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Breakthrough of two pesticides into tile drain and shallow groundwater: comparison of tile drain reaction and soil profiles within a field scale irrigation experiment

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Preferential flow in macropores is a key process which strongly affects infiltration and may cause rapid transport of pesticides into depths of 80 to 150 cm. At these depths they experience a much slower degradation, may leach into shallow groundwater or enter a tile-drain and are transported into surface water bodies. Therefore, preferential transport might be an environmental problem, if the topsoil is bypassed, which has been originally thought to act as a filter to protect the subsoil and shallow groundwater.

To investigate the behaviour of two pesticides with different chemical characteristics and to compare their transport behaviour in soil and into the tile drain an irrigation experiment was performed on a 400 m^2 field site. The experimental plot is located in the Weiherbach valley, south-west Germany, which basic geology consists of Loess and Keuper layers, the soil at the test site is a gleyic Colluvisol. The distance of the irrigation site to the Weiherbach brook is approximately 12 m, the field is drained with a tile-drain in about 1.2 m depth and shows discharge over the entire year. Three hours before the irrigation started, the farmer applied a pesticide solution consisting of Isoproturon (80 g) and Flufenacet (20 g) (IPU and FLU) according to conventional agricultural practice on the field plot. The irrigation took place in three time blocks (80 min, 60 min, 80 min) with in total 33.6 mm of precipitation. During the first block 1600 g of Bromide were mixed in the irrigation water. The drainage outlet was instrumented with a pressure probe. About 50 water samples ware taken during the experimental day, and several samples more the days after the experiment. They were analysed for the pesticides, bromide and water isotopes.

In the two days after the experiment three soil profiles were excavated and soil samples were taken on a 10x10 cm^2 scheme. One week after the experiment two additional profiles were excavated. The soil was analysed for IPU, FLU and bromide.

The tile drain water showed traces of bromide and both pesticides within a few minutes. IPU showed highest concentration before the hydrograph started to increase, while bromide and FLU are strongly correlated to the hydrograph. Although IPU is less sorptive than FLU the concentrations and total transported mass of FLU were significantly higher then for IPU. The hydrograph reacted with two peaks on the three block irrigation; the two peaks can be attributed to the second and third irrigation block. Analysis of the water isotopes showed that during the experiment the event water mainly consisted of soil water.

While the tile drain showed significant reaction in pesticides transport the picture deriving from soil profiles were different. Especially FLU was found mainly in the upper soil parts, so the bypassing might occurred so fast that it was only marginally absorbed in deeper soil party, but transported to the drain or shallow groundwater.

As preferential flow paths earthworm burrows of different species could be identified, although the area

density and species number of anecic earthworms was quite low compared to other field sites.