PESTICIDES AND BEE HEALTH

An evaluation of the application of the 2013 European Food Safety Authority Bee Guidance document as a mechanism to protect bees from agricultural pesticides.

Greenpeace Research Laboratories
Technical Report (Review)
January 2019

GREENPEACE

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AN EVALUATION OF THE APPLICATION OF THE 2013 EUROPEAN FOOD SAFETY AUTHORITY BEE GUIDANCE DOCUMENT AS A MECHANISM TO PROTECT BEES FROM AGRICULTURAL PESTICIDES.

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Greenpeace Research Laboratories Technical Report (Review) 01-2019

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Suggested citation:
Miller, K. A., Thompson, K. F., Achterberg, F. & Santillo, D. Pesticides and bee health. An evaluation of the application of the 2013 European Food Safety Authority Bee Guidance document as a mechanism to protect bees from agricultural pesticides. Greenpeace Research Laboratories Technical Report (Review) 01-2019

TAKE-HOME MESSAGES

- **Pesticide testing guidance on bees.** The European Food Safety Authority's Bee Guidance document (EFSA, 2013a) is the most comprehensive – though by no means perfect – testing regime to assess the potential risks to bees arising from the use of pesticides. It covers wild bee species (bumble bees and solitary bees) in addition to honey bees. It takes into account risks from chronic or repeat exposure to pesticides, and potential risks to larvae. It also considers various routes of exposure, including from spray deposits or dust particles, from contaminated pollen and nectar and from contaminated water (guttation fluid, surface water and puddles). The guidance indicates that it is not acceptable for a honey bee colony to shrink by more than 7% as a result of exposure to pesticides.

- **Only three neonicotinoids fully tested in accordance with the guidance.** The European Food Safety Authority (EFSA) used the Bee Guidance document in the assessment of four neonicotinoid insecticides – clothianidin, imidacloprid, thiamethoxam and acetamiprid (Appendix Table 1). However, only the assessments of clothianidin, imidacloprid and thiamethoxam covered impacts to honey bees, bumble bees and solitary bees. The assessment of acetamiprid was limited to honey bees. No updated risk assessment is available for thiacloprid, another neonicotinoid approved for use in the European Union (EU).

- **A high risk to bees from some pesticides could not be excluded.** The assessments of clothianidin, imidacloprid and thiamethoxam concluded that most uses of these pesticides presented a high risk to bees, or that a high risk could not be excluded. As a result, the EU banned all outdoor uses of clothianidin, imidacloprid and thiamethoxam. In the case of acetamiprid, EFSA concluded that it posed a low risk to honey bees, although it judged the available data insufficient "to draw any firm conclusion on the risk to honey bees, particularly to exclude any potential chronic effect or effect on brood development". The EU renewed the approval for acetamiprid until 2033, without any restrictions on use that would protect bees from exposure to the active ingredient

- **Other pesticides were not tested in accordance with the Bee Guidance document.** EFSA's assessments of three other insecticides that were suspected of being harmful to bees (sulfoxaflor, cyantraniliprole and flupyradifurone) were not based on the 2013 Bee Guidance document but on previous, outdated guidance. None of the three aforementioned assessments covers any wild bee species. In the case of sulfoxaflor, EFSA concluded that a high risk to honey bees could not be excluded for open field uses. EFSA is currently undertaking an additional assessment on this insecticide. In the case of cyantraniliprole, experts considered that the risk to honey bees could be mitigated for some uses if certain conditions are respected. For other uses the risk assessments could not be finalised because there were data gaps. The risk to honey bees from exposure to flupyradifurone was considered low. The EU allowed use all three insecticides for a period of ten years, without any restrictions that would protect bees from exposure to the active ingredients.

- **Chemical alternatives to banned neonicotinoids could be just as harmful to bee health.** In recognition of the above-mentioned limitations, the risk assessments for acetamiprid, sulfoxaflor, flupyradifurone and cyantraniliprole do not provide reassurance that these pesticides pose a low risk to managed honey bees or wild bees. Moreover, further data have become available on some of the pesticides within peer-reviewed publications since the assessments were published. The newly published evidence should also be taken into consideration by EFSA in relation to the assessment of pesticides. An updated, state-of-the-art risk assessment of hould be performed to ensure that they cannot be used as alternatives to the banned neonicotinoids, causing potentially similar harm to bees.

- **Peer-reviewed literature search.** This report details the findings from a systematic search of peer-reviewed literature was performed in relation to the eight pesticides and different bee types (honey bee, bumble bee and solitary bee). The majority of the literature on all eight pesticides is biased toward research on honey bees (661 papers), with fewer papers on bumble bees (78 papers) and only 12 papers that mention solitary bees in the abstract. The literature search also found that between 1994 and 2018, most literature focused on clothianidin, imidacloprid and thiamethoxam (those that are now banned from outdoor use in the EU). Very few publications have so far assessed the risks to bee health from sulfoxaflor, flupyradifurone and cyantraniliprole, although at least some of those that are available indicate cause for concern.

- **Sulfoxaflor.** Subsequent to the publication of its review for sulfoxaflor, the EU requested additional data to help determine the risk to honey bees and other bees. EFSA's initial conclusion was that "a low risk could not be demonstrated for honey bees and non-Apis (wild) bees". In the meantime, a new peer-reviewed study has appeared in the journal Nature suggesting that bumble bees that are exposed to sulfoxaflor may suffer population-level impacts due to reduced reproductive success (Siviter et al., 2018). EFSA is expected to publish a new set of conclusions in March 2019, taking into account the new evidence.

- **Knowledge gaps.** The Bee Guidance document identifies a number of knowledge gaps: it does not mention other pollinators, beneficial insects or arthropods; the same stringent field tests are not required for metabolites (that is, breakdown products) because they are only intended for active ingredients (yet metabolites can be as toxic as the active compound); risk mitigation strategies are only useful if they are understood and interpreted correctly.

1.0 INTRODUCTION

The objective of this report is to provide insight into the current state of the implementation of the European Union (EU) Bee Guidance Document (EFSA, 2013). The report investigates the differences between the way the Bee Guidance document was applied in the EU assessments of a number of systemic insecticides, including those that have been banned for open field uses and others that are permitted for use in the EU.

The eight pesticides included in the analysis are five neonicotinoids – clothianidin, imidacloprid, thiamethoxam, acetamiprid and thiacloprid – and three other systemic pesticides – sulfoxaflor, cyantraniliprole and flupyradifurone. The classification of neonicotinoids is under discussion (Sparks & Nauen, 2015; EFSA, 2017; IRAC, 2018). A report by the Pesticide Action Network Europe suggests that both sulfoxaflor and flupyradifurone should be classed as neonicotinoids because both compounds bind to insect nicotinic acetylcholine receptors and their action is systemic (PAN, 2016). Giorio et al, 2017 suggest that sulfoxaflor and flupyradifurone are fourth-generation neonicotinoid compounds. Cyantraniliprole has been described as an "anthranilic diamide" (Selby et al., 2016) that could replace neonicotinoid seed treatments [1, 2].

1.1 AN ASSESSMENT OF THE EUROPEAN FOOD SAFETY AUTHORITY BEE GUIDANCE DOCUMENT

Under EU law, pesticides can only be approved if their use has "no unacceptable effects on the environment", including potential effects on "non-target species" as well as "biodiversity and the ecosystem" (Regulation (EC) No 1107/2009, Article 4).

In addition, pesticides can only be approved if their use does not lead to unacceptable effects on honey bees. It has to be "established following an appropriate risk assessment on the basis of Community or internationally agreed test guidelines" that their use will either "result in negligible exposure of honey bees" or that it has "has no unacceptable acute or chronic effects on colony survival and development, taking into account effects on honeybee larvae or honeybee behaviour" (Regulation (EC) No 1107/2009, ANNEX II, Point 3.8.3).

EU pesticides law requires that the risk assessment, which forms the basis for regulatory decisions, be "independent, objective and transparent" and carried out "in the light of current scientific and technical knowledge" (Regulation (EC) No 1107/2009, Articles 11 and 36).

In March 2011, the European Commission asked EFSA to review the existing scheme for the assessment of risks posed by pesticides to bees. It considered that the scheme was outdated in that it covered only the acute mortality of adult bees due to pesticide exposure, and did not cover risks from sub-lethal effects, from exposure to contaminated water and from seed treatment.

1 https://entomologytoday.org/2016/10/19/anthranilic-diamides-can-potentially-replace-neonicotinoid-seed-treatments-in-vegetable-crops/

2 https://www.npr.org/sections/thesalt/2016/08/31/491962115/minnesota-cracks-down-on-neonic-pesticides-promising-aid-to-bees

In response to the Commission's request, EFSA published a Scientific Opinion (EFSA, 2012) that showed how the existing risk assessment guidance failed to capture all relevant aspects of bee risk assessment. It advised that the risk of long-term exposure (chronic toxicity) should be assessed, that different life stages (adult and larvae) should be considered and that the risk to bumble bees and solitary bees should be assessed separately, in addition to the risk to honey bees.

EXPOSURE IS RELATED TO BEE SPECIES AND CASTES WITHIN SPECIES.

EFSA (2012) reviewed the science behind the development of a risk assessment of plant protection products on bees. A number of key points relating to exposure risk to all bee species were discussed. Some of the main points are highlighted below.

Different bees (species, castes within the hive and life stages) have different exposure opportunities. The Scientific Opinion document suggests that there is need for a separate risk assessment for bumble bees and solitary bees, in comparison to honey bees.
Exposure through oral intake is highest for bees that are active in winter, forager bees and larvae.
Nurse bees are exposed through pollen and nectar.
Larvae of all bee species may be exposed by contact to wax within the hive.
Foragers, drones, queens and swarms of all bee types may be exposed to droplets and vapour by contact and inhalation.
Worker bees, queens and larvae of bumble bees and adult females and larvae of solitary bees were considered to be the categories that are most exposed through oral uptake.
Larvae of solitary bees may be more exposed to residues in pollen than the larvae of honey bees because solitary bee larvae consume large mass provisions with unprocessed pollen.
Bumble bees and solitary bees may have greater exposure through contact with nesting material (soil or plants) compared to honey bees.
The scientific opinion noted that conventional regulatory tests that assess acute toxicity over short periods (48–96 hours) may not be accurate to assess the risks of long-term exposure. Specific chronic toxicity tests are recommended for each bee type.

When the Commission asked EFSA to assess the risk to bees from the use of three neonicotinoid insecticides (imidacloprid, clothianidin, thiamethoxam) and fipronil, EFSA relied on the Scientific Opinion (EFSA, 2012) to perform the evaluation. EFSA could not use the existing guidance since it was asked to consider "the acute and chronic effects on colony survival and development, taking into account effects on bee larvae and bee behaviour, and the effects of sublethal doses on bee survival and behaviour" (EFSA 2013b). Based on the EFSA assessments, presented in January 2013, the EU imposed a number of restrictions on the use of these insecticides (Commission Implementing Regulations (EU) No 485/2013 and No 781/2013).

Since EFSA found that there were insufficient data to perform a full assessment in line with the Scientific Opinion, the EU required the manufacturers to submit, by end of 2014, additional data on a number of issues including "the risk to pollinators other than honey bees", "the risk to honey bees foraging in nectar or pollen in succeeding crops", "the acute and long term risk to colony survival and development and the risk to bee brood for honey bees from ingestion of contaminated nectar and pollen" (Commission Implementing Regulations (EU) No 485/2013 and No 781/2013).

In July 2013, EFSA published an updated risk assessment guidance (EFSA, 2013a) that takes into account the findings of its 2012 Scientific Opinion.

WHAT IS NEW IN THE UPDATED RISK ASSESSMENT SCHEME?

The 2013 EFSA Bee Guidance document (EFSA, 2013a) contains a risk assessment scheme for the chronic risk to adult honey bees and honey bee larvae as well as for the risk to bumble bees and solitary bees. It considers different routes of exposure to pesticides, including from spray deposits or dust particles, from the consumption of contaminated pollen and nectar and from the consumption of contaminated water (guttation fluid, surface water and puddles).

The Bee Guidance document also details what "no unacceptable effects" means (that is, the protection goal that the EU aims to achieve). It suggests that it is not acceptable for a honey bee colony to shrink by more than 7% as a result of exposure to pesticides at any time.

Despite some weaknesses, the Bee Guidance document represents the most comprehensive methodology for assessing the risks posed by pesticides to bees.

The EU also updated its data requirements for pesticide active substances and formulated products in line with the new Bee Guidance document (Commission Regulations (EU) No 283/2013, No 284/2013). Manufacturers are now required to also submit tests on chronic toxicity as well as a bee brood study. In addition, tests investigating sub-lethal effects, such as behavioural and reproductive effects, on bees and colonies "may be required". The updated data requirements have been valid for application dossiers submitted since 1 January 2014, both for renewals of EU approvals and for new EU approvals.

EFSA used the 2013 Bee Guidance document to assess the additional data submitted by Bayer for imidacloprid and clothianidin (EFSA, 2016a, EFSA 2016b). EFSA has also used the Bee Guidance document for its wider review of the risks posed to bees from all three neonicotinoids, including Syngenta's thiamethoxam, published in February 2018 (EFSA 2018a, EFSA 2018b, EFSA 2018c). Based on these assessments, the EU imposed a near-total ban on the three neonicotinoids in May 2018, permitting their use only in permanent greenhouses. For further information on the use of neonicotinoids in greenhouses please see a Greenpeace report published in 2017 (Thompson, 2017)

1.2 MANY YEARS LATER, STILL NO CONSISTENT APPLICATION

The 2013 the European Commission proposed that the Bee Guidance document should come into force on 1 January 2015. However, the Bee Guidance document is still not consistently applied across all EU pesticide risk assessments. The reason for this is that national governments have not yet endorsed it. Many governments have refused to agree to a step-by-step introduction of its different parts. This is despite the fact that relevant Organisation for Economic Co-operation and Development (OECD) test protocols have been defined (for example, for chronic toxicity tests for honey bees, for acute toxicity tests for bumble bees), and many companies have already submitted relevant tests for their products.

At least one EU country, Belgium, has decided unilaterally to apply large parts of the Bee Guidance Document in the risk assessment of formulated products. In the EU, formulations are authorised at the national level, not at the EU level. Belgian authorities are saying that, "from a scientific point of view, it is not acceptable to ignore available robust toxicity data on vulnerable non-target species simply because there is no generally accepted risk assessment guideline" (FPS Health, Food Chain Safety and Environment, 2018).

INDUSTRY POSITION

Pesticide manufacturers have argued against the application of the 2013 EFSA Bee Guidance document. Syngenta (2018) claimed that "the Bee Risk Guidance document is so conservative and so far removed from the reality of agriculture that its application would see most, if not all agricultural chemicals banned".

In a blog from Bayer Crop Science head of seed growth, Martin Gruss (Gruss, 2017) said that a consistent application of the Bee Guidance document "would result in a denial of registration for most pesticides, even those used in organic agriculture!"

Bayer (Bayer, 2018) also said that the Bee Guidance document should not have been used in the assessment of its products. In response to the EFSA reviews of February 2018, the company said: "Unfortunately, EFSA chose to base its assessment on an unworkable guidance doctument that makes it impossible to field a study that would not find risk, despite repeated requests by Member States for a review of this guidance. EFSA's conclusions can therefore not be used as a measuring stick to justify further neonicotinoid restrictions."

In June 2018, the European Commission announced that it would "adopt an implementation plan for the EFSA Guidance Document on the risk assessment of plant protection products on bees (*Apis mellifera, Bombus* spp. and solitary bees) in order to enhance the risk assessment of pesticides on pollinators" (EC, 2018). The indicated timeline was the end of 2018.

Since 2018, the European Commission services have proposed several draft implementation plans by which an increasingly smaller part of the Bee Guidance document would be applied. They have also suggested that EFSA should be mandated to review key elements of the Bee Guidance document. Under the Commission's plan, even tests that are part of existing EU data requirements, and for which OECD test protocols exist, would not be considered in pesticide risk assessments. Pesticides that fail these tests could be approved in the EU even when it has not been shown that the risk may be acceptable under field conditions. In that sense, the Commission's latest proposals amount to a plan for non-implementation of the Bee Guidance document, and a free pass for the approval of bee-harming pesticides in the EU.

1. 3 BEE DECLINE

Bees are crucially important in maintaining healthy ecosystems and help to sustain biodiversity by providing essential pollination for a wide range of crops and wild plants. Failure of pollination can lead to crop failure and, subsequently, lead to problems with food security. Various statistics have been published to support the importance of pollinators, including that 75% of crops are pollinated by insects (Klein et al., 2003) and that 57 species (mainly bees and only two vertebrate species) are key pollinators for 107 global crops that are of direct human use (Klein et al., 2006).

Globally, it is estimated that there are in the region of 25,000 species of bee. The number of species of bees, and other pollinators, has declined over the past 50 years. It is thought that many bee species are in decline because of multiple stressors including land use change that has caused habitat loss, bee parasites and diseases, and pesticide use (which can be directly toxic to bees but can also kill the wildflowers on which they live). Data from wild bees indicate declines in North American species *Bombus terricola* and *B. occidentalis*; *B. dahlbomii* in South America; and *B. distinguendus* in the United Kingdom, among many others (Goulson et al., 2015).

An estimated 2,000 or so bee species live in Europe. For 1,048 species (55.6%) there is too little scientific information to evaluate their population status, according to the IUCN Red List of Threatened Species for European bees (Nieto et al., 2014).

Approximately 15% of bee species inhabiting Europe (at EU-27 level) are known to be either Threatened or Near-Threatened. According to Nieto et al., (2014), around 30% of all the species threatened (Critically Endangered, Endangered, or Vulnerable) within the geographic area of Europe are endemic.

Bumble bees are the best studied group of wild bees, with less than 10% of data-deficient species. Their status is considerably worse than for bees in general – more than 45% of bumble bee species have a declining population trend and almost 24% are facing extinction (Nieto et al., 2014).

Many EU countres have published national lists of threatened species based on IUCN Red List criteria. They show that more than 50% of wild bee species are threatened with extinction in the Netherlands (Reemer, 2018), and almost one third in Ireland (Fitzpatrick et al., 2006).

1.4 KNOWLEDGE GAPS

The EFSA Bee Guidance Document represents the most comprehensive methodology for assessing the risk posed by pesticides to bees. However, there are a number of significant knowledge gaps associated with assessing the risks to bees, particularly the population-level impacts on wild bees and the sub-lethal impacts of exposure. For further details, see Section 5.

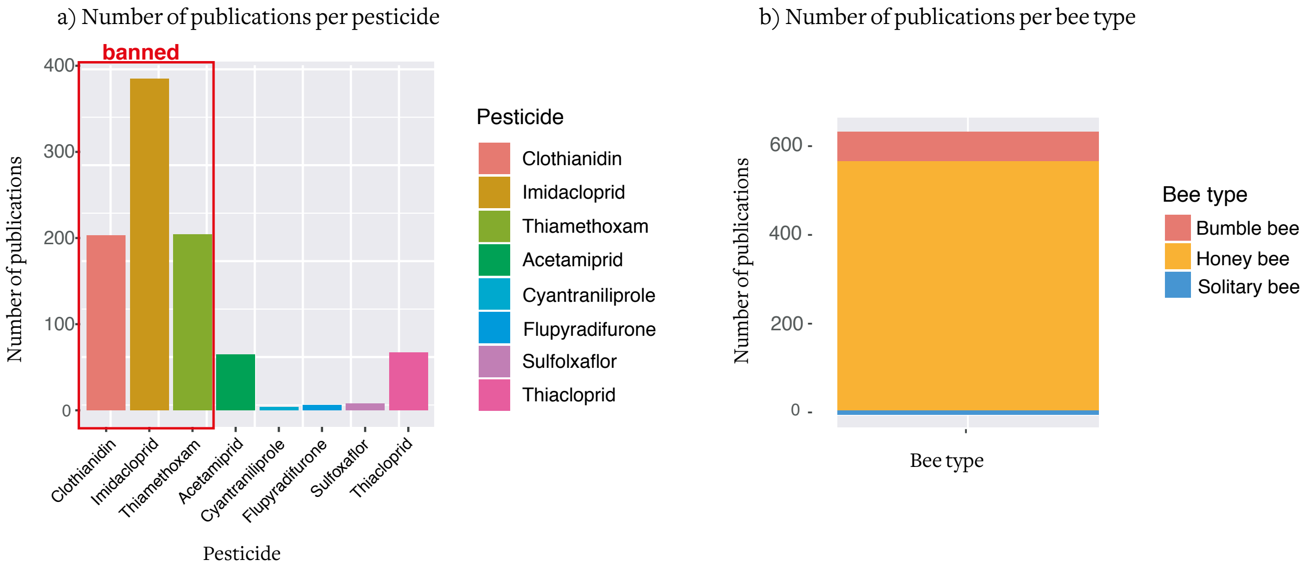
2.0 PEER REVIEWED LITERATURE ON THE EIGHT PESTICIDES UNDER INVESTIGATION IN THIS REPORT:

CLOTHIANIDIN, IMIDACLOPRID, THIAMETHOXAM, ACETAMIPRID, THIACLOPRID, SULFOXAFLOR, CYANTRANILIPROLE AND FLUPYRADIFURONE.

The EFSA pesticide risk assessments were based upon available peer-review (open literature) and unpublished industry studies at the time of submission of the manufacturers application dossier. The majority of these data consisted of unpublished studies. In the absence of access to unpublished studies, an assessment was made of the published literature for each pesticide and each bee type (honey bee, bumble bee and solitary bee). This serves to illustrate the relative amount of research that has been undertaken on each substance, especially for comparing those that have and have not been banned, and what information may be available since the time of publication for each review document.

In this report, a systematic search of the Web of Science Core Collection[3] was used to gain an understanding of previous peer-reviewed publications on all eight pesticides[4] in this report and the three bee types (honey bees, bumble bees and solitary bees) The search terms used were, "pesticide" AND either "honey bee", "bumble bee", "solitary bee", "bee". The search provides information on how many publications mentioned these terms in the title, abstract and keywords and, therefore, there may be overlap in the total number of publications when a publication refers to more than one term. Note that this search did not include analyses of the publications themselves or the context of how the search terms were described within them.

The search found 1,693 peer-reviewed publications dating from 1994 and to 2018, published up until the search date[5]. From the systematic search of the literature it is clear that the main body of peer-reviewed publications has focused on the three banned pesticides (clothianidin, imidacloprid and thiamethoxam) (*Figure 1a*).



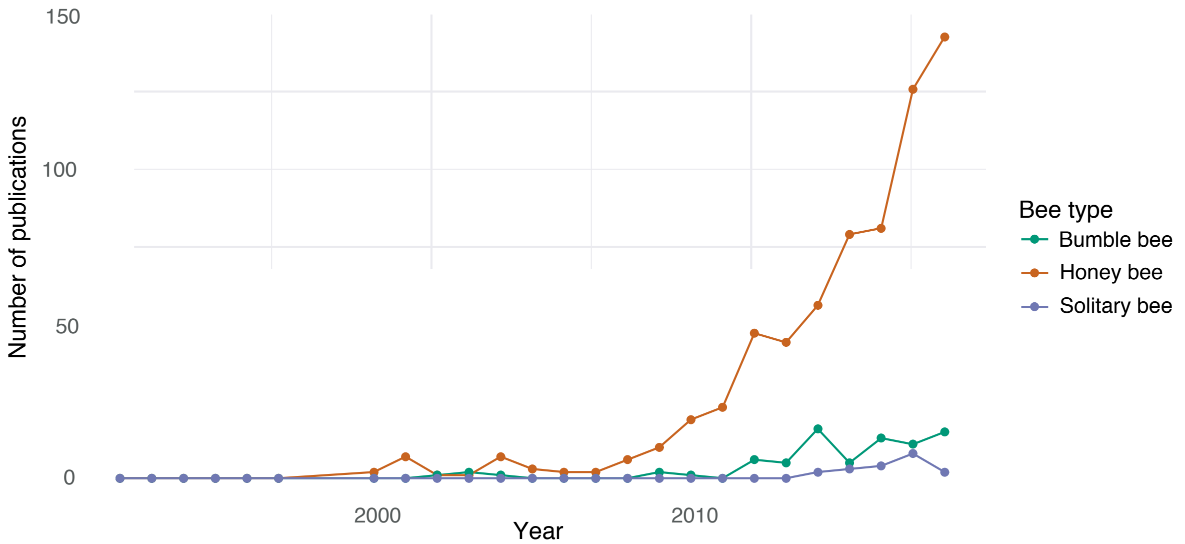
3 http://apps.webofknowledge.com

4 Banned neonicotinoids, clothianidin, imidacloprid, thiamethoxam. Approved neonicotinoids, acetamiprid and thiacloprid. The three other approved pesticides, sulfoxaflor, cyantraniliprole and flupyradifurone.

5 Search date was January 5, 2019.

The largest number of peer-reviewed papers considering "bees" AND "pesticide" were for imidacloprid (385 papers) followed by thiamethoxam (204 papers), clothianidin (203 papers), thiacloprid (67 papers), acetamiprid (65 papers), sulfoxaflor (8 papers), flupyradifurone (6 papers), cyantraniliprole (4 papers). The majority of peer reviewed papers mentioned honey bees (661 papers) and fewer considered bumble bees (78 papers) or solitary bees (12 papers) (*Fig. 1b and Fig. 2a*). Much of the peer-reviewed research was published after 2009, with the greatest numbers of papers considering "bees" and the three banned pesticides, presumably due to the focus on funding for research (*Fig. 2b*).

a) Number of publications per bee type per year (1992–2018)



b) Number of publications that mention bee per year (1992–2018) per pesticide

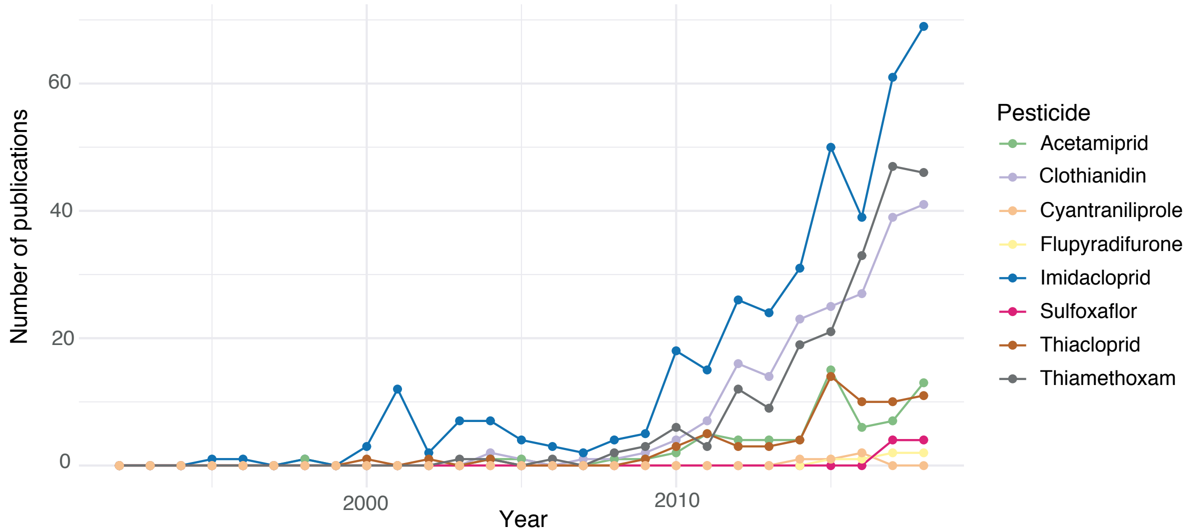


Figure 2. Yearly trends in publications that mention the eight pesticides and three bee types in title, keywords and abstract according to a systematic search of peer-reviewed literature. a) yearly number of publications per bee type, and b) number of publications that mention "bee" and the eight pesticides. For details on the literature related to pesticides other than the three neonicotinoids whose uses have been restricted due to potentially unacceptable risks to bees, please refer to Appendix 2

Although these findings must be viewed separately from our evaluation of the risk assessment documents themselves, they illustrate, nonetheless, that understanding of the environmental fates and effects of those additional five pesticides remains extremely limited. In turn this serves to highlight the dangers in continuing to authorize their use while publicly available, peer-reviewed data remain so completely insufficient to support a thorough, transparent assessment of their risks to bees. Despite those limitations, at least some of the studies that are available for those pesticides already indicate significant cause for concern, indicating that, against a background of very substantial gaps in data and research, the 'benefit of the doubt' cannot safely be conferred to their ongoing use. For further details of this outline overview of available peer-reviewed literature, see Appendix 2.

3.0 THE USE OF THE BEE GUIDANCE DOCUMENT IN PESTICIDE RISK ASSESSMENTS.

Analyses of the pesticide assessments in this report show that the Bee Guidance document is only referenced in the EFSA's 'Conclusion on the pesticides peer review' for four pesticides: clothianidin, imidacloprid, thiamethoxam and acetamiprid. In the case of acetamiprid, there is little evidence to indicate how it was applied in practice (Appendix Table 1). There is currently no updated assessment document for thiacloprid. The current EU approval is based on an assessment report that dates back to 2003. The extent to which the protocols described in the Bee Guidance document were used to review each pesticide vary. The application of the Bee Guidance document was complicated by the fact that it was being prepared at the same time as some of the pesticide risk assessments were being prepared. In addition, the updated data requirements were not yet in force when the application dossiers were submitted. Appendix Table 1 indicates the number of times, and in what context, the Bee Guidance document was cited in the recent EFSA reports.

It is vital that acetamiprid, thiacloprid, sulfoxaflor, cyantraniliprole and flupyradifurone should be subject to thorough assessments for their risk to bees of all types, taking into consideration the available peer-reviewed literature, including those studies that have become available in the period since the initial risk assessments for these pesticides were carried out..

The section below (*section 3.1*) presents a bullet list of key points mentioned in the EFSA documents.

When reference is made to the Bee Guidance document in the pesticide assessments, the context is primarily related to the methodology adopted, rather than in the context of conclusions drawn. For example, the wording in the conclusion on pesticides peer review assessment for clothianidin (EFSA, 2018a) in relation to the tier-1 risk assessment [6] states:

> ***"The Tier-1 risk assessment was carried out using default exposure values in accordance with EFSA (2013c)"***

An analysis was carried out of the statements within the review documents that refer to risk of exposure to bees (honey bees, bumble bees and solitary bees) from nectar, pollen, dust drift, guttation fluid, surface water and any particular statements on toxicity studies and endpoints. This overview of the documents is summarised in *Table 1*.

6 Tier-1 risk assessment. The Bee Guidance document suggests taking a tiered approach to assessing risk of the active substance to bees. Tier-1 is a simple and cost-effective first level; higher tiers are more complex and take place under field conditions. The appendices in the Bee Guidance document (EFSA, 2013a) give more detail on the laboratory and field studies in the tiered assessment scheme.

An overview of the latest review documents found that those that included in-depth analyses of the scientific evidence relating to clothianidin, imidacloprid and thiamethoxam suggest a high risk to bees through several exposure routes, with the exception of thiamethoxam and certain routes of exposure (nectar, pollen and dust drift). For imidacloprid the review document stated that there was a low risk for honey bees through exposure from surface water. The risks were identified using the protocols outlined in the Bee Guidance document (*Appendix Table 1*).

The five pesticides whose EU approval has not been restricted contrast to the three neonicotinoids that have been banned for open field uses in that no full assessments have been made to evaluate the impact to bees of different routes of exposure or toxicity. Only the three updated pesticide risk assessments (for clothianidin in EFSA, 2018a; for imidacloprid in EFSA, 2018b; and for thiamethoxam in EFSA 2018b) followed the methodologies in the Bee Guidance document.

For the EFSA conclusion relating to acetamiprid (EFSA, 2016), reference is made to the Bee Guidance document (EFSA, 2013a) having been used in the ecotoxicology risk assessment, though no specific indications as to how it was applied can be found in the accompanying annex. For the conclusions relating to both cyantraniliprole (EFSA, 2014a) and flupyradifurone (EFSA, 2015), there are no mentions of the Bee Guidance document within the text and the document is not within the reference list. Please see Appendix Table 1.

For the conclusion relating to sulfoxaflor (EFSA, 2014b), the Bee Guidance document was not used. However,, additional confirmatory data (further studies) were requested to specifically investigate (*see Appendix table 1*):

A. the risk to honey bees from the different routes of exposure, in particular nectar, pollen, guttation fluid and dust;

B. risk to honey bees foraging in nectar or pollen in succeeding crops and flowering weeds;

C. the risk to pollinators other than honey bees;

D. the risk to bee brood.

According to the request, these data were requested for submission by August 18, 2017.

The additional investigations resulted in an Addendum to the original sulfoxaflor risk assessment document (i.e. the Draft Assessment Report) that describes and evaluates the newly available laboratory data and higher tier studies. The tier-1 assessment remained unchanged compared to the previous conclusion of the peer review document. However, the higher tier studies for sulfoxaflor included the latest knowledge. According to EFSA (2018d), there were divergent views expressed by Member States during the commenting phase of the review of sulfoxaflor, particularly in relation to:

“***....the interpretation and the use of the available higher tier studies and as regards the consideration of risk mitigation measures for the use of sulfoxaflor.***”

EFSA (2018d) states that:

Based on the data assessed, a low risk could not be demonstrated for honeybees and non-Apis bees as a result of the current assessments (points a –d).

Field-based studies on bumble bees from chronic exposure consistent with post-spray levels of sulfoxaflor during early growth phase suggest that there are significant sub-lethal population-level effects to this species (Siviter et al., 2018). Colonies exposed to sulfoxaflor produced fewer reproductive offspring. The study stated that direct and indirect effects on these bumblebees may have cumulative effects on colonies and the authors urged caution in using this pesticide in field conditions.

The Commission asked EFSA to consider this study in its upcoming conclusions on the potential risks posed to bees by sulfoxaflor.

Table 1: Findings from the tier-1 stage (and higher stages as indicated) of the risk assessments to evaluate risk to honey bees, bumble bees and solitary bees from the different application methods of eight pesticides based on the EFSA review documents. H denotes high risk, L denotes low risk as concluded by EFSA. H–L denotes high risk for some applications / routes of exposure / bee types, but low risk for others. The table contents consider outdoor application only (not greenhouse use).

Route of exposure or toxicity	**Imidacloprid** Application as a seed treatment or as a granule, apart from potato tubers, which are sprayed.	**Thiamethoxam** Application as a seed treatment only.	**Clothianidin** Application as a seed dressing or as a granule
Nectar	**Seed treatment** H - for honey and bumble (dietary route; acute, chronic, larvae). Low risk not demonstrated for solitary (p23). **Granules** H – for honey and bumble (dietary route of exposure; acute, chronic, larvae). Low risk not demonstrated for solitary (p38). **Succeeding crop scenario** H - to honey bees and solitary bees (using surrogate data) at Tier-1 and Tier-2. (No bumble bee data). L - to honey bees; H - to bumble bees (no solitary bee data) at Tier-3. (p42)	**Seed treatment** H - for honey and bumble (oral exposure; acute, larvae. No data available for chronic). L- not demonstrated for solitary (p21).	**Seed treatment** H - for honey and bumble bees. L - for solitary bees not shown in the screening tests acute, chronic, larva). (p24). **Granules** H - for honey and bumble bees for certain crops (Maize, Potatoes, Sorghum, Sweet maize) (acute, chronic, honey bee larvae). L - not demonstrated for solitary bees during screening. (p67).
Pollen	**Seed treatment** H - for honey and bumble (dietary route; acute, chronic, larvae). L - not demonstrated for solitary (p23). **Granules** H – for honey and bumble (dietary route of exposure; acute, chronic, larvae). L - not demonstrated for solitary (p38).	**Seed treatment** H - for honey and bumble (oral exposure; acute, larvae. No data available for chronic). L- not demonstrated for solitary (p21).	**Seed treatment** H - for honey and bumble bees. L - for solitary bees not shown in the screening tests (acute, chronic, larva). (p24). **Granules** H - for honey and bumble bees for certain crops (Maize, Potatoes, Sorghum, Sweet maize) (acute, chronic, honeybee larvae). L - not demonstrated for solitary bees during screening. (p67).

Route of exposure or toxicity	Imidacloprid Application as a seed treatment or as a granule, apart from potato tubers, which are sprayed.	Thiamethoxam Application as a seed treatment only.	Clothianidin Application as a seed dressing or as a granule
Dust drift	**Seed treatment** H - L for honey and bumble bees; risk depends on the crop (crops not listed here) and whether a deflector was used; (contact and exposure routes; acute, chronic, larvae). L - to all bees from spray application to potato crop. L- not demonstrated for solitary (p33). **Granules** H – for honey and bumble (contact & dietary routes; acute, chronic, larvae). L- not demonstrated for solitary (p39).	**Seed treatment** H – L for h oney and bumble bees. Risk depends on the crop. L for all three bee types for use on sugar beet. Contact and dietary routes. But data deficient for chronic dietary exposure. L- not demonstrated for solitary bees (p45).	**Seed treatment** Contact exposure H -for contact route of exposure to honey and bumble bees for certain crops alfalfa, carrot, winter cereals, spring cereals, chicory, clover, maize, mustard, sunflower) L–H for contact route of exposure honey bees and bumble bees for certain crops (winter rape, spring rape, sugar beet, fodder beet, poppy). L- not demonstrated for contact exposure for solitary bees (p59). **Oral exposure** H -for oral route of exposure to honey and bumble bees for certain crops (Alfalfa, carrot, winter cereals, spring cereals, chicory, clover, maize, mustard, sunflower, winter rape, spring rape, poppy) L–H for oral route of exposure honey bees and bumble bees for certain crops (sugar beet, fodder beet). L- for oral route of exposure not demonstrated for solitary bees (p59). **Granules** H - honey and bumble bees for contact and oral exposure to certain crops (maize, potatoes, sorghum, sweet maize) (acute, chronic and honey bee larvae). L - to solitary bees not demonstrated. (p69).

Route of exposure or toxicity	Imidacloprid Application as a seed treatment or as a granule, apart from potato tubers, which are sprayed.	Thiamethoxam Application as a seed treatment only.	Clothianidin Application as a seed dressing or as a granule
Dust drift	**Seed treatment** H - L for honey and bumble bees; risk depends on the crop (crops not listed here) and whether a deflector was used; (contact and exposure routes; acute, chronic, larvae). L - to all bees from spray application to potato crop. L- not demonstrated for solitary (p33). **Granules** H – for honey and bumble (contact & dietary routes; acute, chronic, larvae). L- not demonstrated for solitary (p39).	**Seed treatment** H – L for honey and bumble bees. Risk depends on the crop. L for all three bee types for use on sugar beet. Contact and dietary routes. But data deficient for chronic dietary exposure. L- not demonstrated for solitary bees (p45).	**Seed treatment** Contact exposure H -for contact route of exposure to honey and bumble bees for certain crops alfalfa, carrot, winter cereals, spring cereals, chicory, clover, maize, mustard, sunflower) L–H for contact route of exposure honey bees and bumble bees for certain crops (winter rape, spring rape, sugar beet, fodder beet, poppy). L- not demonstrated for contact exposure for solitary bees (p59). **Oral exposure** H -for oral route of exposure to honey and bumble bees for certain crops (Alfalfa, carrot, winter cereals, spring cereals, chicory, clover, maize, mustard, sunflower, winter rape, spring rape, poppy) L–H for oral route of exposure honey bees and bumble bees for certain crops (sugar beet, fodder beet). L- for oral route of exposure not demonstrated for solitary bees (p59). **Granules** H - honey and bumble bees for contact and oral exposure to certain crops (maize, potatoes, sorghum, sweet maize) (acute, chronic and honey bee larvae). L - to solitary bees not demonstrated. (p69).

Route of exposure or toxicity	Imidacloprid Application as a seed treatment or as a granule, apart from potato tubers, which are sprayed.	Thiamethoxam Application as a seed treatment only.	Clothianidin Application as a seed dressing or as a granule
Guttation	**Seed treatment** No risk assessment was carried out (p36). **Granules** Risk not stated.	**Seed treatment** L - honey bees. Data deficient for other bees. No risk assessment carried out.	**Seed treatment** No risk assessment from exposure to contaminated guttation fluids was carried out at Tier-1. H - to honey bees at Tier-2 level. Data deficient for other bee types. **Granules** No Tier-1, Tier-2, or Tier-3 risk assessments of exposure to guttation fluids were carried. L risk to honey bees (no other bees mentioned) was demonstrated. Data gaps acknowledged out (p70).
Puddles	**Seed treatment** L - to honey bees (p37) (data gaps for other species). **Granules** L - to honey bees (p40) (data gaps for other species)	**Seed treatment** No assessment carried out (because “always negligible when seeds are drilled below the soil surface”) (p.49).	**Seed treatment** Risk was considered negligible to for honey bees (no mention of other bees) and so no assessment was carried out. **Granules** No assessment carried out. Surface runoff was considered negligible.
Surface water	**Seed treatment** L–honey bees (p37) (data gaps for other species). **Granules** L - to honey bees (p40) (data gaps for other species)	**Seed treatment** Risk for honey bees from exposure to surface water could not be performed.	**Seed treatment** Risk for honey bees from exposure to surface water not assessed. No mention of other bees. **Granules** Risk for honey bees from exposure to surface water not assessed. No mention of other bees.

3.1 KEY POINTS MENTIONED IN THE EUROPEAN FOOD SAFETY AUTHORITY ASSESSMENTS

For more excerpts from the EFSA documents, see Appendix 1.

The European Food Safety Authority has published updated risk assessments in relation to the effect on bees for three neonicotinoids: clothianidin (EFSA, 2018a), imidacloprid (2018b) and thiamethoxam (2018c). Some key points from the three updated risk assessments of neonicotinoids in the three 'Conclusion on pesticide peer review documents' are bulleted below:

Imidacloprid

- Exposure to imidacloprid from pesticide residues from dust drift was found to pose a high risk for all bee groups (that is, honey bees, bumble bees and solitary bees).
- With regards to tier-1 risk assessments to assess exposure to the active compound, there were no toxicity data for bumble bees and solitary bees so the data were extrapolated from honey bee studies.
- In accordance with the EFSA Bee Guidance document (EFSA, 2013a), when data are missing, surrogate endpoints for different bee species can can be calculated using toxicity data for honey bees.

Thiamethoxam

- Dust drift was found to pose a low risk to bees if used in indoor greenhouses but a high risk for all other uses.
- No agreed methodology is available on how to use or interpret data to estimate exposure to field margin vegetation or adjacent crops when measured at the individual trial sites.
- There are data deficiencies when trying to assess the impact of acute versus chronic exposure. For example, with regards to studies involving honey bees there were five reliable acute contact endpoints, three reliable acute oral endpoints but there were no reliable data available to derive a chronic lethal dietary dose. For bumble bees, there was only one reliable acute oral toxicity study and one acute contact toxicity study. There were no reliable toxicity data available for solitary bees.
- Several routes of exposures are not covered by the risk assessment scheme, for example insect honeydew and exposure through the soil.

Clothianidin

- The report found a low risk to honey bees when the active substance was used on sugar and fodder beet, but a high risk from other outdoor uses. The report also noted that there was a high risk to honey bees and bumble bees, but more data are needed to fully assess the effect on solitary bees.

In addition to the three pesticides with EU-wide restrictions on use, there are other pesticides that are licenced for use in the EU that are of concern because of potential toxicity to bees. These include:

Acetamiprid (***not banned in EU apart from in France***)

- Several data gaps were identified in relation to the ecotoxicology of the active compound and the report suggests that further information would be needed to address the risk assessment for birds, mammals, aquatic organisms, bees and non-target arthropods.

- Based on tier-1 studies, a "low risk to honeybees (acute, chronic and larvae) and to bumble bees (acute) was concluded for all scenarios for the representative uses on pome fruit (post-flowering application) and potatoes".
- However, EFSA concluded that available higher tier studies were insufficient "to draw any firm conclusion on the risk to honeybees, particularly to exclude any potential chronic effect or effect on brood development".
- EFSA also concluded that: "No data were available to perform a complete risk assessment for bumble bees or solitary bees. Information was available in the RAR from public literature data indicating that bumble bees may be more sensitive than honeybees."
- EFSA noted data gaps on "sublethal effects on bees (i.e. HPG)" and on "the risk to honeybees via exposure to residue in guttation fluids".

Cyantraniliprole

- The conclusion of the peer review (EFSA, 2014a) does not refer to the Bee Guidance document (EFSA, 2013).
- The crop on which the pesticide is used can have an impact on its toxicity to bees. For example, it was found in the tier-1 risk assessment that there was a high risk for the active substance for all the representative uses, but a there was a low risk for honey bees when the formulated product was used on potatoes and mandarins. The risk to honey bees for use on lettuce was judged to be low because lettuce is not attractive to honey bees (it is not a flowering crop).
- In some cases, there were not sufficient data to be able to conclude a high or a low risk to bees. For example, when using the active compound as a spray application on apples, pears, nectarines, peaches or apricots, plums, citrus, mandarins, olives, grapes, a high risk could not be excluded with the available data.
- No risk assessment was performed for wild bees.
- Ecotoxicology data gaps were identified to further address the risk to mammals, bees and non-target arthropods.

Flupyradifurone

- The conclusion of the peer review (EFSA, 2015) does not refer to the Bee Guidance document (EFSA, 2013a).
- The risk to honey bees was considered to be low for the representative uses of flupyradifurone.
- No risk assessment was performed for wild bees.
- No data gaps were identified.

Sulfoxaflor

- The conclusion of the peer review (EFSA, 2014b) does not refer to the Bee Guidance document (EFSA, 2013).
- The rapporteur Member State (Ireland) did not provide a transparent evaluation.
- The myriad uses for this pesticide include tomatoes, aubergine, cucumber, water melon, winter cereals and cotton.
- Tier-1 risk assessments found a high risk to honey bees.
- Because of data gaps, more studies are needed to address the risk to honey bees for the field uses.
- With the available assessments a high risk to bees was not excluded for field uses.
- No risk assessment was performed for wild bees.

Thiacloprid

- Recent assessment not available yet.

4.0 PESTICIDES APPROVED FOR USE:

ACETAMIPRID, THIACLOPRID, SULFOXAFLOR, CYANTRANILIPROLE AND FLUPYRADIFURONE

The overview of the five pesticides that are still approved for use in the EU (with the exception of France) uses both the EFSA (European Food Safety Authority) review documents and the Pesticide Properties Database of the University of Hertfordshire[8] (PPD) (Appendix 3). For thiacloprid, only the PPD was reviewed in the absence of an EFSA review document. To assess the risks in using these substances a list of mitigation measures, as suggested in the EFSA review documents, are noted in Appendix 3.

The mitigation measures put forward by EFSA within the review documents are claimed to reduce the risks to bees of the relevant pesticide. In practice, many of these measures are focused on protection of aquatic habitats (and are not focused on bees or non-target arthropods). While some of the mitigation measures do focus on non-target arthropods, they could only ever reduce this risk, but not eliminate the risk to bees. For completeness, a compilation of the mitigation measures suggested by EFSA are included in Appendix Table 3. For example, for sulfoxaflor a high risk to bees was concluded by the experts at the EFSA meeting to discuss toxicological risks. Some risk mitigation steps were proposed at the review meeting, but 'the experts at the meeting did not consider that the data and the assessments that were available were sufficient to demonstrate a low risk to bees for the field uses even with the proposed measures'. A data gap was agreed to further address the risk to bees in field situations. Risks were also highlighted for pollinators in situations in which sulfoxaflor is used in greenhouses and it was suggested that colonies be covered or removed until residues on leaves and surfaces within the greenhouse have dried.

8 https://sitem.herts.ac.uk/aeru/ppdb/en/atoz.htm#A

5.0 MAJOR KNOWLEDGE GAPS FROM USE OF THE BEE GUIDANCE DOCUMENT AND THE EFSA REVIEW DOCUMENTS

This chapter notes a number of key knowledge gaps within both the Bee Guidance document and the review documents. Any knowledge gaps that are mentioned in the Bee Guidance document are highlighted and to address uncertainties, the authors of the Bee Guidance document have attempted to give a qualitative indication of the level of conservatism for the risk assessment scheme[9].

The following knowledge gaps also relate to the reading of the Bee Guidance document and EFSA reviews:

- ***Conservatism.*** While some conservatism is built into the Bee Guidance document document, there are certain areas where key knowledge gaps could have significant impact on pollinators and other species. For example, the assessment is field-based and not landscape-based and, therefore, there is no assessment of realistic scenarios where multiple plant protection products are used. Assessments also assume healthy bees and there are no assessments of sub-lethal effects.
- ***Sub-lethal doses.*** It is not possible to determine the risk of sub-lethal doses for reasons that include the lack of tier-1 studies that are relevant at the colony level (therefore representing a knowledge gap).
- Guttation water. More studies are needed to assess the extent to which crops produce guttation water and the extent to which bees consume/take back to hive, and whether it is used in brood food. Residues of pesticide in guttation droplets varied and depended on the crop type. More research is also needed to assess the best distance from the field to provide a permanent water supply for bees. Bees prefer permanent water supplies to guttation water and an assessment of suitable mitigation options for the replacement of guttation water is necessary.
- ***Honeydew.*** Risk assessment for exposure from honeydew was not included in the Bee Guidance document because there is a lack of information on the issue.
- ***Metabolites.*** The same stringent field tests are not required for metabolites as they are for active ingredients. Metabolites can be just as toxic as the active compound.
- ***Mitigation methods.*** There are uncertainties relating to some proposed mitigation methods. Risk mitigation strategies are only useful if they are read and interpreted correctly by the relevant agricultural worker.
- ***Toxicology of mixtures.*** A chemical-by-chemical approach to risk assessment is too simplistic because often mixtures contain several active ingredients.
- ***Multiple, simultaneous exposure routes.*** More studies are needed on multiple exposures by nurse bees, and also exposure through water consumption and exposure by inhalation of vapour from fields/spraying crops.
- ***Dust.*** Application of the Bee Guidance could lead to underestimation of the exposure of bees to contaminated dust during seed sowing. The Bee Guidance document assumes that the wind blows from one direction only, and applies a dilution factor of 3 when estimating exposure concentrations for bees flying through the dust cloud,, which could in some circumstances lead to an underestimation of the true exposure.

9 See Table 1 on page 9, EFSA (European Food Safety Authority), 2013a.

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APPENDICES

Appendix Table 1. A summary of the EFSA assessments relating to eight plant protection products licensed for use in the EU.

Substance	Reference	What topic does the Bee Guidance relate to.	Outcomes and other comments
Banned from outdoor use in EU from Dec 2018 (apart from France, which banned all five neonics from Sept 1, 2018)			
Imidacloprid	Peer review of the pesticide risk assessment for bees for the active substance imidacloprid considering the uses as seed treatments and granules (EFSA, 2018b).	The Summary specifies that: "Risk assessments were performed for honeybees, bumblebees and solitary bees according to the EFSA guidance document on the risk assessment of plant protection products on bees." Says in the Summary that: "For exposure via residues in pollen and nectar… when all the bee groups (honeybees, bumblebees and solitary bees) are considered, a high risk was concluded or it was concluded that a low risk was not demonstrated for all the uses assessed." Exposure via residues from dust drift: high risk for all bee groups. Exposure via water consumption: low risk from guttation water or puddles, high risk for some other uses. Reading the Peer Review Assessment document, the EFSA Bee Guidance document (referred to as EFSA 2013c) was referred to and cited throughout. But a more thorough reading and reading the methods and appendices will be necessary to more fully understand the risk assessment processes and data used.	This document refers to the Bee Guidance document 62 times - counted using a 'search and find' method - probably includes the reference. Section 3.2. In relation to Tier-1 risk assessments to assess exposure to the active compound: In the absence of toxicity data for bumble bees and solitary bees, data were extrapolated from honeybees assuming the endpoint is a factor of 10 lower. Tier-1 risk assessment carried out in accordance with the Bee Guidance document. Section 3.3 says that "no stepwise approach is offered for higher tier risk assessment". Section 3.3.1.1. Residues in nectar and pollen. The Bee Guidance document was discussed in relation to Appendix R, about exposure in the field. 3.3.1.2 Use of the Bee Guidance document for values to use in shortcut values. 3.3.2 used the Bee Guidance document re dust drift, weeds (3.3.2), water sources (3.3.4) 3.3.4, p15. Says that: "following EFSA (2013c), a refinement of the exposure can only be performed if at least five field studies are available for the same crop" then goes on to say "Residues from five field studies were not available for any of the crops being assessed here." And then that "No exposure refinement was necessary for assessing residues in puddles as using the Tier-1 exposure assessment indicated low risk"

Substance	Reference	What topic does the Bee Guidance relate to.	Outcomes and other comments
Imidacloprid			Section 3.4, p15. Discusses the Bee Guidance document in relation to refinement with higher tier experiments. Page 16, re levels of exposure: "The daily consumption values, for pollen and nectar, for each bee caste were taken from EFSA (2013c)." Page 20: "In accordance with EFSA (EFSA, 2013c), where data are missing, surrogate endpoints can be calculated using toxicity data for honeybees divided by 10.." So they used surrogate data in the risk assessment. P23. The Bee Guidance document was used for exposure assessment data in Tier-1 P25. "Tier-2 risk assessments performed by using the EFSA's BeeTool (v.3.) (Appendix Y of EFSA (2013c)) for honeybees."
Thiamethoxam	Peer review of the pesticide risk assessment for bees for the active substance thiamethoxam considering the uses as seed treatments and granules (EFSA, 2018c).	Info from the Summary: Pollen and nectar: low risk of exposure in some cases but a high risk in others. When Tier-3 assessment was carried out, the data did not demonstrate low risk but neither did it indicate a clear high risk. Dust drift: low risk from indoor greenhouses; high risk for other uses. Water consumption: low risk to honey bees from puddles and sugar beet guttation fluid. High risk to honey bees from other plants' guttation fluid.	This assessment follows the recommendations in the Bee Guidance document (mentioned in the document 45 times). Says: "The basis of the risk assessment according to EFSA (2013c) is to ensure that the specific protection goals (SPG) for honeybees, bumblebees and solitary bees are met." There are numerous references to the Bee Guidance. Appendix C is a Tier-1 assessment based on the Bee Guidance document. Section 3.2 Tier-1 assessment carried out according to the Bee Guidance. 3.2.1: "The endpoint was considered as relevant for a risk assessment according to EFSA (2013c)" Residues in pollen and nectar: studies used "protocol proposed in Appendix G of EFSA (2013c)."

Substance	Reference	What topic does the Bee Guidance relate to.	Outcomes and other comments
Thiamethoxam			3.3.2: Dust drift: “According to the EFSA (2013c), exposure to dust drift in the field margin or in adjacent crops are considered relevant for seed treatment uses and granular formulations.” Also describes what the assessors thought to be a reliable study. Also mentions that they read about “dust drift outside the boundary of the treated field was also measured using vertical gauze netting.” but that “These vertical gauze results were not used further, as it was not clear how the results reported as g a.s./ha were derived and what they represent. Also, an agreed methodology is not available on how to use or interpret such values that may have utility in estimating exposure to field margin vegetation or adjacent crops when measured at the individual trial sites.” The assessment followed the EFSA Bee Guidance to refine the assessments in higher tiers. P14, exposure through pollen and nectar: “The daily consumption values, for pollen and nectar, for each bee caste were taken from EFSA (2013c).” P18, section 4. Relevant info: “Five reliable acute contact endpoints were available for honeybees” “Three reliable acute oral endpoints were available for honeybees””No reliable data were available to derive a chronic lethal dietary dose (LDD50) for honeybees.” “For bumblebees, only one reliable acute oral..and one acute contact [study available]” “No reliable toxicity data were available for solitary bees.”. 5.1.1.2. Treated crop scenario testing. Bee Guidance says “it is preferable to have measured residues in pollen and nectar collected from bees in open field conditions.” Residues in pollen and nectar collected directly from honeybees was available in some studies. Residues from pollen and nectar collected directly from other bee species were not available. P35. A metabolite of thiamethoxam is clothianidin, which is also toxic.

Substance	Reference	What topic does the Bee Guidance relate to.	Outcomes and other comments
Thiamethoxam			P55: “as acknowledged in EFSA, 2013c, there are several routes of exposures which are not covered by the risk assessment scheme. (e.g. insect honeydew, exposure via soil).”
Clothianidin	Peer review of the pesticide risk assessment for bees for the active substance clothianidin considering the uses as seed treatments and granules (EFSA, 2018a).	In the Summary: “Risk assessments were performed according to EFSA (2013c) - the Bee Guidance - for honeybees, bumblebees and solitary bees.” In summary: “...residues in pollen and nectar a low risk was concluded for some bee groups/use/scenario combinations, while a high risk was concluded in other cases.” In Summary: Re dust drift: “low risk to honeybees for the use to sugar and fodder beet” but a high risk from other outdoor uses” and “high risk to honeybees and bumblebees” but a low risk to solitary bees was not demonstrated. In Summary: Water consumption: low risk to honeybees from puddles, and low risk to honeybees from guttation fluid from “winter cereals, sugar beet and potatoes. A high risk was concluded for all other uses. A risk assessment for honeybees from exposure via surface water could not be performed.”	The Bee Guidance document is referred to in this assessment 54 times. P8 in the Background info: States clearly that: “The EFSA guidance document on the risk assessment of plant protection products on bees (EFSA, 2013c) was used for the current evaluation.” Section 4.1, toxicity endpoints: “There was no reliable toxicity data available for solitary bees. No data giving the chronic oral toxicity to bumblebees or toxicity to bumblebee larvae were available. In accordance with EFSA (2013c), where data are missing, surrogate endpoints can be calculated using toxicity data for honeybees divided by 10. Surrogate endpoints were therefore calculated for the acute contact and oral toxicity to solitary bees and for the chronic oral toxicity to bumblebees and solitary bees.” In general, there are several instances that mention lack of data relating to the substance under question and the bee species.

Substance	Reference	What topic does the Bee Guidance relate to.	Outcomes and other comments
Approved for use in EU (all five neonics are banned in France)			
Acetamiprid	**Peer review of the pesticide risk assessment of the active substance acetamiprid (EFSA, 2016).**	This document refers to a request for more info on acetamiprid in pollen / bee products as bees are attracted to potatoes. It is a general risk assessment, not only addressing risks to bees/pollinators but also aquatic and mammalian toxicity. It states that Bee Guidance document was used in ecotoxicology risk assessment. It also states: "A low risk to honeybees (acute, chronic and larvae) and to bumble bees (acute) was concluded for all scenarios for the representative uses on pome fruit (post-flowering application) and potatoes."	P4: "Several data gaps were identified in the area of ecotoxicology, i.e. to further address the risk assessment for birds, mammals, aquatic organisms, bees and non-target arthropods." A separate online EU statement verifies that EFSA deemed that this pesticide was concluded to be of low risk to bees.
Cyantraniliprole	Conclusion on the peer review of the pesticide risk assessment of the active substance cyantraniliprole (EFSA, 2014a).	This document does not refer to the Bee Guidance document It is a general risk assessment, not only addressing risks to bees/pollinators but also aquatic and mammalian toxicity. In the Summary: "A data gap was identified for a search of the scientific peer-reviewed open literature on the active substance and its relevant metabolites."	Some points from the document. P13: "The applicant's dossier did not include any information to address the effect of water treatments processes on the nature of the residues that might be present in surface water and groundwater, when surface water or groundwater are abstracted for drinking water." This was identified by the panel as a data gap. P14, section 5. Ecotoxicology. p14: Long-term risk to mammals was deemed high risk until reanalysis of the data concluded low risk.

Substance	Reference	What topic does the Bee Guidance relate to.	Outcomes and other comments
Cyantraniliprole			P15: honey bees. "The first-tier risk assessment based on the oral and contact HQ approach indicated a high risk for the active substance for all the representative uses." But a low risk for honey bees when the formulated product is used on potatoes and mandarins. P16. Detail on field trials to assess toxicity to honey bees. Spray application to field vegetables: "risk to honeybees could be considered as low only if the first application is carried out before the flowering period and the second application is carried out during the flowering period but after daily bee flight"The panel added that further data is needed to address uncertainties. "The risk to honeybees for the representative use in lettuce (spray) was considered as low because it is not attractive to honeybees (i.e. it is not a flowering crop)." P17: "representative uses as spray application on apples, pears, nectarines peaches and apricots plums citrus, mandarins, olives, grapes a high risk could not be excluded with the available data." Re mammalian toxicology, there is no critical area of concern. Data gaps were identified for further assessment of some metabolites. In the area of ecotoxicology data gaps were identified to further address the risk to mammals, bees and non-target arthropods. The risk assessment could not be finalised for all non target organisms " P17 (in this column due to space): "By taking into account that these crops [apples, pears, nectarines peaches and apricots plums citrus, mandarins, olives, grapes] may be highly attractive to honeybees, overall, EFSA considered that the risk assessment for cyantraniliprole and its metabolites for these representative uses should be further addressed (data gap).

Substance	Reference	What topic does the Bee Guidance relate to.	Outcomes and other comments
Cyantraniliprole			However, for the representative uses applied only after the flowering period, the risk can be considered as low, provided that risk mitigation measures are taken to avoid direct exposure of the bees foraging on flowering weeds." P17:" on the basis of the residue data provided, EFSA noted that it was not possible to observe a clear trend for the residue decline." P17: assessments for all the field uses refer to honey bees and other pollinators such as wild bees are not covered." P17: "data on melons cannot be extrapolated to the representative uses in tomato and pepper due to different attractiveness to bees and the intrinsic differences between the plants in terms of residue translocation." P17: "further data would be needed to address the risk to bees for the representative uses as field drip irrigation for example to account for the residue intakes with the consumption of contaminated nectar and pollen." P23-24: A number of data gaps are listed (too many to cover here).

Substance	Reference	What topic does the Bee Guidance relate to.	Outcomes and other comments
Flupyradifurone	Conclusion on the peer review of the pesticide risk assessment of the active substance flupyradifurone (EFSA, 2015).	This document does not refer to the Bee Guidance document. It is a general risk assessment, not only addressing risks to bees/ pollinators but also aquatic and mammalian toxicity.	Some points from the document. “On the basis of the available data and assessments, a low risk to birds (acute and long-term) and mammals (acute) was indicated for all representative uses.” “a low long-term risk for mammals was indicated for the representative use on hops, however for the representative use on lettuce a high risk for small herbivorous mammal was still indicated. Therefore, a data gap was identified” “low risk for fish (acute for parent and metabolites and chronic for the parent), a low risk for algae and a low risk for aquatic plants” P14. Honeybees. “chronic toxicity studies (10-day feeding test) were available for the active substance and for the metabolites difluoroacetic acid (DFA), difluoroethyl-amino-furanone (DFEAF), 6-chloronicotinic acid (6-CNA), 6-chloro-picolylalcohol and BYI02960-hydroxy” They noted “it is likely that the ...metabolites are less toxic to bees than flupyradifurone.” “the risk to honey bees was considered as low for the representative uses of flupyradifurone.” Only one study available for bumblebees therefore not sufficient to make a judgement. “the risk to earthworms and non-target soil macro and microorganisms was assessed as low” In the Summary: “A data gap was identified in relation to the search of the scientific peer-reviewed open literature on the active substance and its relevant metabolites.”

Substance	Reference	What topic does the Bee Guidance relate to.	Outcomes and other comments
Flupyradifurone			“the active substance flupyradifurone has a high potential to exceed the parametric drinking water limit of 0.1µg/L in groundwater” “Data gaps were identified in the ecotoxicology section… [including] long-term risk to small herbivorous mammals from dietary routes in lettuce and to further address the chronic risk to aquatic invertebrates for the representative field uses in lettuce.”
Sulfoxaflor	Conclusion on the peer review of the pesticide risk assessment of the active substance sulfoxaflor (EFSA, 2014b)	This document does not refer to the Bee Guidance document. It is a general risk assessment, not only addressing risks to bees/ pollinators but also aquatic and mammalian toxicity. In the Summary: “Data gaps were identified in the Section on ecotoxicology. With the available assessments a high risk to bees was not excluded for field uses. A high long-term risk was indicated for the small herbivorous mammal scenario for field uses in vegetables and in cotton.”	There are many uses for this pesticide: “report were reached on the basis of the evaluation of the representative uses of sulfoxaflor as an insecticide on fruiting vegetables (field use and glasshouse application; tomato, cherry tomato, pepper (bell and non bell), aubergine), cucurbits (field use and glasshouse application; cucumber, water melon, courgette), spring and winter cereals (wheat, rye, barley, oats, triticale) and cotton as proposed by the applicant. MRLs were assessed in almonds, pecans, apples, pears, cherry, peach including nectarines and apricots, plum, wheat grain, barley grain, broccoli, cauliflower, mustard greens, cabbage, leaf and head lettuce, spinach, celery, cotton seed, oilseed rape seed, grapefruit, lemon, oranges, melon, squash (winter and summer), cucumber, potatoes, sugar beet, carrot, soya bean, beans (pulses), fresh beans with and without pods, strawberry, tomato, peppers, wine grapes and table grapes, and in animal commodities such as milk, eggs, muscle, fat, liver and kidney.” P18: data gaps listed, including: “Information to further address the risk to honey bees for the field uses”

Substance	Reference	What topic does the Bee Guidance relate to.	Outcomes and other comments
Sulfoxaflor			P7: "The applicant carried out and submitted a report of their search of the scientific peer-reviewed open literature on the active substance and its relevant metabolites. The RMS [the rapporteur Member State, Ireland] did not provide a transparent evaluation of this report, or of the pertinent articles that were found. Therefore a data gap has been identified for a search of the scientific peer-reviewed open literature on the active substance and its relevant metabolites, dealing with side-effects on health, the environment and non-target species and published within the last 10 years before the date of submission of dossier, to be conducted and reported in accordance with the Guidance of EFSA on the submission of scientific peer-reviewed open literature for the approval of pesticide active substances under Regulation (EC) No 1107/2009 (EFSA, 2011)." P15, ecotoxicology: "First-tier risk assessments ... indicated high risk to honey bees." and " increased mortality was observed in the tunnel tests when sulfoxaflor was applied on flowering Phacelia during bee flight, and also when the application was in the previous evening (after bee flight). The increase in mortality was only apparent on the day of the application or on the following day. Potential adverse effects on bee brood could also not be excluded from the available data and assessments. high risk to bees was concluded from these data by the experts at the meeting. In order to manage the risk to bees, some risk mitigation measures were proposed by the RMS for the field uses. However the experts at the meeting did not consider that the data and the assessments that were available were sufficient to demonstrate a low risk to bees for the field uses even with the proposed measures (i.e. application only when bees are not present in the crop).

Substance	Reference	What topic does the Bee Guidance relate to.	Outcomes and other comments
Sulfoxaflor			P15: "A low risk was concluded for earthworms and other soil macroorganisms, soil microorganisms, non- target terrestrial plants and organisms"
Sulfoxaflor	EFSA (European Food Safety Authority), 2018. Technical report on the outcome of the consultation with Member States, the applicant and EFSA on the pesticide risk assessment for sulfoxaflor in light of confirmatory data. EFSA supporting publication 2018 (EFSA, 2018d).	This technical report details the outcome of further consultation on certain aspects of risk assessment of exposure to sulfoxaflor, in particular: (a) the risk to honey bees via the different routes of exposure, in particular nectar, pollen, guttation fluid and dust (b) risk to honey bees foraging in nectar or pollen in succeeding crops and flowering weeds; (c) the risk to pollinators other than honey bees; (d) the risk to bee brood.	According to the summary: "The risk assessment for bees has been amended considering the newly available laboratory and higher tier studies. Following the recommendations of the Pesticide Peer Review Meeting 133(EFSA 2015), the co-RMS evaluated the higher tier studies in light of the issues raised in EFSA PPR Panel (2012) and EFSA (2013). It is noted that the tier 1 risk assessment according to the SANCO guidance remains unchanged compared to the previous conclusions reached during the peer review of the risk assessment of sulfoxaflor in 2014. The assessment of the higher tier studies madeuse of the latest state of the knowledge on the topic, without diverging from the SANCO guidance recommendations. The risk assessment included some novel refinement steps on which divergent views were expressed by Member States during the commenting phase. Different opinions were also expressed in relation to the interpretation and the use of the available higher tier studies andas regards the consideration of risk mitigation measures for the use of sulfoxaflor. Based on the data assessed, a low risk could not be demonstrated for honeybees and non-Apis bees as a result of the current assessments (points a –d)."
Thiacloprid	Recent assessment not available yet.		

Appendix Table 2. The number of peer reviewed papers published up to the date on which the search was conducted, on January 14, 2019. The number of papers is included in brackets and is based on a search of Web of Science7 on January 14, 2019 using "substance" AND "bee" AND "[route of exposure]" to indicate the extent to which research has taken place. NADA denotes 'not assessed but literature available' (numbers of published peer-reviewed papers identified in searches are shown in parentheses) and NAND denotes 'not assessed and no literature available'.

Route of exposure or toxicity	Acetamiprid	Sulfoxaflor	Cyantraniliprole	Flupyradifurone	Thiacloprid
Nectar	**NADA (3) (i)**	**NAND**	**NAND**	**NADA (2) (v)**	**NADA (2) (vii)**
Pollen	**NADA (18) (ii)**	**NADA (3) (iv)**	**NAND**	**NADA (2) (vi)**	**NADA (22) (vii)**
Dust drift	**NAND**	**NAND**	**NAND**	**NAND**	**NADA (1) (ix)**
Guttation	**NAND, risk could not be excluded**	**NAND**	**NAND**	**NAND**	**NAND**
Puddles	**NAND**	**NAND**	**NAND**	**NAND**	**NAND**
Surface water	**NADA (6) (iii)**	**NAND**	**NAND**	**NAND**	**NADA (4) (x)**

Citations for the peer-review papers found in the Web of Science searches and indicated in Table 2:

(i) (1) Baines, D. et al. Neonicotinoids act like endocrine disrupting chemicals in newly-emerged bees and winter bees. Sci. Rep. 7, 10979 (2017).

(2) Purdy, J. R. Monitoring in-hive residues of neonicotinoids in relation to bee health status. Conference: 12th International Symposium of the ICP-PR Bee Protection Group - Hazards of Pesticides to Bees Location: Ghent Univ, Fac Bioscience Engn, Ghent, Belgium. Sept. 15-17, 2014. HAZARDS OF PESTICIDES TO BEES: 12TH INTERNATIONAL SYMPOSIUM OF THE ICP-PR BEE PROTECTION GROUP Book Series: Julius-Kuhn-Archiv Volume: 450 Pages: 276-283 (2015).

(3) Pohorecka, K. et al. Residues of neonicotinoid insecticides in bee collected plant materials from oilseed rape crops and their effect on bee colonies. J. Api. Sci. 56, 115–134 (2012).

7 http://apps.webofknowledge.com

(*ii*) (1) Calatayud-Vernich, P. et al. Pesticide residues in honey bees, pollen and beeswax: Assessing beehive exposure. Environ. Poll. 241, 106–114 (2018).

(2) Balsebre, A. et al. Matrix solid-phase dispersion associated to gas chromatography for the assessment in honey bee of a group of pesticides of concern in the apicultural field. J. Chromatog. A. 1567, 47-54 (2018).

(3) Valverde, S. et al. Development and validation of UHPLC MS/MS methods for determination of neonicotinoid insecticides in royal jelly-based products. J. Food Compos Anal. 70, 105-113 (2018).

(4) Bridi, R. et al. LC-MS/MS analysis of neonicotinoid insecticides: Residue findings in Chilean honeys. Ciênc. Agrotec. 42, 51-57 (2018).

(5) Mitchell, E.I.D. et al. A worldwide survey of neonicotinoids in honey. Science 358, 109-111 (2017).

(6) Baines, D. et al. Neonicotinoids act like endocrine disrupting chemicals in newly-emerged bees and winter bees. Sci. Rep. 7, 10979 (2017).

(7) Pohorecka, K. et al. THE EXPOSURE OF HONEY BEES TO PESTICIDE RESIDUES IN THE HIVE ENVIRONMENT WITH REGARD TO WINTER COLONY LOSSES. J. Apic. Sci. 61, 105-125 (2017).

(8) Silvina, N. et al. Neonicotinoids transference from the field to the hive by honey bees: Towards a pesticide residues biomonitor. Sci. Total Environ. 581, 25-31 (2017).

(9) Valverde, S. et al. Fast determination of neonicotinoid insecticides in bee pollen using QuEChERS and ultra-high performance liquid chromatography coupled to quadrupole time-of-flight mass spectrometry. ELECTROPHORESIS 37, 19 Special Issue, 2470-2477 (2016).

(10) Sanchez-Hernandez, L. et al. Simultaneous determination of neonicotinoid insecticides in sunflower-treated seeds (hull and kernel) by LC-MS/MS. FOOD ADDITIVES AND CONTAMINANTS PART A-CHEMISTRY ANALYSIS CONTROL EXPOSURE & RISK ASSESSMENT 33, 442-451 (2016).

(11) Laaniste, A. et al. Determination of neonicotinoids in Estonian honey by liquid chromatography-electrospray mass spectrometry. J. Environ. Sci. Health B 51, 455-464 (2016).

(12) Hao, C. et al. Liquid chromatography/tandem mass spectrometry analysis of neonicotinoids in environmental water. Rapid Comm. Mass Spectr. 29, 2225-2232 (2015).

(13) Lopez-Fernandez, O. et al. High-throughput HPLC-MS/MS determination of the persistence of neonicotinoid insecticide residues of regulatory interest in dietary bee pollen. Analytical & bioanalytical Chem. 407, 7101-7110 (2015).

(14) van der Zee, R. et al. An Observational Study of Honey Bee Colony Winter Losses and Their Association with Varroa destructor, Neonicotinoids and Other Risk Factors. PLoS ONE 7, e0131611 (2015).

(15) Purdy, J. R. Monitoring in-hive residues of neonicotinoids in relation to bee health status. Conference: 12th International Symposium of the ICP-PR Bee Protection Group - Hazards of Pesticides to Bees Location: Ghent Univ, Fac Bioscience Engn, Ghent, Belgium. Sept. 15-17, 2014. HAZARDS OF PESTICIDES TO BEES: 12TH INTERNATIONAL SYMPOSIUM OF THE ICP-PR BEE PROTECTION GROUP Book Series: Julius-Kuhn-Archiv Volume: 450 Pages: 276-283 (2015).

(16) Johnson, S. et al. Evaluation of pesticide toxicity at their field recommended doses to honeybees, Apis cerana and A-mellifera through laboratory, semi-field and field studies. Chemosphere 119, 668-674 (2015).

(17) Yanez, K.P. et al. Trace Analysis of Seven Neonicotinoid Insecticides in Bee Pollen by Solid-Liquid Extraction and Liquid Chromatography Coupled to Electrospray Ionization Mass Spectrometry. Food Analy. Methods 7, 490-499 (2014).

(18) Pohorecka, K. et al. Residues of neonicotinoid insecticides in bee collected plant materials from oilseed rape crops and their effect on bee colonies. J. Api. Sci. 56, 115–134 (2012).

(*iii*) (1) Murano, H. et al. Influence of humic substances and iron and aluminum ions on the sorption of acetamiprid to an arable soil. Sci. Total. Environ. 615, 1478-1484 (2018).

(2) Hao, C. et al. Liquid chromatography/tandem mass spectrometry analysis of neonicotinoids in environmental water. Rapid Comm. Mass Spectrom. 29, 2225-2232 (2015).

(3) Vehovszky, A. et al. Neonicotinoid insecticides inhibit cholinergic neurotransmission in a molluscan (Lymnaea stagnalis) nervous system. Aquatic Toxicol. 167, 172-179 (2015).

(4) Lu, Z. et al. Quantum Yields for Direct Photolysis of Neonicotinoid Insecticides in Water: Implications for Exposure to Nontarget Aquatic Organisms. Environ. Sci. Tech. Lett. , 188-192 (2015).

(5) Wijaya, W. et al. Rapid Detection of Acetamiprid in Foods using Surface-Enhanced Raman Spectroscopy (SERS). J. Food Sci. 79, T743-T747 (2014).

(6) Miranda, G.R.B. et al. Environmental Fate of Neonicotinoids and Classification of Their Potential Risks to Hypogean, Epygean, and Surface Water Ecosystems in Brazil. Human Ecol. Risk Assess. 17, 981-995 (2011).

(*iv*) (1) Cheng, Y. et al. A semi-field study to evaluate effects of sulfoxaflor on honey bee (Apis mellifera). Bull. Insectol. 71, 225-233 (2018).

(2) Zhu, Y. et al. Feeding toxicity and impact of imidacloprid formulation and mixtures with six representative pesticides at residue concentrations on honey bee physiology (Apis mellifera). PLoS ONE 12, e0178421 (2017).

(3) Siviter, H., Brown, M., Leadbeater, E. Sulfoxaflor exposure reduces bumblebee reproductive success Nature 561, 109–112 (2018). doi: 10.1038/s41586-018-0430-6

(*v*) (1) Hesselbach, H. et al. Effects of the novel pesticide flupyradifurone (Sivanto) on honeybee taste and cognition. Sci. Rep. 8, 4954 (2018).

(2) Campbell, J. W. et al. An Evaluation of the Honey Bee (Hymenoptera: Apidae) Safety Profile of a New Systemic Insecticide, Flupyradifurone, Under Field Conditions in Florida. J. Econ. Entemol. 109, 1967-1972 (2016).

(*vi*) (1) Hesselbach, H. et al. Effects of the novel pesticide flupyradifurone (Sivanto) on honeybee taste and cognition. Sci. Rep. 8, 4954 (2018).

(2) Campbell, J. W. et al. An Evaluation of the Honey Bee (Hymenoptera: Apidae) Safety Profile of a New Systemic Insecticide, Flupyradifurone, Under Field Conditions in Florida. J. Econ. Entemol. 109, 1967-1972 (2016).

(*vii*) (1) Ellis, C. et al. The Neonicotinoid Insecticide Thiacloprid Impacts upon Bumblebee Colony Development under Field Conditions. Environ. Sci. Tech. 51, 1727-1732 (2017).

(2) Pohorecka, K. et al. Residues of neonicotinoid insecticides in bee collected plant materials from oilseed rape crops and their effect on bee colonies. J. Api. Sci. 56, 115–134 (2012).

(*viii*) (1) Shi, T. et al. Metabolomic analysis of honey bee, Apis mellifera L. response to thiacloprid. Pest. Biochem. Physiol. 152, 17-23 (2018).

(2) Beyer, M. et al. Pesticide residue profiles in bee bread and pollen samples and the survival of honeybee coloniesa case study from Luxembourg. Environ. Sci. Pol. Res. 25, 32163-32177 (2018).

(3) Valverde, S. et al. Development and validation of UHPLC MS/MS methods for determination of neonicotinoid insecticides in royal jelly-based products. J. Food Compos Anal. 70, 105-113 (2018).

(4) Bridi, R. et al. LC-MS/MS analysis of neonicotinoid insecticides: Residue findings in Chilean honeys. Ciênc. Agrotec. 42, 51-57 (2018).

(5) Mitchell, E.I.D. et al. A worldwide survey of neonicotinoids in honey. Science 358, 109-111 (2017).

(6) Pohorecka, K. et al. THE EXPOSURE OF HONEY BEES TO PESTICIDE RESIDUES IN THE HIVE ENVIRONMENT WITH REGARD TO WINTER COLONY LOSSES. J. Apic. Sci. 61, 105-125 (2017).

(7) Ellis, C. et al. The Neonicotinoid Insecticide Thiacloprid Impacts upon Bumblebee Colony Development under Field Conditions. Environ. Sci.

Technol. 51, 1727-1732 (2017).

(8) Roszko, M.L. et al. Levels of Selected Persistent Organic Pollutants (PCB, PBDE) and Pesticides in Honey Bee Pollen Sampled in Poland. PLoS ONE 11, e0167487 (2016).

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PEER-REVIEW STUDIES THAT ASSESS EXPOSURE. CASE EXAMPLES FROM TABLE 2.

The examples below provide an overview of the sorts of studies available. Note the funding sources.

***Case study 1** (from the Web of Science search "acetamiprid" + "bee" + "pollen")*

Pohorecka, K. et al. (2012) looked at the concentration of neonicotinoid insecticides in pollen, nectar, honey and bee bread (bee-collected pollen). The results showed that acetamiprid, thiamethoxam and thiacloprid were the most prevalent insecticides present in pollen and nectar that had been collected by honey bees. The researchers state that bee colonies are at high risk from pesticide exposure in areas where there is intensive cultivation of oilseed rape. The study did not see any adverse short- or long-term effects following seed treatment and spraying of winter and spring oilseed rape. They conclude that additional research into the toxicological impact of neonicotinoid exposure on bees is warranted. [Funding from an industry source was not indicated.]

***Case study 2** (from the Web of Science search "flupyradifurone" + "bee" + "pollen")*

Campbell, J. W. et al. (2016) studied whether flupyradifurone applied to a bee-attractive crop (buckwheat) would affect a neighbouring bee colony over a study period of three weeks (ie short-term exposure). The study took place in Florida, US, in June 2015 and involved 24 study colonies. The researchers found that the honey bees they observed did not seem to actively avoid the buckwheat plants that had been sprayed with flupyradifurone (control fields of buckwheat had been sprayed with water). The study found a significantly higher level of flupyradifurone in bee-collected pollen in comparison to bee-collected nectar, but did not find that when flupyradifurone had been applied as directed by the manufacturer that there was an adverse effect on bee colonies. [Note that Bayer, Crop Science Division provided funding for the research.]

***Case study 3** (from the Web of Science search "thiacloprid" + "bee" + "pollen")*

Ellis, C. et al. (2017) conducted a field study to look at the effects of the neonicotinoid thiacloprid on bumble bee colonies. In particular, the study looked into whether proximity to a non-treated and good food source mitigated the bees' exposure to the pesticide if the colonies were moved to a location far from the treated crop. Thiacloprid has a lower toxicity to bees than imidacloprid, thiamethoxam or clothianidin, but it has been shown to cause a higher level of mortality in honey bees. The study took place on nine raspberry farms in central Scotland. In the study (summer 2013), nine test bee colonies were placed adjacent to a sprayed raspberry crop (spraying according to the manufacturer's recommendation) and, in a separate location, control bee colonies were placed adjacent to a non-sprayed raspberry crop. Bees foraged at their farm for two weeks. The results found that bee colonies exposed to thiacloprid were more likely to fail. The exposed colonies that survived had a lower weight and had fewer reproductives in comparison to the control colonies. They found that some colonies were exposed to very high levels of thiacloprid (up to 771 ppb in pollen), which they state is around two orders of magnitude higher than concentrations of neonicotinoids in nectar and pollen of seed-treated crops. It would seem that spraying crops exposes the bees to slightly higher levels of the pesticide than seed-treated crops. They also note that the crop is significant when determining exposure; bees are highly attracted to raspberry flowers (as they are to oilseed rape, although they are not as attracted to corn). The study did not investigate the mechanisms by which bumble bees are affected by thiacloprid. The researchers say that there is a small chance that the control bees were exposed to pesticides, either by long-distance foraging to nearby farms or because much of the farmed landscape is contaminated with pesticide residues. In conclusion, thiacloprid used at the manufacturer-suggested concentration can harm bumble bee colonies. Further research on the long-term impact to bees (and other pollinators) is warranted. [Funding from UK research grants including the BBSRC.]

***Case study 4** (**from the Web of Science search "thiacloprid" + "bee" + "surface water"**)*

Lu, Z. et al. (2015) studied the persistence of neonicotinoid pesticides (thiamethoxam, clothianidin, imidacloprid, acetamiprid, and thiacloprid) in water in the laboratory under environmentally relevant conditions. The study found that in water, the half-life of thiamethoxam was 0.2-1.5 days, depending on the season (and the sunlight available to degrade the active substance) The researchers conclude that other neonicotinoids are likely to behave similarly. [Funding from the Natural Sciences and Engineering Research Council of Canada, a University of Manitoba Graduate Fellowship, and the Canada Research Chairs Program.]

***Case study 5** (**from the Web of Science search "thiacloprid" + "bee" + "dust drift"**)*

Pochi, D. et al. (2015) looked at the potential exposure of honey bees to dust from maize seeds that had been treated with thiacloprid and which were being sown in a field. The study was designed to investigate a new drilling prototype that mitigates dust drift, which it compared with conventional drilling. Using a number of Petri dishes and air sampling devices, the researchers assessed the amount of dust drift from conventional and modified seed sowing. The study found that the prototype reduced dust drift by 93.4% in comparison to conventional seed sowing. In both conventional and prototype seed sowing, the amount of dust drift to the field edges was similar at a 5m and at 20 m from the field edge, which the researchers suggest could be because of wind velocity at distances further from the field. The results show that exposure to thiacloprid from dust drift to a bee flying through a field in which conventional sowing is taking place could be in the range 2.0-49.9 ng bee-1. By contrast, the figures are reduced to 0.3-7.4 ng bee-1 when the prototype dust-mitigation sowing was used. [Funded by the Italian Ministry of Agriculture, Food and Forestry Policies.]

Appendix Table 3. An overview of the five pesticides included in our study whose EU approvals have not been restricted due to potential risks to bees. Information is based on the EFSA review documents for each pesticide and the Pesticides Properties Database of University of Hertfordshire (PPD). Information on thiacloprid from PPD only as no EFSA document is available. Please note that mitigation measure are directly quoted from review documents and do not reflect a Greenpeace position.

Pesticide	Mode of use	Main target pest / crops	Mitigation suggested by EFSA review document.
Acetamipid	Soluble granules for spray application	Multiple pests (particularly aphids) of tomato, potato and pome fruit, evaluated by EFSA. Other uses include: leafy vegetables; fruiting vegetables; fruit including citrus, apples, pears, grapes; cotton; ornamental plants and flowers.	P20. 'Mitigation measures comparable to 20 m no-spray buffer zone and 20 m vegetated strip were needed to achieve a low risk to aquatic organisms for the use in pome fruit (see Section 5). Mitigation measures comparable to 10 m no-spray buffer zone were needed to achieve a low risk to non-target arthropods for the use in potatoes (see Section 5).'
Cyantran-iliprole	Applied directly to soil but may also be used as a seed treatment or foliar spray.	Broad spectrum insecticide for a wide range of crops that is effective against many key chewing and sucking pests. Pesticides Properties Database states that this pesticide is highly toxic to honey bees. From the EFSA review, representative field uses are for lettuce, tomato, green bean, pepper and potatoes.	P24. 'Mitigation measures such as no-spray buffer zone and/or vegetated buffer strips should be applied to manage the risk to aquatic organisms for the field representative uses.' P24. 'For the representative uses as spray application on field vegetables with 2 applications at 90 g a.s./ha (i.e. field tomato, green bean, and field pepper), the risk to honeybees could be considered as low only if the first application is carried out before the flowering period and the second application is carried out during the flowering period but after daily bee flight For the representative field use in lettuce (spray) and for the representative spray uses in orchards and grapes applied only after the flowering periods, applications during the bee flight should be avoided to prevent potential exposure via flowering weeds.' NOTE: P25 describes six issues that could not be finalised in the review. Included in these issues was the risk to bees for the representative uses as field drip irrigation on tomato and pepper.

Pesticide	Mode of use	Main target pest / crops	Mitigation suggested by EFSA review document.
Flupyradifurone	Foliar and drench/ drip use and a seed treatment.	For the control of Phorodon humuli in hops in Northern Europe and Nasonovia ribisnigri in lettuce in the EU.	P19. ‘Mitigation measures comparable to a total reduction of 95 % (i.e. spray drift and runoff) were needed to address the risk for aquatic organisms for the representative use in hops (see Section 5).’ ‘Mitigation measures comparable to the effects of a 30-metres non-spray buffer zone for hops or 5- metres non-spray buffer zone for field uses lettuce were needed to address the risk for non-target arthropods (see Section 5).’ NOTE: P20 describes five issues that could not be finalised in the review. One of these was the potential for accumulation in groundwater.
Sulfoxaflor	Foliar spray applications	For the control sap feeding insects on fruiting vegetables (tomatoes; peppers; aubergines; cucumbers; melons; courgettes), spring and winter cereals (wheat, rye, barley, oats, triticale) and cotton.	PPD states that sulfoxaflor has a high potential to bioaccumulate, generally moderately toxic to birds and mammals and has a low toxicity to most aquatic species. It is toxic to honey bees and earthworms. P15. ‘A high risk to bees was concluded from these data by the experts at the meeting. In order to manage the risk to bees, some risk mitigation measures were proposed by the RMS for the field uses. However the experts at the meeting did not consider that the data and the assessments that were available were sufficient to demonstrate a low risk to bees for the field uses even with the proposed measures (i.e. application only when bees are not present in the crop). Therefore, a data gap was agreed to further address the risk to honey bees for the field uses. It is further noted that the available assessments for the field uses refer to honey bees and other pollinators such as wild bees are not covered. A high risk to pollinators introduced in glasshouses where sulfoxaflor is used could also not be excluded. Therefore risk mitigation measures such us covering or removing bumble bee colonies for the application until the foliar residues have dried were proposed for these situations.’ P19. The review document states that there are no issues that cannot be finalised.

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Cover image: **KaliAntye / shutterstock.com**

Layout design: **Juliana Devis / julianadevis.com**

Published in January 2019 by
Greenpeace Research Laboratories
School of Biosciences
Innovation Centre Phase 2
Rennes Drive
University of Exeter
Exeter EX4 4RN
United Kingdom

greenpeace.org