The utilization of Artificial Neural Networks (ANN) and Response Surface Methodology (RSM) in conjunction to improve the sustainable phytoextraction of lead from contaminated soil

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Abstract:

Lead (Pb) confinement on the soil surface is commonly acknowledged. For the past few decades, the most successful method for removing lead from soil has been phytoremediation, which entails several chemical reactions and cost analysis. To model and optimize Pb extraction from the contaminated soil via Pelargonium hortorum, this research compares two modeling approaches: artificial neural networks (ANNs) with the genetic algorithm (GA) and response surface methodology (RSM). To determine the importance of the suggested solution, bacteria and citric acid were co-applied on a Pb hyperaccumulator (Pelargonium hortorum L.) on Murashige and Skoog (MS) agar medium after the Pb tolerance of the bacterial strains (NCCP 1844, 1848, 1857, and 1862) was evaluated in vitro studies. Next, to optimize Pb extraction capability from Pb-spiked (0 mg kg-1, 500 mg kg-1, 1000 mg kg-1, and 1500 mg kg-1) soil, Pelargonium hortorum L. was employed in a pot culture experiment. Microbacterium paraoxydance (1 and 1.5 OD) and citric acid (5 and 10 mmol L-1) were added to the mixture. Plants were taken out at 30, 60, and 90-day intervals, and their dry biomass and Pb uptake properties were examined. The maximum Pb extraction efficiency of 86.0% was reached after employing 500 mg kg-1 soil Pb for 60 days. Moreover, Pb extraction from the soil was simulated using RSM. It was predicated on the ANN-based Levenberg- Marquardt Algorithm (LMA) and the Box-Behnken design (BBD). The relevance of the RSM and LMA projected values was demonstrated by their proximity to 36.0% and 86.05%, respectively. Upon careful examination, these findings validated the effectiveness, precision, and stability of the ANN throughout the optimization procedure. Therefore, experimental results showed that ANN is an accurate technique to optimize an integrated phytoremediation system for sustained Pb removal, in addition to being potentially economical and environmentally benign.

Keywords:

Soil pollution, bacteria, ANN, RSM, and citric acid.