Emission of pesticides into the air

Emission of pesticides into the air during and after application to a potato crop

F. van den Berg[1], H.J. Holterman[2] and M. Leistra[1]

[1]Alterra, Centre for Water and Climate
[2]Plant Research International

Emission of pesticides into the air

Contents

- Introduction
- Description of field experiments
- Description of IDEFICS and parameterisation
- Description of PEARL and parameterisation
- Comparison of computations with measurements
- Discussion and conclusions

Emission of pesticides into the air

Introduction

- Substantial emissions can occur during and after application
- Comparatively high volatilisation rates after crop spraying
- Most pesticides are applied to the crop
- Use of models to assess exposure

ALTERRA WAGENINGEN UR

Emission of pesticides into the air

Field experiment at Slootdorp

Emission during application

- spraying of tracer (BSF) on potato crop
- passive and active sampling
- measurements of deposition and airborne drift

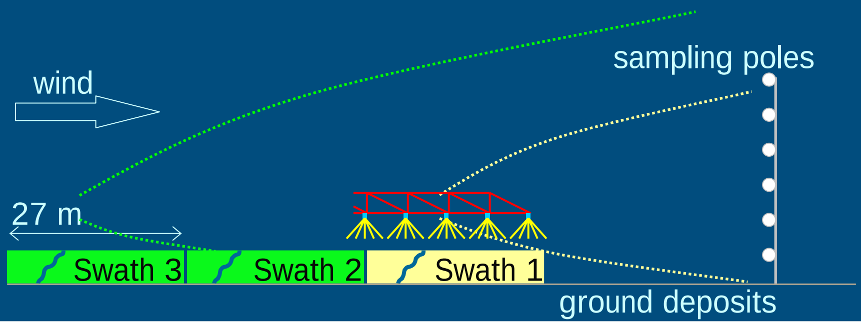
Emission after application

- spraying of fenpropimorph and chlorpyrifos
- measurements of emission fluxes with different methods
- residues on plant surfaces

ALTERRA WAGENINGEN UR

Emission of pesticides into the air

Emission during application: experimental set-up



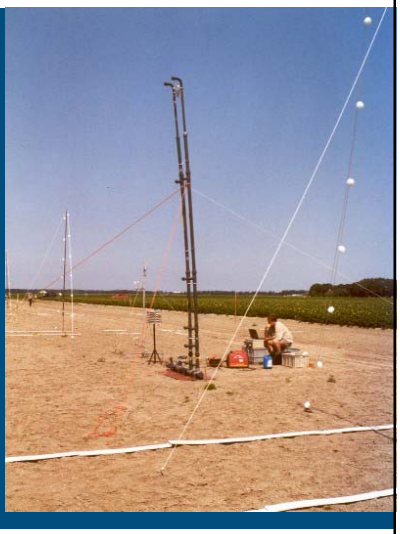
ALTERRA WAGENINGEN UR

Emission of pesticides into the air

Field experiment at Slootdorp (NL)

Application to potato crop on 25 June 2002

Meteorological data obtained by measurements in the field



ALTERRA WAGENINGEN UR

Emission of pesticides into the air

Post-application emission: spraying of pesticides

ALTERRA WAGENINGEN UR

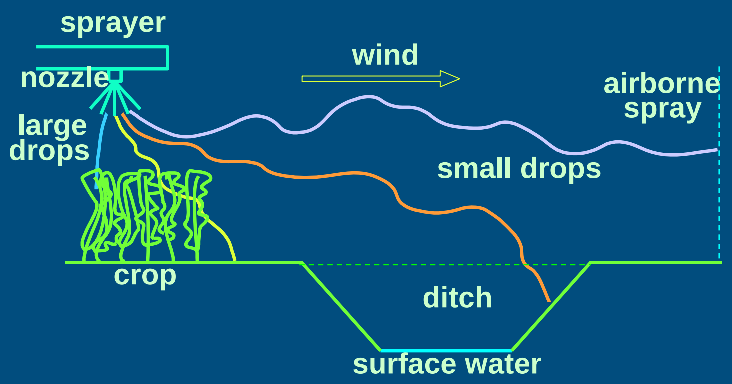
Emission of pesticides into the air

Volatilisation measurements at Slootdorp. Application at 25 June 2002.

ALTERRA WAGENINGEN UR

Emission of pesticides into the air

Transport pathways during application



ALTERRA WAGENINGEN UR

Emission of pesticides into the air

IDEFICS spray drift model

Purpose

- Downwind ground deposits (0 15m)
- Airborne spray distribution
- Developed for conventional field sprayer

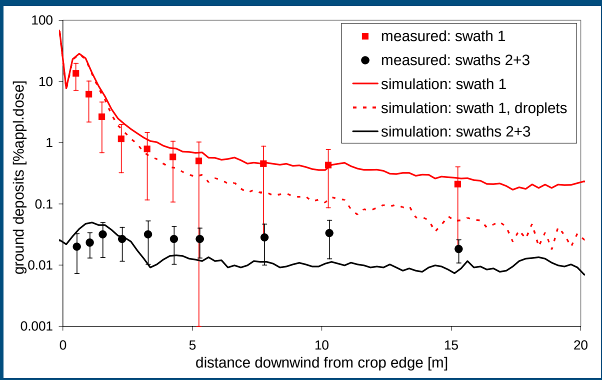
Basic concepts

- Particle tracking model (mixed 2D/3D)
- Equations of motion (deterministic)
- Turbulent air flow (stochastic)
- Evaporating droplets (‘solid core’)

ALTERRA WAGENINGEN UR

Emission of pesticides into the air

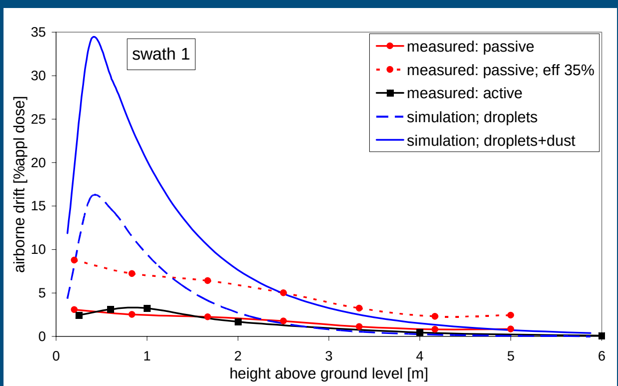
Deposition on the ground as computed with IDEFICS



Conclusion: deposits computed corresponds with those measured

Emission of pesticides into the air

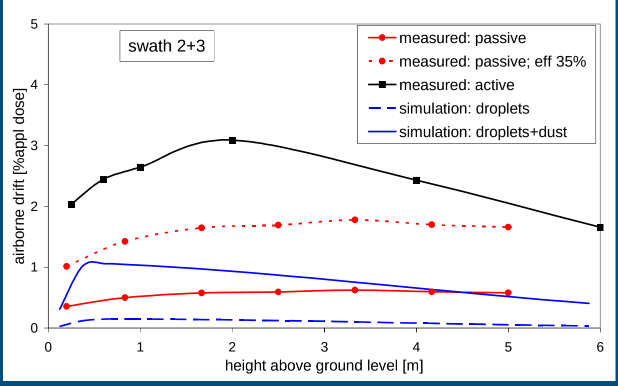
Airborne drift from swath 1 at downwind distance of 5.5 m



Conclusion: model overestimates drift; shape is different

Emission of pesticides into the air

Airborne drift from swaths 2+3 at downwind distance of 5.5 m



Conclusion: model underestimates drift

Emission of pesticides into the air

Averaged airborne emission from treated area at 5.5 m downwind

swath	Measurement [%applied]	Simulation [%applied]
1	0.30	1.86
2+3	0.26	0.17
100m [1)]	0.27	0.59
Flux [2)] [$mg.m^{-2}.hr^{-1}$]	6.9	15.3

[1)] Estimate for a 100 m wide field, assuming a 4th swath identical to the 3rd.
[2)] assumed: 300 l/ha; 5 mg/ml a.i.; 1.8 m/s driving speed; 1 ha field

Conclusion: significant airborne fraction downwind from field

Emission of pesticides into the air

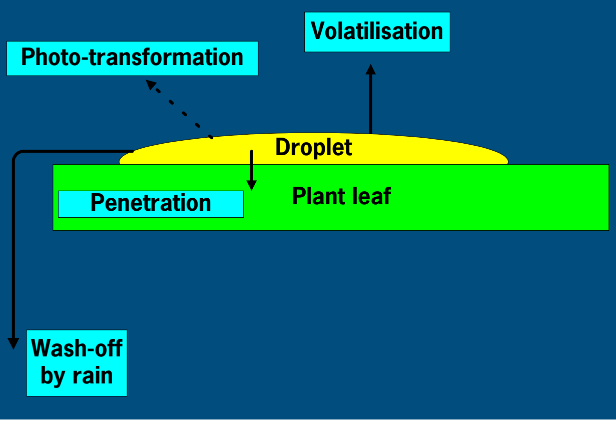
Some major problems in research on emission during application

- Sampling techniques show high variation
- Collection efficiency of samplers not very accurate
- Accurate estimation of droplet paths near the nozzle probably is critical for emission into the air

ALTERRA WAGENINGEN UR

Emission of pesticides into the air

Processes affecting the fate of pesticides on plants



ALTERRA WAGENINGEN UR

Emission of pesticides into the air

Description of processes on plants in PEARL

- Volatilisation: laminar air boundary layer
- Penetration, phototrans-formation and wash-off: first-order processes
- Rate coefficient of photo-transformation function of actual solar radiation

ALTERRA WAGENINGEN UR

Emission of pesticides into the air

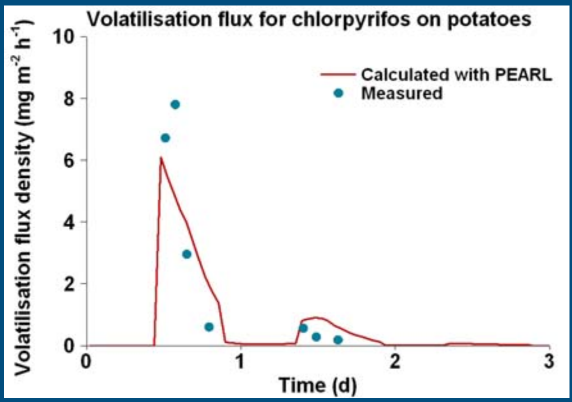
Derivation of input for pesticides

Property	Chlorpyrifos	Fenpropimorph
Vapour pressure	2.7 mPa at 25 °C	2.2 mPa at 20 °C
Half life for penetration	3 d	0.13 d
Half life for photo transformation	3 d	0.13 d
Laminar boundary layer	0.2 mm	0.2 mm

ALTERRA WAGENINGEN UR

Emission of pesticides into the air

Volatilisation of chlorpyrifos from potatoes computed with PEARL

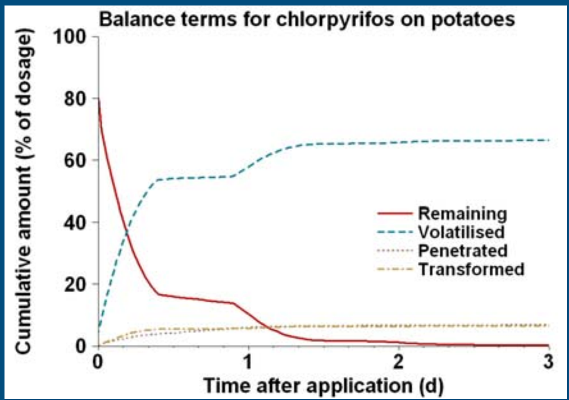


Conclusion: high initial volatilisation losses; diurnal pattern

ALTERRA WAGENINGEN UR

Emission of pesticides into the air

Mass balance of chlorpyrifos on potatoes computed with PEARL

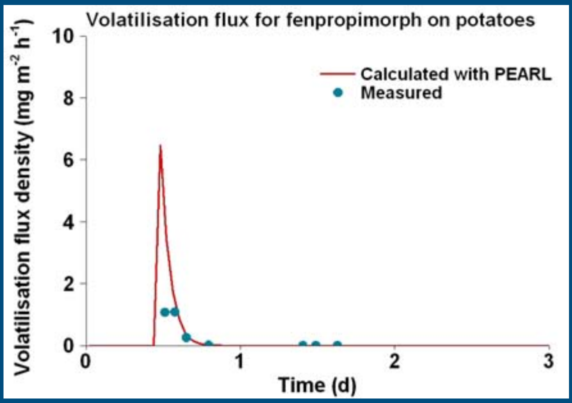


Conclusion: volatilisation dominant process

ALTERRA WAGENINGEN UR

Emission of pesticides into the air

Volatilisation of fenpropimorph from potatoes computed with PEARL

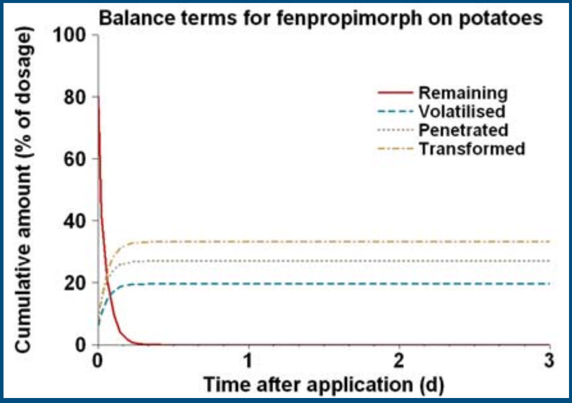


Conclusion: Fast decline in volatilisation rate

ALTERRA WAGENINGEN UR

Emission of pesticides into the air

Mass balance of fenpropimorph on potatoes computed with PEARL



Conclusion: Low volatilisation, other processes dominate

ALTERRA WAGENINGEN UR

Emission of pesticides into the air

Vapour pressure is crucial parameter in modelling volatilisation from plants

- Critical evaluation of available data needed as values may differ strongly
- Value may not correspond to volatilisation behaviour of pesticide (relative to others)
- Measurement should be made following latest OECD Guideline
- Estimation methods may be needed for checking

ALTERRA WAGENINGEN UR

Emission of pesticides into the air

Some major problems in research on emission after application

- Reliability of the input data, e.g. vapour pressure
- Lack of direct input data, e.g. on penetration, wash off, photo transformation
- Not present as pure compound; effect of substances e.g. in formulation
- Very complex geometry of canopy, deposit, etc.
- Complexity and variability of weather conditions

ALTERRA WAGENINGEN UR

Emission of pesticides into the air

Further research

- Improvement of sampling techniques for airborne drift
- Description of airborne drift for orchard spraying
- Experiments to derive rate coefficients for processes competing with volatilisation on plant surfaces
- Description of the distribution of pesticide deposit in the canopy
- Description of atmospheric resistances to volatilisation

Emission of pesticides into the air

Conclusions

- Considerable progress in modelling airborne drift and volatilisation in past 4 years
- Emission into the air during application as well as after application can be measured
- The effect of environmental conditions, substance properties and application characteristics on the total emission into the air can be estimated using IDEFICS and PEARL

Emission of pesticides into the air

Thank you for your attention

ALTERRA WAGENINGEN UR