Removal of Boron from Well Waters for Irrigation of Agricultural Lands

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Boron is widely distributed in both the hydrosphere and lithosphere of the earth (Morgan, 1980). This element is one of the seven essential micronutrients required for the normal growth of most plants. However, Boron if present in excessive amounts may cause problems of toxicity. There is a relatively small range between levels of soil boron causing deficiency and toxicity symptoms in plants (Keren and Bingham, 1985). In the recent years, a significant increase in the concentration of boron in surface and ground waters has been observed, limiting the use of water for crop irrigation. Values between 1.0 and 4.0 µg of B/mL of water produce cellular necrosis, affecting the biological functioning and yields of crops (Vázquez et al., 2011). Before using this water for irrigation of agricultural areas, especially in soils with already limiting physicochemical conditions, a treatment to remove boron and other associated problems is necessary. The use of Diammonium phosphate $(NH_4)_2PO_4$ and Calcium hydroxide $Ca(OH)_2$ in the removal of boron, through the formation of hydroxyapatite (HAp), was evaluated. In addition, the effect of two flocculants (calcium sulphate ($CaSO_4.2H_2O$) and aluminum sulphate ($Al_2(SO_4)_3$) at concentrations of 35% w/v to accelerate the precipitation of calcium borate hydroxide, resulting from the formation of HAp, was studied. Boron removal started to occur at 30 minutes of the reaction time, after $Ca(OH)_2 + (NH_4)_2HPO_4$ were added. Additional removal of boron was obtained when flocculants were added, especially when gypsum was used. Boron concentration was reduced from 18 ppm to about 8.5 ppm after 30 minutes and to about 3 ppm after 4 hours (Figure 1), corresponding to a removal of about 80% as compared to the initial concentration. For smaller initial concentrations (5 µg of B/mL) B content was lowered to about 0.98 µg of B/mL. The results indicated that the use of $Ca(OH)_2 + (NH_4)_2HPO_4$ in addition to the use of gypsum ($CaSO_4.2H_2O$) at 35 % w/v) is an alternative to treat water and remove boron to values acceptable for crop irrigation. However, pH also needs to be adjusted before a recommendation can be made. After the removal process, the pH of the solution was about 11.5 and adjustment was needed to lower the pH to values acceptable for crop production.

To achieve this, a solution of H_2SO_4 0.408N was used and the volume needed recorded. A final pH of about 6.2 was finally achieved. The amounts of $Ca(OH)_2$, $(NH_4)2HPO_4$, gypsum ($CaSO_4.2H_2O$) and H_2SO_4 were stoichiometrically determined and a reactor was built for experimental field work.

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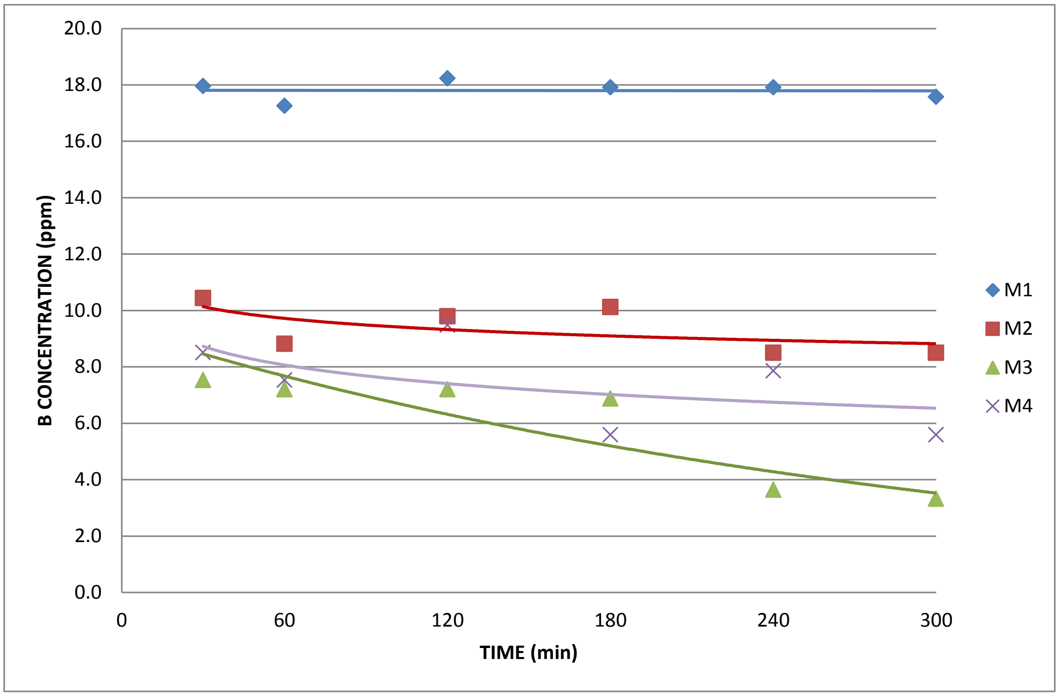

Figure 1. Boron removal from well water (M1 - Control), using Diammonium phosphate $(NH_4)_2PO_4$ and Calcium Hydroxide $Ca(OH)_2$ (M2), and the effect of two flocculants: Calcium sulphate $CaSO_4.2H_2O$ (M3) and Aluminum sulphate $Al_2(SO_4)_3$ (M4).

<u>References</u>

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