



Transport and attenuation of chloroacetanilides in an agricultural headwater catchment

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Chloroacetanilides (e.g., S-metolachlor and acetochlor) are pre-emergent herbicides used on corn and sugar beet and are applied to bare soil, which is prone to runoff and erosion. Some of these herbicides are chiral and the commercial products can be isomerically enriched in the enantiomer-S compared to the enantiomer-R as an example S-metolachlor 80/20% S to R. Determination of the transport of these herbicides in the dissolved and particulate phases of runoff water and degradation in agricultural catchments is currently lacking. The objectives of this study were i) to quantify over a corn growing season the export of chloroacetanilides and their main degradation products (ethane sulfonic (ESA) and oxanilic acid (OXA) degradates of metolachlor (MESA and MOXA) and acetochlor (AcESA and AcOXA)) in a 47 ha agricultural head-catchment in the dissolved and particulate phases, and ii) to evaluate S-metolachlor biodegradation from its application on the field to its export from the catchment using enantiomer analysis. Runoff, erosion, hydrochemistry and chloroacetanilide transport were evaluated at both the plot and catchment scales. Our results showed that an important amount of the pesticide load is missed when only the dissolved concentration of the parent compound is analysed. The total export coefficients for S-metolachlor and acetochlor and their degradation products were 11.4 and 11.8%, respectively, which includes both the dissolved and particulate loads. The partitioning of S-metolachlor and acetochlor between the dissolved and particulate phases varied widely over time and was linked to the suspended solid concentrations. Detection of S-metolachlor degradation products in runoff water was more frequent compared to that of acetochlor degradation products. Enrichment up to 37% of R-metolachlor was observed during the corn growing season, supporting enantioselective degradation of S-metolachlor. Our field study indicates the potential of enantiomer analyses for assessing chloroacetanilide biodegradation and could be complemented with laboratory benchmark studies on enantiomeric fractionation during chloroacetanilide degradation combined with an analysis of the degradation products to evaluate the extent of biodegradation in agro-ecosystems. We anticipate that our results will be a starting point for better understanding and predicting transport and degradation of chloroacetanilides at the agricultural catchment scale.