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Elaidate-Intercalated hydrotalcite as a sorbent material for metalaxyl immobilitzation in soil

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Layered double hydroxides (LDHs), also known as hydrotalcite-like compounds (HTs), comprise a special group of layered materials. Their structure consists of positively charged layers of mixed divalent (MII) and trivalent (MIII) metal hydroxide [MII1-xMIIIx(OH)2]x+, with the positive charge being balanced by inorganic hydrated anions (An-x/n·mH_2O), which occupy the interlayer space. LDHs have anion exchange properties and, therefore, are good sorbents for anionic pollutants. In addition, the anionic exchange properties of LDHs allow the intercalation of organic anions in the interlayer space to render the LDH surface hydrophobic. This increases its affinity to hydrophobic organic compounds.

Pesticides with chiral centers are an emerging class of organic pollutants and it has become clear that addressing the different efficacy, toxicity, and environmental behavior of chiral pesticide enantiomers is necessary to avoid the incorrect assumption that enantiomers have identical environmental behavior. Appropriate soil remediation strategies accounting for the enantioselective behavior of chiral pesticide enantiomers are also needed.

In this work, we evaluated the performance of elaidate-modified hydrotalcite (HT-ELA) as a sorbent to remove the chiral fungicide metalaxyl from aqueous solution and as an amendment for metalaxyl immobilization in soil. Analysis of metalaxyl by chiral high-performance liquid chromatography allowed us to monitor the sorption and mobility of the two enantiomers of metalaxyl, S-(+)-metalaxyl and R-(-)-metalaxyl, independently.

Batch sorption experiments showed that HT-ELA [Mg3Al(OH)8ELA] displayed an excellent performance as an sorbent of the two enantiomers of metalaxyl from aqueous solution and that its addition to a sandy loam agricultural soil at a rate of 1% greatly enhanced the sorption of metalaxyl enantiomers by the soil. Column leaching experiments demonstrated that amending the soil top layer (0-2.5 cm) with HT-ELA at a rate of 1% reduced the leaching of S- and R-metalaxyl. The R-enantiomer of metalaxyl leached less than the S-enantiomer due to its faster degradation in the soil.

Our results illustrate the ability of elaidate-modified hydrotalcite to enhance the retention of the two enantiomers of the fungicide metalaxyl in the tested soil, which may be useful in the design of immobilization strategies, particularly of the more persistent S-metalaxyl enantiomer, which may represent increased risk of ground water contamination.

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