Photo 2 Hilling up soil by tractor with a modified ridge hilling machine

References

OECD Guidance Document No. 75 (2007): Guidance Document on the Honeybee (*Apis mellifera* L.*)* Brood Test under Semi-Field Conditions. OECD Environment, Health and Safety Publications, Series on Testing and Asssessment No. 75, ENV/JM/MONO(2007)22.

OEPP/EPPO (2010): Efficacy evaluation of plant protection products – Side effects on honeybees. OEPP/EPPO, PP 1/170 (4), EPPO Bulletin 40, 313-319.

3.8 'Focal species' – can this well-known concept in higher-tier risk assessments be an appropriate approach for solitary bees?

Johannes Lückmann, Michael Faupel, Jan-Dieter Ludwigs

RIFCON GmbH, Goldbeckstraße 13, 69493 Hirschberg, Germany, johannes.lueckmann@rifcon.de

DOI 10.5073/jka.2018.462.035

Abstract

Bumble bees and solitary bees have to be considered in addition to honey bees regarding environmental pollinator risk assessments. For solitary bees it is proposed to use *Osmia cornuta* (LATR., 1805) or *O. bicornis* (L., 1758) as test organisms. Whereas for higher-tier assessments, semi-field testing of solitary bees has been proved to obtain sound results, experience from current *Osmia* field studies show that exposure of adults and larvae is not necessarily the case due to the pronounced polylectic feeding behaviour. As an alternative refinement option the 'focal species' concept may be used, which is well-known as a kind of first step for higher tier bird and mammal risk assessments. This approach as it applies to solitary bees, as well as its needs, refinement options and limitations is presented.

Keyword: Solitary bees, higher tier, environmental risk assessment, focal species, pesticides, pollinator

Introduction

According to EFSA (2013) bumble bees and solitary bees have to be considered in addition to honey bees regarding environmental pollinator risk assessments (hereafter RA). However, suitable testing methods in the lab are only partly available or under development for species other than *Apis* bees. For solitary bees EFSA (2013) proposes to use *Osmia cornuta* (LATR., 1805) or *O. bicornis* (L., 1758) as test organisms.

Based on Proposals by the ICPPR non-*Apis* working group for solitary bees semi-field testing has been proved to obtain sound results for *Osmia* species. However, experience from currently conducted *Osmia* field studies show that exposure of adults and larvae is not necessarily the case (Peters et al., 2016; EPA, 2017; Ruddle et al., 2017). These solitary bee species have a pronounced polylectic feeding behaviour that can result in a low exposure to a test substance (*i.e.* not worst-case), which might be criticized by Member States (hereafter MS) authorities. In order to solve this problem, the refinement of worst-case solitary bee RA under realistic field conditions may be achieved by using a 'focal species' concept. Focal species are intended to represent a worst-case choice per crop, application time and zone to cover all potentially occurring solitary bee species for these scenarios. Whereas this approach is well-known for bird and mammal RA (EFSA 2009) it is novel for solitary bees. In addition to defining most appropriate species for solitary bee RA, such basic research would also increase knowledge about this important functional insect group and agriculture in current times where evidence for arthropod biodiversity and biomass decrease is in focus (Hallmann et al. 2017). Here, we present this approach, as well as its needs, refinement options and limitations.

Higher tier risk refinement steps for solitary bees

Step 1: Refinement of 1st tier default values for oral exposure of solitary bees

If unacceptable oral risk for solitary bees cannot be excluded in the 1st tier, a refinement of default residues values can be applied. A worst case oral exposure is assumed for the exposure scenarios 'treated crop' and 'weeds in the field'. Refinement options according to EFSA (2013) refer to 'exposure factors' and 'shortcut values' (SV). SVs express the theoretical residue uptake by bees and are calculated using EFSA´s SHVAL-tool (2014) for crops being attractive due to pollen and/or nectar supply, using

consumption rates of pollen and sugar for adults and larvae

sugar content of nectar

default Residues per Unit Dose in pollen and nectar (RUD values)

The default values according to EFSA (2013) are summarized in Table 1. RUDs depend on the kind of application (e.g. downward spraying for horizontal boom sprayers, sideward/upwards spraying for air assisted orchard sprayer, granule applications or seed treaments) and growth stage of the respective crop (i.e. BBCH). Based on specifically obtained residue data, lower RUDs lead to lower SVs and result in more realistic RAs with regard to the applied pesticide and respective application timing.

For further higher tier refinements (if necessary) we propose to use refined exposure and residue data based on 'focal species' (step 2).

Tab. 12 Default values according to EFSA (2013)

Pollen consumption [mg/bee/day or mg/larvae]	Sugar consumption [mg/bee/day or mg/larvae]	Sugar content nectar [%]	Median of RUDs in pollen [mg/kg]*	Median of RUDs in nectar [mg/kg]*
Adults: 10.2 Larvae: 387	Adults: 18 to 77 Larvae: 54	Treated crop: 10 Weeds: 30	Treated crop: 1 to 13.0 Weeds: 1 to 13.0	Treated crop: 1 to 4.0 Weeds: 1 to 2.5

*depending on application type and BBCH

Step 2: Refinement via 'focal species' approach for solitary bees

Identification of 'focal species'

According to EFSA (2009), a 'focal species' is a real species which occurs in a target crop when a pesticide is applied and it shall serve as representative for all other species from the same guild at that time. Guild in this context means the overall type of diet because in bird and mammal RAs the focus of exposure is on digestion of treated diet (EFSA 2009) – as it is in solitary bees. Thus, defining ‘focal species’ adds realism to the environmental RA. To identify suitable ‘focal species candidates’ the following 4-step procedure is proposed (Fig. 1)

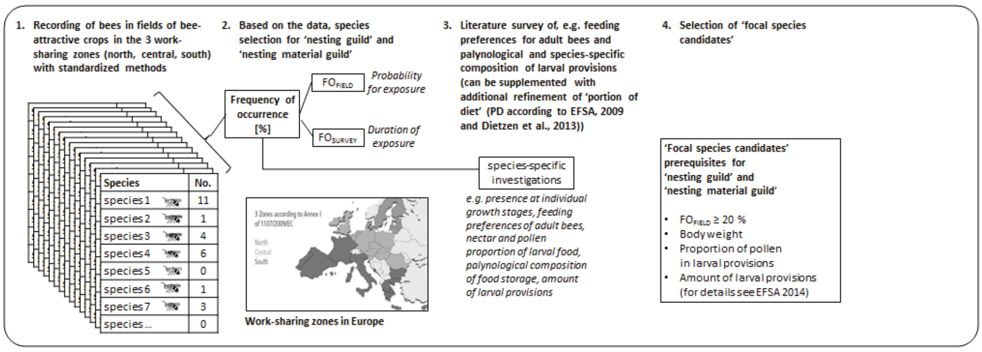

Fig. 13 Proposed 4-step procedure to define suitable ‘focal species candidates’

Following guidance from EFSA (2009),potential ‘focal species’ candidates can be species with a frequence of occurrence (FO) ≥ 20%. These species should be protective for other species that might be exposed to pesticide applications in the field at the same time and exposed to the same extent (EFSA 2009). Thus, exposure dependent parameters must be considered to ensure that the level of protection and uncertainty are taken into account (Dietzen 2013). Concerning solitary bees such criteria can be the FO (see above), the species´ body weight (which influences exposure by allometric daily energetic requirements and thus food ingestion rate), the proportion of pollen in the larval provisions and the total amount of larval provsions.

In contrast to birds or mammals, which consider only adults thus far and differentiate between the overall type of diet used (insectivore, herbivore, omnivore etc.) (feeding guild), two guilds for solitary bees are deemed to be relevant to consider, as this influences the degree and path of exposure (EPA 2017):

- nesting guilds: species nesting in the underground (in soil, ca. 65% of all solitary bee species) *vs* above-ground (cavities in wood, plant stems, crevices, snail shells; self-made nests using mineral or herbal material).

- nesting material guilds: species using mud/soil, pieces of leaves, plant hairs or resin to line out their nest cells.

The relevance of these different guilds has to be clarified for assignment of recorded species within the ranking of ‘focal species’ candidates.

Relevant oral exposure paths and refinement options

The following oral exposure paths are regarded as relevant for solitary bees:

1. Female adults: exposed to residues via pollen and nectar taken up as food (amount of pollen taken up as food is very low) and sampled as brood supply for their progenies.
2. Larvae: exposed to residues via pollen and nectar taken up as as food (data for pollen and nectar can be obtained from respective residue studies). Residues in soil/mud (can be obtained from standard PEC_{soil} calculations) and residues in herbal material (obtained from wildlife relevant residue studies on plants (see EFSA 2009)) may enter the larval food.

The proportion (≤ 1) of pollen of the target crop in the larvae provisions represents an approximation of how long a bee samples in the target crop and collects contaminated pollen and nectar. Such data can be used twice: on the one hand for the adult oral exposure as a measure of field exposure time (i.e. PT (‘portion of diet from treated area/time’) equivalent to EFSA 2009) and thus to correct the exposure factor and the default RUDs/SVs of diet fractions (i.e. PD 'portions of diet' equivalent to EFSA 2009). On the other hand, regarding larvae exposure such data can be used to correct the default RUDs/SVs.

Needs and perspectives

To check whether the proposed concept can be a useful approach to refine risk for all solitary bee species in agricultural areas exposed to pesticide applications in the higher tier it is necessary to

1. agree with MSs on a standardized method to record solitary bees in crops, e.g. number of fields per site and crop, number of sites per zone, survey scheme etc.
2. perform a pilot study in a common crop (e.g. winter oilseed rape in the Central Zone) to evaluate feasability and suitability of the approach for solitary bees and how to select 'focal species candidates'.
3. carry out sound literature surveys and/or case by case species-specific investigations in the field if needed (e.g. to investigate exposure at individual growth stages, feeding preferences of adult bees, nectar and pollen proportion of larval food, palynological composition of food storage, amount of larval provisions etc.).
4. verify the refinement concept.

References

Dietzen, C., P. J. Edwards, C. Wolf, J.-D. Ludwigs, and R. Luttik 2013: Focal Species of Birds in European Crops for Higher Tier Pesticide Risk Assessment. Integr. Environ. Assess. Manag. 10 (2), 247-259.

EFSA 2009: Guidance of EFSA: Risk assessment for birds and mammals. EFSA Journal 7, 1-139.

EFSA 2013: EFSA Guidance Document on the risk assessment of plant production products on bees (Apis mellifera, Bombus spp. and solitary bees) (published on July 04, 2013, updated on 04 July 2014). EFSA Journal 11 (7): 3295, 268 pp.

EFSA 2014: User Manual: A small application developed in R for the estimation of the residue intake rate for certain bee species under given conditions: the SHVAL tool. EFSA supporting publication, EN-623, 10 pp

Hallmann. C. A., M. Sorg, E. Jongejans, H. Siepel, N. Hofland, H. Schwan, W. Stenmans, A. müller, H. Sumser, T. Hörren, D. Goulson, and H. de Kroon 2017: More than 75 percent decline over 27 years in total flying insect biomass in protected areas. Plos One, October 18, 2017.

Peters, B., Z. Gao, and U. Zumkier 2016: Large-scale monitoring of effects of clothianidin-dressed oilseed-rape seeds on pollinating insects in Northern Germany: effects on red mason bees (Osmia bicornis). Ecotoxicology 25 (9), 1679-1690.

Ruddle, N., H. Thomson, O. Klein, and A. Hamberger 2017: Field and semi-field studies to evaluate the effects of foraging on thiamethoxam treated winter oil seed rape on the reproductive capacity of the red mason bee, Osmia bicornis. Oral presentation, 27th Ann. Meeting SETAC Europe, Brussels, Belgium 2017.

EPA 2017: Workshop on Pesticide Exposure Assessment Paradigm for non-Apis Bees. USEPA, Washington, USA, 10 – 12 January 2017.

462

Julius-Kühn-Archiv

Pieter A. Oomen, Jens Pistorius (Editors)

Hazards of pesticides to bees

13th International Symposium of the ICP-PR Bee Protection Group

18. - 20. October 2017, València (Spain)

- Proceedings -

Julius Kühn-Institut
Bundesforschungsinstitut für Kulturpflanzen

History ICPPR-Bee Protection Group conferences

1st Symposium, Wageningen, the Netherlands, 1980
2nd Symposium, Hohenheim, Germany, 1982
3rd Symposium, Harpenden, UK, 1985
4th Symposium, Řež, Czech Republic, 1990
5th Symposium, Wageningen, the Netherlands, 1993
6th Symposium, Braunschweig, Germany, 1996
7th Symposium, Avignon, France, 1999
8th Symposium, Bologna, Italy, 2002
9th Symposium, York, UK, 2005
10th Symposium, Bucharest, Romania, 2008
11th Symposium, Wageningen, the Netherlands, 2011
12th Symposium, Ghent, Belgium, 2014
13th Symposium València, Spain, 2017
14th Symposium scheduled, Bern, 2019

Organising committee 13th conference

Dr. Jens Pistorius (Julius Kühn-Institut, Germany)
Dr. Anne Alix (Dow Agrosciences, United Kingdom)
Dr. Carmen Gimeno (Trialcamp, Spain), local organiser
Dr. Gavin Lewis (JSC, United Kingdom)
Dr. Pieter Oomen (Wageningen, The Netherlands)
Dr. Veronique Poulsen (ANSES, France)
Dr. Guy Smagghe (Ghent University, Belgium)
Dr. Thomas Steeger (US Environmental Protection Agency, USA)
Dr. Klaus Wallner (Hohenheim University, Germany)

Editors

Dr. Pieter A. Oomen, Wageningen, The Netherlands
Dr. Jens Pistorius, Braunschweig

Group photo of all symposium participants, standing in front, from left:

Thomas Steeger (new board member),
Jens Pistorius (new chairman),
Françoise & Pieter Oomen with award (editor & former chairman),
Guy Smagghe (organiser, symposium host and new board member),
Job & Margreet van Praagh with award,
Anne Alix (secretary of the board)

Foto

Pieter A. Oomen (Bumble bee *Bombus lapidarius* on thistle)

The proceedings of the symposia (such as these) are being published by the Julius Kühn Archive in Germany since the 2008 symposium in Bucharest, Romania. These proceedings are also accessible on internet, e.g. the former symposium proceedings published by JKI can be found on https://ojs.openagrar.de/index.php/JKA/issue/archive (Issues 423, 437, 450). Furthermore, proceedings of former meetings have meanwhile been digitalized and can be found on https://www.openagrar.de/receive/openagrar_mods_00032635.

Bibliografische Information der Deutschen Nationalbibliothek

Die Deutsche Nationalbibliothek verzeichnet diese Publikation. In der Deutschen Nationalbibliografie: detaillierte bibliografische. Daten sind im Internet über http://dnb.d-nb.de abrufbar.

ISSN 1868-9892
ISBN 978-3-95547-064-7
DOI 10.5073/jka.2018.462.000

Printed in Germany by Arno Brynda GmbH, Berlin.