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P49: MEASURING DRY DEPOSITION OF PESTICIDES ON SURFACE WATER IN A LABORATORY SYSTEM

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SUMMARY

Pesticides used in agriculture can volatilise from soil or plants after their application and then be transported in the atmosphere by atmospheric dispersion. This atmospheric dispersion of the volatilized fraction can contaminate aquatic surfaces and other ecosystems through dry deposition. This study aims at characterizing pesticide emissions to the atmosphere through volatilization and their dry deposition onto surface water. A lab system has been specially designed to study both processes under controlled conditions. The 17 experiments carried out with various temperatures and relative humidity of the air flow showed a good repeatability of the results. The deposition intensity has been found linked with the emission intensity for almost all compounds (depending on their Henry law's constant).

Key Words (up to 5): dry deposition, air-water exchange, volatilisation, pesticides, risk assessment

INTRODUCTION

Contamination of surface waters by pesticides is widespread near agricultural areas (as in lakes, rivers, etc.) and the contribution of atmospheric pathways to such contamination has been demonstrated. At the local scale, modelling approaches show the existence of situations where the contribution of gaseous dry deposition is of the same order or even higher than the drift contribution [1]. Although drift is a major instantaneous contributor during pesticide application, the longer duration of the volatilization process (several days or weeks after application), may explain these results. Dry deposition is found to depend on atmospheric concentrations of the pesticide and hence, the emission. However, only a few datasets are available in the literature, and there is lack of information to analyse in a mechanistic way the determinism of this deposition process. Deposition velocities are thus difficult to generate. This study aims at measuring simultaneously volatilisation and dry deposition fluxes under controlled conditions in order to identify the main factors driving both processes. Seven pesticides have been selected and experiments were carried out with this lab system with various temperatures and relative humidity of the air flow. First results will be presented here.

MATERIALS AND METHODS

The lab system is composed of an "emission cell" in which a pesticide solution is introduced and a "deposit cell" containing 200 mL of water (Figure 1). A regulated constant air flow circulates between the cells thanks to a pump. The system is placed inside a chamber able to maintain a regulated constant temperature. A mixture of seven pesticides was selected considering their physico-chemical properties, including vapour pressure (P_{vap}), Henry law's constant (H), water solubility (S_w) and octanol-water distribution coefficient K_{ow} (Table 1). To quantify pesticide volatilization rates, volatilized pesticides were trapped on Tenax resin and pesticides deposited on water were extracted by stir bar sorptive extraction (SBSE) with Twisters® (Gerstel). Air and water pesticide trappings were then thermally-desorbed and analysed with an Agilent GC-MS. A set of 17 experiments of 3 hours each has been carried out with varying temperatures and relative humidity of the air.

Substance	H [Pa m ⁻³ mol ⁻¹]	P _{vap} [Pa]	S _w [mg L ⁻¹]	Log(K _{ow}) [-]
Clomazone	4.18E-03	1.92E-02	1100	2.5
Chlorothalonil	3.40E-02	7.60E-05	0.8	2.9
Fenpropidin	8.70E-02	2.10E-02	530	2.6
Fenpropimorph	1.06E-01	2.30E-03	4.3	4.5
Metazachlor	5.74E-05	4.70E-05	715	2.5
S-metolachlor	2.40E-03	4.20E-03	488	3.4

Table 1: Physico-chemical properties of the 7 pesticides selected

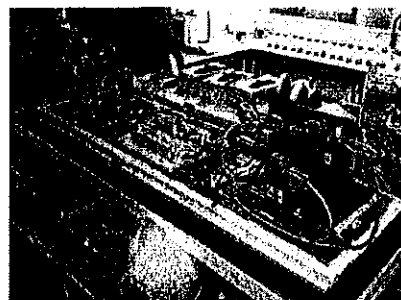


Figure 1: Picture of the lab system

RESULTS and CONCLUSION

First results show that for the volatilization rates at 25°C and 30% of relative humidity 1) the overall mass balance is very close to 100% showing thus a good efficiency of the analytical chain and of the lab system (Figure), and 2) a good repeatability of the results. Deposited fractions ranged from 0.6% to 14.6% of the applied dose depending on the compounds. The intensity of the emission by volatilisation seems to greatly govern the intensity of the deposition for almost all compounds, as also found by [2] when studying clomazone deposition under controlled conditions.

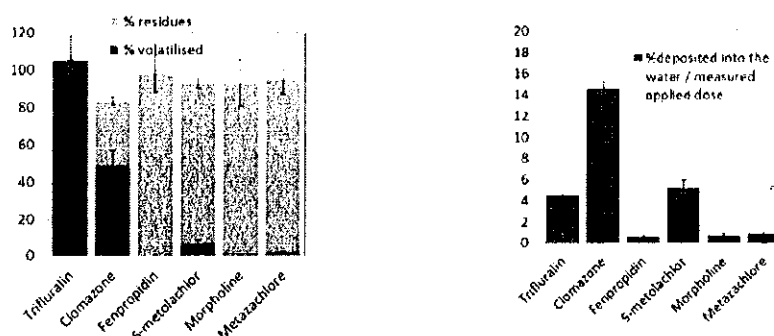


Figure 2: (left) Mass balance within the emission cell (right) % deposited into the water calculated from the measured applied dose (Experiment à 25°C and RH=30%).

Further analysis is focusing on the effect of physico-chemical properties of the compounds, temperature and air relative humidity on the deposition rates.

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