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PII: S0098-8472(14)00270-6
DOI: http://dx.doi.org/doi:10.1016/j.envexpbot.2014.11.008
Reference: EEB 2886

To appear in: *Environmental and Experimental Botany*

Received date: 13-6-2014
Revised date: 10-11-2014
Accepted date: 18-11-2014

Please cite this article as: Shi, Gangrong, Xia, Shenglan, Ye, Juan, Huang, Yanan, Liu, Caifeng, Zhang, Zheng, PEG-simulated drought stress decreases cadmium accumulation in castor bean by altering root morphology.Environmental and Experimental Botany http://dx.doi.org/10.1016/j.envexpbot.2014.11.008

PEG-simulated drought stress decreases cadmium accumulation in castor bean by altering root morphology

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Highlights

Drought stress reduces Cd uptake and accumulation in plants of castor bean.
Cd accumulation in castor plants positively correlates with root morphology.
No significant correlation was found between Cd accumulation and transpiration rate.
Drought-induced decrease in Cd uptake may be due to the change of root morphology.

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Abstract

This study aimed to test the hypothesis that root morphology and transpiration may have a crucial role in drought-induced change in cadmium (Cd) uptake and accumulation in plants. The biomass, Cd accumulation, spectral reflectance, gas exchange, and root morphology of castor bean were determined under different polyethylene glycols (PEG) concentrations (0, 2.5%, 5%, and 10%) along with 0.2 μM $CdCl_2$ through a hydroponic experiment. All tested morpho-physiological parameters of the castor bean were unaffected upon exposure to 0.2 μM $CdCl_2$. PEG-induced drought stress repressed root growth, inhibited leaf gas-exchange, and reduced Cd uptake and accumulation in plants, but increased the photosynthetic pigment contents, as indicated by spectral reflectance indices. Cd accumulation in the roots and shoots, as well as the total Cd in the castor bean plants, positively correlated with plant growth, root/shoot ratio, total root length, surface area, root volume, root tips, and root length with the diameter classes of 0 mm to 0.2 mm, 0.2 mm to 0.4 mm, and 0.4 mm to 0.6 mm. No significant correlation was found between Cd accumulation and transpiration rate. Therefore, the drought-induced reduction of Cd uptake in castor plants may have resulted from the inhibition of root growth and alteration of root morphology, rather than from the decreased transpiration.

Keywords: castor bean, drought stress, cadmium accumulation, root morphology

1. Introduction

Cadmium (Cd) is one of the most hazardous and common pollutants in the environment. Cd can be easily absorbed by plant roots, and then transported into the plant aerial parts, thus posing as risks to human health by entering into the food chain (Gill and Tuteja, 2011). The mechanisms underlying Cd uptake, accumulation, and translocation in plants have been extensively studied in recent years in an attempt to reduce the Cd concentration in the edible parts of crops for safe food production or enhance Cd accumulation in aerial parts of plants for phytoextraction (Lux et al., 2011; Uraguchi