Dynamic multi-crop model to characterize impacts of pesticides in food

Short Course – Exercises (P. Fantke, R. Juraske)

Exercise 1 [25 min.]

Description:

In the production of apples several pesticides can be used for integrated pest management. In this exercise, we want to evaluate the performance of these pesticides in regards to human toxicity. We use dynamiCROP to model pesticide residues in treated apples. We evaluate different application scenarios to identify possibilities for reducing human health impacts based on the assumptions that (a) all pesticides of the same target class are used against the same pests and (b) that all pesticides are equally effective. All required input data, i.e. pesticides and their application characteristics, are listed in Table 1.

In dynamiCROP, please select sheet <data.substances> and adjust in column <AX> the application dose, then select sheet <data.system> and adjust in cell <R16> the pre-harvest interval (PHI) for apple. Run a scenario by selecting sheet <run> in cell <D4> the substance and in cell <D8> the crop for the scenario and push the <Run Model> button. Results are stored in sheet <results> below row <9>.

Table 1: List of pesticides applied in apple production, target class, application type and average dose applied, and pre-harvest intervals, PHI (required time between last application and harvest of apples).

Pesticide	**Target Class**	**Application Type**	**Dose applied** [kg/ha]	**PHI** [days]
Abamectin	Insecticide	foliar	0.02	10
Chlorpyrifos	Insecticide	foliar	7.00	21
Fosetyl	Fungicide	foliar	13.00	14
Glufosinate-ammonium	Herbicide	soil	0.06	14
Glyphosate	Herbicide	soil	0.08	14
Imazalil	Fungicide	foliar	0.01	3
Imidacloprid	Insecticide	foliar	0.55	30
Mancozeb	Fungicide	foliar	10.00	15
Paraquat	Herbicide	soil	0.01	28

Questions:

a. Calculate residues in apples for all pesticides listed in Table 1 at the pre-harvest interval (PHI) meaning that the crop is harvested at the earliest date allowed.
b. Compare residues with maximum residue limits and discuss results in terms of potential human health risk. Do you expect violations of regulatory thresholds? Do you expect residues higher than the MRL when the specific PHI is shorter (half of the values in Table 1)?
c. Calculate ingestion intake fractions of applied pesticides. What is the expected variability over all applied pesticides and between pesticide target groups?
d. Calculate human toxicity characterization factors of applied pesticides and compare those with the intake fractions. What can you conclude from this observation?

Exercise 2 [20 min.]

Description:
The dynamiCROP model is used to assess different food crops. To assess the variability of intake fractions and total human health impacts across crops, we will in this exercise evaluate the fungicide azoxystrobin.

Apply azoxystrobin with a default dose (only for comparative reasons) and crop-specific pre-harvest intervals (PHI) to all crops as given in Table 2.

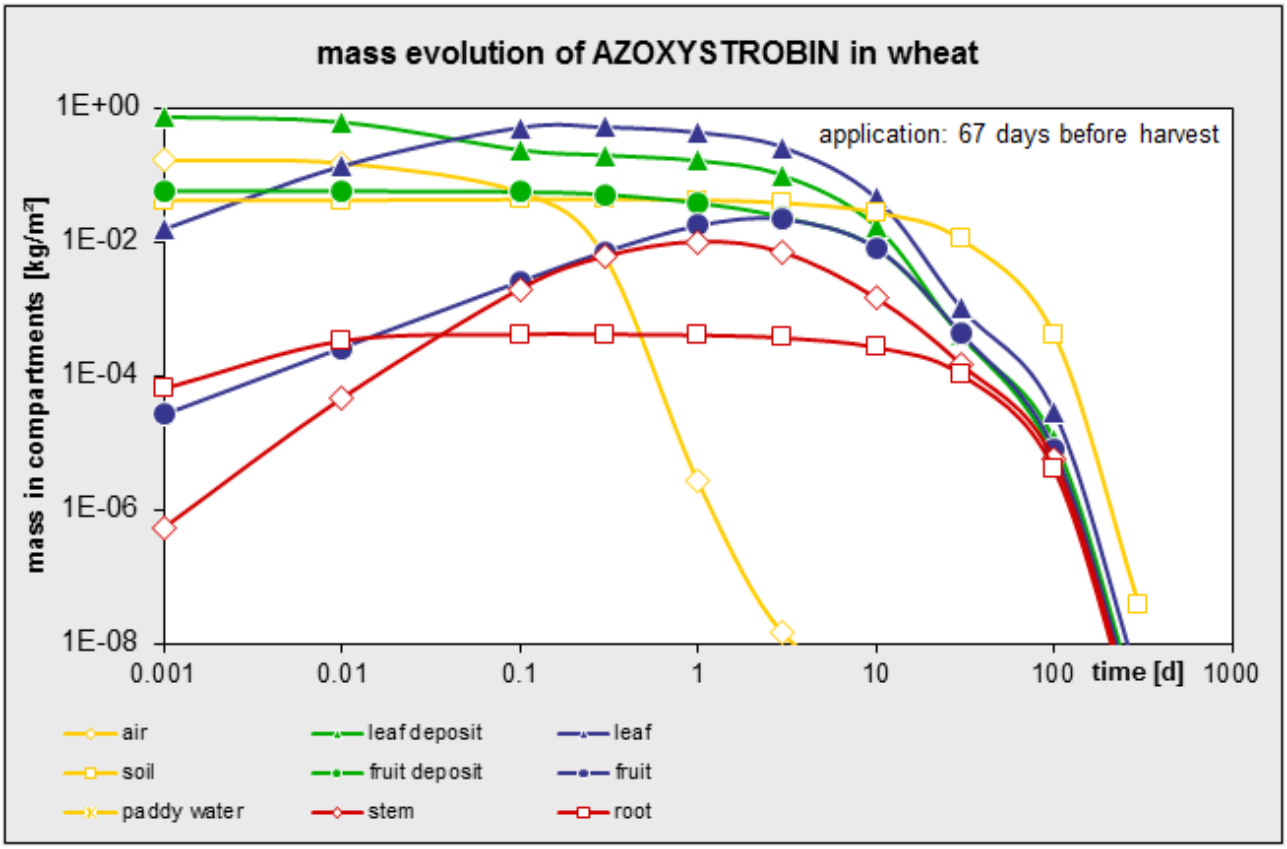
Table 2: List of pesticides applied in apple production, target class, application type and average dose applied, and pre-harvest intervals, PHI (required time between last application and harvest of apples).

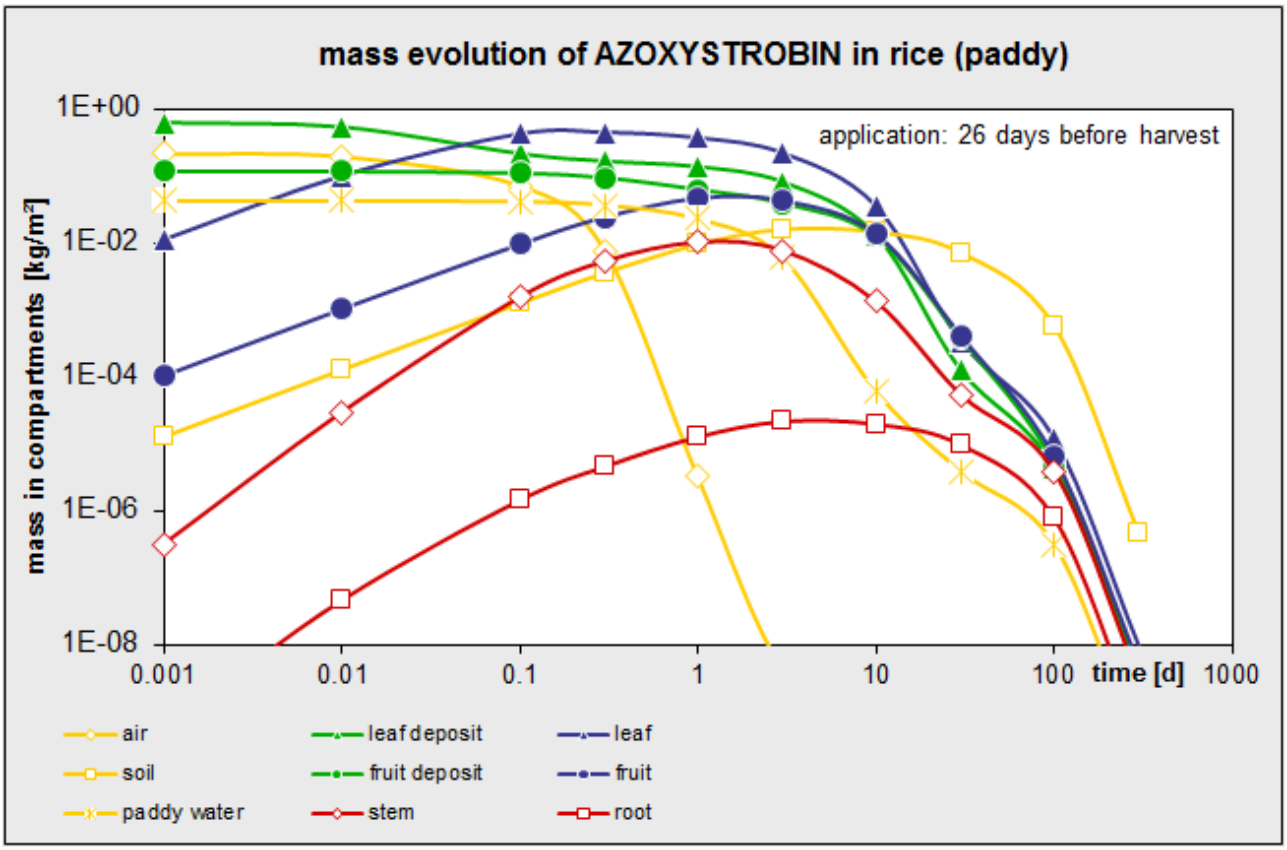
Crop	**Crop Type**	**Dose applied** [kg/m²]	**PHI** [days]
Wheat	Cereals	1	67
Paddy rice	Paddy cereals	1	26
Tomato	Herbaceous vegetables	1	20
Apple	Fruit trees	1	28
Potato	Root crops and tubers	1	37
Lettuce	Leafy vegetables	1	29

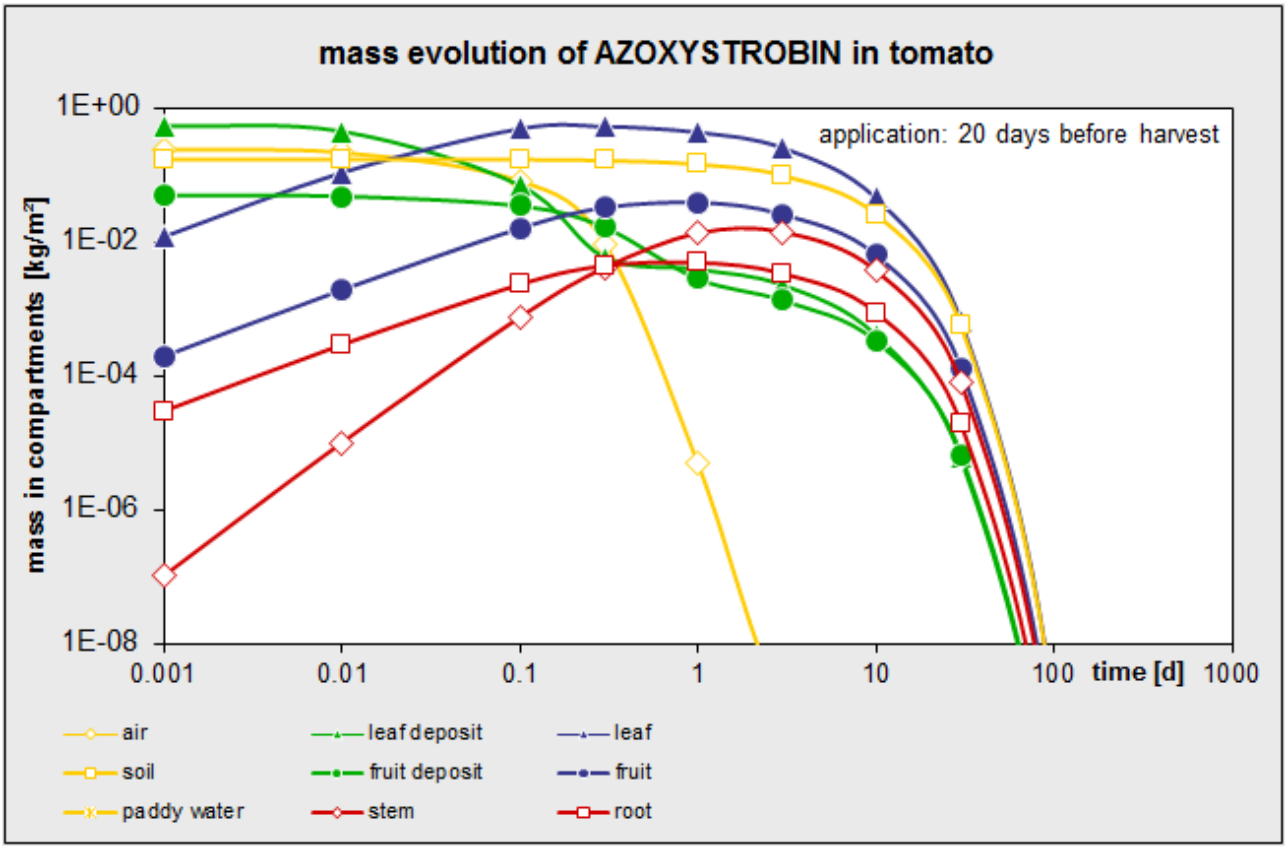
Questions:

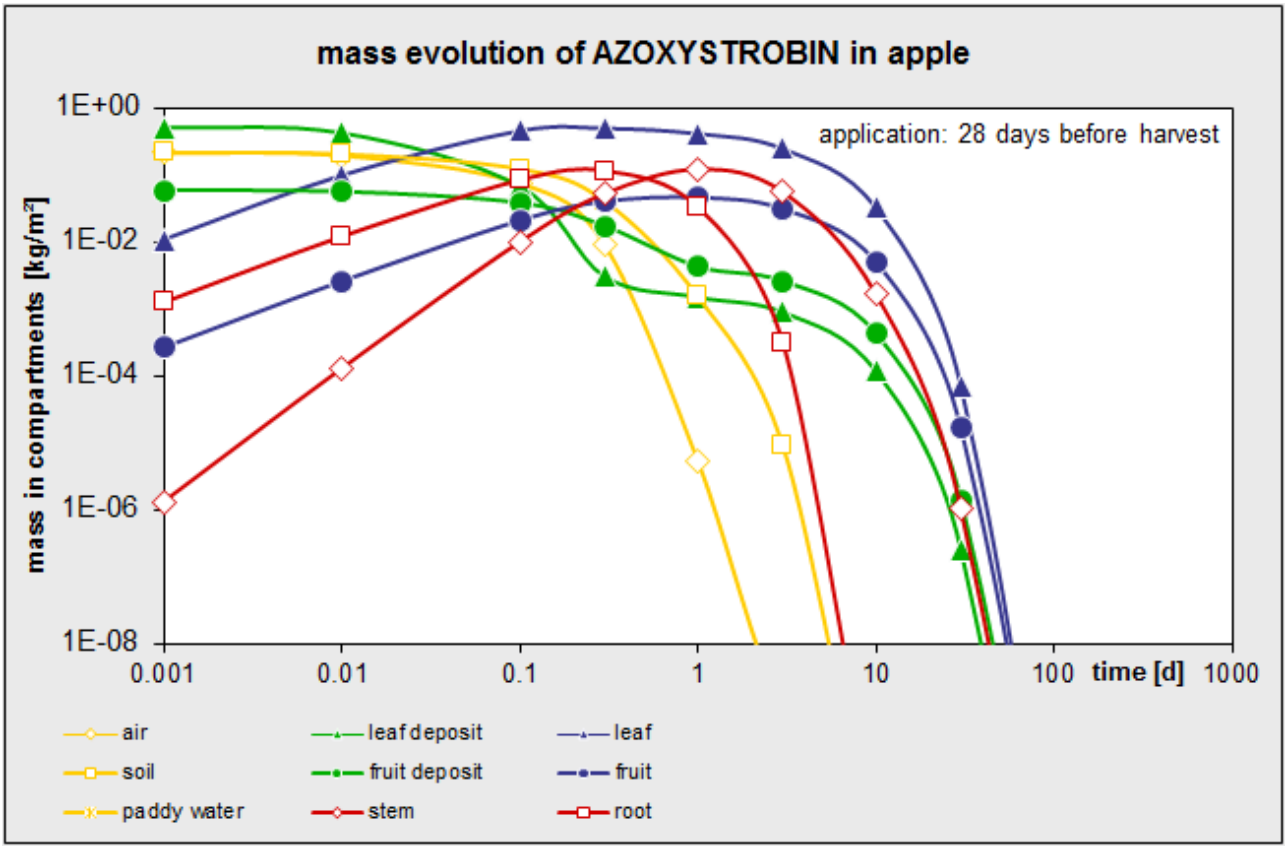
a. Which crops shows the highest and lowest intake fraction?
b. What are the main drivers leading to these results (e.g. crop characteristics, environmental parameters and fate pathways)? Use supporting material given below.
c. Could the impacts be reduced by substituting the applied pesticides through other active ingredient registered for the same purpose? Explain why yes or no.

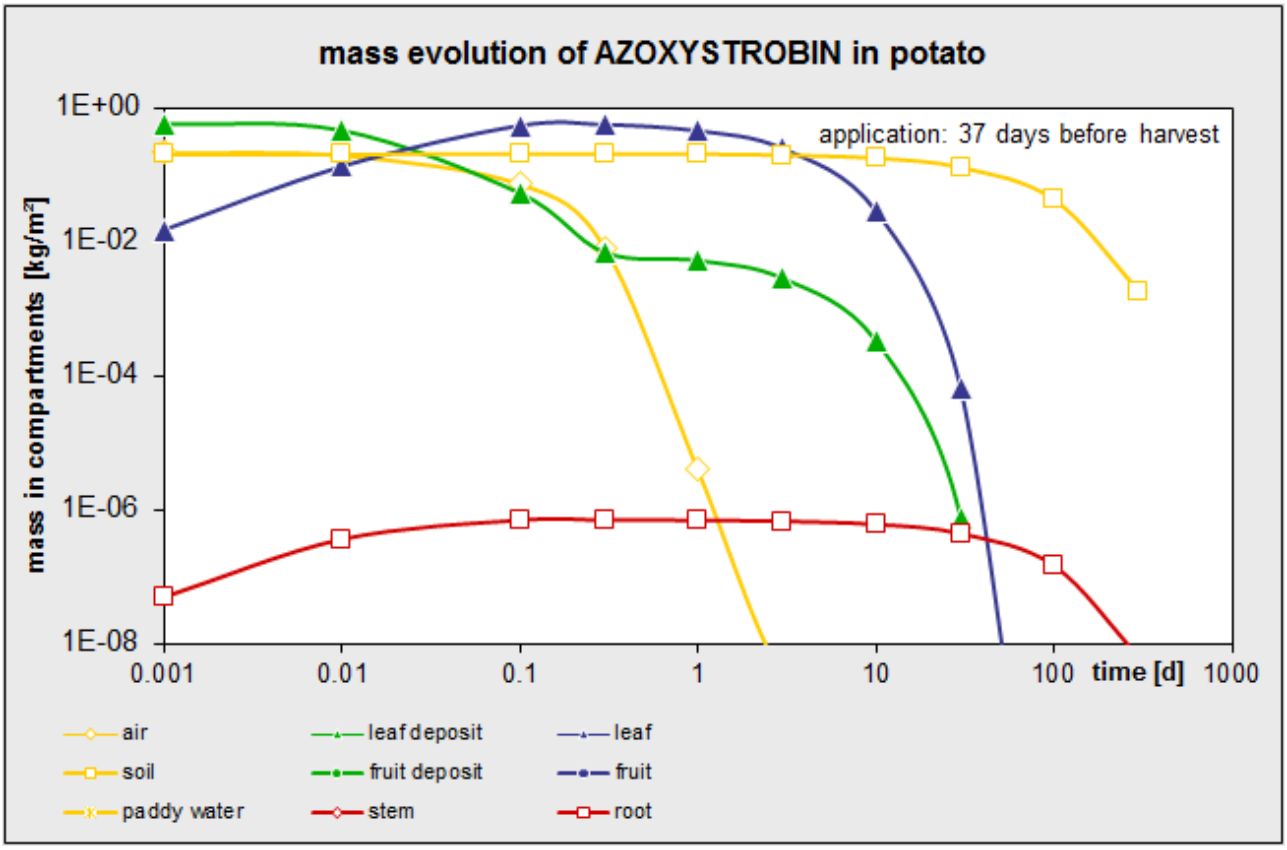
Supporting material for Exercise question 2b:

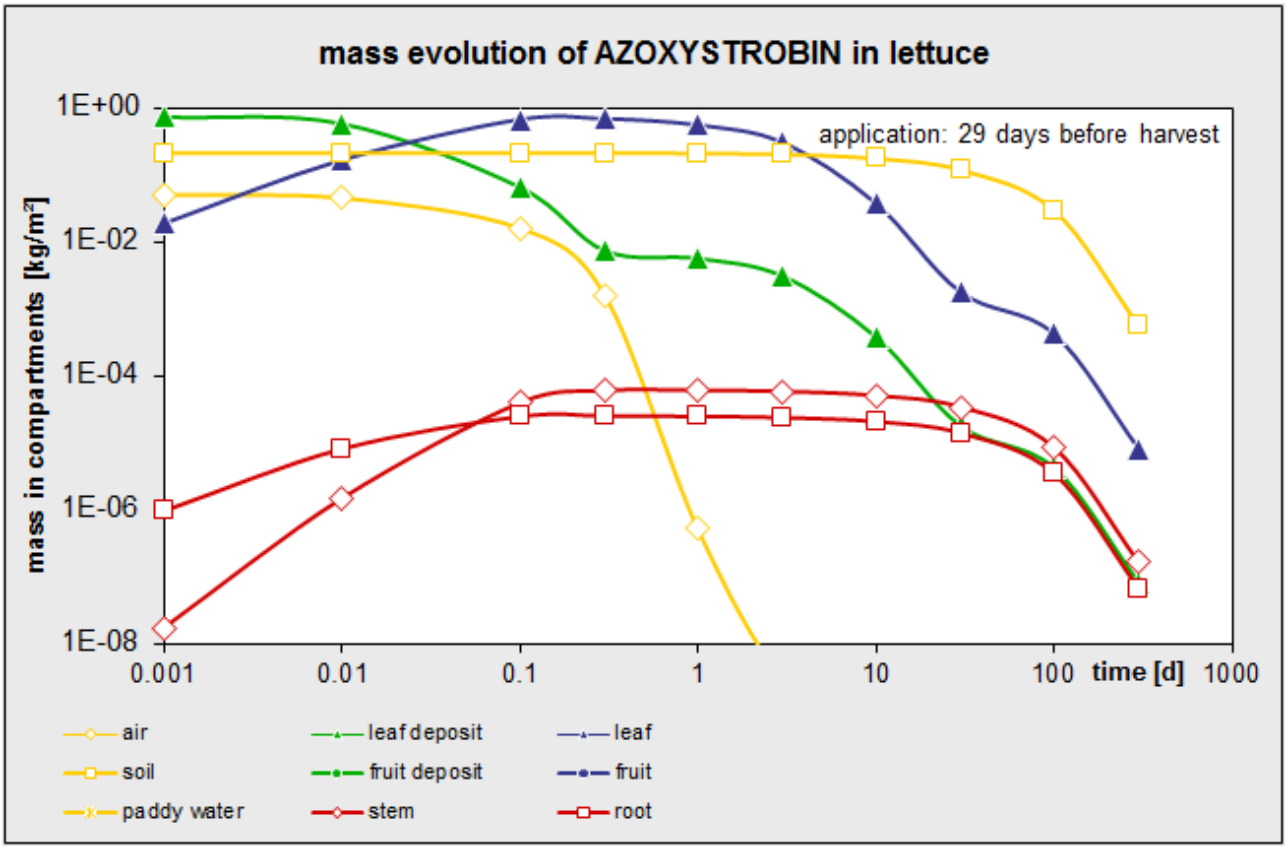





mass evolution of AZOXYSTROBIN in tomato
application: 20 days before harvest
mass in compartments [kg/m²]
1E+00
1E-02
1E-04
1E-06
1E-08
0.001
0.01
0.1
1
10
100
time [d]
1000
air
leaf deposit
leaf
soil
fruit deposit
fruit
paddy water
stem
root


mass evolution of AZOXYSTROBIN in apple
application: 28 days before harvest
mass in compartments [kg/m²]
1E+00
1E-02
1E-04
1E-06
1E-08
0.001
0.01
0.1
1
10
100
time [d]
1000
air
leaf deposit
leaf
soil
fruit deposit
fruit
paddy water
stem
root


mass evolution of AZOXYSTROBIN in potato
application: 37 days before harvest
mass in compartments [kg/m²]
1E+00
1E-02
1E-04
1E-06
1E-08
0.001
0.01
0.1
1
10
100
time [d]
1000
air
leaf deposit
leaf
soil
fruit deposit
fruit
paddy water
stem
root


mass evolution of AZOXYSTROBIN in lettuce
application: 29 days before harvest
mass in compartments [kg/m²]
1E+00
1E-02
1E-04
1E-06
1E-08
0.001
0.01
0.1
1
10
100
time [d]
1000
air
leaf deposit
leaf
soil
fruit deposit
fruit
paddy water
stem
root