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Rapid breakthrough of pesticides via biopres into tile drains and shallow groundwater: a combined experimental and model study

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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 in surface water bodies. Therefore, preferential transport is an environ¬mental problem because the topsoil is bypassed, which has been originally thought to act as a filter to protect the subsoil and shallow groundwater.

To get a better insight in the process of pesticide transport in agricultural soils 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 aprox. 12 m, the field is drained with a tile-drain in about 1.2 m depth and the shows runoff over the entire year. Three hours before the irrigation started the farmer applied a pesticide solution consisting of Isoproturon and Flufenacet according to conventional agricultural practice. The irrigation took place in three time blocks (80 min, 60 min, 80 min) and had a total irrigation rate of 33.6 mm measured with ten precipitation samplers. During the first block a tracer solution of 1600 g Bromide and 2000 g Brilliant Blue was irrigated on the test site. The drainage outlet was instrumented with a pressure probe to measure the water level. About 50 water samples were taken on the day of the experiment from the drainage outlet by hand, and in an eight hour interval for six days with an automatic sample procedure. Discharge at the drainage outlet showed two peaks in response irrigation. The breakthrough of the tracer into the brook is much faster then the reaction of the discharge on the precipitation impulse.

To gain insight in the vertical transport behaviour three vertical soil profiles were excavated on the first day after the irrigation and two vertical profiles were excavated one week after the experiment. In those profiles soil samples were taken in a 10cm*10cm grid to analyse for the tracer concentrations. Based on that information the probability distribution function of the travel depths for each tracer could be calculated for two points in time. As burrows of deep digging earth worms often act as preferential pathways we counted the individuals of worm burrows using a nested sampling procedure. Though endogeic earthworms were apparent we didn't find any individuals of Lumbricus Terrestris nor macropores with diameter larger than 2 mm at a depth larger than 30-35 cm. So far we didn't identify those pathways that caused this rapid pesticide breakthrough into the tile drain, though a very small number macropores would suffice. Based on the collected data we will setup up a numerical model to simulate observed and flow and transport and test the hypothesis that earthworm burrows are the reason for this rapid breakthrough of pesticides into the tile drain.