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Nonlinear Porous Diffusion Modeling of Ionic Agrochemicals in Astomatous Plant Cuticle Aqueous Pores: A Mechanistic Approach

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Abstract : The agriculture industry requires improved efficacy of sprays being applied to crops. More efficacious sprays provide many environmental and financial benefits. The plant leaf cuticle is known to be the main barrier to diffusion of agrochemicals within the leaf. The importance of a mathematical model to simulate uptake of agrochemicals in plant cuticles has been noted, as the results of each uptake experiments are specific to each formulation of active ingredient and plant species. In this work we develop a mathematical model and numerical simulation for the uptake of ionic agrochemicals through aqueous pores in plant cuticles. We propose a nonlinear porous diffusion model of ionic agrochemicals in isolated cuticles, which provides additions to a simple diffusion model through the incorporation of parameters capable of simulating plant species' variations, evaporation of surface droplet solutions and swelling of the aqueous pores with water. The model could feasibly be adapted to other ionic active ingredients diffusing through other plant species' cuticles. We validate our theoretical results against appropriate experimental data, discuss the key sensitivities in the model and relate theoretical predictions to appropriate physical mechanisms.

Keywords : aqueous pores, ionic active ingredient, mathematical model, plant cuticle, porous diffusion
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