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Leaching behaviour of the earthworm expellants formaldehyde and allyl isothiocyanate in soil

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For the expulsion of earthworms from the soil in order to determine their number, biomass, and species as an important parameter in soil ecology no standardized method exists. Chemical expulsion methods (e.g. using formaldehyde and allyl isothiocyanate (AITC)) are the most widely applied techniques. However, the behaviour of these chemicals in the soil are often not satisfactorily explored.

The leaching behaviour of AITC and formaldehyde was tested using soil column experiments. Glass columns with a diameter of 5 cm and a length o 50 cm were filled with a non calceric cambisol. For saturation and operational flow a 0.01 M $CaCl_2$ solution was used. Saturated flow (0.255 mm min^{-1}) was kept constant in all experimental columns. KBr was used as a tracer. The drainage water was collected and the concentration of the test substance was determined. Bromide was detected by ion chromatography, while formaldehyde and AITC were analysed after extraction with octane on a GC-FID.

Br^- was not retarded when leached through the soil, but its recovery was only around 80% in contrast to the expected 100% recovery common for a tracer substance. Formaldehyde was also not retarded, but its amount was reduced by about 80% when transported through the soil column. The applied high formaldehyde concentration was likely too toxic to allow biodegradation, hence other forms of chemical degradation will have prevailed causing the observed reduction of formaldehyde in the soil. AITC recoveries in the drainage water ranged from 30 to 50%. Reactions with the soil matrix and biodegradation and partly volatilisation might explain AITC reduction

in the soil. Leaching of AITC was about twice as slow than leaching of formaldehyde. Due to the oily consistency (low water solubility) of AITC, a tool for analyzing multiple phase flow has to be used for the simulation of this substance. The software HYDRUS-1D was applied for inverse modelling of the bromide and formaldehyde column experiments. In general, the Langmuir and the Freundlich isotherm led to reasonable results when fitting the experimental bromide data, nevertheless mostly with high standard errors. Entrapped air could have complicated the determination of reliable parameter sets. Regarding formaldehyde BTCs, linear adsorption and 1st order decay reactions are assumed. The modelling results for Formaldehyde show that the first-order decay rate constant is approximately in the range of 0.1e-2 to 0.2e-2 min^{-1}, and the K_d value is in the range 3e-5 to 5e-5 $\mathrm{ml} \cdot \mathrm{mg}^{-1}$.