EFSA guidance for exposure assessment of honey bees

Jos Boesten

ALTERRA
WAGENINGEN UR

Outline

- Introduction
- Contact exposure assessment
- Exposure assessment for water consumption in hive
- Exposure assessment for nectar and pollen consumption in hive
  - Overview
  - Higher-tier field exposure experiments
- Concluding remarks

Introduction

- presentation limited to honey bees
  - no bumble bees and solitary bees

honey bee

bumble bee

solitary bee

Introduction

EFSA guidance: risks to honey bees to be assessed resulting from:

- contact exposure (during or shortly after application)
- consumption of water
  - guttation water, surface water, puddles
- consumption of nectar and pollen in hive

possibly important but no guidance yet available:

- consumption of nectar and pollen outside hive (homing)
- consumption of honey dew

Introduction

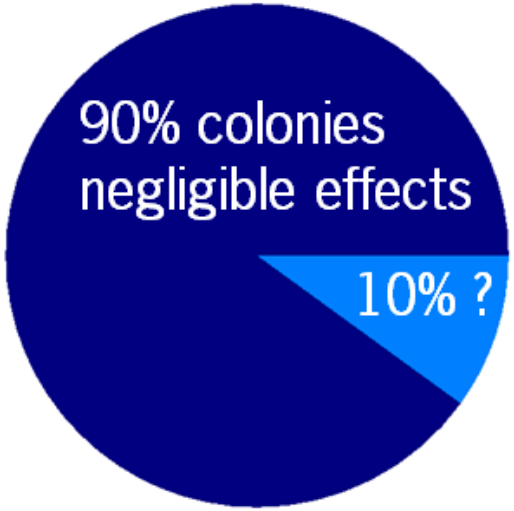
Exposure assessment goal

- 90th percentile worst-case exposure considering colonies at edges of treated fields in area of use of substance
  - e.g. a certain crop in a certain Member State
- so statistical population of colonies includes not all colonies in landscape, but only those at edges of treated fields (more strict of course)
- exposure assessment goal is territory of SCFCAH
- 90th percentile has some tradition in SCFCAH since 1999
  - FOCUS groundwater & surface water, EFSA soil organisms

Introduction

Linking of effect and exposure assessment goals

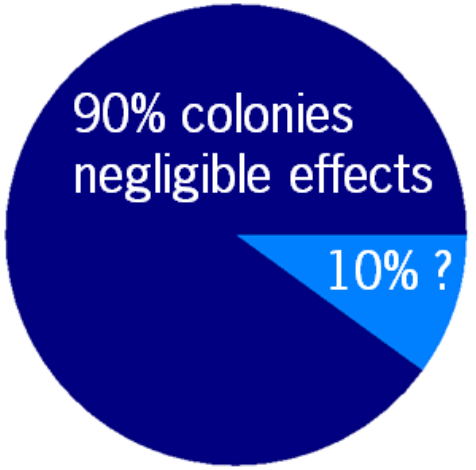
- overall level of protection is combination of effect and exposure assessment goals
  - linked like Siamese twins
- link: effect assessment goal applies to 90th percentile exposure case
- effect assessment goal for honey bees: negligible effects on colonies



Introduction

Linking of effect and exposure assessment goals

- for substances without safety margin it may e.g. be like:
  - 90% of colonies: negligible effects
  - 7% of colonies: small effects
  - 2% of colonies: medium effects
  - 1% of colonies: large effects

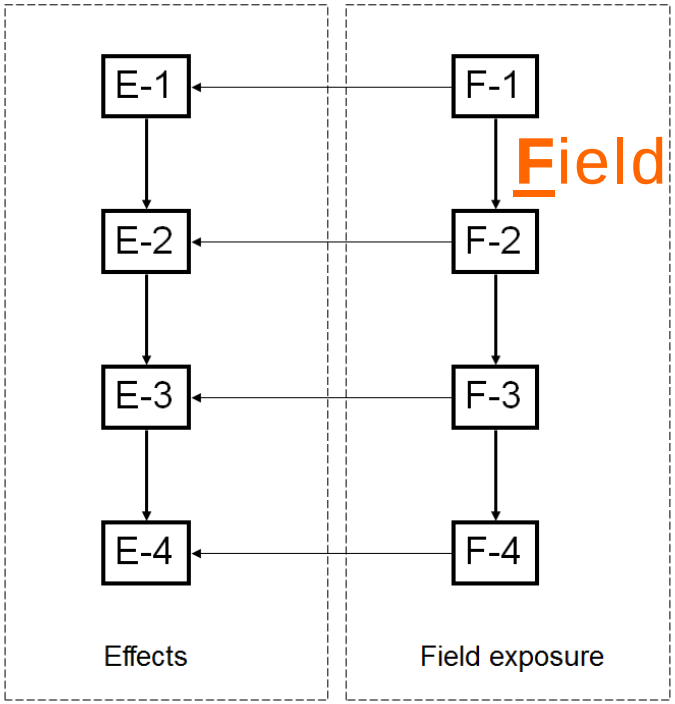


- for substances with a large safety margin it is probably like:
  - 100% of colonies: negligible effects

Introduction

Linking of effects and exposure:

effect assessment uses results of exposure assessment



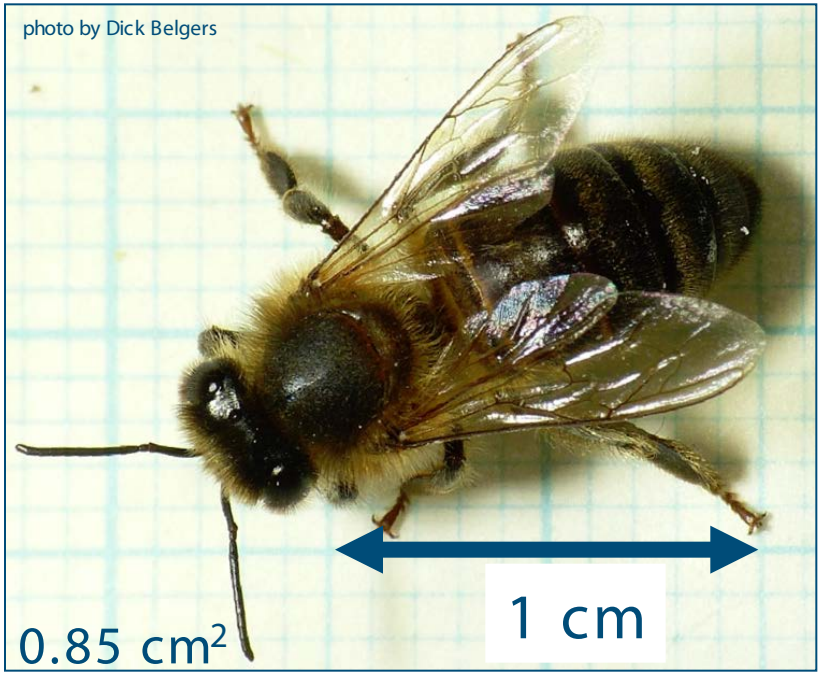
Contact exposure assessment

- spray applications: contact with spray liquid
  - field measurements Koch & Weisser (1997) Apidologie 28: 439-447

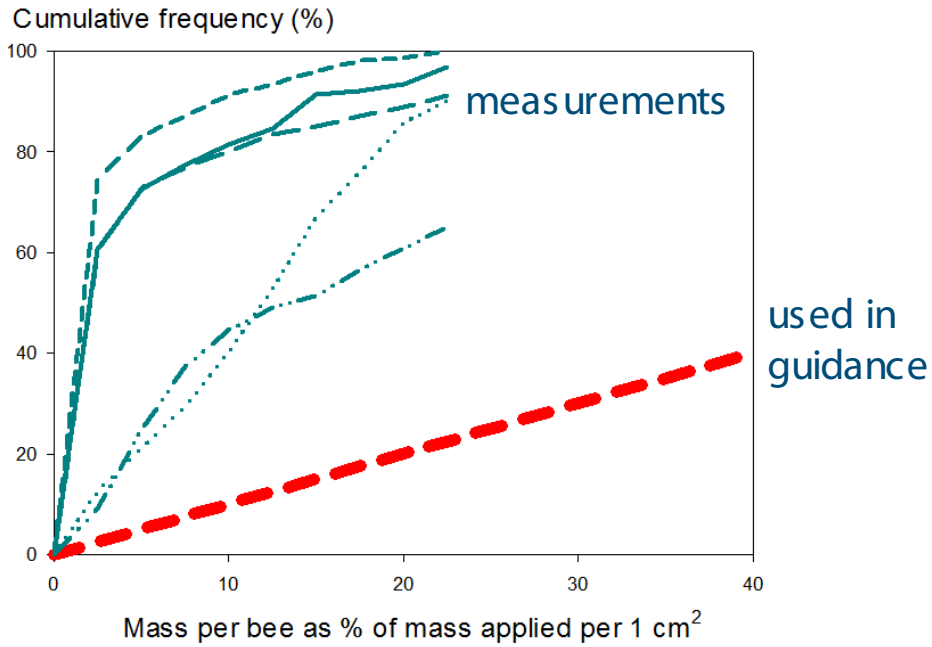
- Koch & Weisser: sodium fluorescein mass on bees returning to hive after downward spray applications in Phacelia
  - 5 field experiments in 4 years

Contact exposure assessment

- do bees fly through spray clouds ?
- one-sided surface area of bee = 1 cm^2 approximately
- mass expressed as % of mass applied per 1 cm^2
  - 100% = "full shower"



Contact exposure assessment



- bees collect considerably less than corresponds to their surface area
- 90th percentile = highest of five experiments (10-30-50-70-90)
- thick dashed line used for downward spraying: only data from one source with one type of spraying equipment and one type of plant
- for upward spraying estimated exposure two times lower based on 9 experiments in apple orchards by Koch & Weisser

Contact exposure assessment

- seed treatments and granule applications: contact with dust

contact with pollen: also dust may stick to bees

- no measurements
- exposure from spray is a matter of hours but dust is longer available
- dust may stick to hairs of foragers

- so dust exposure assumed to be 3 times higher than spray exposure

Exposure assessment for water consumption in hive

bees in hive need water; possible sources:

- surface water
- water from puddles
- guttation water

	surface water	puddle water	guttation water
typical concentration (mg/L)	0.01 (without mitigation)	0.1	100 seed treatments
preference of bees	++	+++	+
likelihood of occurrence	known in landscape	?	?

Exposure assessment for water consumption in hive

surface water:

- exposure assessment available
- effects on bees usually covered by aquatic effect assessment
  - not if substance more toxic to bees than to aquatic insects and crustaceans

water from puddles:

- likelihood of occurrence to be assessed considering location – calendar year combinations
  - 90th percentile remains yardstick
  - runoff risk mitigation not applicable
  - first tier based on FOCUS runoff scenarios

guttation water:

- likelihood of occurrence to be assessed considering location – calendar year combinations plus likelihood of use by bees
  - 90th percentile remains yardstick
- alternative water source is solution but no consensus on acceptability

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Exposure assessment for nectar and pollen consumption in hive

Exposure: function of application method and type of plant

main sources of contamination of nectar and pollen:

application	treated crop	adjacent crops	succeeding crops
sprays	uptake from overspray	spray drift	root uptake
seed treatments	uptake from seed coating	dust drift	root uptake
granules	uptake from dust deposition	dust drift	root uptake

different sources have different drivers, so different flow charts needed for different application-plant combinations

Exposure assessment for nectar and pollen consumption in hive

overall structure of exposure assessment for nectar/pollen entering the hive

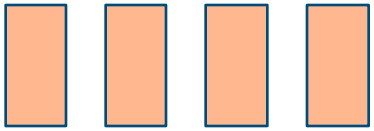
registration based on certain application method so starting point for exposure assessment

spray applications

seed treatments

granule applications

schemes containing all relevant types of plants



flow charts for each type of plant

some flow charts are identical: e.g. sprays, seed treatments and granules use same flow chart for succeeding annual crops

Exposure assessment for nectar and pollen consumption in hive

- target is peak in time of average concentration entering the hive for acute toxicity and 5/10-d TWA for chronic toxicity

- bees collect nectar/pollen from different plants so concentrations from different types of exposed attractive plants needed
  - treated crop
  - weeds in treated field
  - plants in field margins
  - adjacent crops
  - succeeding crops

concentration in nectar (spray appl.)

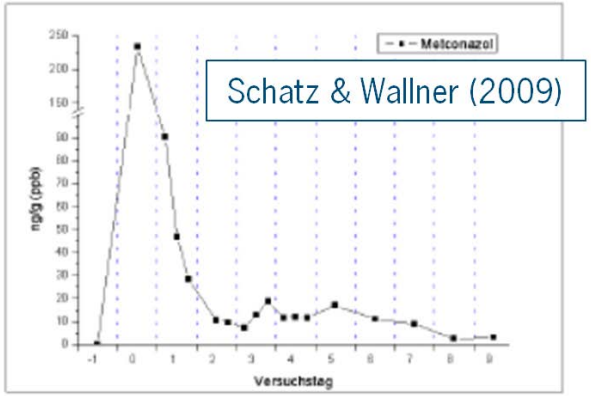


Abbildung 50: Verlauf der Konzentration von Metconazol im Nektar von Volk 1 am Ihinger Hof

time (days)

Exposure assessment for nectar and pollen consumption in hive

- problem: no reliable models/ measurements for linking concentrations in nectar/pollen in treated fields to average concentrations entering the hive
  - in September-2012 draft EFSA asked for such data: 1000 comments but no data
  - landscape-level exposure assessment needed but yet impossible

- so conservative approach in lower tiers: for assessment of concentration entering the hive assume that foragers forage exclusively on one type of plant:
  - treated crop
  - weeds in treated field
  - plants in field margins
  - adjacent crops
  - succeeding crops

Exposure assessment for nectar and pollen consumption in hive

same scheme for spray and granule applications

seed treatments: no weeds in treated fields:

not present at application

almost no root uptake

assess PEC in treated crop 1

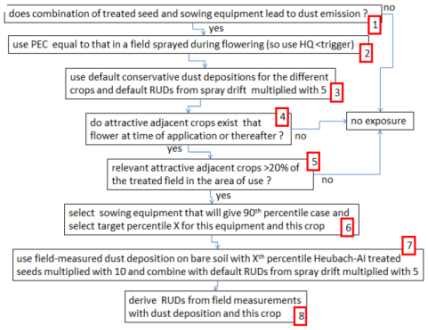
assess PEC in weeds in treated field 2

assess PEC in field margins 3

assess PEC in adjacent crops 4

assess PEC in permanent crops next year and in succeeding annual crops 5

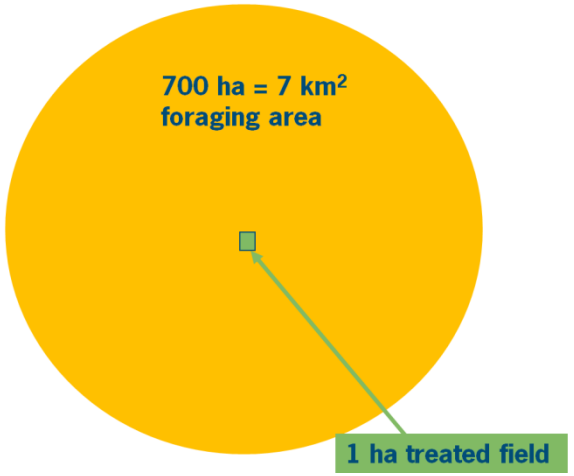
post-authorisation monitoring of concentrations entering the hive



Exposure assessment for nectar and pollen consumption in hive

Higher-tier field exposure experiments

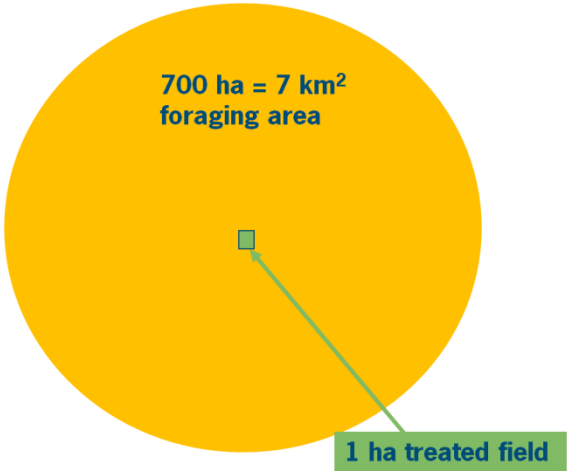
- option in a number of flow charts for spray applications
  - treated crop or crop in treated field next year
- aim 90th percentile of peak concentration in nectar/pollen entering hive
  - five experiments and take highest number (10-30-50-70-90)
- problem: 1-ha treated field may lead to underestimation of concentration entering hive
  - because of dilution caused by “clean” bee-attractive plants
  - because later in agricultural practice more fields in foraging area will be treated with this plant protection product



Exposure assessment for nectar and pollen consumption in hive

Higher-tier field exposure experiments

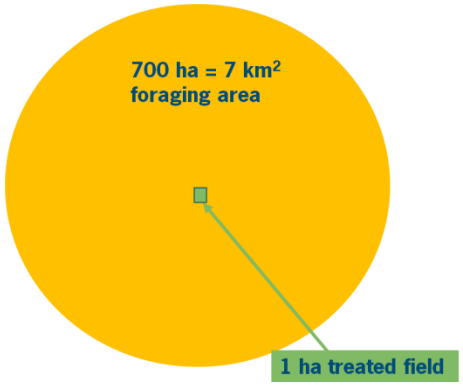
- so no bee-attractive crops within radius of 2 km of hive and minimal other alternative forage
  - may lead to overestimation of concentration entering the hive if much alternative forage under normal agricultural practice
  - may still lead to underestimation of concentration entering the hive if too much alternative forage in experiment
- so need to measure at same time concentrations in nectar/pollen in treated field and in honey and pollen sacks of bees that enter hive
- nectar in treated field can be sampled either from plants or from honey sacks of bees foraging in treated field



Exposure assessment for nectar and pollen consumption in hive

Example: nectar concentrations after spraying 1 kg/ha at five locations in area of use

Location nr	Conc. in treated field (mg/kg)	Conc. entering hive (mg/kg)	Foraging dilution factor (-)
1	1.0	0.3	0.3
2	2.0	1.4	0.7
3	4.0	0.4	0.1
4	5.0	2.0	0.4
5	7.0	1.4	0.2



no experience yet, so expert judgement needed for interpretation

e.g. large dilution in all cases may be due to repellency (to be substantiated by additional data or argumentation)

Exposure assessment for nectar and pollen consumption in hive

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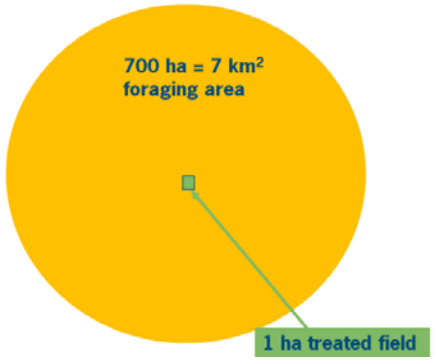

Interpretation for this example case

- 90th percentile is highest of five (10-30-50-70-90)
- 90th percentile entering hive < 7 mg/kg (highest of treated fields)
- 90th percentile entering hive probably close to 2 mg/kg if dilution factor of 0.4 is close to 90th percentile dilution case
- whether this is the case may depend on e.g. market share

Exposure assessment for nectar and pollen consumption in hive

Higher-tier field exposure experiments

- nectar concentrations used in effect assessment for calculation of daily intake of the plant protection product by the bees
- daily intake based on sugar demand
  - 500 mg nectar with 10% sugar = 250 mg nectar with 20% sugar
- so concentrations in nectar should be in mass of substance per mass of sugar, not per mass of nectar
- therefore sugar content of all samples should be measured

Exposure assessment for nectar and pollen consumption in hive

Higher-tier field exposure experiments

linking to the effect field studies

- protection goal: negligible effect for 90% of colonies at edge of treated fields
- so in effect field studies concentrations entering the hive should be at least as high as the 90th percentile from the field exposure experiments
  - so no bee-attractive crops within radius of 2 km of hive and minimal other alternative forage
- for adequate interpretation also in effect field studies nectar/pollen concentrations should be measured both in treated field and in honey and pollen sacks of bees that enter hive
  - nectar concentrations again on sugar basis
- if large dilution due to repellency, then additional data or argumentation needed
- no experience so far, so expert judgement needed on case-by-case basis

Concluding remarks

- exposure assessment of honey bees is quite complex:
  - contact
  - consumption of water
  - consumption of nectar and pollen
    - many flow charts to be followed in parallel
  - in addition different diets for foragers, nurses and larvae

- no experience so far with application of higher tiers of guidance to dossiers so case-by-case expert judgement needed

Thank you for your attention !