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Comparison of three pesticide fate models for two herbicides leaching under field conditions in a maize cropping system

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Losses of pesticides from agricultural soils may influence the quality of groundwater. Therefore, numerous models were developed to assess the transfer of pesticides from the soil surface to groundwater after their application to an agricultural field. Our objective was thus to compare the ability of three pesticide fate models to describe the behavior of water, and S-metolachlor (SMOC) and mesotrione (MES) herbicides as observed under field conditions in a maize monoculture system.

Simulations were based on field experimentations set up in Toulouse area (France). The tested scenario focused on a conventional maize monoculture and included two irrigated cropping periods with a fallow period managed with bare soil. SMOC was sprayed annually at 1.25 and 1.52 kg a.i./ha in 2011 and 2012, respectively, while MES was only applied in 2012 but twice, at 0.150 kg a.i./ha. Simulations were performed with the PRZM, PEARL and MACRO models parameterized with field, laboratory, and literature data, and pedotransfer functions. The results of simulations were compared with soil tension, water content and percolation data monitored at different depths in 2011-2012. The comparison of the results obtained by the three models indicated that PRZM was not able to simulate properly the water dynamic in the soil profile and for example, it predicted that microporosity was always saturated at 1 m-depth. On the contrary, PEARL and MACRO simulated quite well the observed water behavior (water pressure head and volumetric water content) at 20 and 50 cm-depth during the irrigated cropping period of 2012. However, simulated soil moisture and water pressure were overestimated before the rainfall event of 20 May 2012. MACRO and PEARL simulations generally showed similar water flow dynamics for the whole period at the three depths. Neither the dynamic nor the total amount of percolated water was correctly simulated by any model. The three models overestimated the total water volume leached at 1 m-depth by factors of 2 (PEARL and MACRO) and 4 (PRZM) for the period of available data. The calibration of the sorption coefficient Kd of SMOC and of the half-lives of MES was necessary to obtain correct simulations of the herbicide leaching at 1 m-depth. Cumulative observed (0.033% of applied dose) and simulated (0.012% of applied dose) MES losses by leaching were higher than the observed and simulated SMOC losses that represented the 0.001% of applied dose in all cases.

The results of this work showed the complexity in parameterizing the water transfer models to simulate given experimental conditions.