy metals, synthetic materials and coliform bacteria. Heavy metals are not biodegradable in the environment. When accumulated in ecosystems, heavy metals are very harmful even if present in low concentrations [1].

Soil's ability to accumulate heavy metals is very important in soil pollution. Deposition of solutes in water or soil may occur at different pH in varying concentrations of many compounds, such as sulfates. This process reduces the soil's heavy metal content and its rhizosphere concentration through leaching and irrigation runoff [2].

Human activity distributes in the environment numerous toxic heavy metals; this includes industrial and urban activity, as well as agricultural pesticides. Cadmium is a contributor or the primary agent in toxic heavy metals, because it has a different source for environment disruption and high toxicity, as delineated in numerous research articles [3,4]. Lead is another toxic heavy metal, present in rising proportions in wastewater because it is a component in vehicle fuels, especially in urban settings [5]. Arsenic is yet another heavy metal, possessing a negative ionic charge, leading to differing actions or interactions in soil and root absorption.

Plant remediation/phytoremediation is a leading method for soil decontamination. Plants' roots, soil and sewage can be treated through degradation, absorption, storage or transfer of polluted reagents [6].

Heavy metal hyper accumulating plants can absorb and accumulate high levels of toxic ions in their tissues, and then can be used as toxic ion remediators. Plants vary in their ability to detoxify different ions in heavy metals from soil and water, so that each hyper accumulator plant may accumulate any heavy metal more than others and be more suitable for any heavy metal ion remediation [2].

Plants used in phytoremediation may produce hazardous biomass with high levels of toxic material, rendering them unusable in food or livestock. Consequently, the selection of plants with high remediation ability and economic value is vital to phytoremediation.

Sorghum is a core agricultural plant in tropical areas. It is the fifth most consumed cereal in the world, used as food, animal feed and biofuel [7]. Sorghum can grow through wastewater irrigation, and has many remediation properties in soil pollution [8].

The aim of this research is to investigate the practical remediation ability of sorghum on heavy metal–polluted wastewater to improve an actual method for sewage usage.

Material and Methods

Culture conditions

3–5 seeds of sorghum were cultivated in pots 30 cm high (15 kg) in 16 h light and 8 h dark photoperiods, at 28 °C and 18 °C, respectively. The pots were irrigated 3 times a week during a 12-week growth period.

Soil analysis

Soil samples were taken from all treated pots (100 gr),