Soil Column Leaching of [^{14}C]Atrazine in Similar Soils Representing Three Continents.

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Abstract

In the OECD 312 Guideline 'Leaching in Soil Columns' and the EPA Guideline OCSPP 835.1240 'Leaching Studies' define the mobility of an organic chemical in soil. Laboratory-scale designs described in these guidelines and field lysimeter studies have been used successfully for years to identify potential groundwater contamination and other waterways. Column leaching studies often use a reference compound with known mobility to establish a relative mobility factor (RMF) of the test chemical. Atrazine is a typical reference compound used for such a measurement. Atrazine is still one of the most widely used herbicides to combat unwanted grasses and broad-leaf weeds globally.

This study compares the leaching potential of [^{14}C]atrazine in similar agricultural soils representing three continents to highlight similarities or differences in leachability between the continents. The soils used in the study were obtained from North Dakota, USA, Speyer, Germany, and Sao Paulo, Brazil. Leachability was measured based on the soil column penetration depth, and Koc partition coefficients were estimated using published techniques and further compared to known Koc values for atrazine found in published literature. These results are compared and discussed and can be used in future studies employing similar soils.

Materials and Methods

- Experiment conducted generally based on the OECD 312 guideline.
- PVC columns used; filled with 30 cm of dry soil (~700-800 g).
- Tops of soils treated with [^{14}C]Atrazine at ~ 50 mg/kg in upper layer.
- Eluant was 200 mm of 0.01M $CaCl_2$ solution over 48 hours.
- Leachate collected and quantified by LSC.
- Six 5-cm segments sectioned from each column after 48 hours.
- Soils segments extracted and quantified by LSC and profiled by HPLC-RAM.
- Post-extracted soils were combusted and ^{14}C quantified by LSC.
- The equation, Koc = (W-θ Z)/ p C Z (from Bolt, 1976 and the EC directive SCP/KOC/002) was used to calculate Koc, and the %OC was used to back-calculate the Kd values.

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Leachability of [^{14}C]Atrazine was shown to be typical to published values for similar soil types selected for this study representing North America, South America and Europe.

Soil	Source	Texture	%OC	Leaching distance, cm	Koc	Kd
RMN	USA	Sandy Loam	2.6	10	61.8	1.6
Speyer 2.3	Germany	Sandy Loam	0.64	30	45.6	0.3
Neossolo	Brazil	Clay	1.3	20	44.2	0.6
Gleissolo	Brazil	Sand	0.86	20	78.5	0.7
Latossolo	Brazil	Sandy Loam	1.9	20	30.0	0.6
Mean			1.5	20	52.0	0.7

Table 1: Summary of Leaching distance, calculated Koc and Kd of [^{14}C]Atrazine

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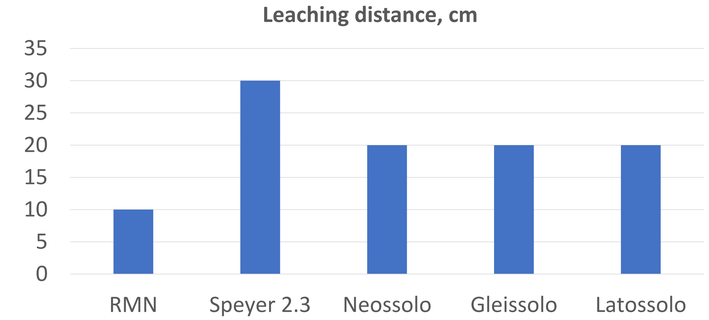


Figure 1: Leaching distance of [^{14}C]Atrazine in cm through 30-cm soil columns

Results

- Soil types were set up in duplicate columns, and results were consistent between replicates.
- Leaching distances correlated well with the %OC content of the soil, with the most adsorption to the least adsorption following the pattern of 10, 20, 20, 20, and 30 cm traveled for the RMN 2.6 %OC, Latossolo 1.9 %OC, Neossolo 1.3 %OC, Gleissolo 0.9 %OC and finally the Speyer 0.6 %OC soil, respectively.
- Calculated Koc values ranged from approximately 30 to 80 L/kg with corresponding Kd values ranging from approximately 0.3 for the lowest %OC soil (Speyer 2.3, Germany) to 1.6 for the highest %OC soil (RMN, USA).

Discussion and Conclusions

The leachability results for [14C]Atrazine in soil were typical for Atrazine which is classified as moderately mobile (Class 3) by OECD. The Brazilian soils, which were the most represented, covered the range of Kd values of all the soils, demonstrating that leachability is a function of soil type, not the place of soil origin.

The calculated Koc and Kd values derived from the leaching distances are similar to values reported in the literature, mostly obtained from batch equilibrium study design, especially when compared to sandy soils showing Atrazine Kd values from 0.4 to 0.9 (Sonon and Schwab, 1995). Additionally, EPA has used Koc input values as low as 38 L/kg.

This study shows that soils across continents are similar in their leaching behavior using Atrazine as a model compound. These results also show that a soil column leaching study is a viable alternative procedure for estimating the Koc values, at least for moderately mobile compounds.