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Simulation of the enviromental fate of the fungicide Penconazole and its transformation products in a vineyard-terraces catchment

DIETER VOLLERT[1]; MATTHIAS GASSMAN[2], KLAUS KÜMMERER[1], OLIVER OLSSON[1]

[1]Institute for Sustainable and Environmental Chemistry, Leuphana University of Lüneburg, 21335 Lüneburg, Germany, dieter.vollert@leuphana.de
[2]Institute for Water, Waste and the Environment, University of Kassel, 34109 Kassel, Germany

Common practice in the viniculture is the foliar application of fungicides on the plant surface, resulting in high concentrations in runoff water. During rainfall-runoff events in 2016, the fungicide Penconazole occurred frequently in runoff water in the Loechernbach catchment, a 180 ha vineyard catchment in south-west Germany. This catchment is characterized by a typical terraces structure and the connection of a dense road network. The washing off from drift-depositions on the streets is expected to be a major pathway for pesticides. The main objective of this study was the first-time adaption of a catchment model to simulate the transport and transformation processes of fungicides and its transformation products (TPs). Based on this model, source areas of Penconazole residue pollution and its export pathways will be identified and provide urgently needed information for the development of water pollution control strategies.

The distributed, process-based, reactive transport catchment model ZIN-AgriTra was used for the evaluation of the pesticide mobilization and the export processes. The hydrological model was successfully calibrated for a 6-month high-resolution time series of discharge data. Pesticide modelling was calibrated for single rainfall events. TPs of Penconazole were simulated using literature substance parameters and compared to occurrence of observed TPs in the environment. The effect of non-target application on the street was characterized using different non-target entries on the road system.

The simulation results of outflow and Penconazole concentration show best fit with the measurements at the catchment outlet. The first flush after application caused main field release of Penconazole, with concentrations up to 0.7 µg/l. Furthermore, measurements and simulation results show that baseflow pesticide concentrations up to 5 ng/l were an order of magnitude lower than the rainfall event concentrations. Additionally, the results show that non-target application on the road surfaces without soil sorption contributed significantly to the export of pesticides through the first flush in this catchment. Therefore, the mobilization process of the fungicide is characterized by a combination of both sorptive (e.g. at the soil) and non-sorptive (e.g. on the plant/ road surface) storages.

For the simulated transformation products, the modelling results show a maximum concentration of 0.05 µg/l. The environmental occurrence of TPs can be explained by the model. The results show that subsurface flow from the field is the major release pathway for the TPs. Nevertheless, the best fit for the occurrence of this TP is by washing off the TPs from the surface. This shows the importance of monitoring and usefulness of modelling to estimate environmental concentrations.

Concluding, the catchment model is an applicable tool to simulate the individual processes of the Penconazole fate in the vineyard catchment. It was confirmed that roads receiving pesticide drift are the major loss areas of Penconazole in the Loechernbach catchment and that the pathways of parent compounds and transformation product are different.