Statistical optimization of the phytoremediation of arsenic by ludwigia octovalvis in a pilot reed bed using response surface methodology (RSM) versus an artificial neural network (ANN)

ABSTRACT

In this study, the removal of arsenic (As) by plant, Ludwigia octovalvis, in a pilot reed bed was optimized. A Box-Behnken design was employed including a comparative analysis of both Response Surface Methodology (RSM) and an Artificial Neural Network (ANN) for the prediction of maximum arsenic removal. The predicted optimum condition using the desirability function of both models was 39 mg kg-1 for the arsenic concentration in soil, an elapsed time of 42 days (the sampling day) and an aeration rate of 0.22 L/min, with the predicted values of arsenic removal by RSM and ANN being 72.6% and 71.4%, respectively. The validation of the predicted optimum point showed an actual arsenic removal of 70.6%. This was achieved with the deviation between the validation value and the predicted values being within 3.49% (RSM) and 1.87% (ANN). The performance evaluation of the RSM and ANN models showed that ANN performs better than RSM with a higher R2 (0.97) close to 1.0 and very small Average Absolute Deviation (AAD) (0.02) and Root Mean Square Error (RMSE) (0.004) values close to zero. Both models were appropriate for the optimization of arsenic removal with ANN demonstrating significantly higher predictive and fitting ability than RSM.

Keyword: Artificial neural network; Optimization; Phytoremediation; Pilot scale; Response surface methodology