**Reduction of post-application pesticide volatilisation by the use of surfactants from glass surfaces**

Authors: Michael Houbraken1 and Pieter Spanoghe1

1University at Ghent, Department of Crop Protection, Ghent, 9000, Belgium

Volatilisation represents a major dissipation pathway of pesticides from the crop as well as a contamination to the environment. Losses of pesticide active ingredients (a.i.) range from 30-50% up to 90% of the applied dose and can even exceed run-off 1,2. Formulation of a pesticide can reduce the volatilisation through an increased uptake of the pesticides into the plant or by preventing the active ingredients to become available to volatilise. However, data regarding the effect of formulation additives on the volatility of pesticides is very limited. The aim of this study is to evaluate the volatilisation of pesticides by the effect of formulation additives on the volatility of the pesticide active ingredients

In this study, the dissipation of a.i. (fenpropimorph, pyrimethanil, lindane and chloorpyrifos-ethyl) on the solid/gas interface was evaluated in a wind tunnel. The samples were prepared using aqueous solutions of pesticides (100 mg/l). Pesticides were formulated with surfactants (Atlas G5002-L: butyl block copolymer, polymeric surfactant; Atplus 310: alkoxylated phosphate ester anionic surfactant). Of each pesticides solution, 0.5 ml was applied on to glass surfaces. Experiments were performed in the dark to minimise phototransformation. Wind speed was set at 0.1 m.s-1. Volatilisation was calculated by an empirical model assuming exponential decay of the volatilisation rate3:

|  |  |
| --- | --- |
| $$\frac{dM}{dt}=-k\_{1}e^{-k\_{2}t}M- k\_{3}M$$ | Equation 1 |

where the first term corresponds to volatilisation losses, the second term to degradation, k1, k2 and k3 being the reaction rate constants (h-1). With degradation negligible and after integration, the equation becomes:

|  |  |
| --- | --- |
| $$ln\left(\frac{M}{M\_{0}}\right)=\frac{k\_{1}}{k\_{2}}\left(e^{-k\_{2}t}-1\right)$$ | Equation 2 |

where M0 is the amount of pesticide3. The obtained residue data were fitted by least square optimization to Equation 2. Residue data was collected over a period of four days. The fenpropimorf and pyrimethanil samples were analyzed by gas chromatography mass spectrometry (GC/MSD). The lindane and chlorpyrifos samples were analyzed by gas chromatography and electron capture detector (GC/ECD).

Table 1. Constants of the model (h-1) and initial volatilisation rate (µg.h-1) for the four pesticides

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sample** | **vp** | **Fenpropimorph**3.5 mPa (20°C)4 | **Lindane**2.6 mPa (20°C)4 | **Pyrimethanil**1.1 mPa (20°C)4 | **Chloorpyrifos**1.4 mPa (20 ºC)4 |
| Without surfactant | k1 | 0.064 | 0.065 | 0.053 | 0.054 |
| k2rate | 0.0255.700 | 0.0098.200 | 0.0383.500 | 0.0144.600 |
| Polymeric surfactant | k1 | 0.028 | 0.034 | 0.045 | 0.025 |
| k2rate | 0.0001.360 | 0.0220.620 | 0.1211.150 | 0.0441.030 |
| Anionic surfactant | k1 | 0.011 | 0.098 | 0.033 | 0.048 |
| k2rate | 0.0150.513 | 0.0195.070 | 0.0292.650 | 0.0281.550 |

Figure 1. Residue of chlorpyrifos upon volatilisation in the dark, wind speed 0.1 m.s-1 and at 20°C: (●) experimental values without surfactant; --- model without surfactant; (▲) experimental values with anionic surfactant; ─ model with anionic surfactant; (■) experimental values with polymeric surfactant; ∙∙∙∙ model with polymeric surfactant

A clear difference is observed between the volatilisation of pure pesticide and pesticide-surfactant solution. Results indicate that a higher vapour pressure of the a.i. results in a higher volatilisation and a faster decay of the volatilisation rate. However, addition of a surfactant can significantly change the volatilisation rate of the pesticide, making the use of the vapour pressure as an indicator for the volatility or the use in pesticide emission model difficult. Also, the reliability of vapour pressure has to be evaluated for each pesticide. A difference between the effect of the surfactants is present but further research is needed to evaluate the effect of different surfactant on the volatilisation. Formulation can affect the uptake into the leaf but also the availability of the pesticide on the leaf for volatilisation.

References:

**1.** Gish TJ, Prueger JH, Daughtry CST, et al. Comparison of Field-scale Herbicide Runoff and Volatilization Losses: An Eight-Year Field Investigation. *Journal of Environmental Quality.* Sep 2011;40(5):1432-1442.

**2.** Bedos C, Cellier P, Calvet R, Barriuso E, Gabrielle B. Mass transfer of pesticides into the atmosphere by volatilization from soils and plants: overview. *Agronomie.* Jan-Feb 2002;22(1):21-33.

**3.** Da Silva JP, Da Silva AM, Khmelinskii IV. Dissipation of triadimefon on the solid/gas interface. *Chemosphere.* Nov 2001;45(6-7):875-880.

**4.** Tomlin C. *The Pesticide Manual*. BCPC, 7 Omni Business Centre, Omega Park, Alton, Hampshire, GU34 2QD, UK.2003.