Natural mineral materials as sustainable carriers for herbicides: from synthesis to environmental impact assessment

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Pesticide use is essential to reach high crop yields in a worldwide growing population scenario. However, their use often leads to a high environmental impact with potential risks for human health, flora and fauna. Nanotechnology can play an important role in reducing pesticide pollution, particularly for highly soluble and volatile active ingredients. The nanoformulation proposed in this work is based on the use of low-cost mineral materials (as montmorillonite, zeolite, kaolin) and food-grade biopolymers, employed to incorporate two different herbicides, namely Dicamba and S-Metolachlor.

The synthesis process was performed in laboratory at room conditions. The reduced environmental mobility and persistence of the nanoformulation were assessed by comparing them against the pure herbicide and a commercial product in laboratory-scale mobility and degradation tests. In particular, the reduced mobility in the subsoil was tested by means of column transport tests, in both saturated and unsaturated conditions, in sand and standard soils. The tests were performed at different scales, from small columns (1.6cm diameter, 10cm length) up to a laboratory lysimeter (30cm diameter, 70cm length) and showed on average a mobility reduced by up to 60% of the nanoformulation compared to the commercial product. Batch degradation tests performed in soils showed comparable DT50 values for nanoformulation and commercial based product. The efficacy of the nanoformulation was tested against conventional products in greenhouse by dose-response tests on selected sensible weeds. The nanoformulation showed at least equal efficacy against weeds compared to the commercial competitor for both dicamba and S-Metolachlor.

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