Determination of the Break-through Volume of Sodium Chloride for Soil Columns in Pesticide Leaching

by

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The extent of leaching of pesticides in soils is an important factor in judging the potential of a chemical for ground water contamination. It is commonly determined in soil columns. For comparable results standardization of the soil columns with the help of a highly leachable substrate such as NaCl is required to determine the "break-through volume" (V_B) for every column and soil used.

In this report we suggest a definition for V_B and describe a fast and simple method for its determination by the use of low concentrations of sodium chloride-^{36}Cl.

MATERIALS and METHODS

The 15 inch long leaching column was constructed of Plexiglas tubing, 2.75 inches I.D., closed at the bottom end with a 100 mesh stainless steel screen.

Air-dried soil of a known water content was tamped into the column to a height of 12 inches. Sea sand was added as a slurry. Water was added to the soil in excess, then allowed to drain. The total volume of water retained in the soil when drainage stopped was considered the void volume (V_o).

Soils used were: (1) Manchester sandy loam; 61.4% sand, 23.8% silt, 14.8% clay, 1.89% organic matter, pH 5.5, cation exchange capacity 8.5 m.e./100 g; V_o = 517 ml; (2) sea sand, washed and ignited (product of Fisher Scientific Co.), V_o = 454 ml; (3) unidentified series clay loam; 37.6% silt, 28.5% clay, 5.1% organic matter, pH 7.4, cation exchange capacity 13.0 m.e./100 g, V_o = 455 ml.

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The sodium chloride-^{36}Cl (product of New England Nuclear) had a specific activity of 3.84 mCi/g Cl and a concentration of 1.5 μCi ^{36}Cl/ml (0.7 mg NaCl) was used. One ml of the solution corresponding to a rate of 1.6 lbs./acre was spread over the surface, dropwise, with a syringe. A spray of distilled water was started without delay at a rate of one inch per hour.

The eluate from the column was collected in fractions until no significant amounts of ^{36}Cl could be detected. One ml of each fraction was counted in the Oxifluor-H_2O cocktail (product of New England Nuclear) in a Beckmann LS-250 liquid scintillation spectrometer with a wide open variable discriminator module.

RESULTS and DISCUSSION

The mobility of any chemical through soil columns is influenced by the column matrix geometry, diffusion as well as by retardation due to adsorption, ion exchange, etc. (KAY and ELRICK 1967). For a non-reactive solute such as NaCl there is negligible or no retardation and therefore V_B is expected to be equal to the void volume (V_o) of the column. We suggest defining the breakthrough volume (V_B) of sodium chloride as the volume needed to elute 50% of the applied salt out of the column. This can be easily determined with $Na^{36}Cl$ and liquid scintillation counting.

The elution pattern of $Na^{36}Cl$ from three different soil columns by water determined this way is given in Table I and Figure 1. The V_B values on sea sand and two soils used are in good agreement with V_o of the columns, indicating they were set up properly. For sea sand $V_B = 0.97\ V_o$, sandy loam $V_B = 0.92\ V_o$, and for clay loam $V_B = 1.05\ V_o$. The use of $Na^{36}Cl$ is of advantage because natural soil components and other salts present in considerable amounts in soils do not interfere with the analytical procedure. Furthermore, $Na^{36}Cl$ can be applied simultaneously with ^{14}C-labeled pesticides and both radioisotopes determined in one analysis on two-channel liquid scintillation counters with variable discriminator module (set at lower 5.10, upper 10.00) to

TABLE I

Elution of $Na^{36}Cl$ from soil columns

Sandy loam (1)		Sea sand (2)		Clay loam (3)	
Cumulative % of ^{36}Cl eluted	Volume eluted in V_o Fract.	Cumulative % of ^{36}Cl eluted	Volume eluted in V_o Fract.	Cumulative % of ^{36}Cl eluted	Volume eluted in V_o Fract.
0.0	0.460	0.0	0.739	0.0	0.433
0.12	0.573	1.01	0.844	1.46	0.541
3.43	0.658	42.12	0.960	6.29	0.658
16.83	0.754	81.47	1.066	16.83	0.759
35.78	0.853	94.38	1.176	27.90	0.878
56.69	0.946	97.14	1.291	40.63	0.983
70.50	1.039	97.90	1.396	54.87	1.087
82.34	1.151	97.98	1.500	69.39	1.194
88.77	1.228	98.04	1.712	86.44	1.295
91.74	1.309			95.98	1.415
93.95	1.400			99.00	1.527
96.75	1.689			99.93	1.716
97.34	1.973				

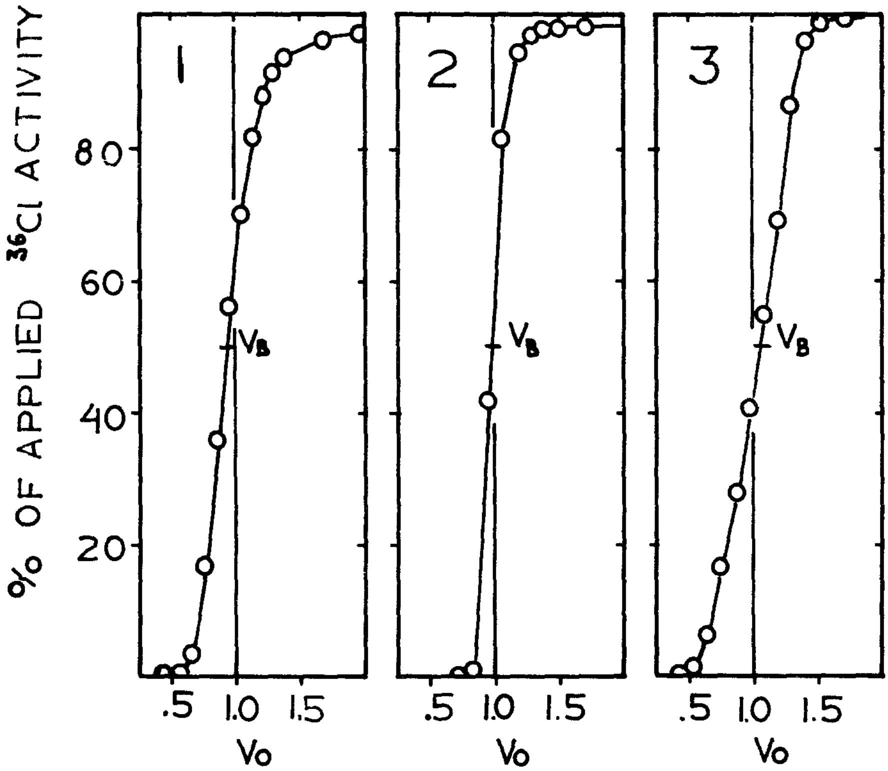

FIGURE 1: Cumulative elution curves of $Na^{36}Cl$ from sandy loam (1), sea sand (2) and clay loam (3).

eliminate ^{14}C on one channel. The amount of ^{36}Cl and ^{14}C can then be calculated as described by KOBAYASHI and MAUDSLEY (1970). This makes column leaching studies more nearly accurate and intercomparable.

REFERENCES

KAY, B. D., and ELRICK, D. E.: Soil Sci. 104, 314 (1967).

KOBAYASHI, Y., and MAUDSLEY, D. V.: The Current Status of Liquid Scintillation Counting, edited by E. D. Bransome, New York, Grune & Stratton, Inc., p. 76, 1970.