



The responses of a soil bacterial community under saline stress are associated with Cd availability in long-term wastewater-irrigated field soil

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HIGHLIGHTS

- Soil salinity increased Cd availability in Cd-contaminated soil due to long-term wastewater irrigation.
- Saline stress significantly changed major soil bacteria in Cd-contaminated soil.
- Bacterial community structure is associated with soil Cd availability under saline stress.
- Seasonal variation played a critical role in altering soil physiochemical characteristics and shaping bacterial communities.

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ABSTRACT

Long-term wastewater irrigation impacts soil geochemical properties (salinity, pH and soil aggregates) and promotes the bioaccumulation of heavy metals to plants, which may change soil function, decrease soil health, decrease the productivity of farmland, and even cause land degradation. In this study, we explored the impact of saline stress on soil bacterial communities and Cd availability in long-term wastewater-irrigated field soil. Different amounts of saline stress by adding 0.1, 0.3 and 0.5% salts in a fixed proportion ($\text{NaCl} : \text{Na}_2\text{SO}_4 : \text{NaHCO}_3 : \text{Na}_2\text{CO}_3 = 1:9:9:1$) were applied in a 1-year, multiple cropping system with winter wheat (*Triticum aestivum* L.) and summer maize (*Zea mays* L.) in wastewater-polluted soil. Increased salinity in the soil increased Cd availability: compared with CK (no extra salts addition), addition of 0.5% mixed salts significantly increased soil available Cd up by 67.5% and grain Cd concentration by 43.7%, and adding 0.5% salts also resulted in the increases of soil pH (−0.5 unit) and electric conductivity (97.4%). Soil saline stress significantly changed major soil microbes in Cd-contaminated soil. Increased saline stress enriched taxa in the Bacillaceae, Staphylococcaceae and Pseudomonadaceae bacterial families, while one family within Proteobacteria (Sphingomonadaceae) was the most sensitive biomarker, based on Cd contamination without saline stress in CK-treated soils. Structural equation modeling (SEM) analysis revealed that soil saline stress induced an increase in soil Cd availability that was regulated by the bacterial community.

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1. Introduction

Agricultural irrigation with wastewater is inevitable, due to severe water scarcity in arid, semiarid and dry areas around the world, unfortunately the use of untreated wastewater is becoming an urgent problem especially in developing countries. Globally, at least 18 million hectares of land are irrigated by treated, untreated

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