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Managing the leaching of water-soluble herbicides in soils using eco-compatible nanocarriers

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Pesticide use plays a crucial role in achieving high crop yields in the context of a global population growth scenario. However, the extensive application of pesticides has progressively led to the contamination of environmental matrices, particularly soils and groundwater, posing potential risks to human health, flora, and fauna. Nanopesticides can be instrumental in mitigating pesticide pollution, especially for highly soluble and volatile active ingredients. They are formed by nanoparticles (nanocarriers) containing an active ingredient, sometimes shielded by a coating, and dispersed in a colloidal suspension. The nanoformulations proposed in this study utilize low-cost mineral materials (such as montmorillonite, zeolite, kaolin) and food-grade biopolymers to incorporate two distinct herbicides, namely dicamba and S-metolachlor, characterized by high solubility (and thus high migration potentian in the subsoil) and, for dicamba only, moderate volatility.

The efficacy of the newly developed nanoherbicides in terms of reduced mobility in porous media, reduced persistency, and efficacy toward target weeds was assessed in the laboratory against the pure herbicide and commercial formulations containing the same active ingredients. Specifically, the mobility in porous media was tested through column transport experiments under both saturated and unsaturated conditions, using sand and standard soils (representative, respectively, of top soil and aquifers). These tests were conducted at various scales, ranging from small columns (1.6 cm diameter, 10 cm length) to a laboratory lysimeter (30 cm diameter, 70 cm length). Batch degradation tests in soils indicated comparable DT50 values for the nanoformulation and the commercially available product. The efficacy of the nanopesticides was also examined against conventional products in greenhouse settings through dose-response tests on selected sensitive weeds. The greenhouse tests revealed that clay-based nanoformulations do not impede the effectiveness of dicamba against target weeds, showing efficacy comparable to the commercial competitor for both dicamba and S-Metolachlor, although variations were observed depending on the treated species.

Despite the small scale of the tests conducted in the laboratory and greenhouse, these initial results suggest the promising efficacy of the proposed nanoformulation approach in controlling the environmental spread of soluble herbicides without compromising efficacy against target

species.

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Reference

Granetto M., Serpella L., Fogliatto S., Re L., Bianco C., Vidotto F., Tosco T. (2022). Natural clay and biopolymer-based nanopesticides to control the environmental spread of a soluble herbicide. Science of The Total Environment 806(3),151199, https://doi.org/10.1016/j.scitotenv.2021.151199