Microscale Three-dimensional Spatial Variability of Atrazine and Chloride Leaching in Soil

by

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ABSTRACT

Pesticide leaching experiments utilizing widely spaced sampling schemes may not adequately characterize chemical leaching behavior such as preferential flow between sampling points. As a result, interpretations from these experiments may be limited and somewhat superficial. This study was conducted to determine the three-dimensional variability of atrazine and chloride movement within a small volume of soil (2700 cm^3) under field conditions. A 1 m^2 area of bare, undisturbed Williamson silt loam (coarse-silty, mixed, mesic Typic Fragiochrept) was sprayed uniformly with atrazine (2-chloro-4-ethylamino-6-isopropylamino-*s*-triazine) (1.12 kg active ingredient ha^{-1}) and chloride (80 kg ha^{-1}). LEACHM, a one-dimensional pesticide leaching model, was used to simulate chemical movement. After 65 mm of rainfall over 29 d, 36 squares (5 by 5 cm) in the center of the treated area were sampled at 6 depth increments (0-2, 2-5, 5-10, 10-15, 15-21, and 21-30 cm) and were analyzed for atrazine and Cl^- concentrations. Coefficients of variance (CVs) for atrazine significantly increased with depth and ranged from 26-353%, while CVs for Cl^- were independent of depth and ranged from 32-66%. Derived atrazine concentration isograms illustrated several preferential flow pathways. Although LEACHM overestimated atrazine movement in the upper 15 cm, it was fairly accurate in the lower 15 cm. However, Cl^- flow was underestimated throughout the profile. Due to its one-dimensional nature, LEACHM could not estimate macropore flow nor the variability between points. Absolute recovery of atrazine was 26% of the amount applied while chloride recovery was 138% of the amount applied. The slight excess in chloride recovery may be due to high background levels of the anion, a parameter which we did not measure. We calculated that at least 43% (assuming a 30 d half-life) and no more than 74% (assuming no degradation) of the applied atrazine was lost from our experimental cube of soil. The fate of this atrazine is unknown, but it is highly likely that a significant portion of it reached the subsoil/groundwater. Our results demonstrate that important soil leaching processes such as preferential flow can vary greatly over small distances and may be missed in larger sampling schemes and in pesticide simulation models such as LEACHM, possibly leading to the underestimation of groundwater contamination risk. Perhaps more importantly, our lack of accountability for a significant portion of the applied atrazine shows that the herbicide can be a significant threat to groundwater.