Rapid breakthrough of pesticides via biopores into tile drains and shallow groundwater

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Introduction and goals
Earthworms play a pivotal role in agro-ecosystem functioning by modulating soil structure that significantly influences soil hydrological properties, organic matter dynamics, and plant growth. 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 where they experience a much slower degradation, or can directly enter brooks via tile drains or shallow groundwater bodies. Therefore an experimental study was set up, gain insight in pesticide transport in agricultural landscapes due to biopores. The used pesticides are typical for the Weiherbach catchment (Isoproturon and Flufenacet). The experiment was performed in September 2008 and is on going. The used pesticides are typical for the Weiherbach catchment (Isoproturon and Flufenacet). The experiment was performed in September 2008 and is on going.

Study site
The study site is an agricultural field with shallow groundwater and a tile drain. The plot is directly located on an earthworm brook. The site is located in the Weiherbach catchment an experimental catchment in an intensive used agricultural loess area. The geology is dominated by Keuper and a Loess layer of up to 15 m thickness. The climate is semi-humid with an average annual precipitation of 750-800 mm, average annual air temperature of 7.0°C and annual potential evaporation of 775 mm. The average annual air temperature is 6.5°C. A typical soil catena follows the hilltops; the morphology exists. The experimental field located at the hill foot, consists of a colluvial with gleylic character starting around 60 m depth. The tile drain drains the site in about 1.2 m depth and shows discharge during the whole year.

Irrigation experiment
In September 2008 the irrigation experiment was performed by simulating a typical mid-intensive thunderstorm of approx. 35 mm/h at a 400 sqm field plot. Precipitation was measured with ten 200 sqm precipitation samplers and sprinkled with eight Canastra sprinkler at the field plot. The ditch discharge was measured with a pressure sensor and a triangular weir. Pesticides were applied by the farmer according to conventional agricultural practice using a tractor and a mounted spray bar. Brilliant Blue and Bromide were used as additional tracer. The mass of the applied pesticides were 80 g IPU and 20 g Fluorescein. As Tracers 1600g Bromide and 2000g Brilliant Blue were applied.

Experimental results 1
Ditch discharge and Bromide transport
The ditch discharge showed no significant reaction to the first irrigation impulse. Only at the end of the first irrigation block the discharge showed a small increase. So the field irrigation increased mainly the soil moisture. Starting with the second irrigation block the system reacts instantly and the discharge increased from 0.3 l/s to about 0.5 l/s, after stopping the irrigation the discharge decreased very fast. The system showed an even stronger response to the last irrigation. Eight minutes after the end of the irrigation, discharge reached its peak, after the peak there is a clear recession curve.

Discussion and Conclusions
Isoproturon is known to be mobile and easy to wash out via tile drains in surface waters and therefore also to be transported into shallow groundwater bodies. In this experiment we showed that Fluorescein also is mobile and transported through preferential flow paths in the soil. However it was found, that peat, peat soils and peat sites occur in the parts of the study soils that are regulated by the ditch impact. But the water flow leading to the preferential transport is not stable yet. None of the five soil profiles showed transport below the depth of 0.6 m. So it is to call in question, if it is possible to make predictions on depth transport only based on vertical soil profiles. This again, confirmed the importance that in future studies further steps need to be performed in order to perform large scale experiments on agricultural sites to understand the transport of pesticides into shallow groundwater bodies. Although the link between precipitation and ditch discharge is important to understand, as it is the driving force of transport.

References


Acknowledgements

Peter, Janis, Steve, Tobi and Elham for their support in the field and/or the lab. We would like to thank Steffi and Sibylle for their support with the analytics and Markus, Peter, Janis, Steve, Tobi and Elham for their support in the field and/or the lab. Funding was provided by the DFG DE 533/5-1 and is grately acknowledged. We gratefully acknowledge financial support from the DFG DE 533/5-1 and are deeply indebted to the study site that are regulated by the ditch impact.