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Individual and combined application of EDTA and citric acid assisted phytoextraction of copper using jute (*Corchorus capsularis* L.) seedlings

Muhammad Hamzah Saleem [a], Shafaqat Ali [b,*], Muzammal Rehman [c], Muhammad Rizwan [b], Muhammad Kamran [d], **Ibrahim A.A. Mohamed** [a], Zaid khan [a], Atif A. Bamagoos [e], Hesham F. Alharby [e], Khalid Rehman Hakeem [e], Lijun Liu [a,*]

[a] *MOA Key Laboratory of Crop Ecophysiology and Farming System in the Middle Reaches of the Yangtze River, College of Plant Science and Technology, Huazhong Agricultural University, Wuhan 430070, China*

[b] *Department of Environmental Sciences and Engineering, Government College University, Allama Iqbal Road, 38000 Faisalabad, Pakistan*

[c] *School of Agriculture, Yunnan University, Kunming 650504, China*

[d] *Key Laboratory of Arable Land Conservation (Middle and Lower Reaches of Yangtze River), Ministry of Agriculture, Huazhong Agricultural University, Wuhan, 430070, PR China*

[e] *Department of Biological Sciences, Faculty of Science, King Abdulaziz University, 21589 Jeddah, Saudi Arabia*

abstract

Jute (*Corchorus capsularis*) can generate substantial biomass and has the ability to uptake large amounts of heavy metals from metal-contaminated soil. However, a low bioavailability of heavy metals in soil or other media and insufficient movement of heavy metals in the above-ground parts of the plant limit phytoextraction efficiency. The application of chelators, such as citric acid (CA) and ethylenediaminetetraaceticacid (EDTA), increases metal uptake by plants. In addition to improving the phytoextraction potential of a plant, chelator application can improve plant growth, chlorophyll contents, and gas exchange attributes while alleviating oxidative stress by enhancing the antioxidative defence system. This article discusses the individual and combinatorial effects of CA and EDTA on copper (Cu) uptake and its translocation to harvestable parts of *C. capsularis*. The effects on plant growth, biomass, chlorophyll contents, gaseous exchange attributes, oxidative stress, antioxidative enzyme and cellular organelles (transmission electron microscopy study) were investigated using 3 mM of EDTA and 3 mM of CA in Hoagland nutrient solution under a Cu level of 80 μML^{-1}. All plants were able to grow for 28 days in the nutrient solution in a growth chamber (Philips 20W TLD, China) under conditions of 12 h natural light per day. The results revealed that, relative to the control treatment (no chelator application), the individual and combinatorial application of CA and EDTA increased the phytoextraction potential of *C. capsularis* by increasing Cu uptake in roots, stems and leaves. Furthermore, both chelators improved plant growth, biomass, chlorophyll contents, gas exchange attributes and ultra-structure of chloroplast while ameliorating oxidative stress by enhancing the antioxidative defence system. Analyses of bioaccumulation factor (BAF) and translocation factor (TF) revealed that *C. capsularis* has potential to perform the phytoextraction of Cu, and the values of BAF and TF in Cu-stressed plants significantly increased under chelator application. EDTA was more effective than CA in increasing phytoextraction potential and improved growth and development in *C. capsularis*. The results of this study suggest that the co-application of these chelators represents an efficient strategy for improving the phytoextraction of Cu by jute grown in Cu-contaminated soil.

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