Multidimensional modelling of targeted pesticide application techniques

Science For A Better Life

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Introduction

- targeted application techniques of plant protection products (e.g. drip chemigation, coating of seeds) are increasingly used in agriculture for more effective and environmentally friendly treatments
- these practices lead to heterogeneous distributions of water and/or solute in soil, not only in vertical but also in lateral direction

Aim of study

- explore local concentrations after drip chemigation by simulation of transport and redistribution of a plant protection product with the multidimensional model Hydrus 2D/3D
- relate resulting concentrations to efficacy levels of a target organism (e.g. nematodes)

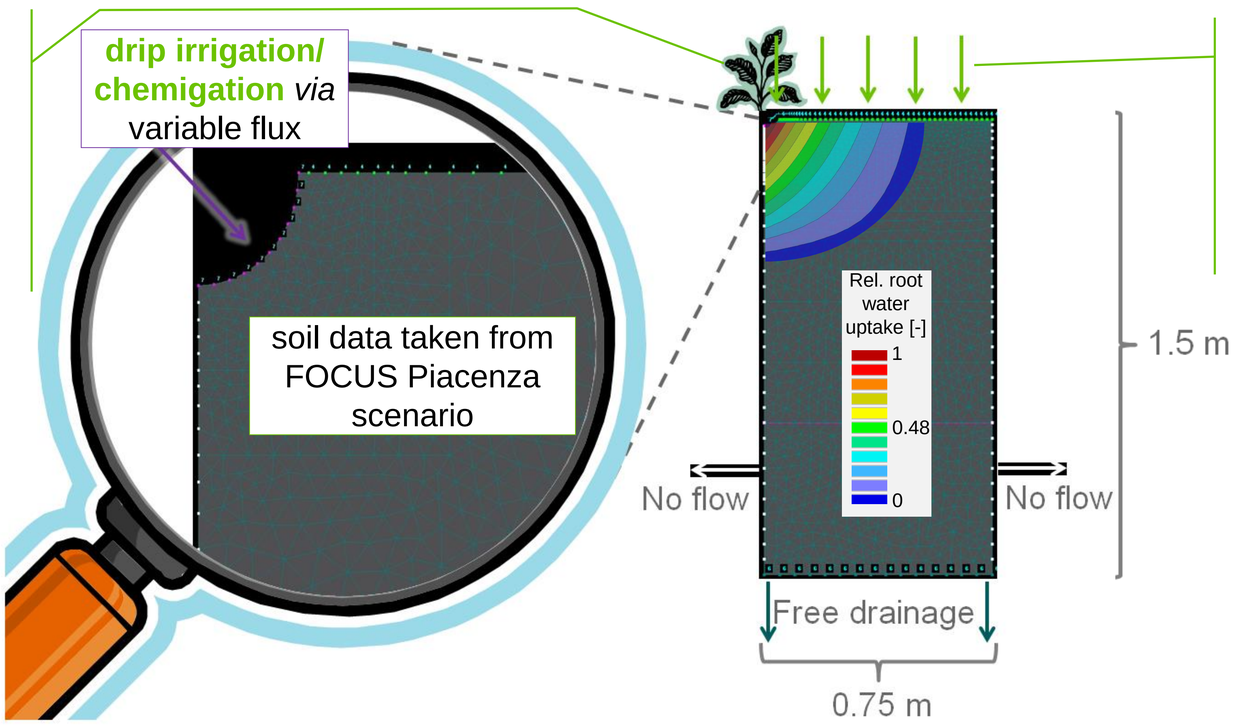
Materials and methods

Tomato plant

- fully developed
- realistic root distribution (see relative uptake distribution to the right)
- root water uptake implemented as sink, based on a water stress response function
- unlimited passive root solute uptake (PUF = 1)

Irrigation/ application

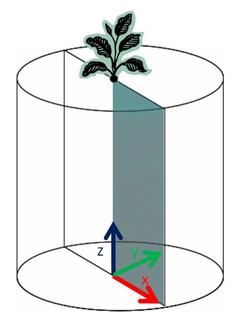
- drip irrigation: from 10th of May to 25th of August, every 3rd day (every 2nd day in later season)
- drip rate per emitter: 1.3 to 3.2 L/day (increasing over the season)
- substance props.: Koc = 400 L/kg, 1/n = 0.90, DT50 = 125 d
- PPP applied at 10th of May with two patterns:
  a) 1 x 1000 g/ha b) 2 x 500 g/ha, 3 d interval



Atmospheric boundary conditions

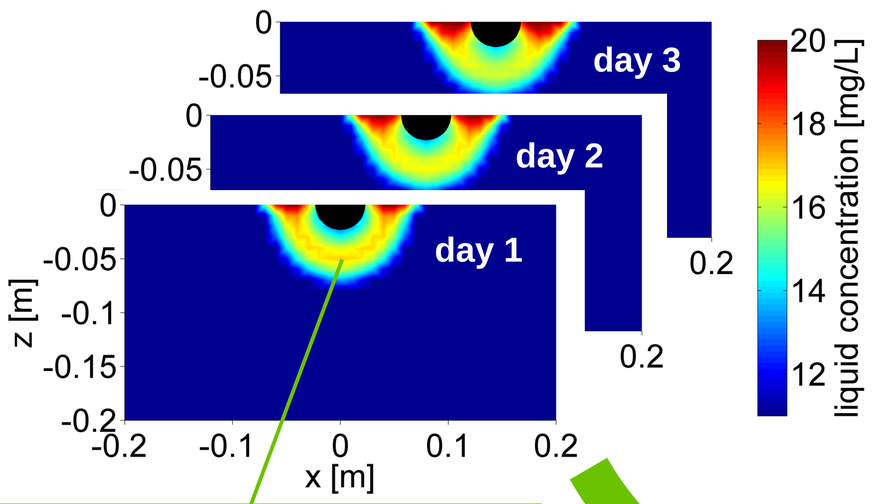
- weather data taken from FOCUS Piacenza scenario

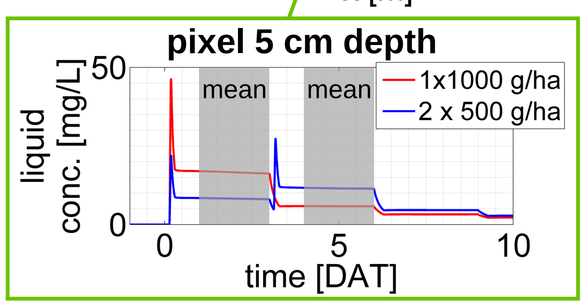
Axisymmetrical domain

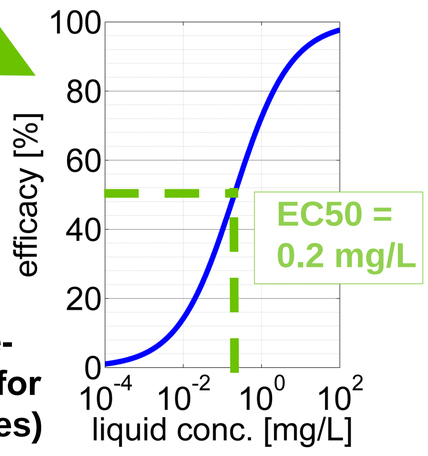


Results

Calculation of 'pixel-wise' average concentration for day after first treatment (DAT) 1-3 and DAT 4-6

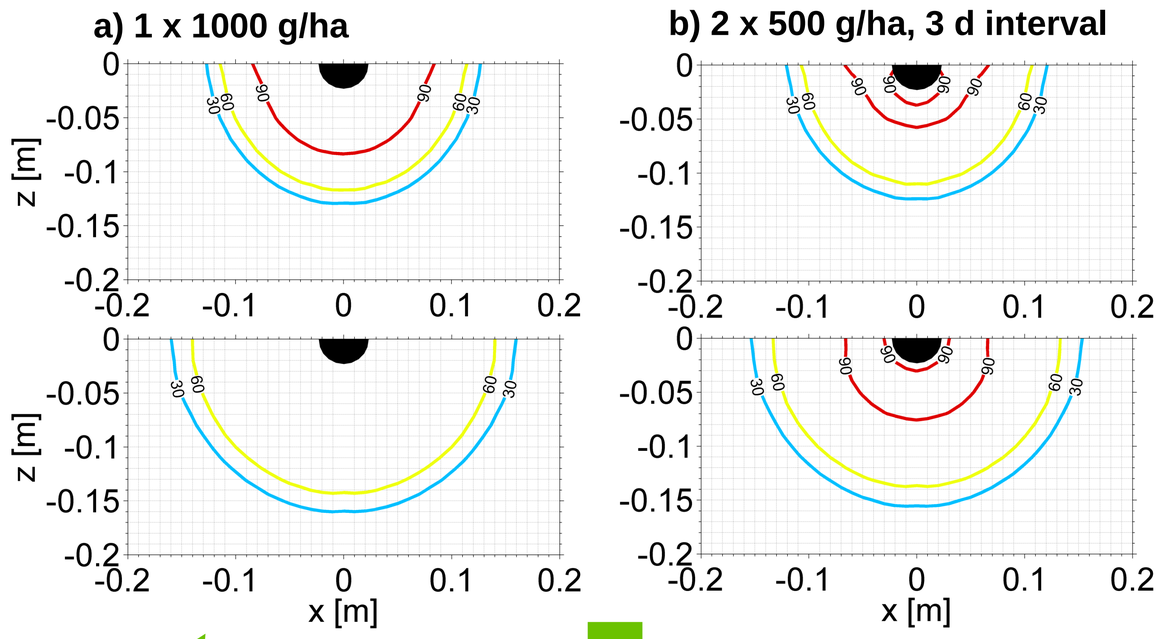






Assumption of sigmoidal dose-response curve ('Hill equation') for a target organism (e.g. nematodes)

Predicted efficacy [%]



Estimates of protective radii of > 90 % efficacy [cm]

	1 x 1000 g/ha	2 x 500 g/ha, 3 d int.
DAT 1-3	8.4	5.8
DAT 4-6	0	7.6

Conclusions

- single application is more effective (> 90 % efficacy) right after first application compared to split application
- split application is more effective (> 90 % efficacy) after DAT 4
- efficacy patterns are pretty similar in the lower efficacy range (< 60% efficacy) for both single and split application

General:

- a modelling framework is provided to relate exposure patterns to effects on target organisms
- the framework can easily be transferred to non-target organisms
- however, mobility and lifecycle of organisms is not considered, i.e. coupling with a spatially explicit population model would be beneficial