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Cost-effectiveness of boron (B) removal from irrigation water: an economic water treatment model (EWTM) for farmers to prevent boron toxicity

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Abstract

Protection of water sources which are used for irrigation has raised great interest in the last years among the environmental strategists due to potential water scarcity worldwide. Excessive boron (B) in irrigation water poses crucial environmental problems in the agricultural zones and it leads to toxicity symptoms in crops, as well as human beings. In the present research, economic water treatment models consist of dried common wetland plants (Lemna gibba, Phragmites australis, and Typha latifolia) and Lemna gibba accumulation was tested and assessed to create a simple, cost-effective, and eco-friendly method for B removal from irrigation water. Significant amount of B was removed from irrigation water samples by EWTMs and B concentrations decreased below < 1 mg L^{-1} when the components were exposed to 4 and 8 mg L^{-1} initial B concentrations. Moreover, the results from batch adsorption study demonstrated that dried L. gibba had a higher B loading capacity compare to other dried plants, and B sorption capacity of dried L. gibba was found as 2.23 mg/g. The optimum pH value for sorption modules was found as neutral pH (pH = 7) in the batch adsorption experiment. Boron sorption from irrigation water samples fitted the Langmuir model, mostly B removed from irrigation water during the first 2 h of contact time. Techno-economic analysis indicated that EWTM is a promising method that appears to be both economically and ecologically feasible, and it can also provide a sustainable and practical strategy for farmers to prevent B toxicity in their agricultural zones.

Keywords: Boron removal; Dried plants; Irrigation water; Lemna gibba; Sorption.

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