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Long-term simulations of water and isoproturon dynamics in a heterogeneous soil receiving different urban waste composts

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Implementing various compost amendments and tillage practices has a large influence on soil structure and can create heterogeneities at the plot/field scale. While tillage affects soil physical properties, compost application influences also chemical properties like pesticide sorption and degradation. A long-term field experiment called "QualiAgro" (https://www6.inra.fr/qualiagro_eng/), conducted since 1998 aims at characterizing the agronomic value of urban waste composts and their environmental impacts. A modeling study was carried out using HYDRUS-2D for the 2004-2010 period to confront the effects of two different compost types combined with the presence of heterogeneities due to tillage in terms of water and isoproturon dynamics in soil. A municipal solid waste compost (MSW) and a co-compost of sewage sludge and green wastes (SGW) have been applied to experimental plots and compared to a control plot without any compost addition (CONT). Two wick lysimeters, 5 TDR probes, and 7 tensiometers were installed per plot to monitor water and isoproturon dynamics. In the ploughed layer, four zones with differing soil structure were identified: compacted clods (Δ), non-compacted soil (Γ), interfurrows (IF), and the plough pan (PP). These different soil structural zones were implemented into HYDRUS-2D according to field observation and using measured soil hydraulic properties. Lysimeter data showed (2004 -2010 period) that the CONT plot had the largest cumulative water outflow (1388 mm) compared to the MSW plot (962 mm) and SGW plot (979 mm). HYDRUS-2D was able to describe cumulative water outflow after calibration of soil hydraulic properties, for the whole 2004-2010 period with a model efficiency value of 0.99 for all three plots. Isoproturon leaching showed had the largest cumulative value in the CONT plot (21.31 μg) while similar cumulated isoproturon leachings were measured in the SGW (0.663 μg) and MSW (0.245 μg) plots. The model was able to simulate isoproturon leaching patterns except for the large preferential flow events that were observed in the MSW and CONT plots. The timing of these preferential flow events could be reproduced by the model but not their magnitude. Additional simulations were carried out, assuming temporal variation of the IPU degradation rate to explain the leaching events observed at the end of the monitoring period (2010). Modeling results indicate that spatial and temporal variations in pesticide degradation rate due to tillage and compost application play a major role in the dynamics of isoproturon leaching. Both types of compost were found to reduce isoproturon leaching on the long-term (6 years) duration of the field experiment.

Keywords: Compost amendment; Soil heterogeneity; Conventional tillage; Water flow; Isoproturon; HYDRUS-2D