Proposed Re-evaluation Decision PRVD2018-12

Imidacloprid and its Associated End-use Products: Pollinator Re-evaluation

Consultation Document

(publié aussi en français)

31 May 2018

This document is published by the Health Canada Pest Management Regulatory Agency. For further information, please contact:

Publications
Pest Management Regulatory Agency
Health Canada
2720 Riverside Drive
A.L. 6607 D
Ottawa, Ontario K1A 0K9

Internet: canada.ca/pesticides
hc.pmra.publications-arla.sc@canada.ca
Facsimile: 613-736-3758
Information Service:
1-800-267-6315 or 613-736-3799
hc.pmra.info-arla.sc@canada.ca

Canada

ISSN: 1925-0959 (print)
1925-0967 (online)

Catalogue number: H113-27/2018-12E (print)
H113-27/2018-12E-PDF (PDF version)

Table of Contents

Proposed Re-evaluation Decision

Under the authority of the *Pest Control Products Act*, Health Canada's Pest Management Regulatory Agency (PMRA) conducted a re-evaluation of all agricultural, turf and ornamental uses for imidacloprid and its associated end-use products, specifically to assess the risk to pollinators. This re-evaluation assessed the potential risk to pollinators in light of international updates to the pollinator risk assessment framework, including information requirements. Extensive information obtained from published literature was considered, as well as data received from registrants. In 2016, PMRA published a preliminary pollinator risk assessment, *Re-evaluation of Imidacloprid - Preliminary Pollinator Assessment* (REV2016-05) based on available data at that time. Since then, PMRA has received additional data from the registrants, and considered more studies available from the open literature resources. This update of the pollinator risk assessment considers all the available data to date. Health Canada applied internationally accepted risk assessment methods as well as current risk management approaches and policies. In addition to the pollinator risk assessment, the value of the active ingredient to the use sector was considered.

Health Canada and the United States Environmental Protection Agency (USEPA) collaborated on this pollinator assessment, based on the jointly developed harmonized *Guidance for Assessing Pesticide Risks to Bees*. The Agencies have also been working closely with the California Department of Pesticide Regulation (CDPR).

This document presents the proposed regulatory decision for the pollinator re-evaluation of imidacloprid, including proposed risk mitigation measures to further protect pollinators, as well as the science evaluation on which the proposed decision was based. This proposed decision is subject to a 90-day public consultation period, during which the public, including manufacturers and stakeholders, may submit written comments and additional information to Health Canada. The final re-evaluation decision will be published taking into consideration any comments and information received.

Prior to the publication of this proposed regulatory decision for the pollinator re-evaluation of imidacloprid, the PMRA published the proposed decision for the re-evaluation of imidacloprid in November 2016, which presented the risk assessments for both health and environment (excluding pollinators), as well as value (Proposed Re-evaluation Decision PRVD2016-20, Imidacloprid). While PRVD2016-20 proposed to phase-out all the agricultural and a majority of other outdoor uses of imidacloprid over three to five years for the protection of the environment, the current proposed regulatory decision is based solely on the pollinator risk assessment for imidacloprid. A final decision that integrates both imidacloprid re-evaluations is anticipated in December 2018 and will be published taking into consideration any comments and information received during the respective consultation periods. Additional reviews related to re-evaluations and special reviews previously announced in respect of other neonicotinoids are ongoing. Anticipated time frames for decisions related to these activities are outlined in: Update on the Neonicotinoid Pesticides (December 2017).

Outcome of Science Evaluation

Imidacloprid is an insecticide that is widely used in Canada on a variety of crops. This document summarizes the potential risks posed by imidacloprid to insect pollinators, such as honey bees, bumble bees, and solitary bees in Canada, as well as proposed strategies to reduce the risks to these pollinators. With over 700 native species in Canada, bees are the most common pollinators. Bees and other insect pollinators are critical to the production of many crops and play an essential ecological role.

Products containing imidacloprid are sold as sprays to be applied to plants and to bare soil. Imidacloprid is also used as a coating on crop seeds to prevent insects from eating the seeds when they are planted in the ground and to protect the plants grown from treated seeds. Some uses result in imidacloprid being taken up by the plants from the soil or through their leaves, where it then moves into parts of the flower where nectar and pollen are produced. As a result of bees using nectar and pollen as their primary sources of food, bees may be exposed to imidacloprid (and its breakdown products) when they visit certain flowers to collect pollen and nectar. Bees may also be accidentally sprayed or collect water containing imidacloprid. Imidacloprid can also be injected into the trunk of deciduous and coniferous trees for the control of insect pests. Assessment for imidacloprid tree injection has recently been published separately (Proposed Registration Decision PRD2016-16, Imidacloprid) and is not included in this re-evaluation for pollinators.

Health Canada's Pest Management Regulatory Agency (PMRA) examined hundreds of laboratory and outdoor field studies with bees from research conducted around the world. These studies examined possible effects on bees from a wide range of situations including:

- bees contacting imidacloprid while visiting flowers;
- bees consuming imidacloprid in the pollen and nectar of flowers;
- bees exposed to imidacloprid for a short period of time (acute exposure) and for a long period of time (chronic exposure);
- bees exposed to imidacloprid in water;
- bees exposed to dust that may be generated while planting seeds that were coated with imidacloprid;
- adult bees, developing bees and the whole colony exposed within bee hives; and
- exposure of different species of bees including honey bees (also called *Apis* bees) and other species of bees, such as bumble bees and solitary bees (also called non-*Apis* bees).

This risk assessment, conducted according to the *Guidance for Assessing Pesticide Risks to Bees*, has determined that there are varying degrees of effects on bees. Some current uses of imidacloprid are not expected to affect bees; however, there are some uses of imidacloprid that may pose a risk of concern to bees. Therefore, mitigation measures are proposed to minimize potential exposure to bees, where necessary. Mitigation measures include cancellation of some uses, changes to the use pattern, and label improvements. When imidacloprid is used in accordance with these new proposed risk reduction measures, the reduced environmental

exposure is deemed adequate and risks are considered to be acceptable. Label statements informing users of the potential for toxicity to pollinators will be required on product labels.

Bees may be exposed to dust produced during planting of treated seed for certain cereal and legume crops. There are already label statements in place to reduce exposure to dust produced during planting of treated corn and soybean seed; these label statements include best management practices, as well as mandatory use of dust-reducing fluency agents in certain types of planters. Details can be found on Health Canada's Pollinator Protection webpage. In addition, Health Canada will require the addition of label statements for all cereal and legume crops to minimize exposure to dust during planting of treated seed; these statements would include general best management practices, but would not include use of a dust-reducing fluency agent.

Health Canada also assessed the risks to bees posed by water sources that may be used by pollinators for water collection (for example, water from puddles, streams and plants) in areas where imidacloprid is applied, and determined that water sources do not pose risks of concern to bees.

Proposed Regulatory Decision for Imidacloprid

Under the authority of the *Pest Control Products Act* and based on the evaluation of currently available scientific information related to pollinators, products containing imidacloprid are being proposed for continued registration in Canada, and risk mitigation measures are required to be in place to further protect pollinators.

Registered pesticide product labels include specific directions for use. Directions include risk mitigation measures that must be followed by law. As a result of this re-evaluation of imidacloprid, further risk mitigation measures for product labels are being proposed.

Measures to Protect Pollinators

Due to the attractiveness of some crops to bees when their flowers are in bloom, and based on an assessment of the risks to bees, the application of pesticides containing imidacloprid can lead to effects that may impact the survival of bee colonies or solitary bee species.

In order to protect pollinators, Health Canada is proposing to phase out the following uses of imidacloprid:

- Foliar application to pome fruit, stone fruit, certain tree nuts with high pollinator attractiveness, small fruit and berries (caneberry; bushberry; low-growing berry excluding strawberry and excluding lowbush blueberry followed by renovation; berry and small fruit vine excluding grape);
- Soil application on legume vegetables, fruiting vegetables, cucurbit vegetables, herbs (excluding herbs that are harvested before bloom), small fruit and berries (caneberry; bushberry; low-growing berry; berry and small fruit vine excluding grapes);
- Soil application to ornamentals that will result in pollinator exposure.

In order to protect pollinators, **Health Canada is proposing that the following crops cannot be sprayed before or during bloom:**

- Foliar application to fruiting vegetables, herbs (excluding herbs that are harvested before bloom), legume vegetables (broad beans/fava beans/*Vicia faba* only), strawberry, lowbush blueberry if followed by renovation after harvest, tree nuts excluding those with high pollinator attractiveness.

In order to protect pollinators, **Health Canada is proposing that the following crops cannot be sprayed during bloom:**

- Foliar application to potato, sweet potato, grapes, legume vegetables (excluding broad beans/fava beans/*Vicia faba*), hops, peanut, tobacco.

To minimize bee exposure to dust during planting of treated seed, **additional label statements are proposed for the following use**:

- Seed treatment of cereal and legume crops.

International Regulatory Context

Imidacloprid is under registration review by the United States Environmental Protection Agency (USEPA). PMRA conducted the pollinator risk assessment according to the *Guidance for Assessing Pesticide Risks to Bees* in collaboration with the USEPA.

The European Food Safety Authority (EFSA) published updated risk assessments for seed treatments and granules in February 2018 and concluded that overall, neonicotinoids represent a risk to bees. In April 2018, based on EFSA's risk assessments, Member States endorsed the European Commission's proposals to ban the outdoor uses of imidacloprid, thiamethoxam, and clothianidin.

Next Steps

The public, including the registrants and stakeholders, are encouraged to submit additional information that could be used to refine risk assessments during the 90-day public consultation period[1] upon publication of this proposed re-evaluation decision.

All comments received during the 90-day public consultation period will be considered in the preparation of the re-evaluation decision document,[2] which could result in revised risk mitigation measures. The re-evaluation decision document will include the final re-evaluation decision, the reasons for it and a summary of comments received on the proposed re-evaluation decision with the PMRA's responses.

1 "Consultation statement" as required by subsection 28(2) of the *Pest Control Products Act*.
2 "Decision statement" as required by subsection 28(5) of the *Pest Control Products Act.*

Science Evaluation

Introduction

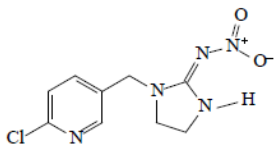
Imidacloprid is a first-generation neonicotinoid insecticide. Imidacloprid is classified by the Insecticide Resistance Action Committee (IRAC) as Group 4A mode of action insecticide. It acts via contact exposure or ingestion by binding to the nicotinic acetylcholine receptor sites in the central nervous system of insect pests. While the enzyme acetylcholinesterase normally breaks down acetylcholine to terminate signals from these receptors, it does not readily break down neonicotinoid insecticides. The prolonged stimulation of the cholinergic nerves leads to paralysis and eventually death. Neonicotinoids are known to have greater affinity for the insect nicotinic acetylcholine receptors than that of birds or mammals. The reason for this is that nicotinic acetylcholine receptors are different in insects and vertebrates thus affecting the ability to bind nicotinoids (described in detail in Tomizawa and Casida, 2003 and 2005).

Following the re-evaluation announcement for imidacloprid, the registrants of the technical grade active ingredients in Canada indicated their continued support for all registered uses of imidacloprid in Canada.

Imidacloprid is currently found in 29 end-use products to which pollinators may be exposed. Appendix I lists all these imidacloprid end-use products that are registered under the *Pest Control Products Act* as of December 2017. Twenty-eight of them are Commercial Class products and one is Domestic Class product. The Commercial Class products are registered for uses on a number of crops, including cereals, fruits, greenhouse food and ornamental crops, herbs, legumes, oilseeds, vegetables, Christmas trees, outdoor ornamentals and turf. These products can be applied using conventional ground equipment such as airblast sprayers, boom sprayers, backpack and hand wand sprayers, conventional aerial equipment (such as fixed wing and rotary aircraft), tree injection equipment, granular spreaders, chemigation equipment, seed treatment equipment (commercial treatment facilities and on-farm using closed and open systems), potato seed piece treatment equipment used by farmers, farm workers and professional applicators. One Domestic Class imidacloprid product may be applied by the general public using granular spreaders on turf. Imidacloprid may not be applied to the same site/field by multiple combinations of application methods (for example, a foliar application to a crop grown from treated seed is not permitted). In addition, imidacloprid may not be combined with any subsequent uses of other Group 4 insecticides within the same growing season. Appendix II provides a summary of the use pattern of imidacloprid products considered in the pollinator risk assessment.

1.0 The Technical Grade Active Ingredient

1.1 Identity

Common Name	Imidacloprid (Development Code: NTN 33893)
Function	Insecticide
Chemical Name	
1. International Union of Pure and Applied Chemistry (IUPAC)	(*E*)-1-(6-chloro-3-pyridylmethyl)-*N*-nitroimidazolidin-2-ylideneamine
2. Chemical Abstract Services (CAS)	(2*E*)-1-[(6-chloro-3-pyridinyl)methyl]-*N*-nitro-2-imidazolidinimine
CAS Number	138261-41-3
Molecular Formula	$C_9H_{10}ClN_5O_2$
Molecular Weight	255.67 g/mol
Structural Formula	

1.2 Physical and Chemical Properties of the Active Ingredients

Property	Result
Vapour pressure at 25°C	9×10^{-7} mPa
Ultraviolet (UV) / visible spectrum	pH λ_{max} (nm) 4,7,9 270
Solubility in water at 20°C	610 mg/L
n-Octanol/water partition coefficient at 21°C	log K_{ow} = 0.57
Dissociation constant	The test substance shows very weak basic properties. Complete protonation can be achieved only in non-aqueous solvents in presence of very strong acids. It is not possible to specify a pK_a value of the test substance in pure aqueous systems.

2.0 Pollinator Assessment

2.1 Fate and Behaviour in the Environment

A summary of available information pertaining to the fate and behaviour of imidacloprid in the

environment is provided in Appendix III. The environmental fate and behaviour of imidacloprid are summarized as follows:

- Imidacloprid comes in contact with soil when it is applied directly on the ground, sprayed on foliage, or when imidacloprid contained in the seed coating moves away from the seed into the surrounding soil.

- Imidacloprid is not expected to volatilize from soil surface.

- Imidacloprid may persist long enough to carryover from one growing season to the next. When imidacloprid is used for multiple years in succession, concentrations in soil initially increase and then may stabilize after approximately three to four years.

- Imidacloprid may enter the aquatic environment through spray drift or run-off from the application site. Imidacloprid in water dissipates relatively quickly if exposed to sunlight. In the absence of sunlight, imidacloprid degrades more slowly. Imidacloprid has been detected in surface water, including puddles, which bees may use as a source for drinking water.

- Major product formed from the microbial degradation of imidacloprid is imidacloprid-urea in the soil, and imidacloprid-guanidine in water.

- Imidacloprid is readily taken up by plants through treated seed or roots growing in treated soil where it moves upward inside the plant through the xylem.

- Plant pollen and nectar have been found containing imidacloprid because of the upwards movement or when spray droplets or dust containing imidacloprid (produced during the sowing of treated seeds) are deposited directly on open flowers. Imidacloprid residues have also been detected in the guttation liquid of plants because of this upward movement.

- Once inside the plant, imidacloprid remains the predominant residue. It may be metabolized and form imidacloprid-urea, 5-hydroxy-imidacloprid, imidacloprid-olefin, imidacloprid-guanidine, 6-chloronicotinic acid and other metabolites in the plant. Two of the transformation products, 5-hydroxy-imidacloprid and imidacloprid-olefin, have been shown to be toxic to bees and are therefore considered in the pollinator risk assessment.

2.2 Approach to Pollinator Risk Assessment

2.2.1 Background

The pollinator risk assessment followed a tiered framework developed jointly by Health Canada's Pest Management Regulatory Agency (PMRA), USEPA and the California Department of Pesticide Regulation in 2012 with guidance published in 2014 (*Guidance for Assessing Pesticide Risks to Bees*). The tiered risk assessment framework consists of exposure characterization and effects characterization relative to bees, and moves from a highly

conservative risk assessment at lower tiers to a more realistic assessment at higher tiers (see Appendix IV for further details on the risk assessment framework). The risk assessment considered the following:

- Potential acute and chronic risk to adults and brood for *Apis* (honey bees) and non-*Apis* (e.g., bumble bees) bees from foliar, soil and seed treatment applications.
- Potential individual and colony level effects for *Apis* and non-*Apis* bees considering measured residues in pollen and/or nectar after plants are treated in the field.
- Effects to bees from other field studies (tunnel studies, field studies, incident reports and monitoring).
- Potential risk from exposure to water sources (both guttation and surface water).

Multiple factors influence pollinator exposure including application type (foliar, soil, seed treatment); specific pesticide properties (systemic, non-systemic, persistence); agronomic considerations (whether crop has pollen/nectar source; harvest relative to bloom; flowering period). Potential for pollinator exposure also takes into account crop pollination requirements, crop attractiveness to *Apis* and non-*Apis* bees, whether it is a major or minor source of pollen and/or nectar, timing of application (pre-, during and post-bloom application), time of harvesting (pre- or post-bloom), crop acreage, etc. (see Appendix IV for criteria for determining pollinator exposure).

The potential of a treated crop to result in pollinator exposure to pesticides is considered in both the risk characterization and in determining appropriate risk management.

An extensive data set (> 280 effects and residue studies) from the open literature and registrant were considered for the imidacloprid pollinator risk assessment (Appendix V summarizes the available studies). All studies were reviewed for strengths and limitations and considered in the risk assessment in a weight of evidence approach (see Appendix IV for details).

In 2016, PMRA published a preliminary risk assessment for pollinators for imidacloprid, based on available data at that time (details in Re-evaluation Note REV2016-05, Re-evaluation of Imidacloprid – Preliminary Pollinator Assessment). This updated pollinator risk assessment includes all the information available to PMRA, including new information available since the preliminary assessment. Eleven comments from the public were received on the preliminary risk assessment and were considered in the updated risk assessment. See Appendix XIII for the response to the public comments.

2.3 Endpoints considered in the pollinator risk assessment

2.3.1 Tier I risk assessment

The Tier I risk assessment considered acute and chronic laboratory endpoints for adult bees and bee brood. There were more than 100 Tier I studies available for consideration in the risk assessment from the registrant and open literature. Details on the strengths and limitations of these studies can be found in Appendix V. The endpoints in Table 1 were considered the most relevant in the Tier I risk assessment.

Table 1. Summary of Endpoints Selected for the Tier I Imidacloprid Risk Assessment

Chemical	Life Stage	Exposure	Endpoint value	Degree of toxicity	Reference
Imidacloprid Technical (99.4%)	Adult	Acute Contact 48-h observation period	LD_{50}: 0.043 µg a.i./bee	Highly Toxic[1]	PMRA 2351182
		Acute Oral 48-h observation period	LD_{50}: 0.0038 µg a.i./bee	Highly Toxic[1]	PMRA 2351184
		Chronic dietary 10-d continuous feeding	NOEC: 3.9 µg/L (actual intake 0.00016 µg a.i./bee/day)	NA	Boily *et al*., 2013
	Brood	Chronic dietary 3-d *in-vitro* feeding; 22 day observation period	NOEC: 40 µg a.i./kg diet (actual intake 0.0018 µg a.i./larva/day)	NA	PMRA 2182453
		Acute dietary single-day exposure	LD_{50}: 4.17 µg a.i./larva	NA	Dai *et al*., 2017
Transformation Products					
5-Hydroxy-Imidacloprid	Adult	Acute Oral 96-h observation period	LD_{50}: 151.4 ng/bee	Highly Toxic[1]	PMRA 1086431
imidacloprid-olefin	Adult	Acute Oral 96-h observation period	LD_{50}: 23 ng/bee	Highly Toxic[1]	Suchail *et al*., 2001

[1] classification based on Atkins *et al*. (1981).
NA: relevant classification information is not available.

A number of effect studies from registrant and open literature are available for non-*Apis* bees, including bumble bees (*Bombus terrestris, B. impatiens*), mason bees (*Osmia cornifrons, O. lignaria*), the alfalfa leafcutting bee (*Megachile rotundata*) and stingless bees (*Melipona quadrifasciata, Nannotrigona perilampoides*). Ranges of the toxicity endpoints for honey bees, bumble bees and other non-*Apis* bees are listed in Table 2. The available Tier I effects information indicates that individual bumble bees have similar sensitivity to imidacloprid as honey bees on an acute oral basis but may be less sensitive than honey bees on an acute contact basis. The range of the sensitivity to other non-*Apis* bee adults is broader than that of honey bees on an acute contact basis. The other non-*Apis* bee larvae have a similar chronic toxicity to imidacloprid as honey bee larvae based on a dietary concentration although not on a dietary dose basis. Overall, the available toxicity information suggests that the effect information for the honey bee species may be considered as an adequate surrogate for non-*Apis* bees for the Tier 1 risk assessment.

Table 2. Summary of Toxicity Information Available for Imidacloprid to Honey Bees, Bumble Bees and Other Non-*Apis* Bees.

	Acute Contact LD50 (µg a.i./bee)	Acute oral LD50 (µg a.i./bee)	Adult chronic NOEL (µg a.i./bee/day)	Acute larvae LD50 (µg a.i./larva)	Chronic larva NOEL (µg a.i./larva/day) (equivalent concentration)
Honey bees	0.0128-0.243	0.0037-0.536	0.00016	4.17	0.0018 (40 µg a.i./kg diet)
Bumble bees	0.049-85.3	0.0046-0.15	NA	NA	NA
Other non-Apis bees	0.001 – 0.66	NA	NA	NA	< 0.0003 (< 40 µg a.i./L liquid diet) 30 µg a.i./kg pollen provision in another study for *Osmia*

NA: relevant information is not available.

Other than typical endpoints summarised above, available laboratory studies also reported imidacloprid metabolism in bees, potential sublethal effects of imidacloprid on the learning and flight activity of adult bees, as well as sperm viability in queens and drones. These studies were conducted for various research purposes. The overall applicability of these additional sublethal endpoints in relation to whole colony effects and applicability under field conditions is unclear. Therefore, results from these studies were not quantitatively used in the risk assessment, but were considered qualitatively as additional lines of evidence in the risk assessment for pollinators.

2.3.2 Tier I refined assessment - Residues

There were approximately 100 residue studies available for consideration in the risk assessment. Risk estimates based on field residues from all relevant residue studies were considered based on how similar the crop type, application rate and application timing in the study design were in comparison to the registered Canadian use pattern for each crop. Residue information selected for the risk assessment is outlined in the refined risk assessment tables for foliar (Appendix VII), soil (Appendix VIII) and seed treatment (Appendix IX) applications. The residue studies used in the risk assessment are summarized in Table 3.

Table 3 Summary of Available Residue Studies for the Imidacloprid Risk Assessment

Application type	Application Timing	Residue studies
Foliar	Pre-bloom	sugarmelon, soybean, citrus, cotton[1]
	During bloom	Cotton,[2] turf, tomato[3]
	Post-bloom	Apple,[4] cherry
	Rotational crop	clover
Soil	At planting or after planting	potato, tomato, melon, sugarmelon, pumpkin, squash, strawberry, blueberry, citrus, cotton, apple, stone fruit (cherry, plum, apricot and peach),[5] off-field wildflowers
	Rotational crop	clover, phacelia, mustard or corn,
Seed treatment	At planting	soybean, canola, corn, sweet pepper, melon
	Rotational crop	phacelia and maize, winter oilseed rape
Monitoring		Honey bee hives in maize field, honey bee hives in urban and suburban in USA, honey bee hives near agricultural fields in France, flowers of ornamental plants sold in USA.

1. pre-bloom foliar application after a seed treatment
2. two studies were available, one of them was during-bloom foliar application after a soil application
3. during-bloom foliar application after a soil application
4. post-bloom foliar after a post-bloom soil application
5. post-bloom soil application and foliar applications

2.3.3 Tier II refined assessment

The Tier II refined risk assessment considered effects from colony feeding studies compared to measured residues in pollen and/or nectar from labeled application to crops. There were 47 colony level feeding studies available from the registrant and open literature for consideration in the risk assessment (see Appendix V for details on strengths and limitations for each study). The endpoints in Table 4 were considered the most relevant in the Tier II refined risk assessment.

Table 4 Summary of Endpoints Selected from Colony Feeding Studies for the Tier II Refined Imidacloprid Risk Assessment

Study Type	Matrix that was dosed & length of exposure	Species and caste	Endpoint value	Endpoints affected	Limitations	Reference
Imidacloprid colony feeding study (including overwinterin	Sucrose solution 42 days of exposure	Honey bee Whole colony	NOEC: 23.3 ppb in sucrose solution LOEC:	Integration of multiple measurements including hive weight, number of individuals at	Other pesticides were detected occasionally in monitoring hives. Imidacloprid was detected in some samples from	PMRA 2474495

Study Type	Matrix that was dosed & length of exposure	Species and caste	Endpoint value	Endpoints affected	Limitations	Reference
g) Open	and 276 days of observation		46.7 ppb in sucrose solution	different life stages in hive, hive honey and pollen stores and hive overwintering survival	control hives. The overwintering mortality was higher in the control than in the lower test concentrations.	
Imidacloprid colony feeding study (including overwintering) Open	Pollen patties 42–84 days of exposure Approximately 10 months of observation	Honey bee Whole colony	NOEC: 20 ppb in pollen patties LOEC: 100 ppb in pollen patties	Increased queen supersedures and decreased overwintering survival	There was wide dosing space between NOEC and LOEC. The effect at LOEC was inconsistently observed. It was detected only in one of the two test years. No other effects were detected on multiple colony parameters. Increased Varroa mite infestation was found in one of the two years of measurement. Interaction between the treatment and Varroa mite infestation on the colony effect is unclear.	Dively et al., 2015
Imidacloprid colony feeding study Open	Sucrose solution 5 weeks exposure and observation period	Bumble bee colony *Bombus terrestris*	LOEC: 2.5 ppb in sugar syrup, the only test concentration	Reduced number of brood cells by 46% compared to the control	Lack of details on feeding such as amount of sugar syrup provided, and how often the syrup was replenished. Lack of details of colony condition at the study.	Moffat et al., 2016
Imidacloprid colony feeding study Open	Mixture pollen and sugar solution 14-day exposure in lab 28- or 42-day observation in the field	Bumble bee colony *Bombus terrestris*	LOAEC: 6 ppb in pollen + 0.7 ppb in sugar solution, the lowest test concentration	Reduced colony size, number of new queens produced, number of empty pupal cells, and pollen foraging efficiency	Residue analysis was not conducted to confirm level of exposure. Longer term exposure and effects (beyond 42-day observation period) were not investigated in the study.	Whitehorn et al., 2012; Feltham et al., 2014

2.4 Incident Reports

Since 26 April 2007, registrants have been required by law to report pesticide incidents to the PMRA that are related to their products. In addition, the general public, medical community, government and non-governmental organizations are able to report pesticide incidents directly to the PMRA.

Incident reports related to imidacloprid have been presented previously in the publication Update on Canadian Bee Incident Reports 2012-2016.

Incident reports related to spray applications of imidacloprid have been reported in Canada and the United States. In Canada, one bee mortality incident was reported after spraying of imidacloprid in a British Columbia orchard. In the United States, 12 reported incidents associated with crops including orange trees, cotton, soybean, holly trees and linden trees. In two of the incidents imidacloprid was applied during bloom of citrus and linden trees. For the remaining spray incidents, it is uncertain if the application occurred during the bloom period and whether bees would be actively foraging on these crops during the application. Foliar spray applications made while bees are foraging on crops or nearby plants may result in direct contact exposure and more likely cause bee mortalities.

Incident reports related to soil applications of imidacloprid have been reported in Canada and the United States. Two incidents were reported in Canada. One of them reported that dead bumble bees were found around potted lobelia plants in Saskatchewan that were recently purchased, and imidacloprid, among other pesticides, was detected in the plant and soil. The other was on ornamental linden trees that had imidacloprid soil injection. The incident occurred in the United States, not in Canada, but was reported to both the PMRA and the USEPA. In the United States, 11 incidents were reported and were associated with various crops (watermelons, orange and citrus trees, linden trees, rose bushes, sweet pepper bushes and garden). Aside from one incident when it is known that the application occurred just as the trees were blooming the timing of application is either known to occur prior to bloom or it is unclear from the information available in the database.

There were seven incidents with a suspected link to seeds treated with imidacloprid reported in USEPA EIIS database. One of the incident reports showed a suspected link to treated corn seed; however, information resulted in the USEPA determining that it was unlikely that imidacloprid contributed to this incident. Two of the reports listed in the database dated back to 1995 and 1999. In 1995, beekeepers reported losing “thousands” of honey bee colonies during the period when canola was treated with imidacloprid. In 1999, imidacloprid treated sunflower seeds in France were suspected to be related to declines in honey bee populations. Limited information was available for these two incident reports. Two more recent incidents (one in the United States and one in the United Kingdom) both reported an incident that was suspected to be associated with the planting of imidacloprid treated canola/rape oilseed. For both of these incidents imidacloprid was detected in hives samples. One incident that occurred in Slovenia was suspected to be associated with the planting of imidacloprid treated corn seed. Information available for this incident indicates that dust generated during planting was likely deposited on neighbouring canola plants that were in bloom. Incidents with seed treatments have primarily been associated with dust generated during planting of treated seeds.

The PMRA has not received any incident reports suspected to be associated with imidacloprid treated seeds. During an investigation conducted by PMRA on the honey bee incidents that coincided with the planting of corn and soybean in Canada, imidacloprid was detected in a small portion of samples and at low concentrations. The percentage of samples detected with imidacloprid and the maximum detection were 0–4% in bee samples with the maximum of 1.1 ppb, 2-15% in hive nectar samples with the maximum of 4.76 ppb, and 1–42% in comb pollen samples with the maximum of 32.1 ppb respectively. The frequency of detection decreased from 2014 to 2016 in all three measured matrices. The investigation noted that although imidacloprid is registered for corn and soybean seed treatment, it is not typically used in Canada. As such, it is concluded that the detection of imidacloprid in hives and bees was not a result of seed dust containing this active ingredient. Dust generated from planting of treated corn and soybean seed was previously identified as a concern in Canada, and risk reduction measures were put in place in 2014 to reduce exposure to dust during planting of neonicotinoid-treated corn and soybean. With this mitigation in place for the 2014 planting season, the number of reported incidents during this and subsequent planting periods decreased.

2.5 Pollinator Risk Characterization

2.5.1 Pollinator Risk Assessment Framework

As previously described, the pollinator risk assessment framework uses a tiered approach in which Tier I uses the most conservative assumptions, and Tier II and III use progressively more realistic assumptions.

Tier I and Tier I refined assessment

The Tier I default or screening level risk assessment considers the most relevant and conservative effect endpoints from the laboratory studies (both registrant and open literature) for different castes of bees along with a range of application methods and rates in order to determine which uses present a possible risk. The determination of contact and oral exposure is based on conservative default values for estimating concentrations in pollen and nectar for each application method: foliar, soil, and seed treatment. For each application method, both the minimum and maximum application rates are assessed in order to determine the risk in relation to the use pattern. The focus of this assessment is at the individual bee level, considering toxicity to individual bees, individual bee contact exposure, and oral exposure based on individual bee consumption rates.

The Tier I refined risk assessment considers the endpoints from the laboratory toxicity studies in addition to the residues from field studies (also referred to as Tier II residue studies). Therefore, the assessment is still based on individual bees, but is moving from conservative default exposure values to residues measured in the environment, in bee relevant matrices. The residue field studies are typically designed to establish the amount of imidacloprid in pollen and/or nectar (either collected from bees, the hive or from the plant itself) resulting from realistic field applications. Since residue studies are designed and conducted across Canada and the United States, applications can be conducted on a range of crops and rates, which are sometimes conservative (higher) compared to Canadian rates. Relevance of residue information compared to the Canadian use pattern is taken into consideration when assessing the potential for risk. The

refined Tier I assessment is still intended to screen for possible risks, and is therefore conservative.

Field residues of imidacloprid and transformation products sampled from nectar and pollen in different matrices (i.e., hives, plants, bees) following applications with imidacloprid were selected from available residue information to refine the Tier I screening level acute and chronic estimated environmental concentrations (EEC). To derive an **acute EEC value** for use in the refined acute oral risk assessment, the maximum residue values in pollen and nectar were selected from relevant residue trials. The maximum value was considered the most relevant for the acute risk assessment as there was considerable spatial and temporal variability in the available residue data. To derive a **chronic EEC value** for use in the refined chronic oral risk assessment, the highest daily mean residue values in pollen and nectar were selected from relevant residue trials. The highest daily mean was considered the most relevant for the chronic risk assessment as bees in the Tier I chronic studies are typically exposed to imidacloprid over a prolonged period of time (3-4 days for larvae and 10 days for adults).

Acute and chronic risk estimates considered the amount of pesticide that could be ingested by relevant bee castes (estimated daily dose value). The **estimated daily dose value** for relevant bee castes is based on the refined acute or chronic EEC values from residue studies and the most conservative estimated food consumption rates for adult bees (292 mg/day nectar and 0.041 mg/day pollen for worker bees foraging for nectar (nectar foragers); 140 mg/day nectar and 9.6 mg/day pollen for nurse bees consuming pollen and nectar) and mature bee larvae (i.e., 120 mg/day nectar and 3.6 mg/day pollen). The relative importance of each caste of bee in maintaining hive health was not a factor in the choice of food consumption rates, as adverse effects on any of the castes could potentially affect the hive.

- The **acute estimated daily dose value** is calculated by adding the daily nectar dose [(nectar consumption rate (mg/day) × maximum nectar residue (µg/kg))/ 1.0×10^6] with the daily pollen dose [(pollen consumption rate (mg/day) × maximum pollen residue (µg/kg))/1.0×10^6].
- The **chronic estimated daily dose value** is calculated the same way except using the highest daily mean residues in nectar and pollen.

Acute and chronic risk quotients (RQ) were calculated in accordance with the *Guidance for Assessing Pesticide Risks to Bees* for each bee caste by dividing the estimated daily dose by the corresponding Tier I toxicity endpoint. The RQ value is compared to the corresponding level of concern (LOC) value for either acute (0.4) or chronic (1.0) risk. If one or more of the RQ values exceeds the LOC, risk to honey bee colonies cannot be excluded and a higher tiered risk assessment may be warranted.

Risk to bees was also estimated in registered crops where crop specific residue information was not available by using residues from available relevant crops. All residue data were considered for relevance based on the similarity of the crop type, application rate and application timing to the registered use pattern.

When risks are identified during the Tier I refined risk assessment using individual bee toxicity information and measured pollen and nectar residues, a higher Tier assessment may be conducted considering colony level effects and more realistic exposure scenarios. Higher tier effect studies, such as Tier II semi-field studies (tunnel studies and colony feeding studies) and Tier III field studies are intended to assess potential toxicity using the whole colony. How the higher Tier studies are incorporated into the risk assessment is further discussed below.

Tier II assessment

The Tier II assessment considers Tier II tunnel studies which examine potential effects from specific application methods. The tunnel studies are typically considered worst-case exposures since bees are confined in tunnels with the treated crops, and therefore must forage only on the treated crops. Specific use patterns with and without various risk reduction measures can be studied to determine potential colony effects. A limitation of the tunnel study is that the exposure period must be a relatively short duration (typically two weeks or less) as bees can only be confined for limited periods.

In addition to tunnel studies, the Tier II assessment also considers the effect endpoints from Tier II feeding studies by comparing them to exposure estimates from measured pollen and nectar residues. Complimentary to the tunnel study in which the colony exposure period is limited to a short period, open field feeding studies allow testing of effects over a longer period of time so that potential chronic effects may be investigated.

There are challenges associated with the use of colony feeding studies for characterizing risk; however, the majority of these challenges are expected to result in conservative estimates of risk. These challenges, as described below, should be considered when using colony feeding study effects information and pollen and nectar residue information to characterize risk at the Tier II level.

Challenges in characterizing risk using colony feeding studies:

- *Relevance of single exposure route*
  Typically, effect endpoints for use in the risk assessment from honey bee colony feeding studies are generated from a single exposure route, either from pollen or sugar solution. However, in the field, honey bees forage on both pollen and nectar, thus exposure to residues may occur simultaneously through both pollen and nectar routes for most crops, except for a few crop species that produce only pollen or nectar (for example, corn produces only pollen). The exposure route (pollen or nectar) may affect how residues are distributed among hive food stores (bee bread, honey, royal jelly) thereby affecting which stages of bees may be exposed, and what effects may be observed in the colony. It is unknown how observed effects may be affected when exposure routes are through a combination of both pollen and nectar. The comparison of the residues in pollen or nectar with the effects observed from the respective single exposure route therefore introduces some challenges to the risk assessment.

- *Duration of exposure*
  Duration of exposure in the colony feeding study should be considered in relation to the exposure expected in the field. Colony feeding exposure duration may be compared to the expected blooming period for specific crops. For example, pome fruit and stone fruit typically have a 2–3 week bloom period, whereas other crops such as cucurbits have indeterminate bloom periods and may bloom all season. Also of consideration is that a longer field exposure period may occur when bees forage on multiple crops that have been treated consecutively, or when commercial hives are moved from one crop to another to provide pollination services. In these cases the exposure period could be longer than the flowering period of a single crop.

- *Constant exposure level*
  The detected residues represent a snapshot of residues at a specific time point of sampling. The actual peak of the residues and the dynamics of the residues in plants, including the time period residues remain at a particular level are likely different compared with the effect outcome of the feeding study in which hives were fed with imidacloprid at a consistent level during the entire exposure period.

Tier III assessment

The Tier III assessment considers field study information, which is generally considered to provide the most realistic estimate of exposure and effects. There are, however, also multiple challenges associated with the field study, which are discussed in the *Guidance for Assessing Pesticide Risks to Bees*. The main limitation is that bees may forage on other crop or non-crop forage in addition to the test fields, which can confound results because of exposure dilution or contamination of control groups.

Overall risk characterization

The overall risk characterization uses a weight of evidence approach considering information from all tiers of the risk assessment in addition to any available incident information. Relevance of information to the Canadian use pattern, climate, and bee species are considered, along with the limitations and challenges in interpretation of the assessment.

2.5.2 Risk Characterization

The overall pollinator risk characterization for imidacloprid is presented below based on the tiered risk assessment approach and application method to the crop (foliar, soil and seed treatment). The results of the Tier I default screening assessment for each application method are presented in Appendix VI. Refined Tier I and II risk assessment for each application method are presented in Appendix VII (foliar applications), Appendix VIII (soil applications), Appendix IX (seed treatment applications), and Appendix X (using residues from available hive monitoring studies). Appendix XII further summarizes the overall risk characterization and conclusions for imidacloprid.

2.5.2.1 Foliar applications

2.5.2.1.1 Tier I screening

The Tier I screening level risk assessment was conducted using honey bees (*Apis* bees) as a surrogate based on highly conservative exposure estimations and effect endpoints generated from laboratory studies (Table 1–3, Appendix VI). From the Tier 1 screening assessment, with the exception of larvae that are acutely exposed at the minimum label rate, all foliar uses of imidacloprid pose a risk to bee adults and larvae from both acute and chronic routes of exposure. In addition, the Tier 1 screening indicates that there is a risk from spray drift of foliar uses of imidacloprid to bees. Therefore, a Tier 1 refined assessment was conducted.

2.5.2.1.2 Tier I refined

For the Tier I refined assessment, risk estimates from foliar applications were based on available field residues from pre-bloom sugarmelon, soybean, citrus, cotton and turf (i.e., turf with re-blooming clover); during-bloom cotton, tomato, and turf; post-bloom cherry, apple and stone fruit. Residues from rotational clover grown in fields after foliar application were also available. When residues specific to a registered crop or crop group were not available, all residue data were considered for relevance based on the similarity of the crop type, application rate and application timing to the registered use pattern. Compared with the Canadian label rates for various crops, available residue information was generated at relevant rates for cotton (during bloom), and conservative rates (rates higher than Canadian rates) for cotton (pre-bloom), soybean, sugarmelon, cherry, turf and citrus. In tomato, apple and stone fruit studies, foliar applications were conducted after a soil application, which is expected to represent a conservative exposure scenario for foliar application.

Overall, considering relevant residue information, the Tier I refined risk assessment indicated that there is a potential for acute and or chronic dietary risks to adult bees in all registered bee-attractive crops for pre-bloom, during bloom or post-bloom foliar applications, with the exception of one case for pre-bloom application on soybeans. In the soybean study, the maximum residues were measured from honey bee nectar and hive comb pollen sampled 16 days after the last foliar application at a test rate (2 × 100 g a.i./ha) that was higher than the Canadian label rates (24–49 g a.i./ha, with up to 3 applications). In another similar soybean study, except that sampling was conducted at 26 days after the last foliar application, chronic risk was identified, but not acute risk. No risk is identified for honey bee larvae on an acute exposure basis for any foliar uses (see Appendix VII for details). Therefore, a Tier II risk assessment was further conducted.

The attractiveness of registered crops and level of exposure expected was also taken into consideration in the risk assessment. For the following crops, no potential for risks are expected due to the limited exposure, as the crops are either typically harvested before blooming or they are not attractive to bees. For those crops that are typically harvested before bloom, there is a potential for exposure when they are grown for seed; however, growing for seed is not common in Canada for those crops:

Harvested before blooming:

- CG 1: Root and Tuber Vegetables (Excluding potato and sweet potato)
- CG 2: Leaves of Root and Tuber Vegetables
- CG 4: Leafy Vegetables (except brassica vegetables)
- CG 5: Brassica (Cole) Leafy Vegetables
- CG 19A: Herbs – some herbs are harvested before bloom

Not attractive to bees:

- Christmas trees
- Turf (Sod Farm and Golf Course) [The turf is managed to control flowering weeds that may be attractive to bees.]

2.5.2.1.3 Tier I non-*Apis*

Tier I effects information indicates that individual non-*Apis* bees, specifically bumble bees, have a similar sensitivity to imidacloprid exposure as compared to honey bees on an acute oral basis and bumble bees may be less sensitive than honey bees on an acute contact basis. Therefore, effect endpoints derived from the Tier I honey bee laboratory studies are considered suitable as a surrogate for non-*Apis* bees. Similarly, the results of the Tier I screening and refined risk assessment outlined above for *Apis* bees are considered relevant to non-*Apis* bees.

2.5.2.1.4 Tier II (colony feeding study) refined

The Tier II refined risk assessment considered *Apis* and non-*Apis* colony feeding studies. The critical effect endpoints from nectar or pollen colony feeding studies were compared to measured pollen and nectar residue concentrations and estimated residue concentrations in bee bread. A potential for risk is indicated when pollen or nectar residues levels or estimated residues in bee bread are greater than the effect endpoints from pollen or nectar feeding studies.

Apis* and Non-*Apis

Overall, using the residue from specific test crops, the Tier II refined assessment indicates a potential risk to *Apis* and non-*Apis* bees for all during bloom foliar applications on bee attractive crops. Risks are also identified for all pre-bloom and post-bloom applications, with the exception of pre-bloom application on soybean and in one of the two pre-bloom application studies on sugarmelon. The different outcomes from the two sugarmelon studies indicate a potential for variable risks for bumble bees on sugarmelon. No risk is identified for rotational crops using the representative plant, which was clover. Below is a summary of potential risks (see Appendix VII for details).

For pre-bloom foliar application (residues were available for pre-bloom application to cotton, sugarmelon, soybean, citrus and turf (turf on re-blooming clover); all pre-bloom residue test rates were higher than Canadian rates):

- CG 1: Root and Tuber Vegetables (potato and sweet potato) – A potential for risk was identified for bumble bees and honey bees using cotton as a surrogate, and risk for

bumble bees (not honey bees) using sugarmelon as a surrogate. Minimal potential for risk was identified for pre-bloom application using soybean as a surrogate.

- CG 6: Legume Vegetables – No risk was found for honey bees and bumble bees using representative soybean residues measured 16 day after the last spray application.

- CG 8: Fruiting Vegetables– A potential for risk was identified for bumble bees and honey bees using cotton as a surrogate and risk for bumble bees (not honey bees) using sugarmelon as a surrogate. Minimal potential for risk was identified for pre-bloom application using soybean as a surrogate.

- CG 13A: Small Fruit and Berries-Caneberry,
  CG 13B: Small Fruit and Berries-Bushberry,
  CG 13F: Small Fruit and Berries-Vine, and
  CG 13G: Small Fruit and Berries-Low growing berry – A potential for risk was identified for both honey bees and bumble bees using cotton pre-bloom application as a surrogate. A potential risk for bumble bee was identified using sugarmelon pre-bloom application as a surrogate.

- CG 14: Tree Nuts–A potential for risk was identified for both honey bees and bumble bees using the surrogate crops citrus and cotton.

- CG19: Herbs–A potential for risk was identified for bumble bees and honey bees using cotton as a surrogate and risk for bumble bees (not honey bees) using sugarmelon as a surrogate. Minimal potential for risk was identified for pre-bloom application using soybean as a surrogate.

- No associated crop group: hops, peanut and tobacco – A potential for risk was identified for bumble bees and honey bees using cotton as a surrogate, and risk for bumble bees (not honey bees) using sugarmelon as a surrogate. Minimal potential for risk was identified for pre-bloom application using soybean as a surrogate.

- Turf (other than Sod Farms and Golf Courses) – A potential risk was identified for honey bees and bumble bees based on residues in re-blooming clover in turf.

For post-bloom foliar application, residues were available for cherry, apple, and stone fruit. Cherry was considered for all post-bloom applications and the cherry application rates were higher than Canadian rates. Although the test rates for foliar application to apple and stone fruit were comparable to Canadian rates, it should be noted that these followed a soil application, and the residues resulting from the post-bloom foliar spray for apple and stone fruit could not be separated from those resulting from the soil application. The studies with apple and stone fruit, therefore, presented a conservative scenario and were used for their specific crop groups:

- CG 11: Pome Fruit – A potential for risk for bumble bees was identified using orchard crop (apple) as a surrogate for post-bloom application and using cherry as a surrogate for pre-fruit harvest or post-fruit harvest application. For honey bees, when using cherry as a

surrogate, there is a potential for risks for post-fruit harvest application, and possibly for pre-fruit harvest application. Using apple residue information, a possible risk was also identified for honey bees.

- CG 12: Stone Fruit – A potential for risk was identified for bumble bees using orchard crops (cherry and stone fruit). For honey bees, when using cherry residues, there is a potential for risks for post-fruit harvest application, and possibly for pre-fruit harvest application. Using multiple stone fruit residue information after a combination of uses, potential risks were identified for both bumble bees and honey bees.

- CG 13A: Small Fruit and Berries-Caneberry,
  CG 13B: Small Fruit and Berries-Bushberry,
  CG 13F: Small Fruit and Berries-Vine, and
  CG 13G: Small Fruit and Berries-Low growing berry – There is a potential for risk identified for bumble bees using cherry as a surrogate. For honey bee, when using cherry residues, there is a potential for risks for post-fruit harvest application, and possibly for pre-fruit harvest application.

- CG 14: Tree Nuts – A potential for risk was identified for bumble bees using a surrogate orchard tree crop (cherry). A potential for risk to honey bees was identified for application conducted after fruit harvest, but not post-bloom prior to fruit harvest. Earlier post-bloom application is expected to reduce the risk.

- CG 19: Herbs – Crops in this group can be perennials or annuals. There is potential for exposure from post-bloom application to perennial herb crops if residues are present in pollen and nectar of blooms the following season. A potential for risk was identified for bumble bees using cherry a surrogate crop. There is a negligible potential for exposure from post-bloom application to annual herb crops as crops are harvested at the end of season. No risks to bees are expected for post-bloom application to annual herbs due to the lack of exposure.

- No associated crop group (hops, peanut and tobacco)
  Crops in these groups are typically harvested at the end of season. Hops are a perennial deciduous plant that dies back to the ground each winter. No risks to bees are expected from post-bloom application due to the lack of exposure as no blooms are present and crops are typically harvested at the end of season, and/or plants die back each season.

- Turf (other than Sod Farms and Golf Courses) – A potential for risk was identified for honey bees and bumble bees using residues from a representative crop (re-blooming clover flowers) after foliar application.

2.5.2.1.5 Tier II tunnel studies

Apis

During the preliminary risk assessment, one Tier II tunnel study was available for honey bees from the open literature in which multiple foliar spray application rates were examined with the

maximum of 14 g a.i./ha. Bees were observed during a 4-day exposure period (Schnier et al., 2003). Temporary reduction of foraging activity was observed. After the preliminary risk assessment, two additional Tier II tunnel studies from the registrant demonstrated similar outcomes. Reduced foraging activity of honey bees, but no increased mortality was observed for a spray application during bee-flight at 2.0–14 g a.i./ha. Both increased honey bee mortality and reduced foraging activity were observed for spray applications at 21 and 35 g a.i./ha on flowering plants without direct spray exposure to bees. The increased mortality was observed when flowering plants were treated up to 4 days prior to the exposure to bees.

It is noted that Canadian foliar application rates range from approximately 24–281 g a.i./ha. The minimum Canadian label rate for foliar application is greater than the test rate of 14 g a.i./ha and some Canadian use rates are comparable to the test rate of 21–35 g a.i./ha. In addition, the test rates can be less than or similar to the estimated off-field rates resulting from spray drift. The outcomes of available tunnel studies, therefore, suggest that there is a potential for risk to bees that are exposed to flowering crops treated with imidacloprid foliar application during bloom, and to off-field plants receiving spray-drift during bloom.

Non-*Apis*

During the preliminary risk assessment, one bumble bee tunnel study was reviewed for foliar application on turf. Bumble bee colonies were placed on turf fields and allowed to forage after the fields were treated with a single foliar application of imidacloprid at 336 g a.i./ha. After application, the test fields were either irrigated or not irrigated immediately after the pesticide was applied. The test turf fields were covered by white clover flowers at 25 to 50%. No effects (up to 30 days) were observed for the foliar application immediately followed by irrigation, whereas effects were observed for foliar application without irrigation. Foliar application on turf is registered in Canada at 281 g a.i./ha, slightly lower than the test rate, and requires rainfall or irrigation after the application. The study suggests that no risks are expected for bumble bees from the Canadian foliar application on turf.

After the preliminary assessment, one additional bumble bee tunnel study was reviewed for imidacloprid foliar applications on tomato. After 6 weeks of exposure to flowering tomato that had been sprayed with imidacloprid at 15 g a.i./ha, reduced fruit setting of the plants and reduced sugar water consumption of the colonies were reported. However, there were no significant effects in the bumble bee colonies in any measured colony parameters, including lifespan of the colony, number of larvae and pupae and hive weight. Since the test rate is much lower than any Canadian labelled rates, the study is considered to have less weight in the overall consideration of the potential for risk for bumble bees for foliar applications.

2.5.2.1.6 Tier III field studies

Apis

No field studies with foliar applications of imidacloprid were available for review for *Apis* bees.

Non-*Apis*

No field studies with foliar applications of imidacloprid were available for review for non-*Apis* bees.

2.5.2.1.7 Summary of incident reports

Incident reports related to spray applications of imidacloprid have been reported in Canada and the United States. In Canada, one bee mortality incident was reported after spraying of imidacloprid in an orchard in British Columbia. In the United States, there were 12 reported incidents associated with crops including orange trees, cotton, soybean, holly trees and linden trees. In two of the incidents, imidacloprid was applied during bloom of citrus and linden trees. For the remaining spray incidents, it is uncertain if the application occurred during the bloom period and whether bees were actively foraging on these crops during the application. Foliar spray applications made while bees are foraging on crops or nearby plants may result in direct contact exposure and are more likely to cause bee mortalities.

2.5.2.2 Soil applications

2.5.2.2.1 Tier I screening

The Tier I screening level risk assessment was conducted using honey bees (*Apis* bees) as surrogate based on highly conservative exposure estimations and effect endpoints generated from laboratory studies. All soil uses of imidacloprid pose a risk to adult bees from both acute and chronic exposures and to larvae from chronic exposure at the maximum label rate (Appendix VI). Therefore, a Tier I refined assessment was conducted.

2.5.2.2.2 Tier I refined

Refined risk estimates for soil applications were based on available field residues from studies on potato, tomato, cucurbits (sugarmelon, melon, pumpkin, squash), blueberry (post-bloom), strawberry, stone fruit (cherry, plum, apricot and peach), apple, citrus, cotton, and turf, as well as non-target plants off-field, and rotational crops following soil applications. Compared with Canadian labelled soil rates, the test rates included rates relevant to Canadian uses, with some exceptions. It is noted that the following three studies included soil application combined with foliar applications: two studies (one apple study, and one stone fruit study) were conducted with a combination of post-bloom soil application and foliar application; one cotton study was conducted with a combination of pre-bloom soil application and during bloom foliar application. Residues resulting from soil application only could not be distinguished from those from other types of applications in these three studies.

When residues specific to a registered crop were not available, all residue data were considered for relevance based on the similarity of the crop type, application rate and application timing to the registered use pattern. The attractiveness of registered crops and level of exposure expected was also taken into consideration in the risk assessment.

The results of the refined risk assessment for soil applications using residue values from residue information are presented in Appendix VIII.

Overall, the Tier I refined assessment indicates a potential for risk from soil applications for all tested crops, including rotational crops and off-field non-target forage plants, with the exception of residues from potato and some of the studies of pumpkin, strawberry and melon. For potato, the residues in potato pollen were likely underestimated. The measured pollen samples were collected by free-flying bumble bees in two effect field studies with a test rate (180 g a.i./ha) that was less than half of the maximum Canadian label rate (480 g a.i./ha). For pumpkin where no risk was identified, the test rate was much lower than the maximum Canadian label rate and potential risk was identified using the other four relevant pumpkin studies. For strawberry and melon, no risk was found in some studies on medium-textured soil types, but risk was identified for other soil types. In addition, the interval between the treatment and sampling dates was either not specified or was long (199 days). Therefore, risks for pumpkin, strawberry and melon could not be excluded at the Tier 1 refined assessment based on the residue information.

For rotational crops and wildflowers located off the field , no risks were identified using residues in rotational crops of phacelia, mustard or corn, but a chronic risk to adult forager bees was identified using residues in clover grown in and outside of potato fields previously treated with soil application of imidacloprid.

For soil applications, the attractiveness of registered crops and level of exposure expected was also taken into consideration in the risk assessment. For the following crops, no potential for risks are expected due to the limited exposure, as the crops are either typically harvested before blooming or they are not attractive to bees. For those crops that are typically harvested before bloom, there is a potential for exposure when they are grown for seed; however, growing for seed is not common in Canada for those crops:

Harvested before blooming:

- CG 1: Root and Tuber Vegetables (Excluding potato and sweet potato)
- CG 2: Leaves of Root and Tuber Vegetables
- CG 4: Leafy Vegetables (except brassica vegetables)
- CG 5: Brassica (Cole) Leafy Vegetables
- CG19A: Herbs – some herbs are harvested before bloom

Not attractive to bees:

- Turf (Sod Farms and Golf Courses) [The turf is managed to control flowering weeds that may be attractive to bees.]
- Certain ornamentals:
  - Coniferous evergreen ornamentals (pine, fir, juniper, spruce, arborvitae, hemlock, cypress, yew, live Christmas trees)
  - Ornamental grasses
  - Greenhouse grown cut flowers

2.5.2.2.3 Tier I non-*Apis*

Tier I effects information indicates that individual non-*Apis* bees, specifically bumble bees, have a similar sensitivity to imidacloprid exposure as compared to honey bees on an acute oral basis and bumble bees may be less sensitive than honey bees on an acute contact basis. Therefore, the effect endpoints derived from the Tier I honey bee laboratory studies are considered suitable as a surrogate for non-*Apis* bees. Similarly, the results of the Tier I screening and refined risk assessment outlined above for *Apis* bees are considered relevant to non-*Apis* bees.

2.5.2.2.4 Tier II (colony feeding study) refined

Apis and Non-Apis

The Tier II refined risk assessment considered *Apis* and non-*Apis* colony feeding studies. The critical effect endpoints from nectar or pollen colony feeding studies were compared to measured pollen and nectar residue concentrations and estimated residue concentrations in bee bread. A potential for risk is indicated when pollen or nectar residue levels or estimated residues in bee bread are greater than the effect endpoints from pollen or nectar feeding studies.

Overall, the Tier II refined risk assessment indicates that there is a potential for risks to the colonies of honey bees and bumble bees for a number of soil applications for various crops/crop groups. Minimal potential for risk is expected to bees foraging on fields that were treated the previous year with soil application of imidacloprid. Below is a summary of potential risk (see Appendix VIII for details).

- CG 1: potato and sweet potato – No risks were identified using residues in representative crop (potato) pollen collected by free-flying bumble bees. However, the study contains limitations, primarily that the test rate used in the study was low.
- CG 6: Legume vegetables – A potential for risk was identified for bumble bees in almost all test scenarios and for honey bees in some cases using residues from surrogate crops of tomato, melon, pumpkin, strawberry, and cotton.
- CG 8: Fruiting Vegetables – Using residues from representative crop tomato, a potential for risk was identified for both honey bee and bumble bee colonies.
- CG 9: Cucurbit Vegetables – There is a potential for risk for bumble bees using residue data from multiple representative crops: melon, sugarmelon, pumpkins and squash. While a potential for risk was identified in most cases, risk was not identified using mean residue data from a Tier III field effect study on pumpkin, or from a pumpkin residue study where the treatment rate was low (30 g a.i./ha), or from two of the four sugarmelon studies in which the test rate was 210 g a.i./ha. Risks for bumble bee colonies were identified in all other studies in which the test rates ranged between 202 to 422 g a.i./ha. A possible risk for honey bee from pollen was identified using pumpkin studies in which the test rates ranged between 211 to 422 g a.i./ha with transplant water, but not from any other available cucurbit studies (melon, sugarmelon, squash ranging from 210 – 411 g a.i./ha). Overall, considering the Canadian label rate of 100–400 g a.i./ha, it appears that the Tier II refined risk assessment indicates there is a potential for risk for bumble bees, and variable risk for honey bees for uses on CG9.

- CG 13A: Small fruit and berries-Caneberry,
  CG 13B: Small fruit and berries-Bushberry,
  CG13F: Berry and small fruit vine including grapes, and
  CG 13G: Small fruit and berries-Low growing berry (strawberry) – Using residues from strawberry, there is a potential for risks for bumble bees and for honey bees for crops grown in treated coarse soil, but not in medium-textured soil. Using residues from blueberry applied post-bloom and post-harvest, a potential for risks was identified for bumble bees but not for honey bees the following bloom season.
- CG 19A: Herbs, and
  No associated crop group (peanut and tobacco) – A potential for risk was identified for bumble bees under almost all test conditions, and there is a risk for honey bee in some cases using residues in surrogate crop of tomato, melon, pumpkin, strawberry, and cotton.
- Ornamentals – A potential for risk was identified for honey bees using monitoring residue data in plants purchased directly from retail stores, and risk for bumble bees from plants purchased directly from retail stores and that re-bloomed after the plants were transplanted in the field.
- Turf (other than sod farms and golf courses) – There is a potential for risk using residues in clover after foliar application and in re-bloomed clover grown in the turf field. No specific residue information was available for turf for soil application.
- Rotational crop and wildflowers located off the field. – No risk is identified using residues from representative rotational crops of clover, phacelia, mustard or corn, and wildflowers located off the field.

2.5.2.2.5 Tier II tunnel studies

Apis

No valid Tier II tunnel study for soil application was reviewed during the preliminary risk assessment. One tunnel study became available for soil applications for honey bees and was reviewed after the preliminary assessment. The study provided evidence that there were potential short-term effects to honey bees foraging on potted ornamental plants treated with imidacloprid soil applications during blooming period at a comparable Canadian label rate. The risk might be positively related to the portion of treated flowers in a foraging area. The potential short-term adverse effects might include slight increase of bee mortality and reduction of foraging activity.

Non-*Apis*

During the preliminary risk assessment, one bumble bee tunnel study was reviewed for granular soil application on turf fields. Overall, no effects (up to 30 days) were observed on bumble bee colonies foraging on the turf fields that were treated with imidacloprid soil application at 448 g a.i./ha immediately followed by irrigation. The treated turf fields were covered with 25 to 50% of white clover. The Canadian use pattern has a similar soil turf application at a lower rate of 280 g a.i./ha and requires rainfall or irrigation after application. Based on this tunnel-study information, effects to bees are not expected for the Canadian soil application on turf with restriction for follow-up irrigation, which is required by the current label.

After the preliminary risk assessment, two additional tunnel studies for soil application became available for bumble bees. Both studies were conducted on potted ornamental plants using rates comparable to Canadian label rate. Short-term adverse effects on bumble bees, including increase of bee mortality and reduction of foraging activities, were observed during 14 days of the exposure in tents after either pre-bloom or during-bloom soil applications. In addition, both studies indicated that the adverse effects might be positively related to the portion of flowers being treated in the foraging area. Results of these studies indicate that there are potential short-term effects to bumble bees for imidacloprid soil application at the Canadian labelled rates during either pre-flowering period or during-flowering period, on potted ornamental plants that bumble bees may forage on.

2.5.2.2.6 Tier III field studies

There were no valid Tier III effect studies available for soil applications during the preliminary risk assessment. After the preliminary assessment, seven Tier III field studies from the registrant became available for soil applications. Five of the studies were tested in Germany for *Bombus terrestris* (two in potato fields and three on ornamental plants). The other two studies were conducted in the United States with honey bees in cotton fields, and with honey bees and bumble bees *(B. impatiens*) in pumpkin fields during 2015–2016.

During the assessment, results from the Tier III field studies were not extrapolated for other crop groups due to their specific study design, and application pattern. Cotton is not grown in Canada. This study was not directly used in the Tier III risk assessment, but it was considered as an additional line of evidence in the overall risk assessment.

Apis

Pumpkin: No treatment-related effects were observed for honey bee colonies placed in flowering pumpkin fields that were treated with imidacloprid soil application at 0.43 kg a.i./ha at the six true leaf stage. Effects were measured for 6 weeks starting 26 days after the treatment, including honey bee colony condition, hive weight, overwintering colony survival, and queen condition. The study had limitations, which included background contamination from other pesticides. Imidacloprid contamination was also detected in the plants and hive matrices in the control during the entire study period.

Cotton: Honey bee hives placed in the cotton field treated with imidacloprid at various application methods and rates ranging from 0.07–0.50 kg a.i./ha showed no observed adverse effects in terms of the number of adults, brood cells and bee bread cells, hive weight gains and queen supersedure. In this study, hives were exposed to the treated cotton field for six weeks starting 18–30 days after the last application of imidacloprid. However, compared with the control, the hive mortality was higher in the treatment after overwintering by the end of study, indicating potential effects on the hive overall survival after overwintering. There were multiple limitations related to the study, including high background contamination of other pesticides, contamination of imidacloprid itself during the entire study period (detected in both plant and hive matrices), variation of treatment methods and rates and interval between the last application and initiation of exposure, and low number of replicates.

Cotton is not grown in Canada. This study was not directly used in the Tier III risk assessment, but was considered as additional line of evidence for overall risk assessment. The results may suggest that there is a potential for long-term effects on honey bees when the level of exposure to imidacloprid becomes severe in the field.

Outdoor ornamental shrub: Two field studies were conducted for soil application at 1.29–5.2 g/shrub on outdoor ornamental plants with both honey bees and bumble bees. A high level of imidacloprid residues was detected in the blossom of treated plants (maximum of 5.01 mg imidacloprid/kg blossom) for a long period of time (the longest sampling period up to 117 DAT). One study reported no mortality or behavioural abnormalities for foraging bumble bees and honey bees at individual level without any examination on colony conditions. In the second study, colonies of honey bees and bumble bees were consecutively exposed to two different flowering ornamental plants (*Rhododendron* followed with *Hibiscus*). The number of individual dead bees (both honey bees and bumble bees) was greater in the treatment than in the control, and high concentration of imidacloprid residues were detected in almost all dead bees found in the treatment field, with the maximum of 1.663 mg/kg bee, likely indicating there was a treatment related cause-effect relationship. Imidacloprid was also detected in dead bees found from the control sites, indicating contamination to the control bees. In the second study, colony conditions were also measured at the beginning and at the end of the study, and no differences were detected for honey bee colonies between the treatment and control. However, all bumble bee colonies (both in control and treatment) completely died 8 weeks after the end of study (estimated to be at the end of July to early of August), although the colonies had shown normal foraging at 4 weeks after the start of exposure. While the cause of the complete bumble colony death is unknown, it is possible that the bumble bee colony health was compromised by the treatment in both treatment and control. High levels of imidacloprid residues detected in dead bees in both treatment and control sites indicated that there was exposure to bees in the treatment, as well as in the control. There are limitations associated with the two studies. The test rates were greater than the Canadian labelled rates for outdoor ornamentals. In addition, the test plots were very small (18 plants) and closely located. Test bees could have foraged between the treatment and control plots, resulting in contamination of the control. Exposure dilution to test plants likely occurred for honey bees and bumble bees through foraging on untreated test plants and alternative untreated flowering plants artificially placed in the test site.

Overall, the available studies provided evidence that under the study conditions soil application on outdoor ornamentals may result in high concentrations of imidacloprid residues in blossoms. The treatment may cause mortality of bumble bees and honey bees at individual level. However, there likely are no effects for honey bees at the colony level. It may be possible that the treatment compromises bumble bee colony health, although given the outlined limitations of the available studies, the effects of imidacloprid on bumble colony health under field conditions of use are not definitive.

Non-*Apis*

Pumpkin and cotton: The pumpkin field effect study for soil application that was described above also tested with bumble bees. It was not possible to make any determinations regarding the effects on bumble bee colonies as all bumble bee colonies performed very poorly in both control

and imidacloprid-treated sites and no detailed effect data were provided for bumble bees. The cotton field effect study that was described above did not test bumble bees. However, in both pumpkin and cotton studies, non-*Apis* bees were examined in terms of species richness and abundance and no treatment-related effects were observed in either study.

Potato: In two studies, in-furrow soil application at 180 g a.i./ha on potato resulted in low levels of imidacloprid in pollen carried by bumble bee foragers. No adverse effects to bumble bee colonies were detected. Based on the result of this study, it was considered to be reasonable to extrapolate that there is also no potential for risk for honey bees at the test rate on potato, since the honey bee is less attracted to potato. In addition, the honey bee is less sensitive to imidacloprid than bumble bees at the colony level, based on the toxicity information from available colony feeding studies. However, there is a limitation because the test rate in the study (180 g a.i./ha) did encompass some Canadian use rates but was lower than the maximum Canadian rate (100–480 g a.i./ha).

Potted ornamentals: Increased bumble bee mortality was observed in field gardens containing potted ornamental plants in which soil was treated with imidacloprid at 0.015 g a.i./L soil. The detected mortality increase was slight but prevalent, across almost half of the 17 test gardens. The test rate is comparable to the Canadian label rate for potted ornamentals.

Outdoor ornamental shrub: Bumble bees were tested in the same studies in outdoor ornamental shrubs as described above in *Apis* section. See above for details.

2.5.2.2.7 Summary of incident reports

Incident reports related to soil applications of imidacloprid have been reported in Canada and the United States. Two incidents were reported in Canada. One of them reported that dead bumble bees were found around potted lobelia plants in Saskatchewan that had been recently purchased, and that imidacloprid, among other pesticides, was detected in the plants and soil. Another incident was on ornamental linden trees that had been treated with an imidacloprid soil injection. This incident occurred in the United States, but was reported to both Canada and the United States. In the United States, 11 incidents were reported and were associated with various crops (watermelons, orange and citrus trees, linden trees, rose bushes, sweet pepper bushes and gardens). Aside from one incident in which the application occurred just as the trees were blooming, the timing of application is either known to occur prior to bloom or unclear from the information available in the database.

2.5.2.3 Seed treatment

2.5.2.3.1 Tier I screening

The Tier I screening level risk assessment was conducted using honey bees (*Apis* bees) as surrogate for all bees based on highly conservative exposure estimations and effect endpoints generated from laboratory studies. The Tier I screening assessment indicated that all seed treatment applications of imidacloprid pose a risk to adult bees from both acute and chronic exposures, and pose a risk to larvae from chronic exposure route (Appendix VI). Therefore, a Tier 1 refined assessment was conducted.

2.5.2.3.2 Tier I refined

The refined risk assessment used residue information from rapeseed, canola, corn, sweet pepper, melon and soybeans. In addition, residue information from rotational crops, including clover, winter oilseed rape, Phacelia, and corn, were available to assess risks from carryover. Also, residue information was available from wildflowers adjacent to fields planted with cotton and soybean treated seed. Most of these studies were conducted at rates comparable to Canadian label rates, except for corn which was conducted at higher test rates. When residues specific to a registered crop were not available, all residue data were considered for relevance based on the similarity of the crop type, application rate and application timing to the registered use pattern.

Overall, the Tier I refined risk assessment using available pollen and nectar residues indicated that there is a potential for acute risk to honey bees from seed treatment for melon and from one of two wildflower studies near cotton and soybean seed treatment fields. There is a potential for chronic risk for canola, soybean, corn, melon, rotational crops, and one of two wildflower studies near cotton and soybean fields. The risk for melon and wildflowers adjacent to planted fields is considered to be overestimated as residues in pollen and nectar were not available and whole flowers were used as surrogates for pollen and nectar in these two studies. See Appendix IX for details in the Tier I risk estimation for seed treatment.

The potential for exposure through consumption of pollen and nectar was considered for seed treatments on a crop basis. Negligible potential for risks is expected for the following crops due to the limited exposure, as they are either typically harvested before blooming or rarely foraged by bees. For those crops that are typically harvested before bloom, there is a potential for exposure when they are grown for seed; however, these crops are not typically grown for seed in Canada.

Harvested before blooming:

- CG 1: Root and Tuber Vegetables (Excluding potato and sweet potato)
- CG 3: Bulb vegetables
- CG 4: Leafy Vegetables (except brassica vegetables)
- CG 5: Brassica (Cole) Leafy Vegetables

Not attractive to bees:

- CG 15: Cereal Grains (wheat, barley, rye)

2.5.2.3.3 Tier I non-*Apis*

Tier I effects information indicates that individual non-*Apis* bees, specifically bumble bees, have a similar sensitivity to imidacloprid exposure as compared to honey bees on an acute oral basis and bumble bees may be less sensitive than honey bees on an acute contact basis. Therefore, the effect endpoints derived from the Tier I honey bee laboratory studies are considered suitable as a surrogate for non-*Apis* bees. Similarly, the results of the Tier I screening and refined risk assessment outlined above for *Apis* bees are considered relevant to non-*Apis* bees.

2.5.2.3.4 Tier II (colony feeding study) refined

Apis and* Non-*Apis

The Tier II refined risk assessment considered *Apis* and non-*Apis* colony feeding studies. The critical effect endpoints from nectar or pollen colony feeding studies were compared to measured pollen and nectar residue concentrations and estimated residue concentrations in bee bread. A potential for risk is indicated when pollen or nectar residue levels or estimated residues in bee bread are greater than the effect endpoints from pollen or nectar feeding studies.

Overall, the Tier II refined risk assessment indicates that there is a minimal potential for risk for honey bee colonies for imidacloprid seed treatment on bee attractive crops. Risks for honey bee colonies for wildflowers adjacent to planted fields was identified from one of two wildflower studies, but the risk is likely overestimated as the residues in pollen and nectar of the wildflowers were not available and the whole flower was used as surrogate for pollen and nectar. Using the same residue information for seed treatment, there is a potential for risk for bumble bee colonies for seed treatment on canola, some studies with corn, melon, and one of two wildflower studies. Again, the risks for melon and wildflowers are likely overestimated because of the use of residues in whole flower, instead of pollen and nectar. For corn, the studies were conducted at rates greater than the maximum Canadian rate, and the risk is likely overestimated.

Below is a summary of the potential risk (see Appendix IX for details).

- CG 1: Potato. No potential for risks determined at T1 refined and T2 refined using residues from potato after soil application as surrogate.

- CG 6: Legume vegetables. Potential for risk is not identified for honey bees and bumble bees using residues from representative crop, soybean.

- CG 8: Fruiting Vegetables. Potential for risk is not identified for honey bees and bumble bees using residues from representative crop, sweet pepper. The residues were measured from flowers instead of from pollen and nectar, which likely represent conservative residue information for risk assessment.

- CG 9: Cucurbit Vegetables. Potential risks for bumble bees, but not honey bees using residues from representative crop, melon. However, this risk is likely overestimated by using the residues in whole flower (not pollen and nectar) and the residues in hive pollen and nectar were < LOQ (1 ppb), indicating no risk.

- CG 15: Cereal Grains (corn). Potential for risk is identified using residue from representative crop, corn, in 1 out of 3 test scenarios for honey bee colonies, and 2 out of 3 test scenarios for bumble bee colonies. No risk was found using the study tested at 1.0 mg/seed. The test application rates were 1.0–1.3 mg/seed, all of which were greater than the maximum Canadian rate, 0.63 mg/seed. The identified potential risk is expected to be overestimated.

- CG 20: Oilseeds. Potential risks for bumble bee colony but not honey bee colonies using peak maximum residues from representative crop, canola. The maximum residue was used as mean for the chronic risk assessment as only one sample was measured per time period. The peak maximum residue is only slightly greater than the effect endpoint for bumble bee colonies. In addition, the peak residue concentration was reduced after one week to a maximum of 4.4 ppb, indicating minimal potential of chronic risks to bumble bee colonies.

- Rotational crops and wildflower. No potential for risk is determined for honey bee and bumble bee colonies using residues from representative rotational crops, clover, oilseed rape, phacelia, and maize. Potential for risk was found for honey bee and bumble bees using residues from one of the two wildflower studies adjacent to planted fields; however, the risk is likely overestimated as the residues in pollen and nectar of the wildflowers were not available, and the whole flower was used as surrogate for pollen and nectar. No risk was identified for bumble bees or honey bees in the other wildflower study, with wildflowers adjacent to the same type of planted fields.

2.5.2.3.5 Tier II tunnel studies

Apis

During the preliminary risk assessment, a number of Tier II tunnel studies were reviewed for potential effects that may result from seed treatments (14 studies, 11 from the registrant and three published studies). Test crops examined included summer rape, winter rape, canola, sunflower, and field bean. All available studies were conducted with an exposure period of 14 days or less at rates of 34.7 to 89.2 g a.i./ha, or 4 to 21 g a.i./kg seed. These tested seed treatment rates are in the range of registered rates in Canada for canola, mustard, corn, oats, barley, and wheat but are lower than the registered rates for soybeans, faba bean, lentils, chickpeas, field peas, various beans, and potato.

In general, no overall effects were observed on any of the measured parameters in the majority of seed treatment studies. However, two studies conducted on winter rape reported short-term effects, which either were minor and likely not treatment-related, or returned to control levels shortly after the removal from exposure. All seed treatment tunnel studies were conducted with a short exposure duration and a short observation period (up to 30 days). These studies are not expected to address the long-term sublethal effects that may result from a potential for chronic exposure. It is also noted that most of these studies did not have treatment replicates and used small hives. However, each individual study is expected to contribute to a weight of evidence conclusion of the potential effect of imidacloprid seed treatments.

No additional tunnel studies were available for honey bees after the preliminary risk assessment.

Based on the available tunnel studies for honey bees, potential long-term sublethal effects that may result from chronic exposure due to seed treatment is not fully addressed. This gap was addressed together with the outcome of colony feeding studies and all available residue information, and higher Tier III studies.

Non-*Apis*

One tunnel study (Tasei et al., 1999, the same as PMRA 2142738) was reviewed for the effect of seed treatment of sunflower on bumble bees. The study also has a Tier III component which will be considered in the Tier III assessment. The study indicated that there were no differences between the number of workers visiting and the duration of each individual visit to blooming sunflower heads between the control and treated plants in pots placed in a greenhouse. However, there are uncertainties associated with the study including lack of study replicates, and measurement of residue levels in plant pollen and nectar. In addition, the greenhouse compartment contained only 3 rows of 16 pots.

2.5.2.3.6 Tier III field studies

Apis

Multiple Tier III field studies were available and demonstrated a lack of long-term effects for seed treatment in the field.

All of the Tier III field studies were reviewed during the preliminary assessment. These studies were conducted on sunflower, spring canola, oilseed rape, field beans, winter oilseed rape, spring oilseed rape and maize. Five of them also examined long-term effects either close to the overwintering period or all the way through the end of the overwintering. No long-term effects were reported in any of the studies. Out of 12 field studies, a transitory effect was reported for honey bees in two studies conducted for the seed treatment on sunflower, but not on any other crops.

There are limitations on the relevance of these studies to Canadian use patterns. Most of the studies were not conducted in Canada, therefore overwintering and other field conditions may be different. In addition, high levels of contamination of other pesticides were detected in test hives in some of the field studies. These contaminations likely complicated the detection of treatment effects in the field.

No additional Tier III field studies for seed treatment were available after the preliminary assessment.

Non-*Apis*

During the preliminary assessment, a seed treatment Tier III field study was available for non-*Apis* bees, *B. terrestris*. Seed treatment on sunflowers grown in the field at 0.7 mg a.i./seed showed no effects to bumble bee colonies after 26 days including a 9-day exposure period. During exposure, there was no significant difference in the number of marked worker bees that were lost and did not return to the colonies from the treated fields (33.5%) compared to the control (23.1%). After the 9-day exposure period, colonies were placed in a laboratory for an additional 17 days; no treatment-related differences were seen in the growth rate, or worker and queen production. Based on identification of bee collected pollen, it was confirmed that bees were foraging on sunflower.

The Canadian use pattern does not include sunflower seed treatment; however, this study suggests that effects on bumble bees are not expected from seed treatments that are expected to result in similar pollen and nectar exposure levels. No pollen or nectar residue levels were measured in this study; however, residue levels in sunflower pollen and nectar treated at the same rate as that used in this study are summarized in the residue section.

2.5.2.3.7 Summary of incident reports

The PMRA has not received any incident reports suspected to be associated with imidacloprid treated seeds. The USEPA EIIS database contains 7 reports with a suspected link to seeds treated with imidacloprid. One of the incident reports showed a suspected link to treated corn seed; however, information resulted in the USEPA determining that it was unlikely that imidacloprid contributed to this incident. Incidents with seed treatments have primarily been associated with dust generated during planting of treated seeds. Dust generated from planting of neonicotinoid treated corn and soy seed was previously identified as a concern in Canada, and risk reduction measures were put in place in 2014 to reduce exposure to dust during planting of treated corn and soy seed which includes those treated with imidacloprid. The number of incident reports suspected to be associated with imidacloprid treated seeds is significantly lower than those reported for other neonicotinoids, likely because corn and soybean seeds in Canada are not typically treated with imidacloprid, but rather with other neonicotinoids.

2.5.3 Risk assessment using monitoring data

Available residue information from monitoring studies were compared with the endpoints determined from Tier I studies and Tier II colony feeding studies. While this data may not link to specific uses patterns, it is expected to provide some evidence of the potential risks in the test areas which can be compared to areas where similar uses are expected.

Monitoring data are available for ornamental plants that were purchased from retail stores, and from hives that were located in urban and suburban areas in the United States, as well as agricultural areas. Details of the comparison are shown in Appendix X. A potential for acute or chronic risks is identified at Tier I using all available monitoring data. At Tier II, a potential for risks for bumble bees was identified with data from ornamental plants, but was not identified using residues in hives located in urban and suburban areas. A potential for risks was also identified for honey bees at Tier II level for the ornamental plants purchased directly from retail stores, but not from plants that have been planted and re-bloomed after purchasing. No potential for risks is identified at Tier II refined assessment using residues in pollen and nectar collected from hives that were placed in the fields with corn seed treatment, or in agricultural areas where the main honey type was sunflower, canola, chestnut, and local mixed flower honey, or in urban and suburban areas in United States.

2.5.4 Water assessment

In addition to exposure through pollen and nectar, bees may be exposed to imidacloprid and its transformation products through contaminated water sources such as surface water, puddles, dew droplet formation on leaves and guttation fluids following foliar, soil and seed treatment

applications. The North American *Guidance for Assessing Pesticide Risks to Bees* does not include a method for assessing the potential risk to bees from exposure through water, as it is not considered to be a primary exposure route. However, as some Canadian beekeepers and researchers have raised potential concerns around exposure to neonicotinoids through water sources used by honey bees, the exposure route was explored.

A Tier I risk assessment approach similar to that described above for pollen and nectar was followed, using available monitoring data of surface water sources that may be used by bees, as well as residues measured in plant guttation fluid. Based on available relevant surface water monitoring data, the assessment indicated that no risks are expected to bees consuming surface water in the area treated with imidacloprid. Conversely, the Tier I assessment for guttation fluid showed that both acute and chronic risks to adult and larval bees may be indicated for bees exposed to contaminated guttation fluid from treated plants, but no risks to bees were indicated after exposure to guttation liquid from rotational crops following soil and seed treatment applications. Higher tier effects studies indicate that exposure to high levels of imidacloprid in guttation fluid may have a transitory increase in individual adult forager bee mortality; however, bees were not typically observed using guttation fluid as a water source which indicates limited exposure from this route. No adverse effects on colony and brood development were observed following exposure to contaminated guttation fluid in available higher tier studies. Overall, negligible risk is expected for bees from surface water or plant guttation liquid in areas that are treated with imidacloprid based on the information available to date (Appendix XI).

3.0 Value

3.1 Value of Imidacloprid

Imidacloprid will control a broad spectrum of insect pests on a diverse range of agricultural crops, ornamentals and turf. For some crops it is the only insecticide registered to manage specific insect pests or is one of a limited number of alternatives, and therefore it is considered to be a valuable tool for resistance management.

Imidacloprid is a systemic insecticide which is absorbed and transported throughout the plant, thereby protecting the whole plant. It can be applied as a seed treatment, soil drench or foliar application which provides growers flexibility to target specific life cycle stages of insect pests.

Imidacloprid is registered as a single-active in several end-use products, or as a co-formulation with other insecticide or fungicide active ingredients. This allows growers flexibility to use the solo products that target specific pests under limited pest pressures or narrow pest spectrums, or when necessary as a co-formulated product that further broadens the insect and disease spectrum, such as in seed treatments.

In 2016, PMRA published a value assessment of the use of clothianidin, imidacloprid and thiamethoxam as a corn and soybean seed treatment (Re-evaluation Note REV2016-03: Value Assessment of Corn and Soybean Seed Treatment Use of Clothianidin, Imidacloprid and Thiamethoxam). This document was available for public consultation in early 2016. Comments and responses are summarized in Appendix XIV.

As of 2013, virtually all field corn planted in Canada was treated with either thiamethoxam or clothianidin and greater than half the soybean seeds planted in Canada were treated with thiamethoxam. There was very little reported use of imidacloprid on corn or soybean seed in Canada. As a result the REV2016-03 focused on clothianidin and thiamethoxam. With respect to agricultural practice, it was found that clothianidin and thiamethoxam seed treatments contribute to insect pest management in agriculture in Canada.

4.0 Conclusion

4.1 Overall Risk Characterization

Available information considered in the risk assessment includes: effects on individual bees, residue information, higher tier colony feeding studies, tunnel studies and field studies, available monitoring and incident reports. Effects information is available for honey bees and non-Apis bees, primarily bumble bees. All available information is considered for each crop and application method. Crop attractiveness to bees and crop harvest timing are also considered in the risk assessment and determination of risk mitigation. More restrictive mitigation is proposed for crops with higher potential for exposure.

Based on the risk assessment for imidacloprid and considering the pollinator exposure potential in each crop/crop group, the following risk characterizations are made for each registered use.

Overall risk assessment conclusions are also summarized in Appendix XII along with additional information.

4.1.1 Foliar Applications

Some residue studies were available for foliar application for use in the risk assessment. Compared with the Canadian label uses, the residue information was generated at comparable rates for cotton (during bloom), and conservative rates (higher rates than Canadian rates) for other crops (pre-bloom: cotton, sugarmelon, soybean, citrus, turf (turf on re-blooming clover); during bloom: cotton, tomato, turf; post-bloom: cherry, apple, stone fruit). Higher tier tunnel and field studies were also available for some crops for honey bees and bumble bees.

Overall, there is a risk for all during bloom foliar applications on bee attractive crops (exception: turf with pollinator attractive flowering weeds (e.g. clover) with the restriction that application must be followed with irrigation). There is also a potential for off-field risk to bees resulting from spray drift onto flowering plants. There is a variable risk profile for other uses (pre-bloom application; post-bloom application for perennial crops) as described in more detail in the following section.

(i) For the following crop groups (CGs), there is negligible risk from foliar application due to limited exposure, as they are either harvested before blooming or they are not attractive to bees. For those crops that are typically harvested before bloom, there is a potential for exposure when they are grown for seed; however, these crops are not typically grown for seed in Canada. A negligible risk is also expected for post-bloom foliar application on

annual crops, because flowers are no longer present and the crops are harvested at end of season:

Harvested before blooming

- CG 1 Root and Tuber Vegetables (Excluding potato and sweet potato)
- CG 2 Leaves of Root and Tuber Vegetables
- CG 4 Leafy Vegetables (except brassica vegetables)
- CG 5 Brassica (Cole) Leafy Vegetables
- CG 19A Herbs (some herbs are harvested before bloom)

Not attractive to bees

- Christmas trees
- Turf (Sod Farms and Golf Courses) [managed to control flowering weeds]

Post-bloom application to annual crops

- CG1 Root and Tuber Vegetables: potato and sweet potato
- CG6 Legume Vegetables
- CG8 Fruiting Vegetables
- CG 19A Herbs (some herbs are annuals)
- No associated CG: peanut, tobacco

(ii) For the following crops, minimal potential for risk to bees is indicated based on the risk assessment, including Tier I refined and Tier II refined assessments with Canadian-relevant residue information and Tier II tunnel studies.

- **Rotational crops following foliar application the preceding year**: Risk characterization was based on Tier II colony feeding study effects endpoints compared with residue levels in pollen and nectar from rotational crop clover grown in fields after foliar applications.
- **Turf (municipal, industrial and residential turf sites)** where clover or other flowering plants that are attractive to bees are present: Label requires that applications are followed by irrigation, and currently allows applications when bees are not visiting the treatment area. Potential for risk was indicated when comparing Tier I and Tier II effect endpoints to residue information on blooming clover in turf or re-blooming clover following irrigation and mowing in turf. However, Tier II tunnel studies indicated that there are no effects on bumble bees when application is followed with irrigation, but that there were effects without follow-up irrigation. Residue and tunnel studies were conducted with an application rate nearly twice that of the Canadian rates. Overall, based on the tunnel study results, a minimal potential for risk is expected for imidacloprid turf uses with the current label instructions requiring follow-up irrigation after application.

(iii) For the following crop groups, a potential for risk to bees for pre, during, and post-bloom is indicated based on Tier I screening, Tier I refined and Tier II assessments with surrogate residue information; however, minimal risk to bees is expected considering the lower potential for pollinator exposure in these crop groups:

- **CG1 Root and Tuber vegetables (potato and sweet potato)**: The current label does not allow application when bees are visiting, and does not allow during-bloom applications for sweet potato. A potential for risk from pre-bloom application was determined based on surrogate residues from cotton (honey bee and bumble bee) and one of the sugarmelon residue studies (bumble bee), but not from soybean residues. Rates were higher than Canadian rates. There is negligible risk from post-bloom application as crop is seasonal. However, minimal pollinator exposure is expected based on low crop attraction to most bees. There were no tunnel or field studies available for review.
- **CG13D Small fruit vine climbing (grape)**: The current label allows pre, during, and post-bloom applications, but does not allow application when bees are visiting. A potential for risk from pre-bloom application was determined based on surrogate residues from cotton (honey bee and bumble bee) and one of the sugarmelon residue studies (bumble bee). Rates were higher than Canadian rates. However, minimal pollinator exposure to grape is expected based on low crop attraction to bees. There were no tunnel or field studies available for review.
- **No associated crop group- hops, peanut, tobacco**: The current label allows pre, during, and post-bloom applications, but does not allow application when bees are visiting. A potential for risk from pre-bloom application was determined based on surrogate residues from cotton (honey bee and bumble bee) and one of the sugarmelon residue studies (bumble bee), but not from soybean residues. Rates were higher than Canadian rates. There is negligible risk from post-bloom application as crop is seasonal or, for hops, the crop is a perennial deciduous plant which dies back to the ground each winter. However, minimal pollinator exposure is expected based on low crop attraction to most bees. There were no tunnel or field studies available for review.

(iv) For the following crop group, a potential for risk to bees for during bloom application is indicated; but minimal potential for risk to bees is indicated for pre-bloom application based on Tier II assessments comparing colony effects endpoints with residues from relevant crops at rates higher than Canadian rates. This crop group has a moderate potential for pollinator exposure, which is also considered:

- **CG6 Legume Vegetables (other than broad beans/fava beans/*Vicia faba*)**: The current label allows pre, during, and post-bloom applications, but does not allow application when bees are visiting. There is negligible risk from post-bloom application as crop is seasonal. Minimal potential for risk for pre-bloom application was based on soybean residues at rates higher than Canadian rates. Pollen and nectar in the residue study were collected by honey bees, and it was noted that soybean was not highly attractive to honey bees. Soybean residues are considered relevant for crops in this crop group which also have a moderate potential for pollinator exposure. There were no tunnel or field studies available for review.

(v) For the following crop groups, a potential for risk to bees pre, during, and post-bloom (where applicable) is indicated based on Tier I screening, Tier I refined and Tier II assessments with surrogate residue information, and available Tier II tunnel studies.

These crop groups have moderate potential for pollinator exposure, which is also considered:

- **CG8 Fruiting Vegetables**: The current label allows pre, during, and post-bloom applications, but does not allow application when bees are visiting. A potential for risk from pre-bloom application was determined based on surrogate residues from cotton (honey bee and bumble bee) and one of the sugarmelon residue studies (bumble bee), but not from soybean residues. Rates were higher than Canadian rates. There is negligible risk from post-bloom application as these crops are seasonal. In a Tier II tunnel study, after 6 weeks of exposure to flowering tomato that had been sprayed at a low application rate (15 g a.i./ha), a reduction in foraging activity of bumble bees was found, but no other effects. Fruiting vegetables are not typically attractive to honey bees, but they are attractive to bumble bees and other non-Apis bees, which are sometimes used for pollination services.
- **CG13G Small Fruit and Berries-Low Growing Berries (strawberry)**: The current label does not allow application when bees are visiting. A potential for risk from pre-bloom application was determined based on surrogate residues from cotton (honey bee and bumble bee) and one of the sugarmelon residue studies (bumble bee). A potential for risk for post-bloom application was determined based on surrogate residues from cherry; relevance of cherry residues to strawberry is uncertain, but no other post-bloom residues were available for foliar applications alone. Rates were higher than Canadian rates. Pollinator exposure is low to moderate for strawberry. Most varieties do not require insect pollination, although some varieties do, and pollination services may be used to enhance crop production. There were no tunnel or field studies available for review.
- **CG19A Herbs (excluding lavender and rosemary)**: The current label allows pre, during, and post-bloom applications, but does not allow application when bees are visiting. A potential for risk from pre-bloom application was determined based on surrogate residues from cotton (honey bee and bumble bee) and one of the sugarmelon residue studies (bumble bee), but not from soybean residues. Rates were higher than Canadian rates. There is a potential for risk from post-bloom application on perennials of this crop group using cherry a surrogate crop. There is a negligible potential for risks for post-bloom application on annual herbs as they are harvested at the end of season and no exposure is expected. There is also negligible potential for risks when herbs are harvested before bloom. Herbs which flower may be attractive to honey bee and non-Apis bees. There were no tunnel or field studies available for review.
- **CG14 Tree nut (excluding almond, chestnuts, Chinquapin nuts, Japanese horse-chestnuts)**: The current label allows pre, during, and post-bloom applications but does not allow application when bees are visiting. A potential for risk from pre-bloom application was determined based on surrogate residues from cotton (honey bee and bumble bee) and one of the sugarmelon residue studies (bumble bee). Rates were higher than Canadian rates. There is potential for risk with post-bloom application for bumble bees using surrogate orchard tree crop cherry at rates higher than Canadian rates. There were no tunnel or field studies available for review.

(vi) For the following crop groups, a potential for risk to bees pre, during, and post-bloom (where applicable) is expected based on Tier I screening, Tier I refined and Tier II assessments with surrogate residue information, and/or available relevant residue information. These crop groups have high potential for pollinator exposure, which is also considered; they are typically attractive to honey bee and non-Apis bees, and some may use pollination services:

- **CG6 Legume Vegetables (broad beans/fava beans/*Vicia faba*)**: The current label allows pre, during, and post-bloom applications, but does not allow application when bees are visiting. There is negligible risk from post-bloom application as these crops are seasonal. Minimal potential for risk for pre-bloom application was based on soybean residues at rates higher than Canadian rates, but pollen and nectar in the residue study were collected by honey bees, and it was noted that soybean was not highly attractive to honey bees. Soybean residues might not be relevant for these crops within this crop group, as they have a higher potential for pollinator exposure (are more attractive) than soybean. Residues from other surrogate crops (cotton and one of the sugarmelon studies) indicate potential for risk. Rates were higher than Canadian rates. There were no tunnel or field studies available for review.
- **CG11 Pome fruit**: The current label allows post-bloom applications only. There is potential for risk with post-bloom application for bumble bees using orchard tree crop residues from cherry at rates higher than Canadian rates, and from apple following a combination of uses (soil and foliar). Rates were higher than Canadian rates. There were no tunnel or field studies available for review.
- **CG12 Stone fruit**: The current label allows post-bloom applications only. There is potential for risk with post-bloom application for bumble bees using orchard tree crop residues from cherry at rates higher than Canadian rates, and from apple and other stone fruit following a combination of uses (soil and foliar). Rates were higher than Canadian rates. There were no tunnel or field studies available for review.
- **CG13 Small Fruit and berries: CG13A Caneberry; CG13B Bushberry; CG13G Low Growing berry (excluding strawberry); CG13F Vine Climbing berry (excluding grape):** The current labels do not allow application during flowering and/or allow only post-bloom application for highbush and lowbush blueberry and caneberries. A potential for risk from pre-bloom application was determined based on surrogate residues from cotton (honey bee and bumble bee) and one of the sugarmelon residue studies (bumble bee). Rates were higher than Canadian rates. There is potential for risk with post-bloom application for bumble bees using surrogate orchard tree crop cherry at rates higher than Canadian rates; relevance of cherry residues to berries is uncertain, but no other post-bloom residues were available for foliar applications alone. There were no tunnel or field studies available for review.
- **CG14 Tree nut (Almond, Chestnuts, Chinquapin nuts, Japanese horse-chestnuts)**: The current label allows pre, during, and post-bloom applications but does not allow application when bees are visiting. A potential for risk from pre-bloom application was determined based on surrogate residues from cotton (honey bee and bumble bee) and one of the sugarmelon residue studies (bumble bee). Rates were higher than Canadian rates. There is potential for risk with post-bloom application for

bumble bees using surrogate orchard tree crop cherry at rates higher than Canadian rates. There were no tunnel or field studies available for review.

- **CG19A Herbs (lavender and rosemary)**: The current label allows pre, during, and post-bloom applications, but does not allow application when bees are visiting. A potential for risk from pre-bloom application was determined based on surrogate residues from cotton (honey bee and bumble bee) and one of the sugarmelon residue studies (bumble bee), but not from soybean residues. Rates were higher than Canadian rates. There is a potential for risk from post-bloom application on perennials of this crop group using cherry a surrogate crop. There were no tunnel or field studies available for review.

4.1.2 Soil applications

Multiple pollen and nectar residue studies were available for soil application, including potato, tomato, cucurbit (sugarmelon, melon, pumpkin, squash), blueberry (post-bloom), strawberry, stone fruit (cherry, plum, apricot, peach), apple, citrus, cotton, turf, as well as non-target off-field plants and rotational crops following soil applications. These studies were typically conducted at rates that included rates comparable to Canadian label rates, with some exceptions. Higher tier tunnel and field studies were available for ornamentals, potato, turf, and pumpkin.

Overall, a potential for risk is identified for certain soil uses on bee attractive crops, which are described in more detail in the following section.

(i) For the following crops or crop groups, there is negligible risk from soil application to these crops due to limited exposure, as they are harvested before blooming or not attractive to bees For those crops that are typically harvested before bloom, there is a potential for exposure when they are grown for seed; however, these crops are not typically grown for seed in Canada:

Harvested before blooming:

- CG 1: Root and Tuber Vegetables (Excluding potato and sweet potato)
- CG 2: Leaves of Root and Tuber Vegetables
- CG 4: Leafy Vegetables (except brassica vegetables)
- CG 5: Brassica (Cole) Leafy Vegetables
- CG 19A: Herbs (some herbs are harvested before bloom)

Not attractive to bees

- Turf (Sod Farms and Golf Courses) [managed to control flowering weeds]

(ii) For the following crops, minimal potential for risk to bees is indicated based on the risk assessment, including Tier I refined and Tier II refined assessments with Canadian-relevant residue information and Tier II tunnel studies.

- **Rotational crops following soil application the preceding year**: Risk characterization was based on Tier II colony feeding study effects endpoints compared with residue levels in pollen and nectar from rotational crops clover, phacelia, mustard, and maize grown in fields after soil applications.

- **Wildflowers located off the field:** Risk characterization was based on Tier II colony feeding study effects endpoints compared with residue levels in pollen and nectar from wildflowers next to fields treated with soil applications.
- **Turf (municipal, industrial and residential turf sites)** where clover or other flowering plants that are attractive to bees are present: Label requires that applications are followed by irrigation, and currently allows applications when bees are not visiting the treatment area. Potential for risk was indicated when comparing Tier I and Tier II effect endpoints to residue information on blooming clover in turf or re-blooming clover following irrigation and mowing in turf (using foliar turf residues as a surrogate). However, Tier II tunnel studies indicated that there are no effects on bumble bees when application is followed with irrigation, but that there were effects without follow-up irrigation. Residue and tunnel studies were conducted with an application rate nearly twice that of the Canadian rates. Overall, based on the tunnel study results, a minimal potential for risk is expected for imidacloprid turf uses with the current label instructions requiring follow-up irrigation after application.

(iii) For the following crops, minimal potential for risk to bees is indicated based on the risk assessment and/or considering the low potential for pollinator exposure for these crops.

- **CG1 Root and Tuber Vegetables (potato and sweet potato):** Soil application to potato and sweet potato is typically done at or near the time of planting, or early in the season. The current label for sweet potato indicates application should be made after transplanting and before sweet potato foliage covers more than 25% of the planting bed to ensure adequate soil penetration; as well, application during sweet potato bloom is not allowed. Minimal potential for risk was identified based on TI refined and TII colony feeding study assessment comparing individual and colony level effect endpoints to residues from potato pollen collected by bumble bees. Two Tier III field studies with bumble bees and potato also did not observe treatment-related effects at the colony level for in-furrow soil application 68–77 days before flowering. However, there is a limitation for both the residues and the Tier III studies as they were conducted at 180 g a.i./ha, less than the maximum Canadian label rate (480 g a.i./ha). However, minimal pollinator exposure is expected based on lower crop attraction to most bees.
- **CG13F Berry and small fruit vine (grapes):** A potential for risk from soil application was determined based on surrogate residues from a variety of crops, including surrogate residues from strawberry (pre-bloom) and blueberry (post-bloom, post-harvest). Rates were considered relevant to Canadian rates (slightly higher). However, minimal pollinator exposure is expected for grape based on low crop attractiveness to bees.
- **Greenhouse vegetables [certain crops in CG5A; CG4; CG8; CG9]**: There is minimal potential for risk to pollinators, as crops are located indoors in greenhouses. Also, crops from CG4 and CG5 will be harvested before bloom. However, for pollinators that may be used in greenhouse production for CG8 and CG9, a potential risk is identified based on representative residues. Label warnings will indicate risk to managed pollinators that may be used in greenhouse production.
- **No associated crop group: peanut and tobacco**: A potential for risk from soil application was determined based on surrogate residues from a variety of crops; rates

included those relevant to Canadian rates. However, minimal pollinator exposure is expected based on low crop attraction to most bees.

(iv) For the following crop groups, a potential for risk to bees is indicated based on Tier I screening, Tier I refined and Tier II assessments with relevant residue information, and available Tier II tunnel and Tier III field studies. These crop groups have moderate potential for pollinator exposure, which is also considered.

- **CG6 Legume Vegetables (excluding broad beans/fava beans/*Vicia faba***): Soil application is typically made at or near time of planting or early in the season. A potential risk to honey bee and bumble bee from soil application was determined based on comparing Tier II colony effects endpoints to surrogate residues from a variety of crops at rates relevant to Canadian rates. This group of legume vegetables has moderate attractiveness to bees. There were no tunnel or field studies available for review.
- **CG8 Fruiting Vegetables**: Soil application is typically made at or near time of planting or early in the season. A potential risk to honey bee and bumble bee from soil application was determined based on comparing Tier II colony effects endpoints to relevant residues from tomato pollen at rates relevant to Canadian rates. Fruiting vegetables are not typically attractive to honey bees, but they are attractive to bumble bees and other non-Apis bees, which are sometimes used for pollination services. There were no tunnel or field studies available for review.
- **CG13G Small Fruit and Berries- Low Growing Berries (strawberry)**: The current label does not allow soil application immediately prior to bud opening, during bloom, or when bees are visiting. A potential for risk to bumble bee and honey bee (in some cases) was determined based on comparing colony level effects endpoints to representative residues from strawberry at rates relevant to Canadian rates. Pollinator exposure is low to moderate for strawberry. Most varieties do not require insect pollination, although some varieties do, and pollination services may be used to enhance crop production. There were no tunnel or field studies available for review.
- **CG19A Herbs (excluding lavender and rosemary)**: Soil application is typically made at or near time of planting. A potential for risk to honey bee and bumble bee was determined based on comparing colony level effects endpoints to surrogate residues from a variety of crops at rates relevant to Canadian rates. There is negligible potential for risks when herbs are harvested before bloom. Herbs which flower may be attractive to honey bees and non-Apis bees. There were no tunnel or field studies available for review.

(v) For the following crop groups, a potential for risk to bees is indicated based on Tier I screening, Tier I refined and Tier II assessments with relevant residue information, and available Tier II tunnel and Tier III field studies. These crop groups have high potential for pollinator exposure, which is also considered; they are typically attractive to honey bee and non-Apis bees, and some may use pollination services.

- **CG6 Legume Vegetables (broad beans/fava beans/*Vicia faba*)**: Soil applications are typically made at or near time of planting or early in the season. A potential risk to honey bee and bumble bee from soil application was

determined based on comparing Tier II colony effects endpoints to surrogate residues from a variety of crops at rates relevant to Canadian rates. This group of legume vegetables has high attractiveness to bees. There were no tunnel or field studies available for review.

- **CG9 Cucurbit Vegetables**: Soil applications are typically made near time of planting or early in the season. A potential risk to bumble bee and honey bee (in some cases) from soil application was determined based on comparing Tier II colony effects endpoints to relevant residues from a variety of cucurbit crops (melon, sugarmelon, pumpkin, squash) at rates relevant to Canadian rates. One Tier III field study is available for pumpkin, where soil was treated at the six true leaf stage at a rate comparable to Canadian rates. No effects were observed on honey bee colonies after being exposed to flowering pumpkins for six weeks starting 26 days after the treatment. Honey bees are not highly attracted to pumpkin, thus there may be reduced exposure and risk for honey bees, consistent with field study findings. Potential effects on introduced bumble bees colonies could not be assessed due to very poor bumble bee colony condition in both controls and treatments. However, no effects were observed on species richness and abundance of non-Apis bees in treated pumpkin fields compared to controls. No potential for risk was identified for honey bees or bumble bees by comparing measured mean residues from pumpkin pollen and nectar from the field study with colony feeding study effects endpoints. However a potential for risk was identified for honey bees and bumble bees when comparing the same colony feeding study effects endpoints with residues from other pumpkin residue studies at Canadian relevant rates. The residues in pumpkin pollen and nectar measured in the field study were lower than in other residue studies with pumpkin.
- **CG13 Small Fruit and berries: CG13A Caneberry; CG13B Bushberry; CG13G Low Growing berry (excluding strawberry); CG13F Vine Climbing berry (excluding grape):** The current labels do not allow soil application during flowering for highbush blueberry and do not allow soil application pre-bloom or during bloom or when bees are actively foraging for caneberries. A potential for risk for bumble bee and, in some cases, honey bee was indicated based on relevant residues from strawberry (pre-bloom applications) and blueberry (post-bloom, post-harvest application). Rates were relevant for CG13F vine berries and CG13G low growing berries, but were higher than rates in CG13A Caneberry and CG13B Bushberry. There were no tunnel or field studies available for review.
- **CG19A Herbs (lavender and rosemary)**: Soil application is typically made at or near time of planting. A potential for risk to honey bee and bumble bee was determined based on comparing colony level effects endpoints to surrogate residues from a variety of crops at rates relevant to Canadian rates. There were no tunnel or field studies available for review.
- **Ornamentals:** Timing of soil applications to ornamentals may vary. A potential for risk to bees is indicated based on Tier I screening and Tier I refined assessment. As well, a potential for risk to bees is indicated from the Tier II assessment comparing colony effects to monitoring residue data in plants purchased directly from retail stores (honey bee and bumble bee), and from plants purchased directly from retail stores and re-bloomed after the plants were

transplanted in the field (bumble bee). Tier II tunnel studies showed short-term adverse effects on both honey bee and bumble bee colonies exposed to treated ornamentals; the adverse effects were positively related to the portion of flowers treated in the foraging area. Multiple Tier III field studies were also available for soil treated ornamentals. In potted plants which were soil treated at a Canadian comparable rate, there was a slight but prevalent increase of bumble bee mortality. In outdoor ornamental shrubs which were soil treated at a rate greater than the Canadian rate, a high level of residues was found over a long period of time, and increased numbers of dead honey bee and bumble bee individuals were found in treatment groups. A high level of imidacloprid residues were found in dead bees (in both treatment and controls), suggesting effects may have been treatment related, and that cross foraging may have occurred between treatments and controls. Colony level effects in honey bee and bumble bee were not examined in one study, and in the second study differences were not found at the colony level between controls and treatments.

4.1.3 Seed Treatment Applications

Multiple pollen and nectar residue studies were available for seed treatments, including soybean, canola, corn, sweet pepper, melon and rotational crops after crops with seed treatments. Most of these studies were conducted at rates comparable to Canadian rates, except for corn which used test rates higher than Canadian rates. Multiple higher Tier II tunnel and Tier III field studies on various crops are available for seed treatments (summer rape, winter rape, canola, maize, sunflower, field beans), which indicated no overall long-term effects.

Overall, minimal potential for risks to bees is expected for all seed treatment uses based on the risk assessment using representative/surrogate crops as described in more detail in the following section.

(i) For the following crops or crop groups grown from seed treatments, negligible risk to bees is expected due to limited exposure through pollen and nectar, as they are either harvested before bloom or not attractive to bees. For those crops that are harvested before bloom, there is a potential for exposure when they are grown for seed; however, these crops are not typically grown for seed in Canada:

Harvested before blooming

- CG 1: Root and Tuber Vegetables (Excluding potato and sweet potato)
- CG 3: Bulb vegetables
- CG 4: Leafy Vegetables (except brassica vegetables)
- CG 5: Brassica (Cole) Leafy Vegetables

Not attractive to bees

- CG 15: Cereal Grains (wheat, barley, oats)

(ii) For the following crops grown from treated seed, minimal potential for risk to bees is indicated based on Tier I refined and Tier II refined assessments with Canadian-relevant residue information and/or considering Tier II tunnel and/or Tier III studies:

- **CG 1: Root and Tuber Vegetables (Potato):** A potential for risks is identified at Tier I screening, but not at Tier I refined or Tier II assessment when comparing effects levels to residues from potato pollen after soil application as surrogate for seed treatments. The tested soil application rate on potato (180 g a.i./ha) is slightly lower than the maximum but within the range of Canadian label rate for potato seed pieces treatment (70–280 g a.i./ha). No tunnel or field studies are available for potato seed treatments. However, two potato soil application field studies were available at rates comparable to Canadian seed piece treatment rates, and no treatment effects were reported for bumble bees.

- **CG 6: Legume vegetables**: A potential for risk is identified at Tier I screening and Tier I refined, but not at Tier II assessment comparing colony effects to residues from a representative crop, soybean, at Canadian relevant rates. Tier II tunnel and Tier III field studies were available for seed treatment on field beans from CG6 with honey bees. No effects were observed on endpoints measured in tunnel studies (bee mortality, flower visits, hive weight or brood development) or in field studies (flower visits); however exposure and observation period was only 14 days during flowering, and limited effect variables were measured.

- **CG 8: Fruiting Vegetables:** A potential for risk is identified at Tier I screening, but not at Tier I refined or Tier II assessment comparing colony effects to residues from representative crop, sweet pepper, at Canadian relevant rates. No Tier II tunnel or Tier III field studies were available for seed treatment on CG8.

- **CG 9: Cucurbit Vegetables**: A potential for risks is identified at Tier I screening and refined assessment. At Tier II assessment comparing colony effects to residues from representative crop, melon, a potential for risk is identified for bumble bees but not honey bees. However, the potential risk is likely overestimated as the residues were measured from whole flowers, not from pollen and nectar. From the same residue study, residues from hive pollen and nectar were < LOQ (1 ppb), indicating no potential for risks. No Tier II tunnel or Tier III field studies were available for seed treatment on CG9, but a Tier III field study for soil application (pumpkin) was available, in which no effects were observed for honey bees. Potential for effects on bumble bees could not be assessed. No effects were detected on species richness and abundance of non-Apis bees in treated fields compared to controls. CG9 residues in pollen and nectar from seed treatments are expected to be lower than residues from soil applications.

- **CG 15: Cereal Grains (corn):** A potential for risks is identified at Tier I screening and refined assessment. At Tier II assessment comparing colony effects endpoints to residue levels, a potential for risk is identified using residues

from representative crop, corn. The identified potential risk is expected to be overestimated due the higher test rates; the residue study test rates for corn seed treatments were much higher than the Canadian corn seed treatment rates for imidacloprid. In addition, one Tier III field study for seed treatment on corn reported no treatment-related effects.

- **CG 20: Oilseeds**: A potential for risk is identified at Tier I screening and refined assessment. At Tier II assessment, a potential for risk for bumble bee colonies was indicated using peak maximum residues from a representative crop canola; however, this potential for risk is likely overestimated. In this case, the maximum residue was used instead of mean residue for the chronic risk assessment because only one sample was measured per time period. The peak maximum residue is only slightly greater than the effect endpoint for bumble bee colonies. In addition, the peak residue concentration was reduced after one week to a maximum of 4.4 ppb; at this residue level, there is negligible potential of chronic risks to bumble bee colonies. Multiple Tier II tunnel and Tier III field studies were available and reported no long-term treatment effects.

- **Rotational crops and wildflowers next to treated fields**: No potential for risk is identified at Tier I refined and Tier II assessment for honey bee and bumble bee colonies using residues from representative rotational crops, clover, oilseed rape, phacelia, and maize planted following crops grown from treated seed. A potential for risk was found for honey bee and bumble bees using residue from wildflowers adjacent to planted fields in one of two studies; however this risk is expected to be overestimated as residues were from whole flower rather than from pollen and nectar.

(iii) For **dust-off during planting of treated seed**, minimal potential for risk to bees is indicated for most crop groups, as seeds are not typically dusty and/or do not use planting equipment that tends to contribute to dust emission. Seeds that may be dusty and/or may use planting equipment that could contribute to dust emission tend to be found in CG6 Legumes and CG 15 Cereals. Potential for risk from dust-off during planting of treated corn (from CG15) and soybean (from CG6) seeds was indicated through incident reports, and mitigation, including mandatory use of dust-reducing fluency agents and best management practices, was implemented in 2014. Since 2014, incidents during planting have been reduced by 70 – 90% compared to 2013. Legumes and cereals other than soybean and corn are not typically planted with equipment that tends to contribute to dust emission; however, these types of seeds may be dusty, and best management practices should be followed. These include general best management practices for handling and planting treated seed to minimize dust exposure, such as not loading or cleaning planting equipment near bee colonies, not turning on planters near honey bee colonies, and cleaning up spilled seed.

4.1.4 Water Exposure

Negligible risk is expected for bees, including *Apis* and non-*Apis* bees, that are exposed to guttation water from treated plants or surface water in areas with crops treated with imidacloprid, based on the information currently available.

4.2 Risk Mitigation

Where a potential for risk is identified or the risk potential is uncertain, additional risk management is proposed including the removal of the use or the addition of label restrictions to reduce bee exposure to imidacloprid from the use. In crops where negligible risk is expected, no additional risk management is required; however, for some products, updated standard label statements for bees are proposed. Risk management proposals for each use are presented in Table 5 based on the overall pollinator exposure potential (negligible, low, moderate, high) and the application method to the crop (foliar, soil, seed treatment). Overall risk assessment conclusions and risk mitigation are also summarized in Appendix XII.

Exposure to dust generated during planting of treated seed is possible for certain cereal crops in Crop Group 15 (CG15) and legume crops in Crop Group 6 (CG6). There are already label statements in place to minimize exposure to dust generated during planting of treated corn and soybean seed that include best management practices as well as mandatory use of dust-reducing fluency agents in certain types of planters. In addition, it is proposed that label statements be added to treated seed tags for all CG15 cereals and CG6 legumes to minimize exposure to dust during planting of treated seed; these statements would include best management practices, but would not include use of a dust-reducing fluency agent.

Table 5 Summary of proposed risk mitigation for potential risk to pollinators from exposure to imidacloprid in various labelled crops

No use restrictions are required where negligible risk is identified; however, label improvements may be required.

Proposed risk mitigation measures are provided where a low, moderate, or high risk potential was identified.Application method	Negligible potential for risk No use restrictions required; potential label improvements	Potential for risk + Proposed mitigation	
		Low-Moderate pollinator exposure	High pollinator exposure
Foliar	**<u>No exposure:</u>** <u>Harvested before bloom:</u> • CG 1: Root and Tuber Vegetables (Excluding potato and sweet potato) • CG 2: Leaves of Root and Tuber Vegetables • CG 4: Leafy Vegetables (except brassica vegetables) (CG4A) • CG 5: Brassica (Cole) Leafy Vegetables • CG 19A Herbs (some are harvested before bloom) <u>Not attractive to bees</u> • Christmas trees • Turf (Sod Farm and Golf Course)[managed to control flowering weeds] **<u>High pollinator exposure but negligible risk based on risk assessment</u>** • Rotational crops • Turf (excluding sod farm and golf course) with current use instructions for follow-up irrigation	***Proposed removal of during-bloom use:*** • All during bloom foliar applications for all foliar uses (where not already restricted). ***Proposed removal of pre-bloom use; Maintain post-bloom use only:*** • CG 8: Fruiting Vegetables • CG 13G: Small Fruit and Berries-Low growing berry (**strawberry only**) • CG 14: Tree nuts (excluding almond, chestnuts, Chinquapin nuts, Japanese horse-chestnuts) • CG 19: Herbs (excluding herbs harvested before bloom, and excluding lavender and rosemary) ***Maintain use pre-bloom and post-bloom: based on risk assessment indicating low risk:*** • CG 6: Legume Vegetables (**other than broad beans/ fava beans/ *Vicia faba***) ***Considering low pollinator exposure:*** • CG 1: Root and Tuber Vegetables (potato and sweet potato only) • CG 13F: Berry and small fruit vine (**grapes only**) • No Associated Crop Group: hops, peanut and tobacco	***Proposed removal of during-bloom use:*** • All during bloom foliar applications for all foliar uses (where not already restricted). ***Proposed removal of foliar uses*:** • CG 11: Pome Fruit • CG 12: Stone Fruit • CG 13A: Small Fruit and Berries-Caneberry • CG 13B: Small Fruit and Berries-Bushberry • CG 13G: Small fruit and berries-Low growing berry(**other than strawberry**) • CG 13F: Berry and small fruit vine (**other than grapes**) • CG 14: Tree Nuts (almond, chestnuts, Chinquapin nuts, Japanese horse-chestnuts) • CG 19: Herbs (lavender and rosemary) **Exception**: **maintain post-bloom use with renovation after harvest** for CG13A, B, G (other than strawberry), F (other than grapes) ***Proposed removal of pre-bloom use; Maintain use post-bloom only*:** • CG6: Legume vegetables (**broad beans/ fava beans/ *Vicia faba* only**)
Soil	**<u>No exposure:</u>** <u>Harvested before bloom:</u> • CG 1: Root and Tuber Vegetables (Excluding potato and sweet potato) • CG 2: Leaves of Root and Tuber	***Removal of soil uses***: • CG 6: Legume Vegetables (**other than broad beans/ fava beans/ *Vicia faba***) • CG 8: Fruiting Vegetables • CG8: (pepper only): Greenhouse transplant drench on vegetables to be planted outdoors.	***Removal of soil uses***: • CG6: Legume vegetables (**broad beans, fava beans/ *Vicia faba* only**) • CG 9: Cucurbit Vegetables • CG 13A: Small fruit and berries-Caneberry • CG 13B: Small fruit and berries-Bushberry

Proposed risk mitigation measures are provided where a low, moderate, or high risk potential was identified.Application method	Negligible potential for risk No use restrictions required; potential label improvements	Potential for risk + Proposed mitigation	
		Low-Moderate pollinator exposure	High pollinator exposure
	Vegetables • CG 4: Leafy Vegetables (except brassica vegetables) (CG4A) • CG4: (lettuce only): Greenhouse transplant drench on vegetables to be planted outdoors. • CG 5: Brassica (Cole) Leafy Vegetables • CG5A: Head and Stem Brassica: Greenhouse transplant drench on vegetables to be planted outdoors. • CG 19A Herbs (some are harvested before bloom) <u>Not attractive to bees</u> • Turf (Sod Farm and Golf Course) [managed to control flowering weeds] **<u>High pollinator exposure but negligible risk based on risk assessment</u>** • Rotational crop • Wildflowers next to fields treated with soil applications • Turf (excluding sod farm and golf course) with current use instructions for follow-up irrigation	• CG 13G: Small fruit and berries-Low growing berry(**strawberry only**) • CG 19: Herbs (excluding herbs harvested before bloom, and excluding lavender and rosemary) ***Maintain soil application considering low pollinator exposure:*** • CG 1: Root and Tuber Vegetables (potato and sweet potato) • CG5A; CG4, CG8, CG9 [certain crops]: Greenhouse vegetables for indoor grown vegetables. • CG 13F: Berry and small fruit vine (**grapes only**) • No associated crop group: peanut and tobacco	• CG 13F: Berry and small fruit vine (**other than grapes**) • CG 13G: Small fruit and berries-Low growing berry (**other than strawberry**) • CG 19: Herbs (lavender and rosemary) • Ornamentals: Outdoor and Greenhouse uses (not including cut flowers). Excludes coniferous evergreens (pine, fir, juniper, spruce, arborvitae, hemlock, cypress, yew) as they are not attractive to pollinators

Proposed risk mitigation measures are provided where a low, moderate, or high risk potential was identified.Application method	Negligible potential for risk No use restrictions required; potential label improvements	Potential for risk + Proposed mitigation	
		Low-Moderate pollinator exposure	High pollinator exposure
Seed treatment	**No exposure**: Harvested before bloom: • CG 1: Root and Tuber Vegetables (Excluding potato and sweet potato) (carrot) • CG 3: Bulb vegetables (onion and leek) • CG 4: Leafy Vegetables (except brassica vegetables) (lettuce) • CG 5: Brassica (Cole) Leafy Vegetables (broccoli and cabbage) Not attractive to bees: • CG 15: Cereal Grains–wheat, barley, oats (excludes corn)* **High pollinator exposure but negligible risk based on risk assessment**: • CG 1: Root and Tuber Vegetables (potato) • CG 6: Legume vegetables* • CG 8: Fruiting Vegetables (tomato and pepper) • CG 9: Cucurbit Vegetables • CG 15: Cereal Grains (corn)* • CG 20: Oilseeds (canola, rapeseed, mustard) • Rotational crops • Wildflowers next to fields planted with treated seed	***No additional mitigation:*** Risk is not identified for seed treatments.	

***** Addition of label statements to be added to treated seed tags for all CG6 legumes and CG15 cereals to help minimize exposure to dust during planting of treated seed; these statements would include best management practices. Mitigation statements on seed tags for corn (from CG15) and soybean (from CG6) are already in place.

4.3 Value Considerations

Imidacloprid controls a broad spectrum of insect pests on a diverse range of agricultural crops, ornamentals and turf. For some crops it is the only insecticide registered to manage specific insect pests, or one of a limited number of alternatives, and therefore is considered to be a valuable tool for resistance management. Imidacloprid can be applied as a seed treatment, soil drench or foliar application which gives growers pest management options to help manage pests.

Risk mitigation measures, including the discontinuation of certain uses and limiting foliar applications to pre and/or post-bloom only, have been proposed for a number of crops. As such, comments on the feasibility of the proposed changes, and the impact on pest management practices are being requested. Use information would be considered before a final decision on imidacloprid is published. Use information could include if the proposed changes will impact the application timing necessary to target economically important pests, availability of alternatives to manage pest outbreaks, and importance of the use for overall pest management of the crops.

List of Abbreviations

µg	microgram(s)
µl	microliter(s)
a.i.	active ingredient
Ads	adsorption
atm	atmosphere
BAF	Bioaccumulation Factor
BCF	Bioconcentration Factor
CAS	chemical abstracts service
CG	crop group
cm	centimetre
CS	conditioned stimulus
d	day(s)
DAA	days after application
DAE	days after exposure
DBH	diameter at breast height
DFOP	double first order in parallel
DT_{50}	dissipation time 50% (the time required to observe a 50% decline in concentration)
DT_{90}	dissipation time 90% (the time required to observe a 90% decline in concentration)
dw	dry weight
EC25	effective concentration on 25% of the population
EEC	estimated environmental exposure concentration
ER	endoplasmic reticulum
FA	fraction of species affected
g	gram
GUS	Groundwater Ubiquity Score
h	hour(s)
ha	Hectare
HC_5	Hazardous concentration estimate that is assumed to be protective of 95% of species in a species sensitivity distribution
HD_5	Hazardous dose estimate that is assumed to be protective of 95% of species in a species sensitivity distribution
HPLC	high performance liquid chromatography
IORE	Indeterminate Order Rate Equation Model
IRAC	Insecticide Resistance Action Committee
IUPAC	International Union of Pure and Applied Chemistry
K_d	soil-water partition coefficient
K_F	Freundlich adsorption coefficient
kg	kilogram(s)
K_{oc}	organic-carbon partition coefficient
K_{ow}	octanol-water partition coefficient
L	litre(s)
LC_{50}	median lethal concentration
LD_{50}	median lethal dose
LOAEL	lowest observed adverse effect level

LOEC	lowest observed effect concentration
LOD	limit of detection
LOQ	limit of quantitation
LR_{50}	median lethal rate
LT_{50}	median lethal time
LTM	long-term memory
m	metre(s)
MAS	maximum average score
MAT	months after treatment
mg	milligram(s)
min	minute(s)
mL	millilitre(s)
mm	millimitre(s)
MoA	Mode of Action
MOE	margin of exposure
N/A	not applicable
NC	not calculated
ND	not detected
ng	nanogram(s)
NOAEL	no observed adverse effect level
NOEC	no observed effect concentration
NOEL	no observed effect level
NR	not reported
N/R	not required
PCPA	*Pest Control Produwct Act*
PCP	Pest Control Product number
pKa	dissociation constant
PMRA	Pest Management Regulatory Agency
ppb	parts per billion
ppm	parts per million
PER	proboscis extension reflex
RFID	radio frequency identification
RQ	risk quotient
RT_{25}	residual time to 25% mortality
SRT	sucrose response threshold
SSD	Species Sensitivity Distribution
STM	short-term memory
$t_{1/2}$	half-life
TGAI	technical grade active ingredient
T_R	representative half-life
TSMP	Toxic Substances Management Policy
USEPA	United States Environmental Protection Agency
US	unconditioned stimulus
UV	ultraviolet
wt(s)	weight(s)
w/v	weight per volume
w/w	weight per weight

Appendix I Registered Imidacloprid Products as of 4 December 2017 Subject to This Re-evaluation, Excluding Discontinued Products or Products with a Submission for Discontinuation

Registrant	Marketing Class	Registration Number	Product Name	Formulation type	Guarantee
Bayer CropScience Inc.	Technical grade active ingredient	24468	Bay NTN 33893 Technical Insecticide	Solid	Imidacloprid 98%
	Manufacturing concentrate	25390	Merit 75% Concentrate Insecticide	Wettable powder	Imidacloprid 75%
	Commercial	24094	Admire 240 Flowable Systemic Insecticide	Suspension	Imidacloprid 240 g/L
		25556	Gaucho 75 ST	Wettable powder	Imidacloprid 75%
		25636	Merit 60 WP Greenhouse And Nursery Insecticide		Imidacloprid 60%
		25932	Merit Solupack Insecticide		Imidacloprid 75%
		25933	Merit Granular	Granular	Imidacloprid 0.5%
		26124	Gaucho 480 FL Insecticide	Suspension	Imidacloprid 480 g/L
		27170	Gaucho 600 FL Insecticide		Imidacloprid 600 g/L
		27174	Gaucho CS FL (Insecticide/Fungicide Seed Treatment)		Carbathiin 47.6 g/L Thiram 95.3 g/L Imidacloprid 285.7 g/L
		27349	Genesis 240 Flowable Systemic Insecticide		Imidacloprid 240 g/L
		27357	Intercept 60 WP Greenhouse Insecticide	Wettable powder	Imidacloprid 60%
		27702	Admire 240 SPT Flowable Systemic Insecticide	Suspension	Imidacloprid 240 g/L
		28159	Genesis MZ Potato Seed-Piece Treatment	Dust or powder	Imidacloprid 1.25% mancozeb 6.0%
		28160	Genesis XT Potato Seed-Piece Treatment		Imidacloprid 1.25% mancozeb 6.0% thiophanate-methyl 3.0%
		29609	Stress Shield For Cereals	Suspension	Imidacloprid 480 g/L
		29610	Stress Shield For Cereals and Soybeans		
		29611	Concept Liquid Insecticide	Suspension	Imidacloprid 75 g/L deltamethrin 10 g/L
		30668	Stress Shield 600	Suspension	Imidacloprid 600 g/L
		30972	Sepresto 75 WS	Wettable Powder	Imidacloprid 18.75% clothianidin 56.25%
		31068	Acceleron IX-409 Insecticide Seed Treatment	Suspension	Imidacloprid 600 g/L
	Commercial + Restricted	29703	Confidor 200 SL	Solution	Imidacloprid 17.1%

Registrant	Marketing Class	Registration Number	Product Name	Formulation type	Guarantee
Adama Agricultural Solutions Limited	Technical grade active ingredient	30374	MANA Imidacloprid Technical	Solid	Imidacloprid 98.3%
	Commercial	28475	Alias 240 SC Systemic Insecticide	Suspension	Imidacloprid 240 g/L
		29130	Quali-Pro Imidacloprid 75 WSP Insecticide	Wettable powder	Imidacloprid 75%
		29185	Quali-Pro Imidacloprid 0.5 Granular Insecticide	Granular	Imidacloprid 0.5%
		30505	Sombrero 600 FS	Suspension	Imidacloprid 600 g/L
FMC Corporation	Commercial	28726	Grapple Insecticide	Suspension	Imidacloprid 240 g/L
		29048	Grapple-2 Insecticide		
Arborjet Inc.	Commercial + Restricted	31375	IMA- Jet	Solution	Imidacloprid 58.5 g/L
		31479	IMA-Jet 10		Imidacloprid 117 g/L
Sharda Cropchem Limited	Technical grade active ingredient	32645	Imidacloprid Technical Insecticide	Solid	Imidacloprid 98.53%
SBM Life Science Corporation	Domestic	29738	Bioadvanced Science-Based Solutions Season Long Grub Control	Granular	Imidacloprid 0.25%

Appendix IIa Registered Commercial Class Uses of Imidacloprid Considered in the Pollinator Risk Assessment in Canada as of 4 December 2017.

Site(s)[1]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single	Maximum Number of Applications per year	Minimum Application Interval (Days)
Crop group 5A (greenhouse seedling production): Head & Stem Brassica	Swede midge larvae	Wettable powder	Transplant tray plug drench	2.46 g a.i./1000 seedlings Early season transplants: (1.24 g a.i./m^2) Mid- to late season transplants: (2.1 to 3.2 g a.i./m^2)	1/crop cycle	Not applicable
Greenhouse cucumber, tomato	Aphids, whiteflies	Wettable powder	Ground application:soil drench	9.6 g a.i./1000 plants	1	Not applicable
Greenhouse eggplant						
Greenhouse lettuce (transplant seedlings)	Aphids, whiteflies	Wettable powder	Transplant tray plug drench	2.46 g a.i./1000 seedlings	1	Not applicable
Greenhouse pepper (mature plants)	Green peach aphid, whiteflies	Wettable powder	Ground application: soil drench	9.6 g a.i./1000 plants	1	Not applicable
Greenhouse Pepper (transplant seedlings)			Transplant tray plug drench	2.46 g a.i./1000 seedlings		
Greenhouse ornamentals (container plants)	Aphids, whiteflies	Wettable powder	Ground application:soil drench	0.002 g a.i./2.5 cm pot: 1-2 herbaceous plants/pot 0.003 g a.i./2.5 cm pot: 3+ herbaceous plants/pot or woody perennials	1	Not applicable
Crop group 1B: root vegetables Carrot	Carrot rust fly (suppression)	Wettable powder	Commercial seed treatment facilities: seed treatment equipment Seeds are not treated in Canada but are imported pre-treated with imidacloprid.	0.012–0.023 g a.i./1000 seed	1	Not applicable
Crop group 1B: Root vegetables (except sugarbeet):	Aphids, leafhoppers, flea beetles	Suspension	Ground: Soil application	1.88–2.88 g a.i./100 m of row	1 (1 per crop cycle for ginseng)	Not applicable
Crop group 1D: Tuberous and corm vegetables (except potatoes)	Reduction in numbers of larvae of the European chafer			288 g a.i./ha	1 (1 per crop cycle for ginseng)	

Site(s)[1]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single	Maximum Number of Applications per year	Minimum Application Interval (Days)
Crop group 2: Leaves of root and tuber vegetables	Aphids, leafhoppers (suppression)		Ground: foliar application	48 g a.i./ha	2	5
Globe artichoke	Aphids, leafhoppers (suppression)	Suspension	Ground: foliar application	48 g a.i./ha	2	7
Potato	Colorado potato beetle, potato leafhopper, aphids, potato flea beetle	Suspension	On farm seed piece treatment equipment: seed treatment equipment	6.2 g a.i./100 kg seed pieces–9.4 g a.i./100 kg seed pieces	1	Not applicable
Potato	Colorado potato beetle, potato leafhopper, aphids, potato flea beetle	Dust or powder	On farm seed piece treatment equipment: seed treatment equipment	6.25 g a.i./100 kg seed or 9.4 g a.i./100 kg seed	1	Not applicable
Potato	Colorado potato beetle, aphids, leafhoppers, flea beetles	Suspension	Ground application: soil drench	1.8 to 2.9 g a.i./100 m of row or 100 to 480 g a.i./ha	1	Not applicable
	Reduction in numbers of larvae of the European chafer		Ground application: soil drench	288 g a.i./ha	1	Not applicable
	Colorado potato beetle, aphids, leafhoppers (suppression)		Ground application: foliar spray	48 g a.i./ha	2	7
	Colorado potato beetle, aphids, leafhopper, potato flea beetle, tarnished plant bug, European corn borer (suppression)		Ground application: foliar spray Aerial application: foliar spray	49 g a.i./ha imidacloprid 6.5 g a.i./ha deltamethrin	3	5
Crop group 3: bulb vegetables Leek and onion, dry bulb and green	Onion maggot, seedcorn maggot, thrips	Wettable powder	commercial seed treatment facilities: seed treatment equipment Seeds are not treated in Canada but are imported pre-treated with imidacloprid.	0.04 g a.i./1000 seed (onion - bulb, leek) 0.03 g a.i./1000 seeds (onion- bunching)	1	Not applicable
Crop group 4A: Leafy greens subgroup of leafy vegetables (except Brassica)	Aphids	Suspension	Ground application: transplant tray plug drench	2.45 g a.i./1000 plants	1	Not applicable
	Aphids		Ground application: soil drench	1.44 g a.i./100m of row	1	Not applicable

Site(s)[1]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single	Maximum Number of Applications per year	Minimum Application Interval (Days)
	Aphids, leafhopper (suppression)		Ground application: foliar spray	48 g a.i./ha	2	5
Crop group 4A: Leafy greens Lettuce (leaf and head)	Aphids, leafminer (suppression)	Wettable powder	Commercial seed treatment facilities: seed treatment equipment Seeds are not treated in Canada but are imported pre-treated with imidacloprid.	0.2 g a.i./1000 seeds	1	Not applicable
Crop group 4B: cardoon, celery, Chinese celery, celtuce, florence fennel, rhubarb, Swiss chard	Aphids	Suspension	Ground application: soil drench	1.44 g a.i./100m of row 79.92 to 480 g a.i./ha	1	Not applicable
Crop Group 5 Brassica (cole) leafy vegetables Broccoli and cabbage	Aphids, flea beetle	Wettable powder	Commercial seed treatment facilities: seed treatment equipment Seeds are not treated in Canada but are imported pre-treated with imidacloprid.	0.3 g a.i./1000 seeds	1	Not applicable
Crop group 5: Brassica (cole) leafy vegetables	Aphids	Suspension	Ground application: soil drench	1.56 g a.i./100 m of row	1	Not applicable
Crop group 5: Brassica (cole) leafy vegetables	Aphids (including cabbage aphid, green peach aphid and turnip aphid)		Ground application: side dress application	175.2 g a.i./ha	1	Not applicable
	Aphids, leafhoppers (suppression)		Ground application: foliar spray	48 g a.i./ha	2	7
Head and stem brassica crop sub-group 5A	Imported cabbageworm diamondback moth, cabbage looper, crucifer flea beetle, aphids		Ground application: foliar spray	48.75 g a.i./ha imidacloprid 6.5 g a.i./ha deltamethrin	3	5
Crop group 6: Legume vegetables (except dry soybean)	Aphids	Suspension	Ground application: soil drench	1.8 g a.i./100m of row 100–400 g a.i./ha	1	Not applicable
Crop group 6: Legume vegetables (except dry soybean)	Aphids, leafhoppers (suppression)	Suspension	Ground: foliar application	48 g a.i./ha	2	7

Site(s)[1]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single	Maximum Number of Applications per year	Minimum Application Interval (Days)
Peanut	Aphids		Ground application: in-furrow drench, transplant water drench, soil injection	1.8 g a.i./100 m of row 100–400 g a.i./ha	1	Not applicable
	Aphids, leafhoppers (suppression)		Ground application: foliar spray	48 g a.i./ha	2	5
Crop group 6A and C: Edible podded beans, Jackbean, Dry shelled beans, Broad bean (fava bean)	Potato leafhopper		Commercial and on farm seed treatment facilities: seed treatment equipment	62.4–62.5 g a.i./100 kg seed	1	Not applicable
	Wireworm			62.5 g a.i./100 kg seed		
Chickpea, lentil, field pea						
Faba bean	Pea leaf weevil, wireworm					
Field pea	Pea leaf weevil			62.5–125 g a.i./100 kg seed		
Soybean	Soybean aphid, bean leaf beetle, wireworm, seedcorn maggot, European chafer, Japanese beetle		commercial seed treatment facilities and on farm: seed treatment equipment	62.5–125 g a.i./100 kg seed	1	Not applicable
	Soybean aphid, bean leaf beetle (suppression), Japanese beetle		Ground application: foliar spray Aerial application: foliar spray	24.4–49 g a.i./ha imidacloprid 3.25–6.5 g a.i./ha deltamethrin	3	5
Crop group 8: Fruiting vegetables (except cucurbits): Tomato and pepper	Aphids, leafminer (suppression on tomato), thrips	Wettable powder	commercial seed treatment facilities: seed treatment equipment Seeds are not treated in Canada but are imported pre-treated with imidacloprid.	0.0126 g a.i./ 1000 seeds (tomato) 0.083 g a.i./ 1000 seed (pepper)	1	Not applicable
Crop group 8: Fruiting vegetables except cucurbits	Colorado potato beetle, aphids	Suspension	Ground application: soil drench	1.68–2.88 g a.i./100m of row 93.36 to 559.92 g a.i./ha	1	Not applicable

Site(s)[1]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single	Maximum Number of Applications per year	Minimum Application Interval (Days)
	Colorado potato beetle, aphids, leafhoppers (suppression)		Ground application: foliar spray	48 g a.i./ha	2	5
Eggplant	Colorado potato beetle	Suspension	Ground application: Transplant soil application	1.68–2.4 g a.i./100m of row	1	Not applicable
			Ground application: foliar spray	48 g a.i./ha	2	5
Tomato	Colorado potato beetle		Ground application: Transplant Soil application	1.68–2.4 g a.i./100m of row	1	Not applicable
			Ground application: foliar spray	48 g a.i./ha	2	5
	Colorado potato beetle, tomato hornworm		Ground application: foliar spray	49 g a.i./ha imidacloprid 6.5 g a.i./ha deltamethrin	3	5
Crop Group 9 Cucurbit vegetables:	Aphids, thrips	Wettable powder	commercial seed treatment facilities only: seed treatment equipment Seeds are not treated in Canada but are imported pre-treated with imidacloprid.	0.25 g a.i./1000 seeds	1	Not applicable
Crop group 9: Cucurbit vegetables	Aphids	Suspension	Ground application: soil drench:	1.8 g a.i./100m of row 100–280 g a.i./ha	1	Not applicable
	Cucumber beetles		Ground application: soil drench:	4.32 g a.i./100 m of row 240–280 g a.i./ha		
			Ground application: transplant water	6 g a.i./1000 plants		
Crop group 11: Pome fruit	Aphids (except woolly apple aphid)		Ground application: airblast	55.2 g a.i./ha	2	10
	Mullein bug			91.2 g a.i./ha		
	Tentiform leafminer					10
	Leafhoppers			48 g a.i./ha		10
Crop group 12: Stone fruit	Aphids (except woolly aphid)		Ground application: airblast	55.2 g a.i./ha	2	7
	Leafhoppers			48 g a.i./ha	2	7

Site(s)[1]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single	Maximum Number of Applications per year	Minimum Application Interval (Days)
Cherries	Western cherry fruit fly, black cherry fruit fly		Ground application: airblast	55.2 g a.i./ha	5	7 10
Crop Group 13A: cane berries	Aphids, leafhoppers (suppression only)	Suspension	Ground application: foliar spray	42 g a.i./ha	3	7
	Reduction in numbers of white grubs (larvae of European chafer)		Ground application: Soil drench	288 g a.i./ha	1	Not applicable
Raspberry	Rednecked and raspberry caneborer (suppression)		Ground application: foliar spray	112 g a.i./ha	3	7
Crop group 13B: Bushberry	Reduction in numbers of white grubs (larvae of European chafer and Japanese beetle)		Ground application: soil drench	288 g a.i./ha	1	Not applicable
	Aphids, leafhoppers (suppression)		Ground application: foliar spray	42 g a.i./ha	2	7
	Blueberry maggot			55.2–84 g a.i./ha		
	Japanese beetle adult			84 g a.i./ha		
Saskatoon berry	Woolly elm aphid (suppression), woolly apple aphid (suppression)		Ground application : soil drench	0.03 g/plant	1	Not applicable
Crop group 13F: Berry and small fruit vine including grapes	Leafhoppers		Ground application: soil drench	1.8–2.88 g a.i./ 100m of row 100 to 480 g a.i./ha	1	Not applicable
			Ground application: foliar spray	48 g a.i./ha	2	14
Blueberry (lowbush and highbush)	Blueberry aphid		Ground application: foliar spray	42 g a.i./ha imidacloprid 5.6 g a.i./ha deltamethrin	3	5
Crop group 13G: Berry and small fruit low growing berries	Aphids	Suspension	Ground application: surface band spray	1.8–2.88 g a.i. /100m of row 100 to 480 g a.i./ha	1	Not applicable
	Strawberry aphid (on strawberry only)			204–312 g a.i./ha		

Site(s)[1]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single	Maximum Number of Applications per year	Minimum Application Interval (Days)
	Reduction in numbers of white grubs (larvae of European chafer)		Ground application: soil drench	288 g a.i./ha	1	Not applicable
	Aphids, leafhoppers (suppression)		Ground application: foliar spray	42 g a.i./ha	2	Not stated
Cranberry	Reduction in numbers of white grubs (larvae of European chafer)		Ground application: soil drench	288 g a.i./ha	1	Not applicable
Crop group 14: Tree nuts plus Pistachio	Aphids (except woolly apple aphid)	Suspension	Ground application: airblast	55.2 g a.i./ha	2	6
	leafhoppers (suppression)			48 g a.i./ha		
Barley, oats, wheat	Wireworm	Suspension	Commercial and on farm seed treatment facilities: seed treatment equipment	10–30 g a.i./100 kg seed for early season crop protection 20–30g a.i./100 kg seed in fields with high pest pressure	1	Not applicable
Field corn (seed production only),	Corn flea beetle	Suspension	Commercial seed treatment facilities: seed treatment equipment	48 g a.i./80 000 seeds	1	Not applicable
Field corn (including seed production)	Wireworm		Commercial seed treatment facilities: seed treatment equipment	13 g a.i./80 000 seeds		
Sweet corn (Ontario and Québec only)	Corn flea beetle			250 g a.i./100 kg seed		
	Wireworm			67.2g a.i./100 kg seed		
Crop group 19A: Herbs	Aphids	Suspension	Ground application: soil drench	1.44 g a.i./100 m of row 79.92 to 480 g a.i./ha	1	Not applicable
	Aphids, leafhoppers (suppression)		Ground application: foliar spray	48 g a.i./ha	2	5
Hops	Aphids	Suspension	Ground Application: foliar spray	55.2 g a.i./ha	2	28
Canola, mustard (condiment type only), rapeseed	Flea beetle	Wettable powder, suspension	Commercial seed treatment facilities: seed treatment equipment	400-802 g a.i./ 100 kg seed	1	Not applicable

Site(s)[1]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single	Maximum Number of Applications per year	Minimum Application Interval (Days)
Mustard (oilseed type)		Suspension		400 g a.i./100 kg seed or 800 g a.i./100 kg seed		
Tobacco	Aphids	Suspension	Ground application: foliar spray	48 g a.i./ha	2	7
	Aphids, flea beetles		Ground application: soil drench	2.04 g a.i./100m of row 113.28–453.36 g a.i./ha	1	Not applicable
Residential, commercial, industrial, institutional and agricultural structures (indoors only) Various transport vehicles.	Cockroach (German, brown-banded, American and Oriental)	Paste	Ground application: Gel bait – spot and crack/crevice treatment	Light infestations: 1 placement (i.e., 0.1g of gel) per m^2 or linear meter. Moderate to heavy infestations: 2 placements 0.00215/m^2 for light infestations or 0.0044/m^2 for heavy infestations	Not stated	28
Christmas trees	Balsam twig aphid	Suspension	Ground application: airblast	60 g a.i./ha	2	7
Albizia, ash, birch, box elder, buckeye, elm, hackberry, horse chestnut, maple, mountain ash, poplar, silk tree, sycamore/London plane tree, willow	Asian longhorned beetle (suppression)	Solution	Ground application: trunk injection	0.09–0.19 g a.i./cm DBH	1	Not applicable
Birch, elm, hackberry, horse chestnut, maple, mountain ash, poplar, silk tree, sycamore/London plane, willow	Asian longhorned beetle (suppression)	Solution	Ground application: trunk injection	0.257 g a.i./cm DBH	1	Not applicable
Spruce	Brown spruce longhorn beetle (suppression)					
Ash	Emerald ash borer (suppression)			0.09–0.275 g a.i./cm DBH		
	cottony ash psyllid			0.062 g a.i./cm DBH		

Site(s)[1]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single	Maximum Number of Applications per year	Minimum Application Interval (Days)
Birch	Bronze birch borer (suppression)					
Elm	European elm scale, elm leafminer					
Hemlock	Hemlock woolly adelgid					
Black locust	Locust leafminer					
Ornamental apple	Woolly apple aphid					
Ornamentals (field grown) including herbaceous perennials, ornamental grasses, trees, shrubs	European chafer (larvae) Japanese beetle (larvae)	Wettable powder	Ground application: soil drench	280 g a.i./ha	1	Not applicable
Ornamentals (container grown) including herbaceous perennials, ornamental grasses, trees, shrubs						
Turf (home lawns, business and office complexes, shopping complexes, multi-family residential complexes, airports, cemeteries, parks, playgrounds, athletic fields, golf courses and sod farms)	European chafer (larvae) Japanese beetle (larvae) Ataenius beetle (larvae)	Wettable powder (in water soluble bags)	Ground application:	281.25 g a.i./ha	1	Not applicable
	European crane fly larvae (suppression)					
	European chafer (larvae) Japanese beetle (larvae) Ataenius beetle (larvae)	Granular	Ground application: granular spreader drop and rotary type	280 g a.i./ha	1	Not applicable
	European crane fly larvae (suppression)					

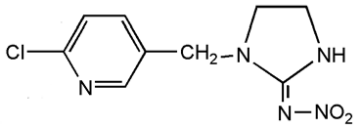
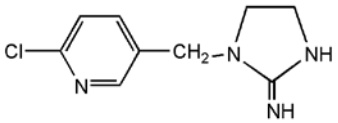
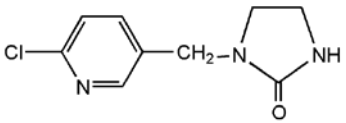
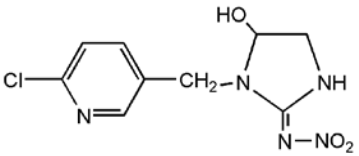
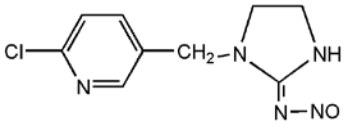
1 Crop groups are identified as listed on the end use product labels and may not be identical to the crop groups listed on the Health Canada Residue Chemistry Crop Groups website: http://hc-sc.gc.ca/cps-spc/pest/part/protect-proteger/food-nourriture/rccg-gcpcr-eng.php

Appendix IIb Registered Domestic Class Uses of Imidacloprid Considered in the Pollinator Risk Assessment in Canada as of 4 December 2017

Site(s)	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate (a.i.)		Maximum Number of Applications per Year	Minimum Number of Days Between Applications
				Maximum Single	Maximum Cumulative		
Turf	Larval stages of: European chafer, Japanese beetle, black turfgrass ataenius beetle, European crane fly	Granular	Granular broadcast spreaders	280 g/ha	280 g/ha	1	Not applicable

Appendix III Pollinator Exposure and Risk Assessment for Imidacloprid

Table 1 Imidacloprid and its transformation products formed in the environment

Code Name	Name	Structure	Matrix: Process (details)
Parent molecule:			
NTN 33893	Imidacloprid		N/A
Transformation products:			
NTN 38014 and NTN 33823	Imidacloprid-guanidine (also known as desnitro-imidacloprid): 1-[(6-chloropyridin-3-yl) methyl]imidazolidin-2-imine		Soil: Aerobic biotransformation (minor) Water: Phototransformation (major), aerobic biotransformation (major), anaerobic biotransformation (major) Plant: Metabolism
NTN 33519 and DIJ9817	Imidacloprid-urea (also known as 2-keto-imidacloprid): 1-[(6-chloropyridin-3-yl) methyl]imidazolidin-2-one		Soil: Aerobic biotransformation (major) Water: Phototransformation (major), aerobic biotransformation (minor) Plant: Metabolism
WAK4103	Monohydroxy-imidacloprid (also known as 5-hydroxy-imidacloprid): (5R,E)-N-[1-[(6-chloropyridin-3-yl) methyl]-5-hydroxyimidazolidin-2-ylidene]nitramide		Soil: Phototransformation (minor) Water: Phototransformation (not quantified), aerobic biotransformation (minor) Plant: Metabolism
WAK3839	Imidacloprid-nitrosimine: (E)-N-[1-[(6-chloropyridin-3-yl) methyl]imidazolidin-2-ylidene]nitrous amide		Soil: Aerobic biotransformation (minor) Water: Aerobic biotransformation (minor) Plant: N/A

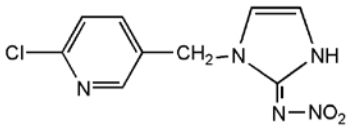
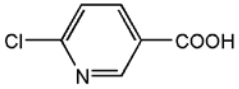
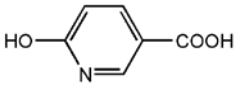
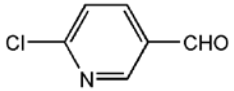
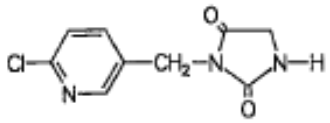
Code Name	Name	Structure	Matrix: Process (details)
NTN35884	Imidacloprid-olefin: (E)-N-[1-[(6-chloropyridin-3-yl) methyl]-1H-imidazol-2(3H)-ylidene]nitramide		Soil: Aerobic biotransformation (minor) Water: N/A Plant: Metabolism
BNF5518A	6-chloronicotinic acid: 6-chloropyridine-3-carboxylic acid		Soil: Aerobic biotransformation (minor) Water: Phototransformation (not quantified), aerobic biotransformation (minor) Plant: Metabolism
GBH4315 and BNF5540	6-hydroxynicotinic acid: 6-hydroxypyridine-3-carboxylic acid		Soil: N/A Water: Aerobic biotransformation (minor) Plant: N/A
MAT10429	6-chloronicotinic aldhehyde: 6-chloropyridine-3-carbaldehyde		Soil: N/A Water: Phototransformation (not quantified) Plant: N/A
WAK5060	2,5-diketo-imidacloprid: 3-[(6-chloropyridin-3-yl) methyl]imidazolidine-2,4-dione		Soil: Aerobic biotransformation (minor) Water: Phototransformation (not quantified), aerobic biotransformation (minor) Plant: N/A

Table 1a Summary of Fate Processes for Imidacloprid in the Terrestrial and Aquatic Environment – Abiotic and Biotic Transformation

Process	$T_{1/2}$ or DT_{50} (days)	DT_{90} (days)	Kinetics (T_R or $T_{1/2slow}$)	Comments	PMRA Reference (original study / foreign review)
Abiotic transformation					
Hydrolysis Technical, 25ºC, 30 days	pH 5: Stable pH 7: Stable pH 9: 346	NR	SFO	Resistant to hydrolysis at environmental pH	1155840
Hydrolysis Technical	pH 10.8: 20 pH 11.8: 2.85	NR	SFO	Hydrolysis is shown to occur under highly alkaline conditions; these conditions are not considered environmentally relevant.	2535318 / (2332664 and 2334762)
Phototransformation soil Technical, sandy loam soil, pH 5.2, 1.4% OC, 25ºC, 15 d.	38.9 (continuous irradiation) 171 (predicted environmental – midsummer sunlight at 40º latitude)	NR	SFO	Photolysis is shown to range considerably in soil (18 hours to 38.9 days under continuous irradiation). The reason for the difference between studies is unclear but may be due to differing soil conditions (for example, soil moisture, adsorption to soil, light penetration into soil, microbial activity). Photolysis not a pathway for transformation of the compound on soil.	1155829 / (2332664 and 2334762)
Phototransformation soil Technical, sandy soil, pH 5.5, 2.7% OM, 25ºC, 6 h.	Continuous irradiation – reported equivalent to natural sunlight in Phoenix at noon in June 19.2 (moist soil) 34.6 (air dried soil)	NR	SFO		2332668 / 2334762
Phototransformation soil Technical, sandy soil, pH 7.1, 1.14% OM, 20ºC, 32 h.	18 hours Authors claim that the apparatus used exhibits a radiation close to natural sunlight.	NR	SFO		2334719
Phototransformation water Technical, pH 7, 23ºC, 2h.	< 1 hour (continuous irradiation) 4.2 hours (predicted environmental – summer sunlight at 35º latitude)	NR	SFO	Rapidly transformed in water.	1155834 / (2332664, 2332663 and 2334762)
Phototransformation water Technical, pH – nr, 25ºC	< 1 hour (continuous irradiation; predicted environmental half-life not reported)	NR	SFO		2332667

Process	$T_{1/2}$ or DT_{50} (days)	DT_{90} (days)	Kinetics (T_R or $T_{1/2slow}$)	Comments	PMRA Reference (original study / foreign review)
Phototransformation water Technical, pH – nr, 25ºC, 1.3 h	< 1 hour (continuous irradiation; predicted environmental half-life not reported)	NR	SFO	Rapidly phototransformed in water. Additional experiments conducted with photosensitizers. Under the irradiation of black light fluorescent lamp, photosensitizers (acetone, hydrogen peroxide and titanium dioxide) were shown to accelerate the photodegradation in aqueous solution. Under UV irradiation, however, addition of acetone inhibited phototransformation of imidacloprid.	2332670
Phototransformation water Technical and Confidor, pH – nr, 25ºC, ~12 h	$t_{1/2}$ (technical) = less than one hour $t_{1/2}$ (Confidor) = 2.1 hours $t_{1/2}$ (Confidor + TiO_2) = 2.4 hours All experiments: continuous irradiation; predicted environmental half-life not reported.	NR	SFO	Rapidly transformed in water. Coloured components of the formulation were shown to slow the rate of transformation.	2332671
AEROBIC SOIL BIOTRANSFORMATION					
Loamy soil (BBA2.2): pH 6.3, 2.15% OC, 20ºC, ~365 days	157	557	DFOP (172 days)	Moderately persistent	1155830
Silt soil (Höefchen): pH 5.5, 1.23% OC, 20ºC, ~365 days	273	6065	IORE (1830 days)	Persistent	1155832
Sandy loam (Monheim): pH 6.76, 1.31% OC, 20ºC, ~365 days	453	2615	DFOP (931 days)	Persistent	1155864
Sandy loam (Kansas): pH 6.5, 1.4% OC, 20ºC, ~365 days	973	4072	DFOP (1330 days)	Persistent	1155838
Soil: pH 6.0, 17.24 g/kg OM, 28ºC, 25 days Soil characteristics not reported.	173.3	NR	SFO	Moderately persistent	2332676

Process	$T_{1/2}$ or DT_{50} (days)	DT_{90} (days)	Kinetics (T_R or $T_{1/2slow}$)	Comments	PMRA Reference (original study / foreign review)
Sandy loam (Exeter): pH 4.6, 0.21% OC Silty clay loam (Drummer): pH 5.6, 4.49% OC 25ºC, 400 days	> 400 Variability and biphasic transformation prevented adequate assessment of the transformation kinetics; the DT50 values were reported as greater than 400 days.			Persistent	2332677
Anaerobic Soil Biotransformation					
A laboratory anaerobic soil biotransformation study was not available for review.					
Aerobic Aquatic Biotransformation					
Kansas water/sediment system Water: pH 8.6, TOC = 4.3 mg/L Sediment: Silty clay, pH 7.62, 3.1% OC 22ºC, 30 days, darkness	Water phase: 160 Whole system: 126	Water phase: 762 Whole system: 419	DFOP (259 days) SFO	Moderately persistent	2142816
Kansas water/sediment system Water: pH 8.6, TOC = 4.3 mg/L Sediment: Silty clay, pH 7.62, 3.1% OC 22ºC, 30 days, darkness	Water phase: 160 Whole system: 126	Water phase: 762 Whole system: 419	DFOP (259 days) SFO	Moderately persistent	2142816
Ijzendoorn water/sediment system Water: pH 7.9 – 8.4 Sediment: loamy silt, 4.1% OC 22ºC, 92 days, darkness	Water phase: 18.2 Whole system: 31.5	Water phase: 60.4 Whole system: 105	SFO SFO	Slightly persistent	2142817
Lienden water/sediment system Water: pH 8.1 – 8.9 Sediment: loamy sand, 0.8% OC 22ºC, 92 days, darkness	Water phase: 138 Whole system: 159	Water phase: 542 Whole system: 529	DFOP (174 days) SFO	Moderately persistent	
Pondwater (Norfolk County, Ontario) Water pH: 7.73 – 9.01 22ºC, 366 days, darkness	Water phase: 331 (no sediment used)	NR	SFO	Persistent	1182373

Process	$T_{1/2}$ or DT_{50} (days)	DT_{90} (days)	Kinetics (T_R or $T_{1/2slow}$)	Comments	PMRA Reference (original study / foreign review)
Pondwater (Norfolk County, Ontario) Water pH: 7.71–9.30 22ºC, 366 days, exposed to artificial light (12 hour light/dark cycle)	Water phase: 4.2 (no sediment used)	NR	SFO	Non persistent	
Anaerobic Aquatic Biotransformation					
Kansas water/sediment system Water: 6.9–7.4, TOC = 5 mg/L Sediment: pH 6.89, 3.15% OC	Whole system: 27	NR	SFO	Slightly persistent	1155865

DFOP = double first order in parallel; IORE – Indeterminate Order Rate Equation model; nr = not reported; OC = organic carbon content; OM = organic matter content; SFO = single first order

Table 1b Summary of Fate Processes for Imidacloprid in the Terrestrial and Aquatic Environment – Mobility

Process	Soil type	K_d or K_f (1/n)	K_{oc}	Comments	PMRA Reference (original study / foreign review)
Adsorption: Imidacloprid	Twelve soils: sand, 6 sandy loam, loamy sand, silt loam, silt, silt clay and loam	0.96–4.18 (0.76–0.89)	109–411	The arithmetic mean (n=12) for the K_{oc} is 225 ± 87.	2332663
	Seven soils: fine sand (Winder), silty clay loam (Drummer), fine sandy loam (Hanford), sandy loam (Tifton), silty clay (Oska-Martin), silt loam (Crane), silty clay loam (Dundee)	0.1–13.3	41–433	Adsorption data determined for three concentrations for each soil (3, 50 and 100 µg /mL). K_d/K_{oc} values were calculated from a single initial solution concentration data using a soil:solution ratio of 1:1.	2142713 / (2332664 and 2332665)
	Sandy loam (day 0)	4.82	249	Calculated sorption coefficients K_d and K_{oc} determined in soil after selected aging periods (0, 2, 7, 14, 28, 56 and 100 days). K_d/K_{oc} values increased by a factor of 3.2–3.8 during 100 days of aging. K_d and K_{oc} values for day 0 and 100 only were reported in the study. K_d/K_{oc} values were calculated from a single initial solution concentration data.	2535320, 2142716
	Sandy loam (day 100)	15.6	869		
	Silt loam (day 0)	2.24	268		
	Silt loam (day 100)	8.6	960		

Process	Soil type	K_d or K_f (1/n)	K_{oc}	Comments	PMRA Reference (original study / foreign review)
	Five soils: P1, P6, P7, P10, P12	3.36–8.95	269–830	The study assessed the influence of different components of the clay fraction in five soils and model sorbents (montmorillonite, Fe oxide and humic acid and their binary and ternary associations on sorption); results shown in this table are for unadulterated soils, not for model sorbents. Freundlich isotherms (K_f, K_{foc}) were determined for soils treated in the range of 0.05 – 1.5 mg/L (4 concentrations). The overall results demonstrated that adsorption on clay soils increases with organic matter content.	2142724
	Four soils: sandy loam (Kansas), silt (Höefchen), standard soil (2.1), silty clay (Ranschbach)	0.36–0.95	47.6–94.8	Highly mobile	1155827
	Six soils: clay (LR-CP), clay (AQ-MC), loamy sand (LR-LN), sand (AQ-TM), sandy loam (AQ-VN), sandy clay loam (PV-VC)	0.55–16.9	158–779	It is uncertain as to whether the adsorption coefficients (K_d) were determined from linear isotherms or single point adsorption data. Brazilian soils.	1086407
	Clay loam (Webster)	17.6 (non aged) 40 (aged)	429 975	Soils were aged for 16 weeks. Results indicate that adsorption increases with soil ageing. K_d values were calculated from single initial concentration data.	1172514
	Silt loam (Waukegan)	7.1 (non aged) 17 (aged)	394 944		
	Sandy loam (Verndale)	7.05 (non aged) 20 (aged)	435 1428		
	Three soil: Clay loam (Webster), silt loam (Waukegan), sandy loam (Verndale)	1.0–64	71–1560	Adsorption data determined for three concentrations for each soil (0.05, 1.5 and 250 g/mL). K_d/K_{oc} values were calculated from a single initial solution concentration data using a soil:solution ratio of 1:5. Results indicate that adsorption of imidacloprid is affected by initial solution concentration, in addition to soil properties such as the soil organic carbon content and % clay content (affinity is less at higher soil solution concentration, resulting in a high potential for mobility).	2142715
	Six soils: S1 – S6	0.61–5.09 (0.72–0.93)	102–243	Percent organic matter content and Kom values were presented in the study.	2332667

Process	Soil type	K_d or K_f (1/n)	K_{oc}	Comments	PMRA Reference (original study / foreign review)
	Clay soil	1.43 (0.76)	210		2334736
	Sandy soil	0.39 (1.12)	59	Adsorption was shown to increase with organic amendments; K_d increased from 0.75 to 4.25 for three organic amendments tested.	2334719
	Heavy clay (Bornsjön)	3.08	130	Adsorption was shown to increase with biochar amendment; K_d increased to 6.19 and 7.40 (Bornsjön and Säby, respectively).	2358285
	Loam (Säby)	4.40	150		
	Sandy clay loam	Low percent sorption over the test period; the average percent adsorption increased to 20.43% within the first 24 hours and increased further to 24.04% by 96 hours.			2334741
	Four surface soils and one acid washed sand	2.4–7.6 (after 24h) 3.5–9.4 (after 28 days)	NR	^{14}C imidacloprid was used and measured via LSC. Transformation products such as imidacloprid-guanidine, imidacloprid-guanidine-olefin, and imidacloprid-urea may have been produced over the course of the study. Imidacloprid-guanidine and imidacloprid-guanidine-olefin are known to adsorb more strongly to soil than parent imidacloprid. The increase in adsorption with time may have been due to increases in these or other transformation products. The K_d values are expected to be representative of parent and increasing amounts of transformation products with time.	2334745
Adsorption: Imidacloprid-guanidine	Clay loam (Webster)	53.4 (non aged) 126 (aged)	1302 3073	Soils were aged for 16 weeks. Results indicate that adsorption increases with soil ageing. K_d values were calculated from single initial concentration data.	2142719
	Silt loam (Waukegan)	40.2 (non aged) 90.6 (aged)	2233 5033		
	Sandy loam (Verndale)	31.4 (non aged) 71.1 (aged)	2243 5078		
	Three soil: Clay loam (Webster), silt loam (Waukegan), sandy loam (Verndale)	36.8–351	2627–8571	Adsorption data determined for two concentrations for each soil (0.05 and 1.5 g/mL). K_d/K_{oc} values were calculated from a single initial solution concentration data using a soil:solution ratio of 1:5.	2142715
	Four soils: sand (#396), loamy sand (#398), silt loam (#307), loam (#318)	2.14–15.53	394–1254	Low to medium mobility	1155825
	Six soils: clay (LR-CP), clay (AQ-MC), loamy sand (LR-LN), sand (AQ-TM), sandy	4.74–134	92–9219	It is uncertain as to whether the adsorption coefficients (K_d) were determined from linear isotherms or single point adsorption	1086407

Process	Soil type	K_d or K_f (1/n)	K_{oc}	Comments	PMRA Reference (original study / foreign review)
	loam (AQ-VN), sandy clay loam (PV-VC)			data. Brazilian soils.	
	Fine sandy loam (Hanford)	6.75 (0.92)	1646	Low mobility	2142714
	Silty clay loam (Drummer)	42.2 (0.83)	1068		
Adsorption: Imidacloprid-urea	Clay loam (Webster)	6.80 (non aged) 14.1 (aged)	165 343	Soils were aged for 16 weeks. Results indicate that adsorption increases with soil ageing. K_d values were calculated from single initial concentration data.	2142719
	Silt loam (Waukegan)	3.03 (non aged) 7.46 (aged)	168 414		
	Sandy loam (Verndale)	2.90 (non aged) 9.61 (aged)	207 686		
	Three soil: Clay loam (Webster), silt loam (Waukegan), sandy loam (Verndale)	2.92–16.9	199–411	Adsorption data determined for two concentrations for each soil (0.05 and 1.5 g/mL). K_d/K_{oc} values were calculated from a single initial solution concentration data using a soil:solution ratio of 1:5.	2142715
	Six soils: clay (LR-CP), clay (AQ-MC), loamy sand (LR-LN), sand (AQ-TM), sandy loam (AQ-VN), sandy clay loam (PV-VC)	0.31–9.50	72–309	It is uncertain as to whether the adsorption coefficients (K_d) were determined from linear isotherms or single point adsorption data. Brazilian soils.	1086407
Adsorption: Imidacloprid-guanidine-olefin	Three soil: Clay loam (Webster), silt loam (Waukegan), sandy loam (Verndale)	43.1–244	308– 7672	Adsorption data determined for two concentrations for each soil (0.05 and 1.5 g/mL). K_d/K_{oc} values were calculated from a single initial solution concentration data using a soil:solution ratio of 1:5.	2142715
	Six soils: clay (LR-CP), clay (AQ-MC), loamy sand (LR-LN), sand (AQ-TM), sandy loam (AQ-VN), sandy clay loam (PV-VC)	2.87–72.3	487–4695	It is uncertain as to whether the adsorption coefffcients (K_d) were determined from linear isotherms or single point adsorption data. Brazilian soils.	1086407
Soil column leaching	^{14}C imidacloprid was added to soil columns (sandy loam) and aged 30 days prior to leaching. 48.5% of the ^{14}C activity remained in the upper soil layer of the columns with 54.2% found in the soil column segments. The leachate contaned ~ 0.14% of ^{14}C activity.				1155853
	Four soils and 1 sand: 27 to 69% of the ^{14}C activity leached from soil columns. 97% leached from the sand column.				2358286
	The effect of soil ammendment with biochar to the leaching potential of imidacloprid was investigated using soil columns (loam and clay soil). The results suggest that increased soil inorganic carbon reduces leaching potential of imidacloprid in soils.				2535319
	Lysimeters were used to monitor transformation and transport of ^{14}C labelled imidacloprid through sandy loam soil cores. A total of 0.024 and 0.037% of the ^{14}C activity was detected in two lysimeters over two trial years. 93% of the ^{14}C activity				1160858

Process	Soil type	K_d or K_f (1/n)	K_{oc}	Comments	PMRA Reference (original study / foreign review)
	was contained in the top 20 cm layer of the lysimeters with virtually no residues detected below 30 cm. The majority of the recovered radioactivity was present as parent.				
Prospective groundwater studies	The potential for imidacloprid to leach through soil into groundwater was investigated in two small scale prospective ground water (PGW) monitoring studies (Monterey County – California and Montcalm County – Michigan). The results of the two PGW studies show that imidacloprid residues can persist in soil long after application and will migrate through soil.				1057483 and 898825

NR = not reported

Table 1c Summary of Fate Processes for Imidacloprid in the Terrestrial and Aquatic Environment – Field Studies

Process	$T_{1/2}$ or DT_{50} (days)	DT_{90} (days)	Kinetics (T_R or $T_{1/2slow}$) (days)	Comments	PMRA Reference (original study / foreign review)
Terrestrial field studies					
Harriston, Ontario Silt loam (bare soil): pH 7.3, 6.2% OM, 1095 days	45–426	~1095	SFO	Residual imidacloprid in soil at end of study was 12–13% of the target application rate.	1174609
Harriston, Ontario Loam (turf cover): pH 7.3, 4.0% OM, 1099 days	2–33	457–743	SFO	Residual imidacloprid in soil at end of study was < LOQ.	1174607
Summerland, BC Sandy loam (turf cover): pH 7.6, 2.9% OM, 729 days	16–21	< 456	SFO	Residual imidacloprid in soil at end of study was < LOQ.	1174611
Kinkora, P.E.I. Sandy loam (bare soil): pH 6.8, 3.03% OM, 1099 days	210–456	> 1099	SFO	Residual imidacloprid in soil at end of study was 77–86% of the target application rate.	1174608
Kinkora, P.E.I. Sandy loam (planted with potatoes): pH 6.9, 2.57% OM, 1095 days	63–178	> 1099	SFO	Residual imidacloprid in soil at end of study was 76–82% of the target application rate.	1174610
Sandy loam (Kirchlauter-Pettstadt): pH 6.5, 0.79% OC, 360 days	178–216	NR	SFO	Field trials were conducted in Germany. After the twelve months of test duration 31 to 44% of the initial concentration of imidacloprid were found in the soil.	1155868/2332663
Silty loam (Swisttal-Hohn): pH 6.8, 1.00% OC, 360 days	185–208	NR	SFO		
Silt loam (Hofchen): pH 6.8, 1.11% OM, 360 days	104–131	NR	SFO		
Loam (Worms-Heppenheim): pH 7.4, 1.56% OC, 360 days	197–228	NR	SFO		
Sandy loam (Laacher Hof): pH 6.7, 1.27% OC, 360 days	152–186	NR	SFO		
Georgia loamy sand: pH 5.8, 2.0% OM, 365 days	> 365	NR	SFO		1155870/2332665
Minnesota sandy loam: pH 6.3, 1.8% OM, 365 days	> 365	NR	SFO		1155835/2332665

Process	$T_{1/2}$ or DT_{50} (days)	DT_{90} (days)	Kinetics (T_R or $T_{1/2slow}$) (days)	Comments	PMRA Reference (original study / foreign review)
California sandy loam: pH 7.1, 1.1% OM, 365 days	146	NR	SFO		1155837/2332665
Georgia loamy sand (turf): pH 5.8, 2.0% OM, 365 days	107	NR	SFO		1155836/2332665
Minnesota loam (turf): pH 7.6, 5.1% OM, 120 days	61	NR	SFO		1155869/2332665
Belgian silt loam: pH 6.8, 2.55% OC. 96 days (after sowing of treated sugar beets seed – 90 g a.i./ha)	87–129 (amended with manure) 42(control)	NR	NR	It was reported that there were no residues of the parent and the transformation products imidacloprid-urea, 6-chloronicotinic acid, and 6-hydroxynicotinic acid detected in the 10–20 cm soil layer in all plots.	2350951
Belgian silt loam: pH 7.0, 1.25% OC. 96 days (after sowing of treated sugar beets seed – 90 g a.i./ha)	105–124 (amended with manure) 44 (control)	NR	NR		2350950
Long-term field dissipation: repeated single seasonal application within apple orchard for 6 consecutive years (150 g a.i./L).	Maximum residues in soil were observed directly after application and declined to 50% or less of the initial value within 3 to 4 months. During the first three years, residues increased in soil (0–30 cm) after which residues reached a plateau level at all three sites. Although the results predominantly show that imidacloprid residues did not move beyond 30 cm depth, transformation products were not identified or quantified in the soil samples. The results, therefore, do not preclude the movement of transformation products beyond 20–30 cm depth.				2464657
Long-term field dissipation: treated winter barley seed sown for 6 consecutive years (35 and 75 g a.i./100 kg seed).	The maximum residues in soil were observed in the upper 20 cm layer; this was expected, since the upper soil layers were mixed by ploughing and harrowing. Cultivation activity may have led to some minor mixing of soil containing imidacloprid residues into the 20–30 cm layer. In the 30–50 cm layer residues were not detected. Residues in the 0–30 cm layer increased gradually during the first three years after which residues reached a plateau level and remained constant. The overall residue levels throughout the trials, however, were low. Overall, the results show that the use of treated seed does not result in the movement of imidacloprid residues beyond 30 cm depth. Transformation products were not identified or quantified in the soil samples; the results, therefore, do not preclude the movement of transformation products beyond 30 cm depth.				2464661
Aquatic field studies					
Outdoor mesocosms: 182 days; Imidacloprid SL200 (17.3% w/w)	Imidacloprid was sprayed onto the surface of ponds at 0.6, 1.5, 3.8, 9.4 and 23.5 µg a.i./L (n=2 per treatment, 3 controls). SFO DT_{50} values for the water column ranged from 5.7 to 13 days (average = 8.2 days). Whole system DT_{50} values were calculated for the two highest test concentrations; values ranged from 10.6 to 29.9 days after both applications (average = 14.8 days).				2142729
Outdoor mesocosm: 7 days; imidacloprid (purity not reported)	The rate of dissipation was followed in mesocosms treated with three pulses of imidacloprid (17.3 µg a.i./L) at 7-day intervals. Overlying water was collected at 6 hours and 1, 2, 3 and 7 days after each pulse and 7 weeks after the 3rd pulse. SFO DT_{50} values for each of the three pulses was 20, 36 and 29 hours. In other mesocosms containing benthic assemblages (treated at 0.6, 1.4, 3.2, 7.5, 17.3 and 40 µg a.i./L), concentrations were detectable in water 7 weeks after the 3rd pulse (0.06–1.72 µg a.i./L) , except at the lowest concentration (0.6 µg a.i./L); concentrations remained detectable in sediment in mesocosms treated with ≥ 7.5 µg a.i./L (0.02 to 0.13 µg /kg).				2544391
Outdoor mesocosms 56 days Imidacloprid (> 95.8%)	The rate of dissipation in water and sediment of mesocosms was followed for 56 days. Imidacloprid was sprayed onto the surface of ponds at 2, 6, 20, 60 and 180 µg a.i./L (n=3 per treatment, 11 controls); four applications were made at 2 week intervals. A half-life in the water column of 1.4 days is reported for after the last application. Imidacloprid did not accumulate in sediment and residues were below the detection limit two weeks after the last application.				1155896

nr = not reported; OC = organic carbon content; OM = organic matter content; SFO = single first order

Appendix IV Pollinator risk assessment framework

The pollinator risk assessment for imidacloprid followed a tiered framework developed jointly by the PMRA, USEPA and CDPR in 2012 (North American Guidance for Assessing Pesticide Risks to Bees https://www.epa.gov/pollinator-protection/pollinator-risk-assessment-guidance). The **risk assessment framework** consists of exposure characterization and effects characterization relative to bees and moves from a highly conservative risk assessment at lower tiers (Tier I) to a more realistic assessment at higher tiers (Tiers II and III). When potential for risk is indicated at a lower tier, the risk assessment can be refined by using higher tier information. **Risk Characterization** is the final phase of the risk assessment and includes an interpretation of the risk in the context of all available information and any limitations and considerations in a weight of evidence approach as well as the degree of exposure. A brief summary of the framework is provided below.

Step 1	**Determine if Bees may be Exposed (Pollinator Exposure: PE)** Considers information on the pesticide use characteristics, chemical properties and potential exposure routes to determine the need for conducting a risk assessment. If exposure is not a concern for a specific use, a presumption of minimal risk is made. Risk assessment proceeds for uses with potential for bee exposure.
Step 2	**Calculate Tier I Screening Level Risks (T1SL)** Considers effects on individual bees in the laboratory compared with conservative default exposure estimates; *Apis* as surrogate; (non-*Apis* T1 effects endpoints suggest similar sensitivity);
Step 3	**If applicable, refine Tier I Screening Level Risk Estimates using residues in pollen and/or nectar (T1R)** • **Residues** – Residues are used to refine oral exposure estimates in pollen and nectar. The relevance of available residue data compared to the Canadian use pattern are considered, including crops rates, and timing. • **Refined Assessment -** Considers effects on individual bees in the laboratory compared with pollen/nectar residue exposure information
Step 4	**If applicable, Tier 2 Risk Estimation (T2)** Considers T2 colony feeding studies and tunnel studies with *Apis* or non-*Apis* bees • **Colony Feeding Study Assessment (T2 CFS) -** Colony Feeding Studies dose whole colonies of *Apis* or non-*Apis* bees with contaminated nectar or pollen. The assessment then considers effects on the colony compared with pollen/nectar residue exposure information. • **Tunnel Studies (T2 Tunnel)** – Considers effects on *Apis* or non-*Apis* colonies resulting from exposure through relevant application to crops/flowering plants; bees are confined to treatment site in tent/tunnel.

Step 5	**If applicable, Tier 3 Risk Estimation (T3)** Considers field studies and incident reports with *Apis* or non-*Apis* colonies • **Field Studies-** Considers effects on colony resulting from exposure through relevant application to crops/flowering plants in the field; bees are free foraging. • **Incidents and monitoring**– Considers information from incident reports and other monitoring type studies in the field.
Step 6	**Risk Characterization** Overall risk description is based on consideration of all available information: • Considers both *Apis* and non-*Apis* bees. • Takes into account considerations and limitations. Risk characterization also considers how risk can be mitigated through restrictive label language and/or best management practices.

Criteria for pollinator exposure

Pollinator Exposure Potential (through pollen/nectar exposure routes):

The potential of a treated crop to result in pollinator exposure to pesticides is considered in both the risk characterization and in determining appropriate risk management.
The main exposure routes considered in the pollinator risk assessment include:

- oral exposure (through pollen and nectar);
- contact exposure (directly to spray or residues on flowers);
- dust exposure through planting of treated seeds (pesticide containing dust emitted from planters may contact foraging bees or flowering forage sources utilized by bees).

Multiple factors influence the potential for pollinator exposure through these routes including:

- method, timing and equipment used for application (e.g, foliar, soil treatment, seed treatment);
- specific pesticide properties (e.g., systemic or non-systemic, persistence, formulation);
- agronomic considerations (e.g., does crop flower with a nectar and/or pollen source; length of bloom period and how long single flowers last; when harvested relative to bloom; presence of flowering groundcover in treatment areas).

Where there is potential for pollinator exposure identified for the contact and particularly the oral route via pollen and/or nectar, there is further consideration regarding the likelihood of pollinator exposure for both *Apis* and non-*Apis* bees. The likelihood of exposure depends on crop attractiveness to pollinators, as well as multiple other agronomic considerations.
Characteristics that are considered when determining the potential for pollinator exposure include the following:

Pollination services	Considers whether: • Crop requires insect pollination for production (i.e. not wind or self-pollinated) • Crop benefits from insect pollination, e.g., by enhanced crop production • Crop uses commercial pollination services • Crop is used for honey production
Crop attractiveness	Use of crop by *Apis* (honey bees) and non-*Apis* (bumble bees, solitary bees) bees as a pollen and/or nectar food source. Considers whether the crop pollen and/or nectar source is major, minor, or not a source: • major (high attractiveness; frequently visited; extensively used) • minor (few bees have been noted to forage on the crop; certain bees visit infrequently; attractive under certain conditions, e.g. when few alternative food sources available) • not a source (bees are absent from a crop or pollen or nectar resource; plant has no source of pollen and/or nectar)
Crop acreage	Considers whether crop has high or low acreage. Higher acreage crops are expected to result in more exposure. Considers total acreage in Canada as well as field sizes and whether they are located over large areas.
Harvest before bloom	Considers whether the crop is harvested before bloom. If harvested before bloom, crop is not attractive to pollinators since there is no nectar or pollen source available.
Seed production	Considers whether crop is grown for seed production in Canada. If a crop harvested before bloom is grown for seed production in Canada, then consideration of the above pollinator exposure characteristics should be used to determine pollinator exposure when grown for seed.

Pollinator Exposure Potential through pollen/nectar was determined to be High, Moderate, Low, or None/Negligible, considering the following:

High	High Pollinator Exposure has the following characteristics: • Pollination services: Crop requires insect pollination for production (i.e. not wind or self-pollinated); Crop benefits from insect pollination; Crop may use commercial pollination services; Crop may be used for honey production • Crop is a major source of pollen and/or nectar to *Apis* and/or non-*Apis* bees • Crop is not harvested before bloom
Moderate	Moderate Pollinator Exposure has the following characteristics: • Pollination services: Crop does not require insect pollination for production (i.e. is wind or self-pollinated); Crop may benefit from insect pollination; Crop may use commercial pollination services;

	Crop may be used for honey production • Crop is a major source of pollen and/or nectar to only a few species of bees, typically non-*Apis* bees, and with medium to low crop acreage; OR • Crop is a minor source of pollen and/or nectar to *Apis* and/or non-*Apis* bees with high crop acreage • Crop is not harvested before bloom.
Low	Low Pollinator Exposure has the following characteristics: • Pollination services: Crop does not require insect pollination for production (i.e. is wind or self-pollinated); Crop does not benefit from insect pollination; Crop does not use commercial pollination services; Crop is not used for honey production • Crop is a minor source of pollen and/or nectar to *Apis* and/or non-*Apis* bees • Crop acreage is medium to low. • Crop is not harvested before bloom.
None/Negligible	No/Negligible Pollinator Exposure has the following characteristics: • Pollination services: Crop does not require insect pollination for production (i.e. is wind or self-pollinated); Crop does not benefit from insect pollination; Crop does not use commercial pollination services; Crop is not used for honey production • Crop is not known to be a source of pollen and/or nectar to *Apis* or non-*Apis* bees, or use of crop pollen or nectar is very rare. • OR Crop is harvested before bloom.

Considerations in the risk characterization

Considerations and Challenges: The overall risk characterization considers all available information and any challenges and considerations. The main considerations and challenges in the risk assessment include:

- Residue information: Consider relevance for Canadian crops, rates, timing.
- Consider amount of higher tier information: Consider whether risk characterization included higher Tier information from Tier II tunnel and/or Tier III field studies, Incident Reports.
- Consider crop bloom time compared to CFS exposure durations: Whether bloom time comparable to, shorter than, or longer than the CFS effects exposure periods, as may potentially result in over/under estimation of risk.
- Effects endpoints: At all Tiers there was variation in effects observed among different studies, as would be expected. This was particularly true among the CFS. There were limitations and differences among some CFS endpoints, particularly for the pollen-CFS. The full range of endpoints was considered for nectar-CFS and pollen-CFS. *Apis* and non-*Apis* endpoints were considered.
    - ***Apis* Pollen-CFS:** A range of effects endpoint values derived from open and closed pollen-CFSs were considered for comparison with residues from pollen and/or estimated bee bread residues. For imidacloprid, there were large gaps between test concentrations in some studies, as well as different exposure durations among pollen-CFS studies making study interpretation challenging. In some of the studies, there

was a lack of raw data to confirm results or a lack of replication of test doses.
    - Specific pollen-CFS endpoints considered were as follows:
        - Imidacloprid: NOEC: 20 ppb and LOEC of 100 ppb in pollen patties from an open field feeding study. It is noted that there was a wide dosing space between the NOEC and LOEC values, and the effects observed at LOEC were not consistently observed among multiple years of the study, thus both endpoints are used in the risk assessment for pollen exposure route.
- ***Apis* Nectar-CFS:** Effects endpoint values derived from an open nectar-CFS were considered for comparison with nectar residues. The effect endpoint value was selected from a relatively robust nectar-CFS. In this study, multiple colony parameters were measured for an extended duration, such as foraging, hive weight, number of individuals at different life stages in the hive, hive honey and pollen stores, disease levels, and hive overwintering survival.
    - Specific nectar-CFS endpoints considered were as follows:
        - Imidacloprid: NOEC: 23.3 ppb and LOEC of 46.7 ppb in sucrose solution. The endpoints were determined considering biological significance and the natural seasonal changes of honey bee colonies, as well as statistical analysis on multiple measurements including hive weight, number of individuals at different life stages in hive, hive honey and pollen stores and hive overwintering survival.
- **Non-*Apis* CFS:** The available non-*Apis* CFS had similar difficulties in interpreting the results as the *Apis* CFS, including variation in measurement parameters and differences in effects levels. A range of effects from open and closed nectar-CFSs and pollen-CFSs for non-*Apis* bees was considered for the endpoint, and the endpoint was compared with residues from pollen and nectar. Variation in measurement parameters and test durations make study interpretation challenging. For imidacloprid, thirteen non- *Apis* bee colonies feeding studies were considered.
    - Specific CFS endpoints considered were as follows:
        - Imidacloprid nectar exposure route: LOEC of 2.5 ppb in sugar solution (effects at 2.5 ppb on the reduction of the number of brood cells by 46% compared to the control).
        - Imidacloprid pollen exposure route: LOEC of 6 ppb in pollen. LOEC of 6 ppb in pollen + 0.7 ppb in sugar solution were reported in two studies (effects on reduced colonies size, the number of new queen production, the number of empty pupal cell, and pollen foraging efficiency). This effect value is reported in two colony studies and is more sensitive than what is reported in another relevant study. While the study was done with a combination of pollen and nectar, it is noted that bees are likely exposed to the combination of pollen and nectar simultaneously in the field, and, in addition, the test concentration in sugar solution is low, and much lower than the pollen concentration.

- Potential pollinator exposure for *Apis* and non-*Apis* bees. There is a different degree of exposure for bees depending on the crop. In some cases, if a crop is very attractive, many bees of different species are expected to forage on that crop, resulting in higher risk owing to higher exposure. In other cases, if a crop is not very attractive, there may be limited foraging on that crop. As such, less risk is expected because fewer bees will be exposed. A brief description of pollinator exposure is included below:

  - **High exposure**: crop requires or benefits from insect pollination; crop provides an available major source of pollen and/or nectar (*Apis* and/or non-*Apis*).
  - **Low/Moderate exposure**: crop does NOT require, but may benefit from insect pollination; crop provides a minor source of pollen/nectar; or crop is typically low acreage and provides a major source of pollen/nectar to only a few species. Pollinator exposure is lower if crop provides a minor source of pollen/nectar and acreage is low.
- In addition to challenges identified for individual studies, there are some additional challenges for the overall risk assessment. These challenges may include potential for combination effects resulting from possible interactions of imidacloprid and other chemicals or pathogens that may co-exist in the environment. Although a large number of non-*Apis* studies (> 40 studies) has been considered in the risk assessment, compared to the higher number of non-*Apis* bee species in the nature, this is relatively small amount of information for all non-*Apis* bees, especially for bee species that has unique biological traits, e.g., ground-dwelling bee species.

Additional consideration of bee bread in the risk assessment

Exposure: pollen and estimation of residue levels in bee bread

Because honey bees do not directly consume pollen, but rather consume bee bread, the possibility of estimating residues in bee bread was also considered. Since bee bread is a combination of pollen and honey (Winston 1987), it will be necessary to weight the empirical residues in pollen and nectar (from crops) based on their relative contributions in bee bread. Available information indicates that bee bread is 55% pollen and 45% nectar (based on dry weight). Potential concentrations of imidacloprid in bee bread will be calculated by adjusting wet-weight based measured concentrations for pollen and nectar (expressed as µg a.i./kg-ww). The adjustment involves converting samples from a wet-weight to a dry weight basis by dividing by the dry content of nectar (1–70% water) and pollen (1–8.4% water; water content is median of three available values). Dry-weight based concentrations in pollen and nectar are then multiplied by their relative proportions in bee bread, i.e., 0.55 and 0.45, respectively. The concentration of imidacloprid in bee bread is then adjusted to a wet-weight basis assuming a 25% water content for bee bread. Note that the differing water content for bee bread compared to pollen and nectar can result in bee bread residue concentrations that are greater than original wet-weight concentrations in pollen and/or nectar.

This approach employs several assumptions. First, bees are foraging in the treated area and pack bee bread cells on the same day with nectar and pollen. Second, that imidacloprid does not degrade while in bee bread, nectar or pollen. Third, that the pollen and nectar contents of bee bread are constant at a ratio of 55:45. There is uncertainty in this assumption because the variability in bee bread is unknown; this ratio is based on data for plants which also showed variability. Fourth, bees are collecting 100% of the contents of bee bread from treated plants. This approach is conservative in that collection of pollen and/or nectar from untreated sites or sites from edge habitats that receive spray drift deposition representing a fraction of the application rate.

While estimation of residues in bee bread were considered as a more realistic exposure estimate for honey bees, it is noted that this bee bread estimation may not actually be more realistic, and pollen is likely an adequately conservative estimation of exposure for the pollen/bee bread exposure route. Residue information is available from pollen and nectar collected directly from plants, honey bee collected nectar (from honey stomachs), bee collected pollen (from bee pollen baskets or from pollen traps), hive pollen (bee bread), and hive nectar and honey. In most cases residue levels tend to be lower in hive collected samples (hive pollen/bee bread; hive nectar/honey) as compared to samples collected from bees or from plants (plants tend to be highest). Therefore, the estimate of bee bread residues, which may result in higher residues than either pollen or nectar because of the different water content, does not seem to provide more realistic residue exposure estimates. Information on measured residues suggest that bee bread is typically much lower in residue levels than pollen and/or nectar collected directly from plants or brought back by bees (presumably due to dilution, degradation, processing, etc.), and therefore the estimation of residues in bee bread may not provide a more realistic estimate of exposure in most cases, even though it is a more realistic food source for honey bees. Use of the bee bread estimation may still be helpful if an estimation of exposure through a pollen route is needed in cases where a plant has only nectar and no pollen, or when it is important to consider the contribution of both pollen and nectar to the exposure through the bee bread route. While bee bread estimations are presented in this risk assessment, it is noted that they are likely overly conservative regarding the estimated exposure, and that pollen may be more representative of exposure and also a conservative estimate.

It is also noted that when using honey bee as a surrogate for non-*Apis* bees, the bee bread exposure route estimate may not be relevant. Most non-*Apis* bees use pollen to create a food provision for larvae, and there may be minimal or no processing of the pollen. In cases where the pollen is processed and/or where nectar is added, the amounts/ratios would be different than that of the bee bread estimate for honey bees.

Appendix V Pollinator Study Reviews

Table 1 Tier I Toxicity for *Apis* and non-*Apis* bees – Registrant Submitted Studies

Test Species	Test Substance	Exposure	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
Honey bee adult	**Imidacloprid Technical** (Substance A; 98.6% NTN33893)	Acute Contact 48-hr observation period	LD_{50}: 0.043 µg a.i./bee (C.I.: 0.026-0.055)	Highly Toxic	Mortality was 0, 43, 63, 73, 90 and 87% after 48 hrs at doses of 0, 40, 56, 78, 110 and 154 ng a.i./bee, respectively. Abnormal behaviours of bees were observed at all doses (40-154 ng a.i./bee) in the contact study during 4, 24 and 48 hrs after application.	2351182
Honey bee adult	**Imidacloprid Technical** (NTN33893 Technical; 99.8% Imidacloprid)	Acute Contact 48-hr observation period	LD_{50}:0.078 µg a.i./bee (C.I.: 0.055-0.108)	Highly Toxic	Mortality was 0, 20, 30, 55, 80 and 95% after 48 hrs at doses of 0, 0.025, 0.050, 0.100, 0.200 and 0.400 µg a.i./bee, respectively. Behavioural abnormalities not reported.	2351184
Honey bee adult	**Imidacloprid Technical** (98.6% imidacloprid)	Acute Contact 72-hr observation period	LD_{50}: 0.104 µg a.i./bee (C.I.: 0.079-0.131)	Highly Toxic	Mortality was 6.7, 23.3, 40, 50, 63.3 and 83.3% after 72 hrs at doses of 0, 42, 85, 125, 166 or 207 ng a.i./bee, respectively. Corrected mortality was 17.8, 35.7, 46.4, 60.7, and 82.1%, respectively. Behavioural abnormalities (paralysed/spasm or frozen behaviour) were observed in bees at 4 hrs when observations first began up to 48 hrs after treatment application at all treatment levels at 42 ng a.i./bee and higher.	1086420
Honey bee adult	**Imidacloprid Technical** (Substance A; 98.6% NTN33893)	Acute Contact 72-hr observation period	LD_{50}: 0.048 µg a.i./bee (C.I.:0.041-0.057)	Highly Toxic	Mortality was 3.33, 40.00, 63.33, 70.00, 96.67 and 100% after 72 hrs at doses of 0, 40, 56, 78, 110 and 140 ng a.i./bee. Sublethal effects, knock-down and stumbling, were observed in doses (40 to 140 ng a.i./bee) during 4 to 48 hrs after treatment.	2351179
Honey bee adult	**Imidacloprid Technical** (Substance A; 98.6%	Acute Contact 96-hr observation period	LD_{50}: 0.069 µg a.i./bee (C.I.:0.056-0.085)	Highly Toxic	Control mortality was 6.7%. Treatment mortality was 36.3, 36.6, 56.6, 80.0 and 80.0% after 96 hrs at doses of 40, 56, 78.4, 109.8 and 153.7 ng a.i./bee, respectively (corrected mortality was 32.2, 32.2, 53.6, 78.6 and 78.6%, respectively). Apathy,	2523522 [a]

Test Species	Test Substance	Exposure	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
	NTN33893)				discoordinated movements, and immobility were observed before bees died. Age of bees not specified.	
Honey bee adult	**Confidor SL 200 Forte** (200.9 g/L Imidacloprid)	Acute Contact 96-hr observation period	LD_{50}:0.045 µg a.i./bee (C.I.:0.034-0.060)	Highly Toxic	Contact toxicity test was extended from 48 hrs to 96 hrs because of progressive mortality observed at 48 hrs. Control mortality was 0 %. Treatment mortality was 0, 6.7, 10.0, 26.7, 33.3 and 86.7 % at doses of 0.0114, 0.0229, 0.0457 and 0.0914 µg a.i. per bee, respectively. Most of the bees showed uncoordinated movement during walking or were inactive at doses of 0.0114, 0.0229, 0.0457 and 0.0914 µg a.i./bee between 24 and 48 hrs. The activity of bees was reduced most at the two highest applied doses of 0.0457 and 0.0914 µg a.i./bee after contact exposure between 24 and 48 hrs. At 72 hrs following contact exposure all healthy bees were active in all test item treatment groups. Most bees demonstrating this behaviour were observed between 48 and 72 hrs.	2523521 [a]
Honey bee adult	**Imidacloprid FS 350A G** (355.2 g/L Imidacloprid)	Acute Contact 96-hr observation period	LD_{50}:0.048 µg a.i./bee (C.I.:0.039-0.058)	Highly Toxic	Due to increasing mortality between 24 to 48 and 48 to 72 hrs the contact test was prolonged for further 48 hrs up to 96 hrs. Dose levels of 500.0, 250.0, 125.0, 62.5, 31.3 and 15.6 ng a.i./bee led to mortality of 100.0, 96.7, 90.0, 73.3, 16.7 and 13.3 % at test termination (96 hrs). No mortality occurred in the 7.8 ng a.i./bee dose group and the control group (water + 0.5 % Adhäsit). During the first 4 hrs behavioural abnormalities (e.g. moribundity, movement coordination problems and/or apathy) were observed in all treatment groups. 24 hrs following the application, the same symptoms were found in all dose groups except in the lowest dose group (7.8 ng a.i./bee). During the 48 hr assessment some bees in the four highest dose groups (500.0, 250.0, 125.0 and 62.5 ng a.i./bee) showed moribundity and uncoordinated	2535874 [a]

Test Species	Test Substance	Exposure	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
					movements. After 72 hrs only one survived single bee in the 500.0 ng a.i./bee dose group showed a uncoordinated movement. At the 96 hrs assessment, no behavioural abnormalities were found any more. All other surviving bees appeared normal.	
Honey bee adult	Imidacloprid SL 200 (imidacloprid: 194 g/l density 1.121 g/ml)	Acute Contact 48 hr observation period	Contact LD_{50} (48 hrs): 0.0422 µg a.i./bee.	Highly Toxic	Delayed mortality was observed, increasing mortality was found between 24 and 48 hours. Behavioural impairments of the surviving bees (apathy, vomiting and discoordinated movements) occurred in all dose groups during the whole experimental time of 96 hours.	2557115[f]
Honey bee adult	Confidor WP 70 (Imidacloprid, 69.03%)	Acute Contact 48 hr observation period	Contact LD_{50}(48h): 0.35 µg product/bee (0.24 µg a.i. /bee)	Highly Toxic	Reported endpoint was on product basis. Sub-lethal effects were not observed	2557114[f]
Honey bee adult	Confidor SC 200 (Imidacloprid, 205.9g/l, density 1.1 g/ml)	Acute Contact 48 hr observation period	contact LD_{50} (48h): 0.29 µg product/bee (0.0542 µg a.i. /bee)	Highly Toxic	Reported endpoint was on product basis. Sub-lethal effects were not observed	2557113[f]
Honey bee adult	co-formulation of Clothianidin + Imidacloprid FS 275 (100 + 175 g/L)	Acute Contact 48 hr observation period	Contact LD50 (48 hrs): 0.29 µg total product /bee.	Highly Toxic	Behavioural abnormalities (e.g. moribund bees or affected bees) were found	2535872[f]
Honey bee adult	co-formulation of Imidacloprid + Pencycuron FS 370 (120 + 250 g/L	Acute Contact 96 hr observation period	Contact LD50 (96 hrs): 0.38 µg product/bee (0.04 µg a.i. /bee)	Highly Toxic	Behavioural abnormalities (e.g. bees were affected, moribund, apathetic) were observed	2535873[f]
Bumble bee *Bombus terrestris*	Technical (98.6% Imidacloprid)	Contact exposure on thorax	LD_{50}: Unable to calculate, estimated at approximately		Adult mortality was 0, 47, 83, 83, 83 and 87% after 72 hrs at doses of 0, 0.1, 4, 8, 31, 65 and 101 µg a.i./bee, respectively. Abnormal effects, described as “frozen behaviour” at which the bumble bees are	1086422

Test Species	Test Substance	Exposure	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
adult		72-hr observation period	0.1 µg a.i./bee (47% mortality)		motionless except for a little trembling of body parts like abdomen, antennae or tarsus, were observed in all test concentrations (0.1–101 µg a.i./bee). These effects were observed during entire test period of 72 hrs. Acute contact LD_{50} for bumble bees could not be calculated as the mortality was reported as 47% at 0.1 µg a.i./bee (the lowest concentration tested) after 72 hrs with continuously increasing mortality during the observation period.	
Bumble bee *Bombus terrestris* adult	Imidacloprid FS 350 (350 g/L imidacloprid)	Contact exposure on thorax 96-hr observation period	LD_{50}: 85.3 µg a.i./bee (CI: 24.6–32 315) Uncertainty with this endpoint.		Adult mortality was 0, 20.0, 33.3, 26.7, 53.3 and 46.7% after 96 hrs at doses of 0, 1.23, 3.70, 11.11, 33.33 and 100 µg a.i./bee, respectively. There was a lack of dose-response relationship. The wide confidence interval associated with the estimated LD_{50} indicates a very high level of uncertainty with this endpoint. Moribund, affected and apathetic bumble bees were observed at all tested dose levels during the entire test period of 96 hrs.	2513415
Bumble bee *Bombus terrestris* adult	co-formulation of Clothianidin + Imidacloprid FS 275 (100 + 175 g/L)	Contact exposure on thorax 72 hour observation period, using tap water as solvent	LD_{50}: 54.9 µg total actives/bumble bee.		Tested with co-formulation of Clothianidin and Imidacloprid FS 275 (100 + 175 g/L) using tap water as solvent. The individual chemicals were not tested. The endpoint was reported as total amount of the two actives added together. Moribund, affected or apathetic bumble bees were observed at all tested dose levels during the entire test period of 72 hours.	2535869[f]
Bumble bee *Bombus terrestris* adult	co-formulation of Imidacloprid + Pencycuron FS 370 (120 + 250 g/L	Contact exposure on thorax 96 hour observation period, using	LD_{50}: 28.1 µg imidacloprid /bumble bee		Tested with co-formulation of Imidacloprid with Pencycuron (a fungicide having no bee toxicity) using tap water as solvent. The endpoint was reported as amount of imidacloprid. Moribund, affected or apathetic bumble bees were observed at all tested dose levels during the entire	2535870[f]

Test Species	Test Substance	Exposure	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
		tap water as solvent			test period of 96 hours.	
Honey bee adult	**Imidacloprid Technical** (98.6%)	Acute Oral 48-hr observation period	LD_{50}: > 0.0204 µg a.i./bee	Highly Toxic	After 48 hours of exposure, mortality was 6.7, 0, 3.3, 0, 0 and 0% in bees exposed to the control, 4.09, 8.63, 13.18, 16.18, 21.22 ng a.i./bee (nominal dose), respectively. Behavioural abnormalities (paralysed/spasm or frozen behaviour) were observed in bees at all dose levels at 8.63 ng a.i./bee and higher, except at the lowest test concentration of 4.09 ng a.i./bee.	1086433
Honey bee adult	**Imidacloprid Technical** (NTN33893 Technical; 99.8% Imidacloprid)	Acute Oral 48-hr observation period	LD_{50}: 0.0038 µg a.i./bee (C.I.: 0.0027-0.0050)	Highly Toxic	Mortality was 5, 20, 50, 65, 90 and 100% after 48 hrs at doses of 0, 0.0015, 0.0031, 0.0063, 0.0125 and 0.0250 µg a.i./bee, respectively. Behavioural abnormalities not reported.	2351184
Honey bee adult	**Imidacloprid Technical** (Substance A; 98.6% NTN33893)	Acute Oral 48-hr observation period	LD_{50}: > 0.045 µg a.i./bee	Highly Toxic	Control mortality was 0%. Treatment mortality was 0, 6.7, 10, 3.3 and 13.3% at doses of 0.94, 2.8, 8.2, 24.6 and 73.6 ng a.i./bee. Significant sub-lethal effects (50-100% knockdown) were observed at 4 hrs in the highest two doses but only 10% knockdown was observed in the highest dose at 24 hrs. Bees in the top treatment group did not consume approximately 39% of the dose which the study author notes may be due to repellency or the large numbers of bees being knocked down and unable to feed. Age of bees not specified.	2523527[a]
Honey bee adult	**Imidacloprid Technical** (Substance A; 98.6% NTN33893)	Acute Oral 48-hr observation period	LD_{50}: > 0.081 µg a.i./bee	Highly Toxic	Control mortality was 3.3%. Treatment mortality was 6.7, 3.3, 20.0, 10 and 46.7% at doses of 1, 3, 9, 27 and 81 ng a.i./bee. Apathy, uncoordinated movements, and immobility were observed before bees died in the two highest treatment groups (27 and 81 ng/bee). Age of bees not specified.	2523522 [a]
Honey bee adult	**Imidacloprid Technical** (WAK 3745;	Acute Oral 96-hr observation	LD_{50}: > 0.0357 µg a.i./bee	Highly Toxic	Mortality was 0, 0, 6.7, 0, 6.7, 0 and 23.3% after 96 hrs at doses of 0, 0.1, 0.6, 1.2, 2.4, 5.6, 10.3, 17.9, and 35.7 ng WAK 3745/bee, respectively. Behavioural abnormalities (coordination/movement	1086430

Test Species	Test Substance	Exposure	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
	98%)	period			problems, apathy and nervousness) were observed in the 5.6, 10.3, 17.9 and 35.7 ng WAK 3745 treated groups during the first 24 hrs of the experiment. No further behavioural abnormalities occurred. There are uncertainties with the study outcome due to the deviations of the study protocol including old age of test bees, high test temperature and humidity and sugar concentrations of the diet. No dose-response relationship was noted; continuously increased mortality was reported beyond 48 hrs after application; and mortality did not exceed 50% in any of the treatment doses ranging from 0.1-35.7 ng.a.i./bee based on actual consumption values.	
Honey bee adult	**Imidacloprid Technical** NTN33893 (99.4%)	Acute Oral 96-hr observation period	LD_{50}: 0.048 µg a.i./bee (C.I.: 0.014-3980.173)	Highly Toxic	Mortality was 10, 0, 0, 6.9, 33.3, 33.3, 30, 16.7 and 53% after 96 hrs at doses of 0, 0.1, 0.8, 1.5, 3.1, 6.0, 12.2, 22.9 or 40.9 ng a.i./bee, respectively. Behavioural abnormalities including apathy, problems with coordination, laziness, nervousness and sitting in one corner of the chamber were observed in the 40.9, 22.9, 12.2, 6.0 and 3.1 ng NTN 33893 treated groups during the first 48 hrs of the experiment. No further behavioural abnormalities occurred. There are uncertainties with the study outcome considering the deviations from the study protocol (i.e., old age of test bees, high test temperature and low humidity and unknown sugar concentrations of the diet). The wide confidence interval further indicates a very high level of uncertainty associated with the estimated LD_{50}. While the reliability of the estimated LD_{50} is considered low, the study does provide some insight into the toxicity of NTN 33893 and will be considered as a line of evidence in the risk assessment.	1086432

Test Species	Test Substance	Exposure	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
Honey bee adult	**Imidacloprid Technical** (Substance A; 98.6% NTN33893)	Acute Oral 96-hr observation period	LD_{50}: > 0.0347 µg a.i./bee	Highly Toxic	The highest mortality was 37% at the highest test rate of 34.7 ng a.i./bee and <10% in all other test rates after 96 hrs. It was noted that the actual food intake reduced with the increase of test normal concentrations during the 3 hr exposure period. The actual food intake dropped from 94% of the total food supply to 43% when bees were fed with sugar solution spiked with imidacloprid at minimal concentration of 1 ng a.i./bee to 81 ng a.i./bee, respectively. Abnormal behaviours of bees were observed at the highest test dose at 34.7 ng a.i./bee in the oral test at 24 hrs and 48 hrs after application.	2351182
Honey bee adult	**Confidor SL 200 Forte** (200.9 g/L Imidacloprid)	Acute Oral 96-hr observation period	LD_{50}:0.053 µg a.i./bee (C.I.:0.038-0.074) (equivalent to 0.29 µg product/bee)	Highly Toxic	Oral toxicity test extended from 48 hrs to 96 hrs because of progressive mortality observed at 48 hrs. Control mortality was 0%. Treatment mortality was 3.3, 16.7, 26.7, 43.3 and 73.3% after 96 hrs at doses of 0.0064, 0.0128, 0.0256, 0.0512 and 0.1025 µg a.i./bee, respectively. Bees exposed to the test item showed uncoordinated movement during walking or were inactive at 24, 48 and 72 hrs at doses of 0.1025 and 0.0512 µg a.i./bee. After 72 and 96 hrs of oral exposure bees exposed at doses of 0.1025 and 0.0512 µg a.i./bee had recovered and were walking or feeding.	2523521[a]
Honey bee adult	**Imidacloprid FS 350A** (355.2 g/L Imidacloprid)	Acute Oral 96-hr observation period	LD_{50}:0.024 µg a.i./bee (C.I.:0.012-0.058)	Highly Toxic	Due to increasing mortality between 24/48 and 48/72 hrs the oral test was prolonged for further 48 hrs up to 96 hrs. The maximum nominal dose levels of the test item in the five highest dose groups (200.0, 100.0, 50.0, 25.0 and 12.5 ng a.i./bee) could not be achieved, because the bees did not ingest the full volume of treated sugar solution even when offered over a period of six hrs. Mortality occurred at all dose levels. Actual oral doses of 91.7, 72.5, 37.8, 17.7, 10.0, 7.2 and 3.5 ng a.i./bee resulted in mortality of 90, 90, 46.7, 40, 26.7, 10 and 23.3%, respectively at test termination (96 hrs). 6.7%	2535874

Test Species	Test Substance	Exposure	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
					mortality occurred in the water control group. During the 4 hr assessment, coordination problems, moribundity, cramp and/or apathy were observed in all treatment groups (91.7, 72.5, 37.8, 17.7, 10.0, 7.2 and 3.5 ng a.i./bee). After 24 hrs, uncoordinated movements, moribundity and/or apathy were found in the 91.7, 72.5, 37.8 and 17.7 ng a.i./bee groups. 48 hours following the application, some bees in the 91.7, 72.5 and 37.8 ng a.i./bee dose groups showed a moving coordination problem and apathy. After 72 hours a few bees in the two highest dose groups (91.7 and 72.5 ng a.i./bee) and after 96 hours only one single bee in the highest dose group (91.7 ng a.i./bee) showed coordination problems.	
Honey bee adult	Imidacloprid SL 200 (imidacloprid: 194 g/l density 1.121 g/ml)	Acute Oral 96 hr observation period	Oral LD_{50} (96 hr): 0.0053 µg a.i./bee	Highly Toxic	Delayed mortality was observed, increasing mortality was found between 24 and 48 hours. Behavioural impairments (e.g. apathy or uncoordinated movements) were found at different treatment doses at different time period.	2557115[f]
Honey bee adult	Confidor WP 70 (Imidacloprid, 69.03%)	Acute Oral 48 hr observation period	Oral LD_{50}(48h): 0.0167 µg product/bee (0.0115 µg a.i. /bee)	Highly Toxic	Reported endpoint was on product basis. Sub-lethal effects were not observed	2557114[f]
Honey bee adult	Confidor SC 200 (Imidacloprid, 205.9g/l, density 1.1 g/ml)	Acute Oral 48 hr observation period	Oral LD_{50}(48h): 0.103 µg product/bee (0.0193 µg a.i. /bee)	Highly Toxic	Reported endpoint was on product basis. Sub-lethal effects were not observed	2557113[f]
Honey bee adult	co-formulation of Clothianidin + Imidacloprid FS 275 (100 + 175 g/L)	Acute Oral 48 hr observation period	Oral LD50 (48 hrs): 0.058 µg total product/bee.	Highly Toxic	Behavioural abnormalities (e.g. moribund bees or affected bees) were found	2535872[f]
Honey bee	co-formulation	Acute Oral	Oral LD50 (96	Highly Toxic	Behavioural abnormalities (e.g. bees were affected,	2535873[f]

Test Species	Test Substance	Exposure	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
adult	of Imidacloprid + Pencycuron FS 370 (120+250 g/L	96 hr observation period	hrs): 0.96 µg product/bee (0.10 µg a.i. /bee)		moribund, apathetic) were observed	
Bumble bee *Bombus terrestris* adult	Technical (98.6% Imidacloprid)	Oral single dose 72-hr observation period	LD_{50}: 0.15 µg a.i./bee (CI: not determined)		Adult mortality was 0, 13, 97, 100, 100 and 100% after 72 hrs at doses of 0, 0.11, 0.33, 0.53, 0.72 and 0.96 µg a.i./bee, respectively. The ED_{50} (motionless, spasms and paralysis) was estimated to be < 0.11 µg a.i./bee, the lowest test dose where effects were observed during 72-hrs of study period.	1086421
Honey bee adult	**Hydroxy-Imidacloprid** WAK4103 (99.4% Hydroxy-NTN33893)	Acute Oral 96-hr observation period	LD_{50}: 0.151 µg a.i./bee (C.I.: 0.078-1.86)	Highly Toxic	At 96 hrs after exposure, mean mortality was 3.3, 3.3, 3.3, 0.0, 6.7, 40.0 and 53.3% in bees exposed to 1.2, 4.6, 10.4, 19.0, 39.1, 81.9 and 159.2 ng WAK 4103/bee, respectively. Behavioural abnormalities including apathy, uncoordinated movements, nervousness and lying on the back were observed during the first day in all WAK 4103 treated groups, except the 1.2 ng/bee group. No further behavioural abnormalities occurred, except for two observations of nervousness at the highest test group after 48 hrs. There was no morality recorded in the solvent control treatment throughout the study. There are uncertainties with the study outcome considering the deviations from the study protocol (i.e., old age of test bees, high test temperature and low humidity and unknown sugar concentrations of the diet). The wide confidence interval further indicates a very high level of uncertainty associated with the estimated LD_{50}. While the reliability of the estimated LD_{50} is considered to be low, the study does provide some insight into the toxicity of WAK 4103 and will be considered as line of evidence in the risk assessment.	1086431

Test Species	Test Substance	Exposure	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
Honey bee adult	**Imidacloprid Technical** (99.4%)	Chronic dietary 10-d continuous feeding	NOEL: 100 µg a.i./L based on mortality (actual intake 2.82 ng a.i./bee/day)	n/a	The cumulative mortality at the final assessment (day 10) was 2.67, 4, 0, 1, and 4% in the control, 10, 20, 50 and 100 µg a.i./L. Bees were observed to be inactive and very calm at 100 µg a.i./L during D5 to D10 of the test period. A small number of bees were affected during day 1 to day 5 at 100 µg a.i./L, showing reduced coordination for movement or low reaction to stimulation. Affected bees were also occasionally observed in treatments at 50 and 20 µg a.i./L in various days during the study. Imidacloprid at nominal concentrations of 10 µg a.i./L and higher reduced food consumption of the test bees. This concentration was equivalent to an average intake of imidacloprid at 0.000397 µg a.i./bee/day in the 10 days of study. This is a non-guideline study. The study is considered to be scientifically sound and is considered to be informative upon the finalisation of the test guidance/guideline for honey bee adult chronic effect study.	2474493
Honey bee adult	**Imidacloprid Technical** (99.4%)	Short term dietary exposure	LOEC: 100 ppb NOEC: 50 ppb (based on PER) (actual intake on a per bee per day basis unknown)	n/a	Short term exposure: Imidacloprid at 100 ppb significantly reduced the conditioned response rate of bees, but not at lower concentrations of 50 ppb, 20 ppb and 10 ppb (feeding duration and dose per bee unknown). Long term exposure: Bees feeding on 10 ppb imidacloprid continuously for 10-12 day in 1 M sucrose solution, showed no clear effects, but learning and memory was relatively lower in treated bees. The NOEC was 10 ppb and the LOEC was 20 ppb on bee communication behaviour. Note that proboscis extension reflex (PER) studies are not used in a quantitative risk assessment.	1086429[b]
		Chronic dietary 12-d continuous feeding	LOEC: 20 ppb NOEC: 10 ppb (based on PER) (actual intake on a per bee per day basis unknown)			

Test Species	Test Substance	Exposure	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
Honey bee adult	**Urea-imidacloprid** (Substance B; 99.4% Urea NTN33893)	Chronic dietary 10-d continuous feeding	NOEC: 10 ppb (actual intake 0.73 ng a.i./bee/day)	n/a	Adult mortality was 4, 10, 8 and 12% after 10 days of exposure at test concentrations of 0, 0.1, 1.0 and 10.0 ppb. No statistically significant effects of the test substance on honey bee mortality were observed. No effects on the behaviour of the bees (or other sublethal effects) were observed in comparison with the control bees.	2523526
Honey bee adult	**Urea-imidacloprid** (Substance B; 99.4% Urea NTN33893)	Chronic dietary 10-d continuous feeding	NOEC: 10 ppb (actual intake 0.43 ng a.i./bee/day)	n/a	After 10 days of exposure, no control mortality occurred and the percent mortality in the 0.1, 1, and 10 ppb treatment groups was 8, 6, and 0%, respectively. Statistical verification of the results was not conducted by the study authors. The No Observed Effect Concentration (NOEC) was visually determined to be ≥ 10 ppb, the highest concentration tested (actual intake: 0.43 ng/bee/day). It was not indicated in the study report how many adult bees per replicate were used and raw mortality data was not provided to verify the results. There was no evidence of analytical measurements being taken during the course of the study. No information was provided on whether bees demonstrated any behavioural abnormalities.	2523534
Honey bee adult	**Urea-imidacloprid** (Substance B; 99.4% Urea NTN33893)	Chronic dietary 10-d continuous feeding	NOEC: 10 ppb (actual intake 0.43 ng a.i./bee/day)	n/a	PMRA 2523531: Study invalidated due to lack of dose response, randomization of test bees and reproducibility. PMRA 2523532: Study invalidated due to high control mortality.	2523531[d] 2523532[e]
Honey bee adult	**6-Chloro-nicotinic acid** (Substance C; 99.6% 6-	Chronic dietary 10-d continuous feeding	NOEC: 10 ppb (actual intake 0.72 ng a.i./bee/day)	n/a	Mortality was 4, 10, 4 and 6% after 10 days of exposure at test concentrations of 0, 0.1, 1.0 and 10.0 ppb (corrected mortality was 6.3, 0 and 2.1%, respectively). No statistically significant effects of the test substance on worker honey bee mortality	2523525

Test Species	Test Substance	Exposure	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
	Chloro-nicotinic acid)				were observed. No effects on the behaviour of the bees (or other sub-lethal effects) were observed in comparison with the control bees.	
Honey bee adult	**6-Chloro-nicotinic acid** (Substance C; 99.6% 6-Chloro-nicotinic acid)	Chronic dietary 10-d continuous feeding	NOEC: 10 ppb (actual intake 0.58 ng a.i./bee/day)	n/a	Mortality of young worker bees was 7, 10, 7 and 7% after 10 days of exposure at test concentrations of 0, 0.1, 1.0 and 10 ppb, respectively (corrected mortality was 3, 0 and 0%, respectively). Behavioural effects (slow motions/problems concerning coordination) were observed at test concentrations of 1.0 and 10 ppb.	2523533
Honey bee adult	**6-Chloro-nicotinic acid** (Substance C; 99.6% 6-Chloro-nicotinic acid)	Chronic dietary 10-d continuous feeding	NOEC: 10 ppb (actual intake 0.47 ng a.i./bee/day)	n/a	Mortality was 0, 2, 4 and 0% after 10 days of exposure at test concentrations of 0, 0.1. 1.0 and 10 µg/L, respectively. It was not indicated in the study report how many adult bees per replicate were used and raw mortality data was not provided to verify the results. No information was provided on whether bees demonstrated any behavioural abnormalities.	2523535
Honey bee adult	**6-Chloro-nicotinic acid** (Substance C; 99.6% 6-Chloro-nicotinic acid)	Chronic dietary 10-d continuous feeding	Endpoints not included.		Study invalidated due to high control mortality.	2523530[ce] 2523536[ce]
Honey bee brood	**Imidacloprid Technical** (99.4%)	Chronic dietary 3-d *in-vitro* feeding; 22-d observation period	NOEC: 40 µg a.i./kg diet (actual intake 1.8 ng a.i./bee/day)	n/a	The combined cumulative mortality at the final assessment (across 4 test runs) (day 22) was 16.7, 25.4, 19.0, 24.6 and 16.7% in the control, 5, 10, 20 and 40 µg a.i./kg diet. The PMRA reviewer noted the following points that may have affected the study outcome: 1. The test larvae were exposed to the test chemical during part of the larval stage, from D4 to D6, rather than the entire larval stage. 2. The test larvae were collected from only 1 or 2 colonies for the study. This is a deviation from OECD 237 in which three colonies are required. Although OECD 237 is	2182453

Test Species	Test Substance	Exposure	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
					developed for acute larval toxicity effect, test with less number of colonies may raise uncertainty of extrapolating of this study results to other honey bee populations at large. 3. During the study, the test temperature varied among 33.1-35.8ºC, which is greater than 34.5 ± 0.5 that is required by OECD 237. There have been concerns on the sensitivity of test temperature to the outcome of the results. Impact of such temperature variation may raise uncertainty in the interpretation of the results. 4. The exposure duration for the positive control, dimethoate, was only one day at D4, while the exposure to imidacloprid was three days from D4 to D6. This difference is considered to have minimum effect to the result as the positive control confirmed the exposure occurred in the test system	

[a] Additional registrant studies were submitted to the USEPA and recently requested by the PMRA. A cursory review of these studies was conducted. None of the endpoints were more sensitive than fully reviewed studies. The endpoints are included for consideration.

[b] A field component was also included in this study in which individually marked bees were trained to visit an artificial food source located 500 m away from the hive. The communication among the bees (waggle and tremble dances) was affected at 20 ppb (directional accuracy) or 50 ppb (distance indication). The NOEC was set at 10 ppb.

[c] Additional registrant studies were submitted to the USEPA and recently requested by the PMRA. A cursory review of these studies was conducted.

[d] Study invalidated due to lack of dose response, randomization of test bees and reproducibility

[e] Study invalidated due to high control mortality. Endpoints not included.

[f] Study was newly reviewed during the update

Table 2 Tier I Toxicity for *Apis* and non-*Apis* bees – Additional Information from Scientific Literature

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
APIS - Tier I Acute Contact Trials				
No endpoints determined	imidacloprid (various levels of a.i.)	CONTACT TOPICAL Test species: *Apis mellifera* compared to 19 other bee species Application method: various; a pesticide was considered suitable for the meta-analysis only if the same endpoint values (LD_{50} contact or/and LD_{50} oral and/or LC_{50}) were available in the same study for A. mellifera and at least another bee species; reviewer presumed topical Number of bees tested: various Caste of bees tested: various Observation period: observations made 24 hours after exposure Effect parameters: mortality	**Information from this study is also in the section:** **NON-APIS - Tier I Acute Oral Trials** **REVIEW:** This meta-analysis looked at 150 paired toxicity endpoints of *Apis mellifera* with other species by creating a sensitivity ratio called R, where R = LD_{50}(*A. mellifera*) / LD_{50}(other species) or LC_{50}(*A.m*)/LC_{50}(o.s.). A resulting ratio of R > 1 indicated that the other species was more sensitive. Acute contact imidacloprid endpoints were compared in 12 cases and the resulting sensitivity ratio was 0.96 (range 0.005-2.36). Acute contact endpoints ranging from 0.001 – 3.82 µg/bee with an *Osmia cornifrons* endpoint as the highest. The analysis examined *A. mellifera* compared to *B. terrestris, O. cornifrons, Megachile rotundata, Nomia melanderi, Nannotrigona perilampoides, Trigona iridipennis, Apis cerana* and *Apis florea*. **MAJOR UNCERTAINTIES:** It is unknown if the data was topical contact or contact transfer via filter paper or leaf. The methodology of comparing LD_{50} values across different studies was not clearly explained and the reviewer could not recreate the R values that the authors reported. It is unclear how to use this analysis in the risk assessment.	Arena, M. and F. Sgolastra. 2014. A meta-analysis comparing the sensitivity of bees to pesticides. Ecotoxicology 23:324–334 DOI 10.1007/s10646-014-1190-1
No endpoints determined.	imidacloprid (< 95%) and Gaucho 480FS (1.6 g imidacloprid /kg seed in 2002; 2.5 g/kg seed in 2003)	MULTIPLE CONTACT TESTS Test species: *Apis mellifera* Application method: *Contact toxicity* single application of 5 mL was applied in a Potter spray Tower to groups of 20 bees/treatment ; 4–5 concentrations were tested that were 0.00008 – 1% solution, controls were treated with solvent mixture *Contact transfer with corn tassels* corn tassels from plants treated	**REVIEW:** *Contact toxicity:* Mortality data was reported in comparison with other insecticides tested. LC_{50} data was also reported but the concentrations were expressed as percent solution (w/v): LC_{50} = 0.0022 **MAJOR UNCERTAINTIES**: It is unclear what the bee sample size or the amount of pollen tassel provided was. **REVIEW:** *Contact transfer with corn tassels:* Mortality was not significantly different for honey bees exposed to pollen tassels grown from treated seed compared to untreated seed in 2002 or 2003. The days after pollen shed had no significance on the results and for all dates and treatments the mean percent	Bailey, J.C., C.D. Scott-Dupree, C.R. Harris, J.Tolman and B.J. Harris. 2005. Contact and oral toxicity to honey bees (Apis mellifera L.) of agents registered for use for sweet corn insect control in Ontario, Canada, Apidologie 36: 623-633.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		with 1.6 or 2.5 g/kg seed of imidacloprid and placed into bioassay chambers with bees were exposed to tassels from Day 1, 2, 3 and 4 of pollen shed; chambers were provisioned with water and *ad libitum* sugar water Number of bees tested: *Contact toxicity:* 20 bees/treatment *Contact transfer with corn tassels:* 25 bees/treatment; replicated 4 times Caste of bees tested: *Contact toxicity:* adult, >20 day old workers *Contact transfer with corn tassels:* adult, pollen-bearing foragers Observation period: 24 hours after exposure Effect parameters: mortality	mortality remained < 10% **MAJOR UNCERTAINTIES:** Pollen residues were not analyzed for the seed treatment groups. Control pollen was not analyzed for potential contamination. It is unknown if any of the corn tassel pollen was consumed by the bees in this contact transfer study since it was not quantified or reported.	
LD_{50} = 0.0261 µg a.i./bee	Provado 1.6F (imidacloprid 17.4%)	CONTACT TOPICAL Test species: *Apis mellifera* Application method: single application of 1 µL/bee was applied to thorax; at least 6 doses were tested, doses not stated Number of bees tested: 10 bees per replicate Caste of bees tested: adult, age unknown Observation period: 48 hours Effect parameters: mortality	**REVIEW:** Acute Contact Topical Endpoint: LD_{50} = 0.0261 µg a.i./bee The fungicide fenbuconazole was mixed with imidacloprid and also tested. This combination enhanced the effects of imidacloprid slightly, but not significantly. **MAJOR UNCERTAINTIES**: No explicit statement of what the dose levels actually were, only that there were "at least 6" for chemical alone and "at least 5" for the mixture with a fungicide.	Biddinger D.J., J.L. Robertson, C. Mullin, J. Frazier, S.A. Ashcraft, E.G. Rajotte, N.K. Joshi, M. Vaughn. 2013. Comparative Toxicities and Synergism of Apple Orchard Pesticides to Apis mellifera (L.) and Osmia cornifrons (Radoszkowski). PLoS ONE 8(9): e72587.
No endpoint	imidacloprid	CONTACT TOPICAL	**REVIEW**: *1. Effects on sperm viability in queens:*	Chaimanee, V.,

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
determined.	(99.9%)	Test species: *Apis mellifera ligustica* Application method: *1. Effects on sperm viability in queens:* single application of 2 µL/bee was applied to topically to the abdomen; doses tested were 20, 100, 200 and 400 ppb *2. Gene expression in treated queens and workers:* mated queens were treated the same as in experiment #1 but with 20 ppb and acetone control; worker bees were treated with 1 µL of 20 ppb and an acetone control Number of bees tested: *1. Effects on sperm viability in queens:* 6 queens tested/dose and 12 queens tested for acetone controls *2. Gene expression in treated queens and workers:* 18 mated queens/dose; unknown # of worker bees Caste of bees tested: *1. Effects on sperm viability in queens:* mated queens *2. Gene expression in treated queens and workers:* mated queens and 5 day old worker bees Observation period: *1. Effects on sperm viability in queens:* 7 days *2. Gene expression in treated queens and workers:* 9 queen bees were left for 24 h before dissection and 9 queen bees were left for 7 days before dissection;	After 7 days of exposure, no queens died after coming into contact with 0–400 ppb. Sperm viability was significantly decreased in queens treated at all four dose levels of imidacloprid when compared to the control; no dose effect was seen between dose levels. There was generally a 50% increase in dead sperm after 7 days of imidacloprid treatment. *2. Gene expression in treated queens and workers:* *Treated queens:* The authors stated that expression levels of specific genes were triggered 24 hours after treatment. The expression levels of P450 subfamily genes, CYP306A1, CYP4G11 and CYP6AS14 were decreased in honey bee queens treated with 20 ppb of imidacloprid. Imidacloprid at this level also suppressed the expression of genes related to antioxidation, immunity and development in queens 24 hours after topical exposure. *Treated workers:* Up-regulation of antioxidants by these compounds in worker bees was observed 24 hours after exposure. **MAJOR UNCERTANTIES:** These results are from a contact test however; the expected route of exposure for queens is mainly through contaminated food consumption. It is not clear how the molecular genetic analysis results can be used in the risk assessment.	Evans, J.D., Chen, Y., Jackson, C., Pettis, J.S. 2016. Sperm viability and gene expression in honey bee queens (Apis mellifera) following exposure to the neonicotinoid insecticide imidacloprid and the organophosphate acaricide coumaphos. J Insect Physiol. 2016 Jun; 89:1-8. doi: 10.1016/j.jinsphys.2016.03.004.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		worker bees were left for either 24 h or 7 days prior to dissection Effect parameters: *1. Effects on sperm viability in queens:* daily mortality, sperm viability after 7 days *2. Gene expression in treated queens and workers:* molecular analysis		
Lethal time to 50% mortality (LT_{50}) LT_{50}=10 hours: A. mellifera and A. florea LT_{50} = 16 hours: A. dorsata	Confidor 200 SL (imidacloprid 17.1%)	CONTACT TRANSFER Test species: *Apis mellifera* Application method: 5 mL applied to a jar and left to air dry before introducing bees, doses tested were 0, 125, 250, 500 and 1000 ppm Number of bees tested: 10 bees in each jar, 3 replicates per test dose Caste of bees tested: adult, age unknown Exposure period: up to 24 hours Observation period: observations made after 3, 6, 12 and 24 hours Effect parameters: mortality	**REVIEW**: Acute Contact Transfer Endpoints: *A. mellifera*: LT_{50} = 10, 8, 7 and 4 for 125, 250, 500 and 1000 ppm respectively. *A. florea*: LT_{50} = 10, 9, 7 and 5 for 125, 250, 500 and 1000 ppm respectively *A. dorsata*: LT_{50} = 16, 12, 10 and 7 for 125, 250, 500 and 1000 ppm respectively. **MAJOR UNCERTAINTIES:** Very little information on test species. Level of control mortality is unknown. Results provided in terms of time to 50% mortality instead of the median lethal dose (LD_{50}).	Husain D., M. Qasim, M. Saleem, M. Akhter, K.A. Khan. 2014. Bioassay of insecticides against three honey bee species in laboratory conditions. Cercetari Agronomice in Moldova 47(2):69,79.
LD_{50} = 0.0179 µg a.i./bee)	Imidacloprid (>99%)	CONTACT TOPICAL Test species: *Apis mellifera* Application method: single application of 1 µL/bee was applied to thorax; 5 to 7 doses tested Number of bees tested: 10–15 bees/cup, repeated 2–3 times per dose (5–7 tested) with a minimum of 30 bees/experiment Caste of bees tested: adult, older workers Observation period: 24 hours Effect parameters: mortality	**REVIEW:** Acute Contact Topical Endpoint: LD_{50} = 0.0179 µg a.i./bee Imidacloprid was tested alone and in a mixture with different synergists (piperonyl butoxide, triflumizole and propiconazole). No significant differences were found for the LD_{50} values between imidacloprid and imidacloprid plus synergist treatments. **MAJOR UNCERTAINTIES:** The study authors reported that the experiments were replicated 2–3 times for each insecticidal dose. The data from these replicated experiments were pooled to estimate the LD_{50} values, presumably without determining or considering the variance among the dose-response experiments.	Iwasa, T., N. Motoyama, J.T. Ambrose, R.M. Roe. 2004. Mechanism for the Differential Toxicity of Neonicotinoid Insecticides in the Honey Bee, Apis Mellifera. Crop Protection. 23: 371-378.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
LD_{50} = 0.027 µg/bee	Imidacloprid SL (17.8%)	CONTACT TOPICAL Test species: *Apis cerana indica* Application method: single application of 1 µL/bee was applied to thorax; doses tested were 0.005, 0.009, 0.016, 0.029, 0.052 µg/bee Number of bees tested: 20 bees/treatment, experiment was repeated 3 times Caste of bees tested: adult, age unknown Observation period: 24 hours Effect parameters: mortality	**REVIEW**: Acute Contact Topical Endpoint: LD_{50} = 0.027 µg/bee The LD_{50} endpoint values are from one laboratory component of this journal article, and are relevant for consideration. A separate bioassay test conducted in the lab was also conducted but the results of the bioassay will not be presented since mortality increased as time went on, indicating there is a mistake in the analysis. **MAJOR UNCERTAINTIES:** The reviewer assumed that the acute toxicity experiments in the laboratory were also replicated three times and 20 worker bees per treatment were used; similar to that of the semi-field study. The age and the health conditions of the bees were not mentioned.	Jeyalakshmi T., R. Shanmugasundaram, M. Saravanan, S. Geetha, S.S. Mohan, A. Goparaju, P. Balakrishna Murthy. 2011. Comparative toxicity of certain insecticides against Apis cerana indica under semi field and laboratory conditions. Pestology 35(12):23-26.
No endpoints determined.	Imidacloprid 200SL (0.0035% a.i.)	CONTACT TRANSFER Test species: *Apis cerana indica* Application method: filter paper treated with test solution; unknown doses tested Number of bees tested: 10 bees/treatment, experiment was repeated 3 times Caste of bees tested: adult, age unknown Exposure period: 10 minutes on filter paper then bees transferred to another cage Observation period: observations made every 6 hours until 54 hours after exposure Effect parameters: mortality	**REVIEW:** LT_{50}=13.52 hours A comparison between the lethal time for 50% and rate of application (to use in the risk assessment) cannot be made. **MAJOR UNCERTAINTIES:** The study indicated that distilled water was included to record natural mortality (control). However, the results were not included in the study. It is difficult to determine the amount in g a.i./ha that was used in the study.	Khan R.B. and M.D. Dethe. 2004. Median lethal time of new pesticides to foragers of honey bees. Pestology 28(1):28-29.
No endpoint determined.	Imidacloprid (not stated)	CONTACT TO EXPOSED BRAIN Test species: *Apis mellifera mellifera* Application method: imidacloprid at concentrations of 10–500 nM and imidacloprid-olefin at 50–500	**REVIEW:** Kenyon cell exposure to imidacloprid and imidacloprid-olefin evoked a rapid, concentration-dependent depolarization of the resting membrane potential. The depolarization is reversed by the nAChR antagonist d-tubocurarine. At 10 nM, clothianidin evoked a significantly larger depolarization than imidacloprid (n = 3-4), consistent with their respective actions	Palmer MJ, Moffat C, Saranzewa N, Harvey J, Wright GA and Connolly CN. 2013. Cholinergic pesticides cause mushroom body neuronal

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		nM was bath-applied to honey bee intact brain while submerged in extracellular fluid to simulate environmental exposure of the Kenyon cells (KCs) in culture, (KCs are the major neuronal component of the mushroom bodies and comprise over 40% of neurons in the honey bee brain) Number of bees tested: *imidacloprid:* 7 bees *imidacloprid-olefin:* 4 bees Caste of bees tested: adult worker bees, age unknown Observation period: immediately after current clamp was applied for approximately 30 seconds Effect parameters: membrane excitability and action potential firing	as full and partial nAChR agonists. The authors indicated that imidacloprid was found to affect KC excitability at concentrations as low as 10 nM, (~ 2.6 ppb imidacloprid). Although low concentrations of neonicotinoids transiently increase KC excitability, the data indicates that the predominant effect of exposure will be inhibition of action potential firing, which is expected to significantly impair mushroom body function. **MAJOR UNCERTAINTIES:** Sample size is very small (N=8). It is unknown how exposure to a partially dissected intact honey bee brain can be used in the risk assessment.	inactivation in honey bees. Nat Commun 4:1634.
No endpoints determined.	Imidacloprid 17.8 SL (presumed to be 17.8%)	CONTACT TRANSFER Test species: *Apis cerana* Application method: insecticides were sprayed in sterilized petri plates using a Potter Spray Tower (2 ml spray solution of 0.005%), petri plates were air dried at room temperature for 10 minutes prior to bees being confined to each treated plates for a period of 30 minutes. Bees were then transferred to iron cages (25 × 20 × 20 cm^3) and covered with black cloth provided with cotton swab soaked in 40% sugar solution. Number of bees tested: 10 bees/treatment plate; replicated 3	**REVIEW**: Mortality of *A. cerana* increased with time. 6 hours: 29.66% mortality 12 hours: 53.35% mortality 24 hours: 80.67% morality 48 hours: 100% mortality **MAJOR UNCERTAINTIES:** Control mortality was < 13% for up to 48 hours. There was inconsistency in reporting what product, formulation or dose was tested. As a result the rate of application is hard to compare to the Canadian registered rates.	Pastagia JJ and Patel MB. 2007. Relative contact toxicity of some insecticides to worker bees of Apis cerana F. Journal of Plant Protection and Environment 4(2):89-92

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		times Caste of bees tested: adult foragers, unspecified age Observation period: mortality was recorded at 6, 12, 24 and 48 hours after exposure Effect parameters: mortality		
No endpoints determined	Clothianidin (99% pure), deltamethrin (98% pure), esfenvalerate (99% pure), imidacloprid (99% pure), lambda-cyhalothrin (98.5% pure), thiamethoxam (98.5% pure)	CONTACT TOPICAL Test species: *Apis mellifera* Application method: single application was applied to wing or thorax; doses tested were 0, 0.5, 5, 10, 40, 50, 75, 100 ng clothianidin/bee, 0, 5, 10, 25, 50, 75, 100, 200, 400 ng imidacloprid/bee, 0, 5, 10, 25, 50, 60, 80, 100, 200 thiamethoxam/bee, 0, 20, 30, 60, 90, 120, 180, 210, 250 ng deltamethrin/bee, 0, 5, 25, 50, 75, 100, 150, 200, 300 esfenvalerate/bee, 0, 1, 5, 10, 20, 40, 60, 75, 150 ng lambda cyhalothrin/bee Number of bees tested: 30 bees/treatment, experiment was repeated 8 times Caste of bees tested: adult, worker bees age unknown Observation period: observations made 24, 48, 96 and 120 hours after exposure Effect parameters: mortality	**REVIEW:** For imidacloprid, the toxicities induced by contact with the wings and thorax were similar. The acute contact LD50 for imidacloprid was reported to be 25.1 ng/bee for thorax exposure and 26.55 ng/bee for wing exposure. For clothianidin and thiamethoxam, the toxicities induced by contact with the thorax was higher (more sensitive) compared to the wings. The acute LD_{50} for thiamethoxam was reported to be 12.13 ng/bee for the thorax and 27 ng/bee for the wings; the acute LD50 for clothianidin was reported to be 25.8 ng/bee for the thorax and 36.5 ng/bee for the wings. **MAJOR UNCERTAINTIES**: There was slightly lower contact toxicity via wing exposure route than via thorax exposure route for some of the test chemicals, including thiamethoxam and clothianidin. The ratio of the contact LD_{50} (wings/thorax) ranged from 0.99–2.23. However, bees were alive during the exposure. Exposure via wings may also result in contact exposure thorough other parts of the bee body, including thorax.	Poquet, Y., G. Kairo, S. Tchamitchian, J.L. Brunet, L.P. Belzunces. 2015. Wings as a new route of exposure to pesticides in the honey bee.Environ Toxicol Chem. 2015 Sep; 34(9):1983-8. doi: 10.1002/etc.3014
LD_{50} =0.104 µg a.i./bee: Netherlands LD_{50} = 0.061	Imidacloprid (> 98%)	CONTACT TOPICAL Test species: *Apis mellifera* Application method: single application of 1–5 µL/bee was applied to thorax; doses tested	**REVIEW:** Acute Contact Topical Endpoints: The LD_{50} tests were repeated at multiple locations. The LD_{50} range was 0.042–0.104 µg a.i./bee. **MAJOR UNCERTAINTIES:** Unclear of exact numbers of bees	Schmuck, R., R. Nauen, U. Ebbinghaus-Kintscher. 2003. Effects of

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
µg a.i./bee: Germany II LD_{50} = 0.05 µg a.i./bee: UK LD_{50} = 0.042 µg a.i./bee: Germany III LD_{50} = 0.043 µg a.i./bee: Germany IV LD_{50} = 0.075 µg a.i./bee: Germany V		were 40–154 ng a.i./bee Number of bees tested: 10 bees/treatment, experiment was repeated 3–5 times Caste of bees tested: adult, worker bees 14–42 days old Observation period: observations made 4, 24 and 48 hours after exposure Effect parameters: mortality	exposed per treatment. Treatment concentrations only provided a range of doses and not exact doses.	imidacloprid and common plant metabolites of imidacloprid in honey bee: toxicological and biochemical considerations. Bulletin of Insectology, 56 (1): 27-34.
LD_{50} = 0.081 µg a.i./bee: A LD_{50} = 0.23 µg a.i./bee: B LD_{50} = 0.243 µg a.i./bee: C WG70 LD_{50} = 0.0597 µg a.i./bee: C SC200	A & B: Imidacloprid (> 98%) C: WG70 (imidacloprid 70%) and SC 200 (not reported)	CONTACT TOPICAL Test species: *Apis mellifera* Application method: single application exact methods unknown; 4–6 doses tested Number of bees tested: 10 bees/treatment Caste of bees tested: adult, age unknown Observation period: 48 hours Effect parameters: mortality	**REVIEW:** Acute Contact Topical Endpoints: The LD_{50} tests were repeated at multiple locations. The LD_{50} range was 0.0597–0.243 µg a.i./bee. **MAJOR UNCERTAINTIES:** The authors provided no description of their acute contact toxicity study methods and whether or not they differed across each testing facility. No indication of control performance was provided. Imidacloprid dose was not analytically verified and no information on the dose response was provided.	Schmuck, R., R. Schoning, A. Strok. 2001. Risk posed to honey bees (Apis mellifera L, Hymenoptera) by an imidacloprid seed dressing of sunflowers. Pest Management Science (2001) 57: 225-238 PMRA 1086438, 2142760
LC_{50} = 0.1 ppm	Imidacloprid 17.8 SL (18%)	CONTACT TRANSFER Test species: *Apis mellifera* Application method: 1 mL of test solution was used to coat a petrie dish that was left to air dry before adding bees; a dose of 125 ppm	**REVIEW:** Acute Contact Transfer Endpoint: LC_{50}=0.1 ppm This study provides relative toxicity information for imidacloprid and thiamethoxam. Only imidacloprid is presented here. The method of exposure tested is different than the OECD method for contact exposure, and also for an RT25 study.	Singh, N., A.K. Karnatak. 2005. Relative toxicity of some insecticides to the workers of Apis mellifera L. Shashpa

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		was tested Number of bees tested: 10 bees/treatment Caste of bees tested: adult, foragers Exposure period: 2 hours on petrie dish then bees transferred to another container Observation period: observations made 1, 12 and 24 hours after exposure Effect parameters: mortality	**MAJOR UNCERTAINTIES:** An untreated control treatment was included but not described well in the methodology part of the study. It is unclear if this article was peer reviewed thoroughly before publication as there are some typographical errors, and errors in the relative toxicity presented under results section.	12(1):23-25.
No endpoints determined.	Tatamida 17.8 SL (not reported)	MULTIPLE CONTACT TESTS Test species: *Apis mellifera* and *Apis cerana* Application method: *Contact transfer:* 500 µL of test solution was applied to filter paper and left to dry for 10 minutes before adding bees *Contact topical assay:* single application of 1 µL/bee was applied to thorax *Bees foraging on treated potted plants:*16 potted plants were sprayed to saturation and allowed to dry for 1 hour, placed into tunnels with bees Application dose: 50 ppm Number of bees tested: *Contact transfer:* 10 bees/treatment, replicated 3 times *Contact topical assay:* 10 bees/treatment, replicated 3 times *Bees foraging on treated potted plants:* 5 bees per species in each tunnel, there were 4 tunnels Caste of bees tested: adult, age	**REVIEW:** *Contact transfer* A. mellifera: 0 and 47% mortality in 24 and 48 h A. cerana: 10 and 27% mortality in 24 and 48 h Imidacloprid showed higher mortality to *A. mellifera* compared to *A. cerana* in the filter paper lab tests by the end of 48 h. **MAJOR UNCERTAINTIES:** Very little information on methodology. Age of foragers not uniform. No LD50 value determined. **REVIEW:** *Contact topical assay* A. mellifera: 50 and 67% mortality in 24 and 48 h A. cerana: 60 and 67% mortality in 24 and 48 h The same level of mortality was achieved in both species by the 48 h assessment point. Higher mortality in *A. cerana* at 24 hours. **MAJOR UNCERTAINTIES:** Very little information on methodology. Age of foragers not uniform. No LD50 value determined. **REVIEW:** ***Bees foraging on treated plants*** A. mellifera: 35, 60 and 60% mortality in 1, 25 and 48 h A. cerana: 15, 65 and 80% mortality in 1, 24 and 48 h **MAJOR UNCERTAINTIES:** Very little information on methodology. No control data for comparison. Age of foragers not uniform. No residue analysis was conducted to confirm exposure level.	Stanley J., K. Sah, S.K. Jain, J.C. Bhatt, S.N. Sushil. 2015. Evaluation of pesticide toxicity at their field recommended doses to honey bees, Apis cerana and A. mellifera through laboratory, semi-field and field studies. Chemosphere 119:668-674

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		unknown Exposure period: *Contact transfer:* 30 minutes on filter paper then bees transferred to another container *Bees foraging on treated potted plants:* 1 hour on potted plants then bees transferred to another container Observation period: *Contact transfer:* observations made 24 and 48 hours after exposure *Contact topical assay:* observations made 24 and 48 hours after exposure *Bees foraging on treated potted plants:* observations made 1, 24 and 48 hours after exposure Effect parameters: mortality		
LD_{50} = 0.0238, 0.0243 µg a.i./bee for 24 and 48 h: *Apis mellifera mellifera* LD_{50} = 0.0151, 0.0128 µg a.i./bee for 24 and 48 h: *Apis mellifera caucasica*	Imidacloprid (98%)	CONTACT TOPICAL Test species: *Apis mellifera mellifera* and *A. mellifera caucasica* Application method: single application of 1µL/bee was applied to thorax; doses tested were unknown Number of bees tested: 20 bees/treatment, experiment was repeated 3 times Caste of bees tested: adult, age unknown Observation period: observations made 2, 4, 6, 10, 14, 20, 24 and 48 hours after exposure Effect parameters: mortality	**REVIEW:** Acute Contact Topical Endpoints: LD_{50}=0.0238, 0.0243 µg a.i./bee for 24 and 48 h: Apis mellifera mellifera; LD_{50}=0.0151, 0.0128 µg a.i./bee for 24 and 48 h: Apis mellifera caucasica An ANOVA indicated a significant ($p< 0.05$) difference of sensitivity to imidacloprid for contact toxicity between the two subspecies at 24 hours but not at 48 hours. **MAJOR UNCERTAINTIES:** Unclear from methods section which doses were tested. No analytical confirmation of the doses was conducted. Contact LD_{50} values are about 12-fold lower than what is reported for registrant submitted studies. This is presumably because the data from the first part of the response curve was used to generate the endpoint but the other points on the curve were not taken into account.	Suchail, S., D. Guez, L.P. Belzunces. 2000. Characteristics of Imidacloprid Toxicity in Two Apis Mellifera Subspecies. Environmental Toxicology and Chemistry. 19 (7): 1901-1905.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
LD_{50} = 0.0671 µg/bee	Imidacloprid (99.9%)	CONTACT TOPICAL Test species: *Apis mellifera* Application method: single application of 1µL/bee was applied to thorax; at least five dose rates were tested (with a maximum of 2-fold between doses) Number of bees tested: experiment was repeated 3 times: total amount of bees unknown Caste of bees tested: adult, worker bees Observation period: observations made 1, 4, 24 and 48 hours after exposure Effect parameters: mortality	**REVIEW:** Acute Contact Topical Endpoint: LD_{50}= 0.0671 µg/bee Imidacloprid was also tested in combination with several ergosterol biosynthesis inhibitor (EBI) fungicides: none of which changed the LD_{50} significantly (LD_{50} = 0.0409 + myclobutanil; LD_{50} = 0.0585 + propiconazole; LD_{50} = 0.0475 + flusilazole; LD_{50} = 0.0347 + tebuconazole). **MAJOR UNCERTAINTIES:** No measure of control mortality.	Thompson H.M., S.L. Fryday, S. Harkin, S. Milner. 2014. Potential impacts of synergism in honey bees (Apis mellifera) of exposure to neonicotinoids and sprayed fungicides in crops. Apidologie 45(5):545-553.
LD_{50}: 0.19 µg/bee for imidacloprid LD_{50}: 0.07 µg/bee for imidacloprid + beta-cyfluthrin	Imidacloprid (not reported)	CONTACT TOPICAL Test species: *Apis mellifera* Application method: single application of 500 mL at 10 psi was applied with a Potter Spray tower into a mesh-topped cage of 25 bees Number of bees tested: 25 bees/treatment, 3 replicates Caste of bees tested: 4–6 day old adults Observation period: observations made 48 hours after exposure Effect parameters: mortality	**REVIEW:** Acute Contact Topical Endpoint: The LC_{50} = 118.17 mg a.i./L for imidacloprid and 44.76 mg a.i./L for imidacloprid + beta-cyfluthrin was converted to LD_{50} based on average fresh body weight for a 16-day old worker bee of 0.125 g and the average volume of pesticide solution deposited on each bee of 1.575 µL per bee. The LD_{50} for this study was estimated in terms of formulated product and active ingredient. **MAJOR UNCERTAINTIES:** The level of control mortality was not stated. A 48 h observation period was stated but the authors wrote observation periods could be extended up to 7 days if needed. Conversion from LC to LD was based on weight of 16-day old bees when 4-6 day old bees were used in this experiment.	Zhu YC, Adamczyk J, Rinderer T, Yao J, Danka R, Luttrell R, Gore J. 2015. Spray Toxicity and Risk Potential of 42 Commonly Used Formulations of Row Crop Pesticides to Adult Honey Bees. J Econ Entomol. 2015 Dec;108(6):2640-7. doi: 10.1093/jee/tov269
NON-APIS - Tier I Acute Contact Trials				
No endpoints determined	Imidacloprid (various levels of a.i.)	CONTACT TOPICAL Test species: *Apis* mellifera compared to 19 other bee species Application method: various; a pesticide was considered suitable	**Information from this study is also in the section:** **APIS - Tier I Acute Oral Trials** **REVIEW**: This meta-analysis looked at 150 paired toxicity endpoints of *Apis mellifera* with other species by creating a	Arena, M. and F. Sgolastra. 2014. A meta-analysis comparing the sensitivity of bees to

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		for the meta-analysis only if the same endpoint values (LD_{50} contact and/or LD_{50} oral and/or LC_{50}) were available in the same study for *A. mellifera* and at least another bee species; reviewer presumed topical Number of bees tested: various Caste of bees tested: various Observation period: observations made 24 hours after exposure Effect parameters: mortality	sensitivity ratio called R, where R = LD_{50} (*A. mellifera*) / LD_{50}(other species) or LC_{50} (*A.m*) / LC_{50}(o.s.). A resulting ratio of 1 indicated that the other bee species had the same sensitivity to thiamethoxam as A. mellifera. A ratio > 1 indicated that the other species was more sensitive. Acute contact imidacloprid endpoints were compared in 4 cases and the resulting sensitivity ratio was 0.96 (range 0.005–2.36). Acute contact endpoints ranging from 0.001–3.82 µg/bee with an *Osmia cornifrons*endpoint as the highest. The analysis examined *A. mellifera* compared to *B. terrestris, O. cornifrons, Megachile rotundata, Nomia melanderi, Nannotrigona perilampoides, Trigona iridipennis, Apis cerana* and *Apis florea*. **MAJOR UNCERTAINTIES:** It is unknown if the data was topical contact or contact transfer via filter paper or leaf. The methodology of comparing LD_{50} values across different studies was not clearly explained and the reviewer could not recreate the R values that the authors reported. It is unclear how to use this analysis in the risk assessment.	pesticides. Ecotoxicology 23:324–334 DOI 10.1007/s10646-014-1190-1
LD_{50} = 0.66 µg a.i./bee	Provado 1.6F (imidacloprid 17.4%)	CONTACT TOPICAL Test species: *Osmia cornifrons* Application method: single application of 1 µL/bee was applied to thorax; at least 6 doses were tested, doses not stated Number of bees tested: 10 bees per replicate Caste of bees tested: adult, age unknown Observation period: 48 hours Effect parameters: mortality	**REVIEW:** Acute Contact Topical Endpoint: LD_{50} = 0.66 µg a.i./bee The fungicide fenbuconazole was mixed with imidacloprid and also tested. This combination enhanced the effects of imidacloprid slightly, but not significantly. **MAJOR UNCERTAINTIES**: No explicit statement of what the dose levels actually were, only that there were “at least 6” for chemical alone and “at least 5” for the mixture with a fungicide.	Biddinger D.J., J.L. Robertson, C. Mullin, J. Frazier, S.A. Ashcraft, E.G. Rajotte, N.K. Joshi, M. Vaughn. 2013. Comparative Toxicities and Synergism of Apple Orchard Pesticides to Apis mellifera (L.) and Osmia cornifrons (Radoszkowski). PLoS ONE 8(9): e72587.
Imidacloprid dissolved in water:	Confidor (imidacloprid 17.8%)	CONTACT TOPICAL Test species: *Bombus terrestris* Application method: single	**REVIEW:** Acute Contact Topical Endpoints: *Imidacloprid dissolved in water:* The contact LD50 for Confidor dissolved in water was 160, 19 and	Bortolotti, L., E. Grazioso, C. Porrini, G. Sbrenna. 1999.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
LD_{50} = 0.39 µg a.i./bee *Imidacloprid dissolved in acetone:* LD_{50} = 0.0053 µg a.i./bee		application of 1 µL/bee was applied to thorax; doses tested were: *Imidacloprid dissolved in water:* 1/10 to 100-fold the field dose of 0.3 mL/100 mL *Imidacloprid dissolved in acetone:* 1/1000 to 1x the field dose of 0.3 mL/100 mL Number of bees tested: unknown Caste of bees tested: adult, medium sized workers Observation period: observations made 72 hours after exposure Effect parameters: mortality	2.2 µg product/bee after 24, 48 and 72 hours, respectively. Based on a guarantee of 17.8% imidacloprid in Confidor, the reviewer calculated the LD_{50} to be 0.39 µg a.i./bee after a period of 72 hours. *Imidacloprid dissolved in acetone:* The contact LD_{50} for Confidor dissolved in acetone was 2.5, 0.08 and 0.03 µg product/bee after 24, 48 and 72 hours, respectively. Based on a guarantee of 17.8% imidacloprid in Confidor, the reviewer calculated the LD_{50} to 0.0053 µg a.i./bee after a period of 72 hours. **MAJOR UNCERTAINTIES:** It was not stated what the doses of imidacloprid were. It was not stated how many bees per treatment level. It was not stated whether a control was used in the study.	Effect of pesticides on the bumble bee Bombus terrestris L. in the laboratory. Hazards of pesticides to bees, Avignon (France), September 07-09, 1999, Ed. INRA, Paris.
LD_{50} = 0.00129 µg a.i./bee	Imidacloprid (95%)	CONTACT TOPICAL Test species: *Melipona scutellaris* Application method: a single application of 1 µL/bee was applied to the dorsal area of the thorax; doses tested for the 24 hour test were 2, 4, 8, 16, 32 and 64 ng a.i./µL and doses tested for the 48 hour test were 0.3, 0.6, 1.2, 2.4, 4.8 and 9.6 ng a.i./µL; bees were also provided *ad libitum* with 50% sucrose solution Number of bees tested: 30 bees with 3 repetitions of 10 bees (each group of 10 was from 3 different colonies) Caste of bees tested: forager bees Observation period: 24 or 48 hours Effect parameters: mortality	**REVIEW**: Acute Contact Topical Endpoint: This study also completed an acute oral test that was determined to be invalid for use in the risk assessment because of the lack of exposure information. *Contact topical toxicity:* After 24 hours the contact topical LD_{50} value was 2.41 ng a.i./bee ($CI_{95\%}$ 1.63–3.27). After 48 hours the contact topical LD_{50} value was 1.29 ng a.i./bee ($CI_{95\%}$ 0.813–1.903). **MAJOR UNCERTAINTIES:** The oral test of the study is considered to be invalid and will not be further considered. Information was not provided allowing estimation of the actual level of exposure. The report did provide the nominal concentrations of imidacloprid test solution, but not how the test solution was provided, neither the volume of test solution fed to the bees nor the duration of feeding.	Costa,L. M.;Grella,T. C.;Barbosa,R. A.;Malaspina,O.;Nocelli,R. C. F. 2015. Determination of acute lethal doses (LD_{50} and LC_{50}) of imidacloprid for the native bee Melipona scutellaris Latreille, 1811 (Hymenoptera: Apidae). Sociobiology 62(4): 578-582
No endpoints determined.	Imidacloprid (> 95%)	CONTACT TOPICAL Test species: *Bombus impatiens*	**REVIEW:** 72, 96 and 100% mortality after 72 hours in the 0.01, 0.1 and 1 g/L treatments.	Gradish, A.E., C.D. Scott-Dupree, L.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		Application method: potter spray tower was used to administer 5 mL of imidacloprid at concentrations of 0.01, 0.1 or 1 g/L (which corresponds to 56 g a.i./ha, 560 g a.i./ha and 5.6 kg a.i./ha) Number of bees tested: 9-11 bees/treatment, experiment repeated 4 times Caste of bees tested: adult, age unknown Observation period: observations made 72 hours after exposure Effect parameters: mortality	**MAJOR UNCERTAINTIES:** No analytical confirmation of imidacloprid in the doses. High concentrations used for the highest concentration in the contact study as well as the sole concentration in the chronic study meaning these results have limited environmental relevance.	Shipp, C.R. Harris, G. Ferguson. 2009. Effect of reduced risk pesticides for use in greenhouse vegetable production on Bombus impatiens (Hymenoptera: Apidae). Pest Management Science. 66: 142-146.
LD_{50} = 0.02 µg/bee	Imidacloprid (not reported)	CONTACT TOPICAL Test species: *Bombus terrestris* Application method: single application of 10 µL/bee was applied between the coxae of anasthetized bees; 2–7 doses tested were tested Number of bees tested: unknown Caste of bees tested: adult, workers Observation period: observations made 3, 6, 24, 48 and 72 hours after exposure Effect parameters: mortality	**REVIEW:** Acute Contact Topical Endpoint: LD_{50} = 0.02 µg/bee **MAJOR UNCERTAINTIES:** The concentrations that the bees were exposed to were not provided. The number of bees that were exposed per treatment level was not provided. While it was stated 5 bumble bees were introduced in each cage, there is no indication as to whether there was one cage per treatment, per test, or some other experimental design.	Marletto, F., A. Patetta, A. Manino. 2003. Laboratory assessment of pesticide toxicity to bumble bees. Bulletin of Insectology 56 (1): 155-158.
Bombus impatiens: LC_{50} = 32.2 µg/kg of bee *Megachile rotundata:*	Imidacloprid (>95%)	CONTACT TOPICAL Test species: *Bombus impatiens, Megachile rotundata* and *Osmia lignaria* Application method: potter spray tower was used to administer 5 mL of imidacloprid at 4–6	**REVIEW:** Acute Contact Topical Endpoints: These endpoints were converted by the reviewer based on the assumption that density of the test solution is 1 g/ml. **MAJOR UNCERTAINTIES:** Reported results were concentrations expressed as percentage of solution (wt:vol) ($\times 10^{-3}$): *B impatiens:* LC_{50} = 0.322	Scott-Dupree, C.D., L. Conroy, C.R. Harris. 2009. Impact of Currently Used or Potentially Useful Insecticides for Canola

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
LC_{50} = 1.7 µg/kg of bee *Osmia lignaria*: LC_{50} = 0.7 µg/kg of bee		concentrations Number of bees tested: 9–11 bees/treatment, experiment repeated 4–-6 times *B impatiens:* 251 bees *M. rotundata:* 299 bees *O. lignaria:* 400 bees Caste of bees tested: *B impatiens:* adult, workers *M. rotundata:* adult, 7 days old (female:male ratio was 2:1) *O. lignaria:* adults, (female: male ratio was 1:1.7) Observation period: observations made 48 hours after exposure Effect parameters: mortality	*M. rotundata:* LC_{50} = 0.17 *O. lignaria:* LC_{50} = 0.07	Agroecosystems on Bombus impatiens (Hymenoptera: Apidae), Megachile rotundata (Hymenoptera: Megachilidae), and Osmia lignaria (Hymenoptera: Megachilidae). J. Econ. Entomol. 102(1): 177-182
LD_{50}= 0.0245 µg a.i./bee (48 hours) LD_{50}= 0.0252 µg a.i./bee (24 hours)	Imidacloprid (not stated)	CONTACT TOPICAL Test species: *Scaptotrigona postica* Application method: a single application of 1 µL/bee was applied to the dorsal area of the thorax; doses tested were 0.005, 0.02, 0.04, 0.06, 0.1 and 0.15 µg imidacloprid/bee Number of bees tested: 60 bees/treatment were collected from 3 different colonies; 20 bees/treatment were tested and the experiment was repeated 3 times Caste of bees tested: worker bees Observation period: 24 or 48 hours Effect parameters: mortality and abnormal behaviour	**REVIEW:** Acute Contact Topical Endpoints: LD50= 0.0245 µg a.i./bee (48 hours) LD50= 0.0252 µg a.i./bee (24 hours) **MAJOR UNCERTAINTIES:** An acute oral test was also conducted as part of this study but it was classified as invalid for use in the risk assessment because the consumed exposure dose could not be determined. *Scaptotrigona postica* is a stingless and eusocial bee species that is not found in Canada.	Soares, H.M., C.R. Jacob, S.M. Carvalho, S. M. Nocelli, R. C. Ferreira and O. Malaspina. 2015. Toxicity of Imidacloprid to the Stingless Bee Scaptotrigona postica Latreille, 1807 (Hymenoptera: Apidae). Bull Environ Contam Toxicol. 2015 Jun;94(6):675-80. doi: 10.1007/s00128-015-1488-6. Epub 2015 Feb 10.
No endpoint was	Imidacloprid (water	CONTACT TRANSFER Test species: *Partamona helleri*	**REVIEW**: *Partamona helleri* For *P. helleri*, imidacloprid at 42 mg a.i./L in water caused 100%	Tomé, H.V.V., W.F. Barbosa, A.S. Corrêa,

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
determined	dispersible granules; 700 g a.i./kg)	and *Scaptotigona xanthotrica* Application method: based on the Brazilian field label rate of 42 mg imidacloprid/L, 500 µL of imidacloprid was applied with an air pump to the plastic bioassay container; the container had a surface of 365 cm^2 and the application rate was equivalent to 0.057µg/cm^2. The application was air dried for 2 h prior to 10 bees being placed in the container for a 3 hour exposure period Number of colonies tested: 3colonies/species were tested; unknown number of bees Caste of bees tested: worker bees, unknown age Observation period: it is unclear how often observations were made hourly for 24 hours after eexposure Effect parameters: mortality	mortality within 5 h with median lethal times (LT50 = 0.25 h). *Scaptotigona xanthotrica* For *S. xanthotrica*, imidacloprid at 42 mg a.i./L in water leading to 100% mortality within 5 h of exposure (LT50 = 0.25 h). **MAJOR UNCERTAINTIES:** Unique test method different from OECD guidelines. The dose unit was estimated by the reviewer and may not be precise.	L.M. Gontijo, G.F. Martins and R.N.C. Guedes. 2015. Reduced-risk insecticides in Neotropical stingless bee species: impact on survival and activity. Annals of Applied Biology 167, 186–196. doi:10.1111/aab.12217
LD_{50}=0.001 µg/bee	Imidacloprid (not reported)	CONTACT TOPICAL Test species: *Nannotrigona perilampoides* Application method: single application of 2 µL/bee was applied to the thorax; doses tested were 0.01, 0.1, 0.5 and 1 µg/bee Number of bees tested: 10 bees/treatment Caste of bees tested: adult, age unknown Observation period: observations made 24 hours after exposure Effect parameters: mortality	**REVIEW:** Acute Contact Topical Endpoint: LD_{50} = 0.001 µg/bee **MAJOR UNCERTAINTIES:** This study has a very limited number of replicates (only 2).	Valdovinos-Nunez G.R., J.J. Quezada-Euan, P. Ancona-Xiu, H. Moo-Valle, A. Carmona, E. Ruiz Sanchez. 2009. Comparative toxicity of pesticides to stingless bees (Hymenoptera: Apidae: Meliponini). J Econ Entomol 102(5):1737-1742.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
APIS - Tier I Acute Oral Trials				
No endpoints determined.	Gaucho 480FS (1.6 g imidacloprid /kg seed in 2002; 2.5 g/kg seed in 2003)	ACUTE ORAL Test species: *Apis mellifera* Application method: pollen from corn tassels was collected from plants treated with 1.6 or 2.5 g/kg seed of imidacloprid and placed into bioassay chambers were bees were exposed to tassels from Day 1, 2, 3 and 4 of pollen shed; chambers were provisioned with water and *ad libitum* sugar water Number of bees tested: 20 bees/treatment; replicated 4 times Caste of bees tested: adult, < 24 h old Observation period: 24 hours after exposure Effect parameters: mortality	**REVIEW:** For oral toxicity trials, authors reported that there were no significant variations across treatments. **MAJOR UNCERTAINTIES:** Pollen residues were not analyzed for the seed treatment groups. Control pollen was not analyzed for potential contamination. It is unknown if any of the corn tassel pollen was consumed by the bees since it was not quantified or reported.	Bailey, J.C., C.D. Scott-Dupree, C.R. Harris, J.Tolman and B.J. Harris. 2005. Contact and oral toxicity to honey bees (Apis mellifera L.) of agents registered for use for sweet corn insect control in Ontario, Canada, Apidologie 36: 623-633.
No endpoints determined.	Imidacloprid (% not reported)	ACUTE ORAL Test species: *Apis cerana indica* Application method: 1 mL of honey and test substance solution was provided to bees at a concentration of 0.4 mL/L (reviewer estimated: 400 µg a.i./bee) Number of bees tested: 25 bees/treatment, experiment was repeated 3 times Caste of bees tested: adult, 25 days old Observation period: observations made 1, 2, 3 and 4 days after exposure Effect parameters: mortality	**REVIEW:** This toxicity test ran for 5 days total. The results from the first 4 days are presented below. The results from day 5 are in the chronic oral Apis table: 5.5, 8.4, 12.8, 15.4% mortality in 1, 2, 3 and 4 days. **MAJOR UNCERTAINTIES:** It was unclear if the solution was replaced every day, and what the ingested amount was per bee. The amount of active ingredient could not be determined (based on assumption that TGAI was used in dosing). The reviewer calculated the amount of dose (based on a density of water) to be approximately 400 ug a.i./bee (0.4 mL/L = 0.4 g/L × 0.001 L/bee = 0.0004 g/bee = 400 ug a.i./bee). It is unclear what the control consisted of, since the Table reported the control as “CD (0.5%)”.	Chandramani, P., B.U. Rani, C. Muthiah, S. Kumar. 2008. Evaluation of toxicity of certain insecticides to India honey bee, Apis cerana indica F. Pestology, 32(8):42-43.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
No endpoints determined.	Imidacloprid (98%)	ACUTE ORAL Test species: *Apis mellifera* Application method: *Conditioning trial:* sucrose solution used as unconditioned stimulus (US), odour delivered was used as conditioning stimulus (CS), after US a reward of sucrose solution was provided *Experiment 1:* bees fed spiked sucrose solution 30 minutes before CS *Experiment 2:* after US a reward of spiked sucrose solution was provided and response tested 30 sec, 3 min., 15 min., 1 hour or 24 hour after exposure *Experiment 3:* CS followed by oral treatment of spiked sucrose solution to test short (30 sec. or 3 min.), medium (15 min. or 1 hour) or long-term (24 hour) memory Application dose: 0.12 and 12 ng/bee; only 12 ng/bee tested in *Experiment 3* Number of bees tested: *Experiment 1:*30 bees/treatment *Experiment 2:* unknown *Experiment 3:*40-50 bees/group Caste of bees tested: adult, 14-16 days old Effect parameters: mortality and proboscis extension reflex (PER)	**REVIEW:** *Mortality:* No difference was found in the mortality rate of the different groups (0.12 ng per bee: 11%; 12 ng per bee: 13%; control: 12%; P > 0:05). *Experiment 1:* Bees treated with 12 ng per bee dose exhibited significantly lower performances compared to the response of the control group (P < 0.001 for both trials). No significant difference was found between treated bees at the lower dose (0.12 ng per bee) compared to the control. *Experiment 2:* A significant decreased response in the groups treated at a dose of 12 ng per bee and tested 1 or 24 h after imidacloprid treatment (P < 0.001 for both time periods). In the control group, 93 and 84% of bees showed a conditioned response at 1 and 24 hrs, respectively. For those same time delays, 12 ng per bee reduced response levels to 50 and 26% of conditioned responses, respectively and no response at the 0.12 ng/bee dose. *Experiment 3:* The post-training treatment at 15 min and 1 h led to significant differences in medium-term retention between treated bees (12 ng per bee) and control bees (15 min: P < 0.05). When imidacloprid was applied after conditioning, it impaired medium-term retention but not short- and long-term retention. **MAJOR UNCERTAINTIES:** The authors did not confirm the nominal level of residues in the final treatment or that the entire dose was consumed with no regurgitation.	Decourtye, A., C. Armengaud, M. Renou, J. Devillers, S. Cluzeau, M. Gauthier, M.H. Pham-Delègue. 2004. Imidacloprid impairs memory and brain metabolism in the honey bee (Apis mellifera L.). Pesticide Biochemistry and Physiology. 78: 83-92.
Imidacloprid LD_{50}= 0.0306 µg/bee *5-hydroxy-*	Imidacloprid (99.4%) 5-hydroxy-	ACUTE ORAL Test species: *Apis mellifera* Application method: bees fed 200 µL/20 bees of sucrose solution (500 g/L) spiked with test solution	**REVIEW:** Acute Oral Endpoints: *Imidacloprid* LD_{50} = 0.0306 µg/bee; *5-hydroxy-imidacloprid* LD_{50} = 0.1535 µg/bee **MAJOR UNCERTAINTIES:** The stock solutions were stored in	Decourtye, A., E. Lacassie, M.H. Pham-Delegue. 2003. Learning performances of

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
imidacloprid LD_{50} = 0.1535 µg/bee	imidacloprid (99.4%)	Application dose: *Imidacloprid:* 5 concentrations ranging from 0.2-3.2 mg/L *5-hydroxy-imidacloprid:* 5 concentrations ranging from 1.25–20 mg/L Number of bees tested: 20 bees/treatment, repeated at least 3 times Caste of bees tested: adult, age unknown (late summer bees) Observation period: 48 hours Effect parameters: mortality	the freezer but removed at ambient temperature and allowed to defrost in daylight. Imidacloprid will photodegrade in daylight therefore it is possible that some degradation occurred prior to exposure to the test substance and may not be captured by the chemical analysis of the stock solution.	honey bees (Apis mellifera L) are differentially affected by imidacloprid according to the season. Pest Manag Sci 59: 269-278.
No endpoints determined.	Nicotine (not reported)	ACUTE ORAL Test species: *Apis mellifera scutellata* Application method: a 0.63 M sucrose diet containing 300 µM (50 ppm) of nicotine was fed to the bees for 72 hours (estimated total body load was 3 µg nicotine/bee over 72 hours) Number of bees tested: 125 bees/cage, 3 cages per treatment Caste of bees tested: adult bees, less than 1 day old Observation period: 72 hours after application bees were destructively sampled Effect parameters: metabolite and protein profile of exposed bees	**REVIEW:** The study showed that active detoxification of nicotine in bees is associated with increased energetic investment such as energy metabolism (oxidative phosphorylation) and carbohydrate metabolism and also antioxidant and heat shock responses. A total of 414 metabolites were identified but the levels of only eight were significantly altered. A total of 1470 proteins were identified with 96 substantially up-regulated and 59 down-regulated in the nicotine exposed samples. **MAJOR UNCERTAINTIES:** This study was conducted with nicotine and not a neonicotinoid. It is unclear how the nicotine metabolic results can be used in the risk assessment.	du Rand EE, Smit S, Beukes M, Apostolides Z, Pirk CW, Nicolson SW. 2015. Detoxification mechanisms of honey bees (Apis mellifera) resulting in tolerance of dietary nicotine. 5:11779. DOI: 10.1038/srep11779
No endpoints determined.	Imidacloprid (analytical standard)	ACUTE ORAL Test species: *Apis mellifera ligustica* Application method: bees were trained to either a nectar or pollen feeder, they were then captured and fed 7 µL of spiked sucrose	**REVIEW:** *Nectar foragers:* *PER:* No statistics were conducted on PER results. At both 0.21 and 2.16 ng/bee, a reduced proportion of the treated bees exhibited PER relative to controls, and a reduced proportion of the high dose (2.16 ng/bee) compared to the low (0.21 ng/bee). *SRT:* Mean nectar forager SRT was significantly higher in the low (18.9%; 0.21 ng/bee) and high (19.2%; 2.16 ng/bee) when	Eiri, D.M., J.C. Nieh. 2012. A nicotinic acetylcholine receptor agonist affects honey bee sucrose responsiveness and decreases waggle

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		and held for 1 hour prior to experimentation Application dose: 24 and 241 ppb (0.21 and 2.16 ng a.i./bee) Number of bees tested: 7–15 bees/trial; 314 nectar and 209 pollen foragers from 3 different colonies Caste of bees tested: adult, pollen foragers and nectar foragers Effect parameters: proboscis extension reflex (PER), sucrose response threshold (SRT) and total PER/bee	compared to the control 10.6% (control). *Total PER/bee:* Control nectar foragers had significantly higher mean total PER/bee (4.1) than either the low (3.0) or high (2.6) treatments. *Pollen foragers:* *PER:* No statistics were conducted on PER results. There was no difference between controls and bees receiving the low (0.21 ng/bee) imidacloprid treatment. Bees receiving the high imidacloprid (21.6 ng/bee) appeared to elicit less PER response at each sucrose concentration. *SRT:* Mean pollen forager SRT was significantly higher in the high (18.1%; 2.16 ng/bee) when compared to the control 5.9% (control). Low (0.21 ng/bee) had only 5.7% SRT. *Total PER/bee:* Control nectar foragers had significantly higher mean total PER/bee (4.8) than the high (3.0) treatment. Low (0.21 ng/bee) had only 4.7 total PER/bee. **MAJOR UNCERTAINTIES**: The source forage of the pollen used in the study was not described and it was not reported if residue analysis was conducted on the sucrose and pollen used to train the honey bees. Residue analysis was not conducted on control or treatment solutions to confirm the reported nominal concentrations tested. It is unclear if the entire dose was consumed.	dancing. The Journal of Experimental Biology. 215(12): 2022-2029
No endpoints determined.	Gaucho 250 FS (imidaclopri d 0.5 mg a.i./seed)	ACUTE ORAL Test species: *Apis mellifera* Application method: guttation water was collected from corn plants grown from treated seed, 30 µL of water was provided to individual bees with or without 15% honey Application concentration: residue analysis of guttation water recovered a dose of 47 ± 9.96 to 82.8 ± 14.07 mg/L Number of bees tested: minimum 12 bees/treatment, unknown if	**REVIEW:** *Time to wing block:* Estimated from a graph, the average time to wing block was about 5.5 min for the treated water. No comparison with control was provided. After adding 15% honey to treated water, bees drank more solution and all bees (n = 63) had irreversible wing block within 2-4 minutes for concentrations > 100 mg/L and 6-15 min at approximate 50 mg/L. Control tests did not result in any mortality or toxicity to bees. *Dose-response evaluation:* for guttation water with 15% honey added, time to reach symptoms took longer than 1hour at ≥ 6.25 mg/L and symptoms appeared immediately at ≥ 100 mg/L; some symptoms were reversible at low doses (not quantified) at observation periods > 1 hour. **MAJOR UNCERTAINTIES**: The authors noted that bees often	Girolami, V., L. Mazzon, A. Sqartini, N. Mori, M. Mazaro, A. Di Bernardo, M. Greatti, C. Giorio, A. Tapparo. 2009. Translocation of neonicotinoid insecticides from coated seeds to seedling guttation drops: A novel way of intoxication for bees. Journal of Economic

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		experiment was repeated Caste of bees tested: adult, age unknown Effect parameters: time to wing block response (wing paralysis but not actual insect death), dose-response evaluation	did not drink when presented with field collected guttation water (thus the addition of 15% honey in their laboratory guttation water experiments). It is unclear from this study whether this reaction is typical for bees and guttation fluid. The level of exposure is unknown since guttation water was collected from field grown plants, and from plants raised in pots in the lab that were planted in individual or in multiples in the same pot. The different planting techniques affect the amount of active ingredient translocated into the leaves.	Entomology, 102(5): 1808-1815.
No endpoints determined.	Imidacloprid (not reported)	ACUTE ORAL Test species: *Apis mellifera* and *Bombus terrestris* (with subspecies *dalmatinus, audux, and terrestris)* Application method: *Behavioural two-choice assays:* *Bumble bee:* three, 3mL perforated feeding tubes contained doses of: deionized water (control), 0.5 M sucrose, or 0.5 M sucrose with imidacloprid for a total of 24 h *Honey bee:* four, 3mL perforated feeding tubes contained doses of: one tube of deionized water (control), two tubes of 1 M sucrose, or 1 M sucrose with imidacloprid for a total of 24 h *Honey bee antennal and mouthpart assays:* Assay 1 – individual honey bees were lightly tapped on the antenna with a solution containing 0.064, 0.418, 3.98, 13.9 ng/bee corresponding to 1, 10, 100 nM and 1 μM of imidacloprid to elicit proboscis extension reflex (PER)	Information from this study is also in the section: NON-APIS - Tier I Acute Oral Trials **REVIEW:** *Behavioural two-choice assays*: Honey bee Honey bees significantly chose imidacloprid at 100 nM and 1 μM (3.98 snd 13.9 ng/bee respectively) doses when presented with both sucrose control and treated choice feeding tube. The total food consumption of forager honey bees was not reduced when bees fed from solutions containing imidacloprid. Bumble bee Bumble bees showed a significant preference for solutions containing thiamethoxam over sucrose alone at the 1 nM (0.064 ng/bee consumed) dose when compared to the sucrose control choice. Bumble bees fed with imidacloprid consumed significantly less total food on average than those fed thiamethoxam or the sucrose control. *Age of bees* The 'attractive' effect of imidacloprid also depended on bee age: newly emerged adult worker bumble bees and honey bees largely avoided 1–10nM imidacloprid. Only imidacloprid was used to test the difference between different aged bees. *Honey bee antennal and mouthpart assays:* None of the sucrose solutions containing imidacloprid affected proboscis extension or retraction. *Electrophysiology experiment:* Stimulation with imidacloprid did not elicit spikes from any of the	Kessler, S.C., Tiedeken, E.J., Simcock, K.L.., Derveau, S., Mitchell, J., Softley, S., Stout, J.C., Wright,G.A.. 2015. Bees prefer foods containing neonicotinoid pesticides. Nature 521: 74–76 doi:10.1038/nature14414 Raine, N.E. and R.J. Gill. 2015. Tasteless pesticides affect bees in the field. Nature. 521: 38-40. doi:10.1038/nature14391

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		Electrophysiology experiment: Electrophysiological recordings were made from taste neurons located in the first 11 sensilla on the honey bee's proboscis and in the first 6 sensilla in bumble bees. Individuals were repeatedly sampled in one of two protocols: (1) 50mM sucrose, 100mM KCl, water, 1µM neonicotinoid, 1mM neonicotinoid, 1mM NHT, 100mM KCl, 50mM sucrose; or (2) 50mM sucrose, 50mM sucrose + neonicotinoid in one of the following concentrations (1nM, 10nM, 1µM), 50 mM sucrose. Number of bees tested: *Behavioural two-choice assays:* Bumble bees - (57, 66, 65 and 66) corresponds to 1, 10, 100 nM and 1 µM Honey bees - 40 cohorts of 25 bees/treatment *Honey bee antennal and mouthpart assays:* 40 bees/treatment *Electrophysiology experiment:* 10 bees/treatment Caste of bees tested: *Behavioural two-choice assays:* *Bumble bee:* newly emerged bees *Honey bee:* foragers *Honey bee antennal and mouthpart assays:* foragers *Electrophysiology experiment:* not stated Observation period: *Behavioural two-choice assays*:	neurons in the galeal sensilla of either bumble bees or honey bees statistically higher than the response to the water control. **MAJOR UNCERTAINTIES**: In general, bumble bees consumed more of the neonicotinoid-laced food than honey bees and were, therefore, exposed to higher pesticide doses. However, bumble bees are also larger in body weight, and the dose is per bee not per weight of the bee. It is unclear how these results can be used in the risk assessment.	

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		24 h *Honey bee antennal and mouthpart assays:* not stated *Electrophysiology experiment:* 2 s Effect parameters: *Behavioural two-choice assays*: mortality, amount of food consumed *Honey bee antennal and mouthpart assays:* proboscis extension reflex (PER), food consumption *Electrophysiology experiment:* taste neuron response		
LD_{50} = 0.191, 0.099 and 0.075 µg/bee for 24, 48 and 72 hours: Beehive 1 LD_{50} = 0.173, 0.104 and 0.047, µg/bee for 24, 48 and 72 hours: Beehive 2 LD_{50} = 0.187, 0.110 and 0.097 µg/bee for 24, 48 and 72 hours: Beehive 3	Confidor 200 SL (imidaclopri d 17.8%)	ACUTE ORAL Test species: *Apis mellifera ligustica* (3 different strains) Application method: 35 µL of sucrose solution was provided for 1 hour in a feeder at doses of 0.15, 0.3, 0.75, 1.5, 3, 7.5, 15, 150 ppm Number of bees tested: 10 bees/treatment, experiment was repeated 4 times Caste of bees tested: adult, foragers Observation period: observations made 1, 3, 6, 24, 48 and 72 hours Effect parameters: mortality	**REVIEW:** Acute Oral Endpoints: LD_{50} = 0.191, 0.099 and 0.075 µg/bee for 24, 48 and 72 hours: Beehive 1; LD_{50} = 0.173, 0.104 and 0.047, µg/bee for 24, 48 and 72 hours: Beehive 2; LD_{50} = 0.187, 0.110 and 0.097 µg/bee for 24, 48 and 72 hours: Beehive 3 This study showed the variability of the LD_{50} values for different strains of bees. Each beehive tested a different strain of bees. **MAJOR UNCERTAINTIES:** Very little information on test species strains. Age of foragers not uniform. No control information was included. It was not clear if Abbott's correction was applied to account for control mortality (if any occurred). Vomiting in bees likely reduced overall exposure. The amount of ingested active did not appear to be calculated; it was based on the feeder size which was 35 µL.	Laurino D., A. Manino, A. Patetta, M. Ansaldi M. Porporato. 2010. Acute oral toxicity of neonicotinoids on different honey bee strains. Redia; 2010.93:99-102.
LD_{50} = 0.193 µg/bee: Colony 1	Confidor 200 SL (imidaclopri d 17.8%)	ACUTE ORAL Test species: *Colony 1: Apis mellifera mellifera* *Colony 2, 3, 5, 6: Apis mellifera*	**REVIEW:** Acute Oral Endpoints: LD_{50} = 0.193 µg/bee: Colony 1; LD_{50} = 0.0298 µg/bee: Colony 2; LD_{50} = 0.065 µg/bee: Colony 3; LD_{50} = 0.025 µg/bee: Colony 5; LD_{50} = 0.035 µg/bee: Colony 6 Approximately 42% of the data presented in this study are from	Laurino, D., A. Manino, A. Patteta, M. Porporato. 2013. Toxicity of

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
LD_{50} = 0.0298 µg/bee: Colony 2 LD_{50} = 0.065 µg/bee: Colony 3 LD_{50} = 0.025 µg/bee: Colony 5 LD_{50} = 0.035 µg/bee: Colony 6		*lingustica* Application method: 35 µL of sucrose solution was provided for 1 hour in a feeder at doses of 15, 7.5, 3, 1.5, 0.75, 0.3, and 0.15 ppm Number of bees tested: 10 bees/treatment, experiment was repeated 2-3 times Caste of bees tested: adult, foragers Observation period: observations made 1, 3, 6, 24, 48 and 72 hours Effect parameters: mortality	previous works (for example; Laurino et al 2010) where the methods described were the same as in the present study; data was not clearly labelled as to which study it originated from. **MAJOR UNCERTAINTIES:** Testing procedures used throughout were uneven and therefore no definitive statement can be made about subspecies differential toxicity for a given chemical.	neonicotinoid insecticides on different honey bee genotypes. Bulletin of Insectology. 66 (1) 119-126
No endpoints determined.	Confidor (not reported)	ACUTE ORAL Test species: *Apis mellifera* Application method: *Experiment 1:* Single dose of 200 µL/bee *Experiment 2:* Dose provided ad libitum. Application dose: 100 and 500 ppb (approximately 2 ng/bee and 10 ng/bee respectively) Number of bees tested: 10 bees/treatment, unknown if experiment was repeated Caste of bees tested: adult, foragers Observation period: observations made from 0-0.5, 0.5-1, 1-2, 6.5-7 and 23-23.5 hours after treatment Effect parameters: stationary behaviour	**REVIEW:** *Experiment 1:* Single dose 0.5–1 hour and 1–2 hours after treatment stationary behaviour was significantly increased in both treatments when compared to untreated. *Experiment 2:* Ad libitum 0–0.5 and 0.5–1 hour treatment stationary behaviour was significantly increased only in 500 ppb only. 1-2 hours after treatment stationary behaviour was significantly increased in both treatments when compared to untreated. **MAJOR UNCERTAINTIES:** Control mortality not stated. No verification or measure of consumption.	Medrzycki P., R. Montanari, L. Bortolotti. 2003. Effects of imidacloprid administered in sub-lethal doses on honey bee behavior. Laboratory test. Bulletin of Insectology. 56: 59-62.
No endpoints determined.	Imidacloprid (98%)	ACUTE ORAL Test species: *Apis mellifera* Application method: whole	**REVIEW:** *Mortality:* When mortality was compared among observation periods, no significant difference was found when colonies were exposed to imidacloprid (P = 0.4).	Ramirez-Romero, R., J. Chaufaux, M.H. Pham-Delégue. 2005.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		colonies were placed in a laboratory flight room and given 4 days untreated syrup, 4 days treated syrup, 4 days untreated syrup Application dose: 48 ppb Number of bees tested: 3 colonies of approximately 10,000 bees each; total number of bees in tests unknown Caste of bees tested: adult, age unknown Observation period: total of 3 observations made after each feeding period (that occurred every 4 days) Effect parameters: mortality, syrup consumption, foraging activity, olfactory performance	*Syrup consumption:* Syrup consumption was significantly lower during treatment than before and after treatment (P = 0.001). *Foraging activity:* Activity was measured on an artificial floral array system. Foraging activity was significantly lower during treatment than before and after treatment (P < 0.01). The mean number of visits during the treatment was 4.8 (± 0.4 SEM), compared to before (23.7 ± 1.3 SEM) and after (20.4 ± 0.8 SEM). The treatment led to a decrease of approximately 20% visits, and the release after treatment led to an increase of ~ 24% visits. *Olfactory performance:* Activity was measured on an artificial floral array system. The percentage of foragers visiting the scented sites during the treatment period (76.8 and 78.2%) were lower in comparison to the percentages of visits before treatment (90.9 and 81.8%) and after treatment (83.8 and 90.6%). Nevertheless, this level always remained significantly higher than a randomised distribution between scented and unscented sites (P < 0.01). **MAJOR UNCERTAINTIES:** No analytical confirmation of imidacloprid in the syrup. No true experimental control as each group served as an alternating control and treatment group. Uncertainty how the artificial floral array system compares to that of natural flowers for obtaining foraging-based endpoints.	Effects of Cry1Ab protoxin, deltamethrin and imidacloprid on the foraging activity and the learning performances of the honey bee Apis mellifera, a comparative approach. Apidologie (2005) 36: 601-611.
LC_{50} = 0.0025 µg/mL/mg: Italian bee stock LC_{50} = 0.0833 µg/mL/mg: Russian bee stock LC_{50} = 0.0393 µg/mL/mg: Carniolan bee	Imidacloprid (> 98%)	ACUTE ORAL Test species: *Apis mellifera* 3 day old adults. 3 honey bee stocks (Russian, Italian, and carniolan) Application method: 4 concentrations were tested from the stock solution; a 1.5 mL microcentrifuge tube containing 1 mL of sucrose solution with imidacloprid was inserted through bioassay chamber cover Application dose: 1 ml of 50% sucrose solution containing	**REVIEW:** Acute Oral Endpoint: The reported LC50s for imidacloprid were 2.5, 83.3, and 39.3 ng/ml/mg bee respectively for Italian, Russian and Carniolan bees. Russian and Carniolan bees were 15.7-fold and 33.3-fold less sensitive than Italian bees. **MAJOR UNCERTAINTIES:** LD_{50}s could not be calculated due to the lack of measurement of food consumption during the study. It is noted that Abbott's correction was included in the analysis.	Rinkevich FD, Margotta JW, Pittman JM, Danka RG, Tarver MR, Ottea JA. 2015. Genetics, Synergists, and Age Affect Insecticide Sensitivity of the Honey Bee, Apis mellifera. PLoS ONE 10(10): e0139841. doi:10.1371/journal.pone.0139841

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
stock		pesticides was provided to each group of 20 test bees for 24 hours. Number of bees tested: 20 bees per treatment group. Repeated tests in 2-4 separate treatment days using 3-5 colonies from each stock. Exposure and observation period: 24 h (up to 72 hours however, no significant additional mortality was observed beyond 24 hours) Effect parameters: mortality Location: USA Year: 2014		
Imidacloprid LD_{50} = 0.041 µg/bee: Germany I LD_{50} > 0.02 µg/bee: Netherlands LD_{50} > 0.081 µg/bee: Germany II LD_{50} > 0.081 µg/bee: UK I LD_{50} > 0.081 µg/bee: Germany III LD_{50} > 0.081 µg/bee: Germany IV LD_{50} > 0.081	Imidacloprid (> 98%) Olefin (> 98%) 5-hydroxy-imidacloprid (> 98%) Di-hydroxy-imidacloprid (> 98%) Urea metabolite (> 98%) 6-chloronicotinic acid (> 98%)	ACUTE ORAL Test species: *Apis mellifera* Application method: single application of 0.2–0.25 mL of spiked sucrose were given in a feeder for 3–4 hours; doses tested were 0.1–81 ng a.i./bee Number of bees tested: 10 bees/treatment, unclear if experiment was repeated Caste of bees tested: adult, worker bees 14-42 days old Observation period: observation made 48 hours after exposure Effect parameters: mortality	**REVIEW:** Acute Oral Endpoints: The LD_{50} tests were repeated at multiple locations. The LD_{50} range for imidacloprid was 0.041 to >0.081 µg a.i./bee. *Olefin:* LD_{50} > 0.036 µg a.i./bee: Germany I; *5-hydroxy-imidacloprid:* LD50 = 0.159 µg a.i./bee: Germany I; *Di-hydroxy-imidacloprid:* LD50 > 0.049 µg a.i./bee: Germany I; *Urea:* LD50 > 99.5 µg a.i./bee: Germany I; *6-chloronicotinic acid:* LD50 > 1121.5 µg a.i./bee: Germany I **MAJOR UNCERTAINTIES:** No control mortality reported. Unclear of exact numbers of bees exposed per treatment. Treatment concentrations only provided as range of doses and not exact doses. Oral exposure duration of metabolites not reported but presumably is 48 hours.	Schmuck, R., R. Nauen, U. Ebbinghaus-Kintscher. 2003. Effects of imidacloprid and common plant metabolites of imidacloprid in honey bee: toxicological and biochemical considerations. Bulletin of Insectology, 56 (1): 27-34.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
µg/bee: Germany V *Olefin* LD_{50} >0.036 µg a.i./bee: Germany I *5-hydroxy-imidacloprid* LD50 = 0.159 µg a.i./bee: Germany I *Di-hydroxy-imidacloprid* LD50 > 0.049 µg a.i./bee: Germany I *Urea* LD50 > 99.5 µg a.i./bee: Germany I *6-chloronicotinic acid* LD50 > 1121.5 µg a.i./bee: Germany I				
Imidacloprid LD_{50} = 0.0037 µg/bee: A LD_{50} > 0.021 µg/bee: B	A, B & C: Imidacloprid (> 98%) C: WG70 (imidacloprid 70%) and	ACUTE ORAL Test species: *Apis mellifera* Application method: single application of 0.2 mL of spiked sucrose; 4-6 doses tested Number of bees tested: 10 bees/treatment	**REVIEW:** Acute Oral Endpoints: The LD_{50} tests were repeated at multiple locations. The LD_{50} range for imidacloprid was 0.0037–0.049 µg a.i./bee. **MAJOR UNCERTAINTIES:** No indication of control performance was provided. It is not known what doses were tested. Imidacloprid concentrations were not analytically verified and no	Schmuck, R., R. Schoning, A. Strok. 2001. Risk posed to honey bees (Apis mellifera L, Hymenoptera) by an imidacloprid seed

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
LD_{50} = 0.0409 µg/bee: C *WG70* LD_{50} = 0.0116 µg/bee: C *SC 200* LD_{50} = 0.021 µg/bee: C	SC 200 (not reported)	Caste of bees tested: adult, age unknown Observation period: 48 hours Effect parameters: mortality	information on the dose response was provided.	dressing of sunflowers. Pest Management Science (2001) 57: 225-238 PMRA 1086438, 2142760
no endpoints determined	imidacloprid (98%)	ACUTE ORAL Test species: *Apis mellifera* Application method: single application of 10 µL of spiked sucrose; 0, 20,50 µg/kg of bee (mean bee weight: 100 mg) Number of bees tested: 20 bees/treatment x at least 3 replicates Caste of bees tested: adult worker, age unknown Observation period: 0, 4, 6, 24, 30 and48 hours Effect parameters: mortality, behaviour Residues: in bees	**REVIEW:** Imidacloprid was metabolised quickly and thoroughly in honey bees. Suchail et al., (2003 and 2004) reported that imidacloprid had a half-life ranging between 4.5 and 5 h in honey bees. Imidacloprid was readily metabolised into five metabolites: 4/5-hydroxy-imidacloprid, 4,5-dihydroxy-imidacloprid, 6-chloronicotinic acid, and olefin and urea derivatives. The urea derivative and 6-chloronicotinic acid were the main metabolites and appeared particularly in midgut and rectum. The olefin derivative and 4/5-hydroxy-imidacloprid preferentially occurred in head, thorax and abdomen, which are nicotinic acetylcholine receptor-rich tissues. Moreover, they presented a peak value around 4 h after imidacloprid ingestion. However they could no longer be detected in the honey bee after 6 and 24 h ingestion of imidacloprid at 20 and 50 µg/kg bee respectively. **MAJOR UNCERTAINTIES:** Different analytical methods were used in the two studies. The limit of quantification was not reported in Suchail, et al. (2004) and it was 0.5 µg/kg in Suchail, et al. (2003)	Suchail, S., Debrauwer, L. and Belzunces, L. P., 2003. Metabolism of imidacloprid in Apis mellifera. Pest. Manag. Sci., 60: 291–296. doi:10.1002/ps.772 Suchail, S., 2004. In vivo distribution and metabolism of ^{14}C imidacloprid in different compartments of Apis mellifera L. Pest Manag Sci 60:1056–1062 DOI: 10.1002/ps.895
Imidacloprid LD_{50} = 0.057, 0.037, 0.037 µg/bee: 48, 72 and 96 h *5-hydroxy-*	Imidacloprid (> 97%) 5-hydroxy-imidacloprid (> 97%)	ACUTE ORAL Test species: *Apis mellifera* Application method: single application of 10 µL of spiked sucrose; dose range tested 1 – 1000 ng/bee Number of bees tested: 3 cages of	**REVIEW:** Acute Oral Endpoints: The decreasing order of toxicity was olefin > imidacloprid > 5-hydroxy-imidacloprid. All other metabolites were not toxic. **MAJOR UNCERTAINTIES:** There was no measure of the amount of treated food consumed per day just an average reported. The doses tested were unknown, only a range was reported.	Suchail, S., D. Guez, L.P. Bezunces. 2001. Discrepancy between acute and chronic toxicity induced by imidacloprid and its metabolites in Apis

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
imidacloprid LD_{50} = 0.258, 0.206, 0.222 µg/bee: 48, 72 and 96 h *olefin* LD_{50} = 0.028, 0.029, 0.023 µg/bee: 48, 72 and 96 h *4,5-dihydroxy-imidacloprid* LD_{50} > 1, 1, 1 µg/bee: 48, 72 and 96 h *Desnitroimidacloprid* LD_{50} > 1, 1, 1 µg/bee: 48, 72 and 96 h *6-chloronicoinic acid* LD_{50} > 1, 1, 1 µg/bee: 48, 72 and 96 h *Urea* LD_{50} > 1, 1, 1 µg/bee: 48, 72 and 96 h	Olefin (> 97%) 4,5-dihydroxy-imidacloprid (> 97%) Desnitroimidacloprid (> 97%) 6-chloronicoinic acid (> 97%) Urea (> 97%)	20 bees/treatment, experiment was replicated at least 3 times Caste of bees tested: adult, workers Observation period: observations were made 2, 4, 6, 10, 14, 20, 24, 30, 48, 72 and 96 hours after exposure Effect parameters: mortality		mellifera. Environmental Toxicology and Chemistry, Vol. 20, No. 11, pp. 2482–2486, 2001
LD_{50} = 0.0054,	Imidacloprid (98%)	ACUTE ORAL Test species: *Apis mellifera*	**REVIEW:** Acute Oral Endpoints: LD_{50} = 0.0054, 0.0048 µg/bee for 24 and 48 h: Apis mellifera mellifera; LD_{50} = 0.0066, 0.0065	Suchail, S., D. Guez, L.P. Belzunces. 2000.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
0.0048 µg/bee for 24 and 48 h: *Apis mellifera mellifera* LD_{50} = 0.0066, 0.0065 µg/bee for 24 and 48 h: *Apis mellifera caucasica*		*mellifera* and *A. mellifera caucasica* Application method: single application of 10µL/bee of spiked sucrose; doses tested were unknown Number of bees tested: 20 bees/treatment, experiment was repeated 3 times Caste of bees tested: adult, age unknown Observation period: observations made 2, 4, 6, 10, 14, 20, 24 and 48 hours after exposure Effect parameters: mortality	µg/bee for 24 and 48 h: Apis mellifera caucasica **MAJOR UNCERTAINTIES:** Unclear from methods section which doses were tested. No analytical confirmation of the doses was conducted. For oral toxicity, the reviewers' caution that the observed results may reflect artifacts of the oral test design, where the doses to individual bees are actually assumed based on equal total consumption among all bees exposed.	Characteristics of Imidacloprid Toxicity in Two Apis Mellifera Subspecies. Environmental Toxicology and Chemistry. 19 (7): 1901-1905.
No endpoints determined.	Imidacloprid (not stated)	ACUTE ORAL Test species: *Apis cerana cerana* Application method: individual bees were fed 10 µL of 1M of sucrose solution (30% w/w) containing concentration of 0 (control), 0.0001 µg (8.87 ppb), 0.001 µg (88.7 ppb) prior to undergoing proboscis extension reflex (PER) tests to examine short-term learning (tested 10, 19, 30 and 40 minutes after learning trial) and longer-term learning (tested 1, 5 and 17 hours after learning trial) Number of bees tested: 30 bees/colony/ treatment; a total of 270 bees were tested Caste of bees tested: foraging adults, age unknown Observation period: observations made after 10, 19, 30 and 40 min to test short-term memory (STM)	**REVIEW:** *Short-term memory* Control group bees exhibited short-term learning that improved with reinforcement trials. Imidacloprid treatments impaired short-term learning (PER in the control was approximately 1.6 fold higher than in both treatments). The differences in PER between the treatment and control was detected at approximately 19 minutes after the first trial. The author stated that there was no significant overall effect of treatment , but there was a significant interaction of treatment*trial because learning curves of imidacloprid-treated bees had significantly different slopes than learning curves of control bees. *Longer-term memory* Adult bees in the control exhibited significantly better longer-term memory (1.3–1.8 fold) than bees treated with imidacloprid at both doses. PER was reduced at 17 h in the control bees, but it is still higher than in treated bees. Memory retention significantly changed over time: memory was poorer at 1 h and 17 h than at 5 h. However, memory at 1 h vs 17 h was not significantly different. The rate of memory extinction was not affected by treatment: there was no significant interaction of treatment*trial. **MAJOR UNCERTAINTIES**: In the longer-term learning and	Tan, K., W. Chen, S. Dong, X. Liu, Y. Wang and J. C. Nieh. 2015. A neonicotinoid impairs olfactory learning in Asian honey bees (Apis cerana) exposed as larvae or as adults. Scientific Reports 5: 10989. DOI: 10.1038/srep10989

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		and after 1, 5, or 17 h to test longer-term memory (LTM) Effect parameters: learning response	retention test of the study, bees were not provided with sucrose reward. The impact of the lack of energy provisions to test bees during 1 hr to 17 h after the last sugar award on the learning memory of bees is unknown. Links between the PER endpoints to the typical environmental and/or colony-level endpoints has not been established.	
LD_{50} = 0.536 µg/bee	Imidacloprid (99.9%)	ACUTE ORAL Test species: *Apis mellifera* Application method: single application of 200 µL/10 bees of spiked sucrose was given in a feeder for 4 hours; 5 doses tested Number of bees tested: 10 bees/treatment, unclear if experiment was repeated Caste of bees tested: adult, age unknown Observation period: observations made 4 and 24 hours after exposure Effect parameters: mortality and knockdown	**REVIEW:** ACUTE ORAL Endpoint: LD_{50}=0.536 µg/bee Imidacloprid was tested in combination with several ergosterol biosynthesis inhibitor (EBI) fungicides: none of which increased the toxicity significantly (LD_{50} = 1.075 µg/bee + myclobutanil; LD_{50}=1.501 µg/bee + propiconazole; LD_{50} = 1.180 µg/bee + flusilazole; LD_{50} = 0.893 µg/bee + tebuconazole). Stumbling and/or knockdown was observed at 4 h in almost all imidacloprid-treated cages (the doses were selected to assess the mortality rather than the behavioural effects), and the data were thus not suitable for the analysis of the dose-response approach required for assessing increased sublethal toxicity. **MAJOR UNCERTAINTIES:** No measure of control mortality. The doses used in the study were not reported, however the LD50 was calculated.	Thompson H.M., S.L. Fryday, S. Harkin, S. Milner. 2014. Potential impacts of synergism in honey bees (Apis mellifera) of exposure to neonicotinoids and sprayed fungicides in crops. Apidologie 45(5):545-553.
No endpoints determined.	Imidacloprid (not stated)	ACUTE ORAL Test species: *Apis mellifera* Application method: *Acute toxicity:* three tubes that were 2 mL in size were filled with 1 M of sucrose solution in each treatment box that were left for 24 h for the bees to feed *ad libitum*; doses tested were 2.56 ppb (10 nM; 0.401 ng/bee/day) and 25.6 ppb (100 nM; 3.70 ng/bee/day) *Behavioural assays:* individual bees were removed from treatment cages and placed in separate cages to observe behaviour over a 15 min interval	**REVIEW:** *Acute toxicity:* Bees fed the 100 nM dose were on average more likely to die overnight than those fed the 10 nM dose. No mortality treatment effects were seen in the bees fed 10 or 100 nM of imidacloprid when compared to the control. *Sucrose solution consumption:* Within the imidacloprid treatment, there was a very small numerically lower amount of solution consumed between the 25.6 ppb (mean volume = 0.144 mL/bee/24 hours) and 2.56 ppb (mean volume = 0.156 mL/bee/day) treatments. *Behavioural assays:* The 2.56 ppb imidacloprid exposed bees were significantly more likely to lose postural control and spend more time laying on their backs, unable to right themselves when compared to the control.	Williamson, S. M.; Willis, S. J., and Wright, G. A. Exposure to Neonicotinoids Influences the Motor Function of Adult Worker Honey bees Ecotoxicology. 2014 Oct;23(8):1409-18. doi: 10.1007/s10646-014-1283-x. Epub 2014 Jul 11

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		(+ 1 min to acclimatize) *Imidacloprid concentrations on behaviour:* 3 concentrations (10, 100 nM and 1 µM) of imidacloprid were examined in the same methods as the behavioural assay for 24 hours Number of bees tested: 15 bees/treatment, experiment repeated four times Caste of bees tested: forager bees, mixed age Observation period: observations made 24 hours after exposure in the acute toxicity trial and during the 15 min behavioural assay Effect parameters: mortality, food consumption, behaviour	The mean duration of each bout was significantly greater for bees exposed to 2.56 ppb imidacloprid when compared to the control. Control bees spent about 80% of the time walking, 5–10% standing still, and 5% were flying. Walking, time sitting still, and flying were not significantly different for any chemical compared to the control. *Imidacloprid concentrations on behaviour:* After 24 hours a dose-dependent reduction was seen in walking with an increase in time spent still. Exposure to 1 µM resulted in bees unable to fly and unable to groom; exposure to 10 and 100 nM resulted in bees spending more time upside down and there was a dose-dependent behaviour on increased grooming behaviour with increased exposure levels. **MAJOR UNCERTAINTIES:** Control mortality appears to be 15–22% without applying Abbott's correction, which is higher than recommended by the OECD 213 guideline. Mortality rates were not reported, a graph was used for visual estimates of the acute toxicity study but there was no mortality reporting for the behavioural assays. The bees tested were all from the same colony where bees were collected outdoors that may have been exposed to other pesticide contaminates. The amount consumed per day appears to be calculated based on each of the assumption that each bee when grouped with 15 other bees consuming the same amount. Individual bee consumption rates were not provided.	
No endpoints determined.	imidacloprid (not stated)	ACUTE ORAL Test species: *Apis mellifera* Application method: proboscis extension reflex (PER); bees fed 0.4 µL of treatment solution that contained doses of either 0.7 M sucrose (control), or 0.7 M sucrose containing 0.1 nM, 1 nM, 10 nM of imidacloprid over 6 conditioning trials *NOTE:* 10 nM solution equates to 2.55 pg/µL. The entire dose received during	**REVIEW:** Imidacloprid in food rewards impaired olfactory learning. Bees fed with sucrose solutions containing 10 nM during massed or spaced conditioning were significantly less likely to learn the task than the control bees. Providing honey bees with sucrose solution containing imidacloprid as a reward did not enhance learning in either the massed *(30 s inter-trial interval was used to examine how imidacloprid would affect learning as bees might experience it during foraging)* or spaced *(5 min inter-trial interval was used to determine the extent to which imidacloprid affected the formation of long term memory (LTM))* learning tasks.	Wright, Geraldine A.;Softley, Samantha; Earnshaw, Helen. 2015. Low doses of neonicotinoid pesticides in food rewards impair short-term olfactory memory in foraging-age honey bees. Scientific Reports | 5:15322 | DOI:

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		conditioning for bees trained with 10 nM over 6 trials would be 6.12 pg/bee or 0.000006 µg/bee *Massed conditioning:* during the conditioning for the PER tests, 30 second inter-trial intervals were used between the conditioned (CS) and unconditioned (US) stimuli, to represent what bees might experience during foraging *Spaced conditioning:* during the conditioning for the PER tests, 5 min inter-trial intervals were used between the CS and US, to determine the extent to which the chemical affected the formation of the long term memory. Number of bees tested: 60 bees/treatment for 10min test, less for the 24 h test since bees died overnight Caste of bees tested: foraging adults, age unknown Observation period: observations made after 10 min to test short-term memory (STM) and after 24 h to test early long-term memory (LTM) Effect parameters: massed and spaced conditioning memory tests, and short term and long term learning response during memory test	Bees fed with imidacloprid 10 nM (2.55 pg/µL) during massed and spaced conditioning were significantly less likely to learn to a task than control bees. At 1 nM, bees were less likely to learn to associate odour with food in both massed and spaced tasks. This effect was noticed as early as the 2nd trial. Therefore an acute dose of 6.12×10^{-7} µg/bee (i.e. six 0.4 µ l droplets of 1 nM) experienced during acquisition was sufficient to reduce the rate of learning. *STM and LTM:* Bees fed 10 nM imidacloprid had significantly lower performance during both the STM and LTM test; significantly lower performance was also seen in the 1 nM dosed bees in the STM 10 minute test. **MAJOR UNCERTAINTIES:** It is unclear if the entire dose was consumed. The doses provided in the PER test are much lower than the identified acute and chronic adult oral toxicity endpoints used in our Tier I risk assessment. The use of a PER test to indicate possible colony level effects in unclear.	10.1038/srep15322
No endpoints determined.	imidacloprid (not stated)	ACUTE ORAL Test species: *Apis mellifera ligustica* Application method: 5 bees/test cage fed *ad libitum* on sucrose	**REVIEW:** *Mortality:* After 4 days of exposure to 20.8 ppb of imidacloprid in sucrose did not significantly increase the level of mortality (11%) when compared to the control (9%).	Zhang, E. and J.C. Nieh. 2015. J Exp Biol. 2015. The neonicotinoid imidacloprid impairs

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		solution containing 20.8 ppb (25.6 µg imidacloprid/L) for 4 days; they were also provided with 10 g of pollen/cage; bees were then subjected to a series of learning tests Number of bees tested: 5 bees/cage were sampled from 17 colonies; 299 control bees and 268 treated bees were tested in the learning trials Caste of bees tested: forager bees, mixed age Observation period: mortality was checked after 4 days; after 4 days, bees were subjected to a series of learning tests Effect parameters: mortality, food consumption, bee learning tests	*Sucrose consumption:* Imidacloprid at a concentration of 20.8 ppb did not significantly affect sucrose consumption. An average of 1.5 ± 0.4 ng imidacloprid/day (total of 6.0 ± 1.5 ng over 4 days) was consumed. *Effects on short-term learning:* This was tested by exposing constrained bees to an odor and then followed by pinching a leg to simulate an attack. The associated odor was then repeated to see if the bees learned to affiliate it with an expected attack (and result in a sting extension reflex in defense). Pesticide exposure decreased bee learning of both attack odors; bees exposed to the either odor that was affiliated with a leg pinch had significantly lower short-term learning when compared to the control. Without the leg pinch, there was no difference in treated compared to control bee response. **MAJOR UNCERTAINTIES:** The source of pollen provided was not stated; it is unknown if it was tested for contamination. The sucrose consumption calculation assumed all 5 bees /cage consumed the same amount each.	honey bee aversive learning of simulated predation. J. of Exp. Biology. 218: 3199-3205. Oct;218(Pt 20):3199-205. doi:10.1242/jeb.127472
NON-APIS - Tier I Acute Oral Trials				
LD_{50} = 0.0046 µg a.i./bee	Confidor (imidacloprid 17.8%)	ACUTE ORAL Test species: *Bombus terrestris* Application method: bees fed with spiked sucrose solution, doses tested were 1/1000 to 1x the field dose of 0.3 mL/100 mL Number of bees tested: unknown Caste of bees tested: adult, medium sized workers Observation period: observations made 24, 48 and 72 hours after exposure Effect parameters: mortality	**REVIEW:** Acute Oral Endpoints: The oral LD50 for Confidor was 0.04, 0.03 and 0.026 µg product/bee after 24, 48 and 72 hours, respectively. These values represent approximately 1/100 of the field dose. Based on a guarantee of 17.8% imidacloprid in Confidor, the reviewer calculated the LD_{50} to be 0.0046 µg a.i./bee after a period of 72 hours. **MAJOR UNCERTAINTIES:** It was not stated what the doses of imidacloprid were. It was not stated how many bees per treatment level. It was not stated whether a control was used in the study.	Bortolotti, L., E. Grazioso, C. Porrini, G. Sbrenna. 1999. Effect of pesticides on the bumble bee Bombus terrestris L. in the laboratory. Hazards of pesticides to bees, Avignon (France), September 07-09, 1999, Ed. INRA, Paris.
No endpoints determined.	Imidacloprid (not reported)	ACUTE ORAL Test species: *Apis mellifera* and *Bombus terrestris* (with	**Information from this study is also in the section:** **Tier I Acute Oral Trials Apis** **REVIEW:** *Behavioural two-choice assays*:	Kessler, S.C., Tiedeken, E.J., Simcock, K.L..,

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		subspecies *dalmatinus, audux, and terrestris)* Application method: *Behavioural two-choice assays:* *Bumble bee:* three, 3mL perforated feeding tubes contained doses of: deionized water (control), 0.5 M sucrose, or 0.5 M sucrose with imidacloprid for a total of 24 h *Honey bee:* four, 3mL perforated feeding tubes contained doses of: one tube of deionized water (control), two tubes of 1 M sucrose, or 1 M sucrose with imidacloprid for a total of 24 h *Honey bee antennal and mouthpart assays:* Assay 1 – individual honey bees were lightly tapped on the antenna with a solution containing 0.064, 0.418, 3.98, 13.9 ng/bee corresponding to 1, 10, 100 nM and 1 µM of imidacloprid to elicit proboscis extension reflex (PER) *Electrophysiology experiment:* Electrophysiological recordings were made from taste neurons located in the first 11 sensilla on the honey bee's proboscis and in the first 6 sensilla in bumble bees. Individuals were repeatedly sampled in one of two protocols: (1) 50mM sucrose, 100mM KCl, water, 1µM neonicotinoid, 1mM neonicotinoid, 1mM NHT, 100mM KCl, 50mM sucrose; or	Honey bee Honey bees significantly chose imidacloprid at 100 nM and 1 µM (3.98 snd 13.9 ng/bee respectively) doses when presented with both sucrose control and treated choice feeding tube. The total food consumption of forager honey bees was not reduced only when bees fed from solutions containing imidacloprid. Bumble bee Bumble bees showed a significant preference for solutions containing thiamethoxam over sucrose alone at the 1 nM (0..064 ng/bee consumed) dose when compared to the sucrose control choice. Bumble bees fed with imidacloprid consumed significantly less total food on average than those fed thiamethoxam or the sucrose control. *Age of bees* The 'attractive' effect of imidacloprid also depended on bee age: newly emerged adult worker bumble bees and honey bees largely avoided 1–10nM imidacloprid. Only imidacloprid was used to test the difference between different aged bees. *Honey bee antennal and mouthpart assays:* None of the sucrose solutions containing imidacloprid affected proboscis extension or retraction. *Electrophysiology experiment:* Stimulation with imidacloprid did not elicit spikes from any of the neurons in the galeal sensilla of either bumble bees or honey bees statistically higher than the response to the water control. **MAJOR UNCERTAINTIES:** In general, bumble bees consumed more of the neonicotinoid-laced food than honey bees and were, therefore, exposed to higher pesticide doses. However, bumble bees are also larger in body weight, and the dose is per bee not per weight of the bee. It is unclear how these results can be used in the risk assessment.	Derveau, S., Mitchell, J., Softley, S., Stout, J.C., Wright,G.A.. 2015. Bees prefer foods containing neonicotinoid pesticides. Nature 521: 74–76 doi:10.1038/nature14414

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		(2) 50mM sucrose, 50mM sucrose + neonicotinoid in one of the following concentrations (1nM, 10nM, 1µM), 50 mM sucrose. Number of bees tested: *Behavioural two-choice assays:* Bumble bees - (57, 66, 65 and 66) corresponds to 1, 10, 100 nM and 1 µM Honey bees - 40 cohorts of 25 bees/treatment *Honey bee antennal and mouthpart assays:* 40 bees/treatment *Electrophysiology experiment:* 10 bees/treatment Caste of bees tested: *Behavioural two-choice assays:* *Bumble bee:* newly emerged bees *Honey bee:* foragers *Honey bee antennal and mouthpart assays:* foragers *Electrophysiology experiment:* not stated Observation period: *Behavioural two-choice assays*: 24 h *Honey bee antennal and mouthpart assays:* not stated *Electrophysiology experiment:* 2 s Effect parameters: *Behavioural two-choice assays*: mortality, amount of food consumed *Honey bee antennal and mouthpart assays:* proboscis extension reflex (PER), food consumption		

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		Electrophysiology experiment: taste neuron response		
24 hours: LD_{50} = 0.04 µg/bee *72 hours:* LD_{50} = 0.02 µg/bee	Imidacloprid (not reported)	ACUTE ORAL Test species: *Bombus terrestris* Application method: bees fed 10 µL/bee over a period of 15 minutes; unknown what doses were tested Number of bees tested: unknown Caste of bees tested: adult, workers Observation period: observations made 3, 6, 24, 48 and 72 hours after exposure Effect parameters: mortality	**REVIEW:** Acute Oral Endpoints: *24 hours:* LD_{50} = 0.04 µg/bee; *72 hours:* LD_{50}= 0.02 µg/bee The concentrations that the bees were exposed to were not provided. The number of bees that were exposed per treatment level were not provided. **MAJOR UNCERTAINTIES:** The concentrations that the bees were exposed to were not provided. While it was stated 5 bumble bees were introduced in each cage, there is no indication as to whether there was one cage per treatment, per test, or some other experimental design.	Marletto, F., A. Patetta, A. Manino. 2003. Laboratory assessment of pesticide toxicity to bumble bees. Bulletin of Insectology 56 (1): 155-158.
No endpoints determined	Imidacloprid (not reported)	ACUTE ORAL Test species: *Bombus terrestris* Application method: bees were fed sugar syrup spiked with 10 nM (2.1 ppb w/w) of imidacloprid for 3 days; afterwards bee brains were removed by dissection, placed in scintillation cocktail, and counted individually Number of bees tested: 63–100 bee brains were sourced from 3 microcolonies (containing 20 intermediate sized bees (250–350 mg)) Caste of bees tested: unknown Exposure period: 3 days prior to dissection Effect parameters: average size of bumble bee brain, spectrometry analysis of bee brains, primary neuronal culture, cytotoxicity assay, mitochondrial membrane	**REVIEW**: This study also presents a Tier II open feeding trial which is summarized in the Tier II and III open literature table. Only the Tier I results are presented below. *Average size of bumble bee brain* 1.16 µL *Imidacloprid effects on bee brains at the cellular level:* After 42 minutes (the length of time authors stated was an average foraging flight), imidacloprid does not reach significant levels in the brain. After 3 days, accumulation reached 9.7 nM and was significantly higher when compared to the control (visually estimated to be 0.25 nM) and to the 42 minute exposure (visually estimated to be 1.0nM). After 24 hours of exposure to 1 µM of imidacloprid, brain neurons did not die in culture. Exposure to high levels of ACh (1 mM, but not 100 µM), induced acute mitochondrial depolarization. In contrast, exposure to imidacloprid induced the same effect at much lower levels (1 µM). Although low-level imidacloprid (10 nM) does not induce mitochondrial depolarization acutely, when neurons are exposed	Moffat,C., Pacheco,J.G., Sharp,S., Samson,A.J., Bollan,K.A.., Huang,J., Buckland,S.T., Connolly,C.N. 2015. Chronic exposure to neonicotinoids increases neuronal vulnerability to mitochondrial dysfunction in the bumble bee (Bombus terrestris). FASEB J. 29: 2112–2119. (doi:10.1096/fj.14-267179)

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		potential, acetylcholinesterase assay	chronically (48 hours) to just 1 nM of imidacloprid, vulnerability to ACh exposure occurred afterwards as a result. **MAJOR UNCERTAINTIES:** The health status and source of the honey bees was not mentioned. It is unclear if all of the bee brains dissected were used in the various tests.	
No endpoints determined.	Imidacloprid (>99%)	ACUTE ORAL Test species: *Bombus terrestris* Application method: *Experiment 1:*bees fed 1.5 mL/bee/day for 4 days; tested concentrations 1, 10 and 100 µg/L *Experiment 2:* bees fed 1.5 mL/bee/day for 3 days then bees fed untreated food for 2 days; tested concentrations 1, 10 and 100 µg/L Number of bees tested: 20 bees/treatment Caste of bees tested: adult, age unknown Observation period: observations made 3, 4 or 5 days after exposure Effect parameters: mortality and feeding rate	**REVIEW:** *Experiment 1:* 15, 5, 5, and 35% mortality after 4 days exposure to control, 1, 10 and 100 µg/L. Overall intake over the 4 day exposure period was significantly lower in the 10 and 100 µg imidacloprid/L treatments than in controls but not in the 1 µg imidacloprid/L treatment. *Experiment 2:* 15, 5, 15, and 15% mortality after 3 days exposure to control, 1, 10 and 100 µg/L. There was no additional mortality in any of the treatments or controls during the following 2 days when untreated sucrose was provided. *Feeding rate:* During days 1 to 3 there was no significant effect of day on consumption, but there was a significant effect of dose. During the subsequent 2 days when they were fed untreated sucrose there were significant effects of both day and the dose administered during the earlier treatment period on consumption. Provision of untreated sucrose for 2 days after a 3 day exposure to imidacloprid resulted in a recovery in sucrose consumption rates by the bees. Bees exposed to imidacloprid displayed a significant dose-dependent reduction in consumption rate. **MAJOR UNCERTAINTIES:** The discussion of certain results were omitted (i.e. mortality data was excluded if 100% mortality was reached before the end of the 4 day experimental period). Authors claim sucrose consumption was recovered and that there was a significant dose-dependent reduction in consumption rate but this article does not present data on amounts consumed to show these trends.	Thompson H.M., S. Wilkins, S. Harkin, S. Milner, K.F. Walters. 2014. Neonicotinoids and bumble bees (Bombus terrestris): Effects on nectar consumption in individual workers. Pest Manage Sci, 71(7):946-950.
LD_{50} = 0.0235 µg a.i./bee)	imidacloprid (700 g a.i./L)	ACUTE ORAL Test species: *Melipona*	**REVIEW:** Acute Oral Endpoint: LD_{50} = 0.0235 µg a.i./bee *Flight activity bioassay:*	Tomé H.V., W.F. Barbosa, G.F.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		quadrifasciata anthidioides Application method: *Toxicity experiment:* bees were fed 10 µL of spiked sucrose solution; doses tested were 5.0, 10.0, 30.0, 50.0, 70.0, and 90.0 ng a.i./bee *Bioassays:* bees were fed 10 µL of spiked sucrose solution at a dose of 5.38 ng a.i./bee Number of bees tested: 30 bees/treatment Caste of bees tested: adult Observation period: observations made 3 and 24 hours after exposure Effect parameters: mortality, flight activity	Flight activity in imidacloprid-exposed bees was greatly compromised, with the bees not reaching heights above 35 cm when all control bees could reach a height of 120 cm. Imidacloprid also significantly impaired the free-fall flight of the workers, which were unable to recover from the initial free-fall after being released, unlike the unexposed workers. **MAJOR UNCERTAINTIES:** No residue analysis was conducted on the bees or treated sucrose solution to confirm test exposure. The amount of sucrose solution consumed was not measured.	Martins, R.N. Guedes. 2015. Spinosad in the native stingless bee melipona quadrifasciata: Regrettable non-target toxicity of a bioinsecticide. Chemosphere 124:103-109
Partamona helleri: LT_{50} = 0.25 h *Scaptotigona xanthotrica:* LT_{50} = 0.25 h	Imidacloprid (water dispersible granules; 700 g a.i./kg)	ACUTE ORAL Test species: *Partamona helleri* and *Scaptotigona xanthotrica* Application method: based on the Brazilian field label rate of 42 mg imidacloprid/L, 500 µL 50% (w/w) sucrose solution was fed to 10 bees at a time by a feeder; the average consumption values calculated by the reviewer are: *Partamona helleri:* 0.038 µg a.i./bee *Scaptotigona xanthotrica:* 0.027 µg a.i./bee Number of colonies tested: 3colonies/species were tested; unknown number of bees Caste of bees tested: worker bees, unknown age Observation period: it is unclear	**REVIEW:** Acute Oral Endpoints: *Partamona helleri* For *P. helleri*, imidacloprid fed at 42 mg a.i./L in 50% aqueous sugar solution (estimated to be 0.038 µg a.i./bee) led quickly to 100% mortality with an LT50 of 0.25 h. *Scaptotigona xanthotrica* For *S. xanthotrica*, imidacloprid fed at 42 mg a.i./L in 50% aqueous sugar solution (estimated to be 0.027 µg a.i./bee) led quickly to 100% mortality with a LT50 of 0.25 h. **MAJOR UNCERTAINTIES:** Unique test method different from OECD guidelines. The length of time (exposure period) for the oral test was not stated (i.e. how long the contaminated food was left for the bees to consume was also not stated in the article). The frequency of the mortality observations was not stated. The health and age of test bees is unknown.	Tomé, H.V.V., W.F. Barbosa, A.S. Corrêa, L.M. Gontijo, G.F. Martins and R.N.C. Guedes. 2015. Reduced-risk insecticides in Neotropical stingless bee species: impact on survival and activity. Annals of Applied Biology 167, 186–196. doi:10.1111/aab.12217

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		how often observations were made in the 24 hours after exposure Effect parameters: mortality, food consumption		
APIS - Tier I Chronic Adult Oral Trials				
No endpoints determined	imidacloprid (% not reported)	CHRONIC ADULT ORAL Test species: *Apis mellifera* Application method: newly emerged adult bees were chronically exposed to imidacloprid in 1.5 g pollen patties (Bee Pro + ground fresh pollen) fed to bees for 9 days in cages. Bees were also provided with contaminated 50% sugar syrup. Another part of the study testing the effect of *Varroa* mite infection (4, 8 and 12 varroa mites/40 bees) was not included in this review. Application dose: imidacloprid in pollen patties: 0, 25 and 50 ppb Number of bees tested: *imidacloprid:* 35 emerged bees/treatment × 3 replicates *Varroa experiment:* 40 bees/treatment × 3 replicates Caste of bees tested: newly emerged adults Observation period: *mortality:* daily during 9 day exposure, bee weight, vitellogenin (Vg) gene expression Effect parameters: mortality, body weight, amount of deformed wing virus, vitellogenin and immune	**REVIEW:** Slight but statistically significant increase of newly emerged honey bee mortality (approximately 6% mortality by the end of 9 days exposure) was detected in the 50 ppb imidacloprid treatment in pollen. In 25 ppb of imidacloprid in pollen patties the mortality was maintained at 1% mortality since day 2 without additional increase. No mortality was found in the control. The body weight gain in was reported to be significantly different among all 3 groups. However, reviewer noted that the average body weight was also different among the treatment groups at the beginning of the study. By the end of 9 day exposure, the average body weight of the bees was 124 mg per bees in the control, 122mg in the treatment of 25 and 109 mg in the treatment of 50 ppb. Vitellogenin (Vg) gene expression was significantly reduced in bees under both 25 and 50 ppb treatments. **MAJOR UNCERTAINTIES:** Not a guideline study. Bees were fed with spiked pollen. Bee weight was not harmonized at the study initiation. No links have bee established between the gene expression and typical environment endpoints for risk assessment	Abbo P.M., J.K. Kawasaki M. Hamilton, S.C. Cook, G. DeGrandi-Hoffman, W.F. Li, J. Liu, Y.P. Chen. 2016. Effects of imidacloprid and Varroa destructor on survival and health of European honey bees, Apis mellifera. Insect Sci. doi:10.1111/1744-7917.12335

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		transcripts		
NOEL < 0.7 ppb based on the increased mortality	Imidacloprid (% not reported)	CHRONIC ADULT ORAL Test species: *Apis mellifera ligustica* and *Apis mellifera mellifera* Application method: 4 treatments were tested: 1. control, 2. infected with *Nosema*, 3. chronically exposed to imidacloprid and 4. infected with *Nosema* and chronically exposed to imidacloprid; *Nosema* spores fed in 2 µL of 50% sucrose solution, imidacloprid in sucrose solution fed to bees for 10 h per day for 10 days Application dose: 0.7, 7 and 70 ppb Number of bees tested: *Mortality:* 3 colonies × 3 cages of 30 bees/treatment *Immune assay:* 3 colonies × 2 cages of 120 bees/treatment Caste of bees tested: adult, 1 day old Observation period: observations made 5 and 10 days after exposure Effect parameters: mortality, consumption	**REVIEW:** *Mortality:* Exposure to imidacloprid alone resulted in a slight but significant increase in mean cumulative mortality (10.4–17.4%) relative to controls (5.6%) for all doses tested. Exposure to Nosema alone resulted in a mean cumulative mortality of 28.1% which was significantly higher than controls (5.6%). Exposure of bees to both imidacloprid and Nosema resulted in the greatest overall mortality rates (40% at 0.7 ppb; 45.6% at 7.0 ppb and 69.6% at 70 ppb). In the case of 0.7 and 70 ppb doses plus Nosema, the mean mortality rates were significantly greater than that from the imidacloprid only or Nosema only treatments. *Consumption:* Bees exposed to imidacloprid only did not increase their sucrose consumption significantly compared to controls, whereas bees infected with Nosema consumed significantly greater amounts of sucrose compared to controls. This increase was statistically significant with Nosema exposure alone and Nosema + imidacloprid treatment at both the 0.7 and 7 ppb treatment groups and at the 70 ppb a significant increase was seen only in the Nosema + imidacloprid treatment. **MAJOR UNCERTAINTIES**: Purity of imidacloprid not provided. No analytical recovery measured in the test solutions. It is not clear what concentrations were used for immune endpoints.	Alaux, C., J.L. Brunet, C. Dussaubat, F. Mondet, S. Tchamitchan, M. Cousin, J. Brillard, A. Baldy, L.P. Belzunces, Y. Le Conte. 2010. Interactions between Nosema microspores and a neonicotinoid weaken honey bees (Apis mellifera). Environmental Microbiology 12(3): 774-782.
LOEL= 0.00024 µg/bee/day (estimated to be 5.85 µg/L) NOEL=0.000	Imidacloprid (Admire 240 F)	CHRONIC ADULT ORAL Test species: *Apis mellifera* Application method: spiked sucrose solution was fed ad libitum to bees at 41 µL/bee/day for a total of 10 days, doses tested were 0.08, 0.16, 0.24 and 0.30 ng/bee	**REVIEW:** Chronic Adult Oral Endpoint: LD_{50} = 0.000227 µg/bee/day There was > 50% mortality at day 10 in the 0.24 ng/bee treatment, and no increased mortality and hyperactivity (tumbling and trembling) at 0.16 ng/bee/day. The actual test concentrations in the feeding sugar solution were 5.85 ug /L and 3.9 ug /L respectively (personal email communication with the study author). The dose in ng/bee/day was calculated based on the observation that bees	Boily M., B. Sarrasin, C. DeBlois, P. Aras, M. Chagnon. 2013. Acetylcholinesterase in honey bees (Apis mellifera) exposed to neonicotinoids, atrazine and

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
16 µg/bee/day (3.9 µg/L)		Number of bees tested: 30 bees/treatment, experiment repeated four times Caste of bees tested: adult, young bees Observation period: observations made 10 days after exposure Effect parameters: mortality	consumed 41 uL of sugar solution per bee per day during the pre-test and the assumption that test bees consumed the same amount of solution during the treatment. Hyperactivity (tumbling and trembling) were found at higher concentrations. LOEL = 0.24 ng/bee/day (estimated to be 5.85 µg/L) NOEL = 0.16 ng/bee/day (3.9 µg/L) **MAJOR UNCERTAINTIES:** Uncertainty is expected during the conversion from the test concentration to dose as the consumption rate may be reduced. The authors assumed all bees consumed the same amount: 41 µL/bee/day. The actual amount consumed per bee was not measured in this test, it was estimated from a preliminary trial.	glyphosate: Laboratory and field experiments. Environ Sci Pollut Res 20(8):5603-5614.
No endpoints determined.	Imidacloprid (not reported)	CHRONIC ADULT ORAL Test species: *Apis cerana indica* Application method: 1 mL of honey and test substance solution was provided to bees Application dose: 0.4 mL/L (reviewer estimated: 400 µg a.i./bee) Number of bees tested: 25 bees/treatment, experiment was repeated 3 times: total of 75 bees Caste of bees tested: adult, 25 days old Observation period: observations made 5 days after exposure Effect parameters: mortality	**REVIEW:** This toxicity test ran for 5 days total. The results from the first 4 days are presented in the APIS - Tier I Acute Oral section of this table and below are the results from day 5 for the APIS - Tier I Chronic Oral section of this table: 5.5, 8.4, 12.8, 15.4% mortality in 1, 2, 3 and 4 days 20.8% in 5 days. **MAJOR UNCERTAINTIES:** It was unclear if the solution was replaced every day, and what the ingested amount was per bee. The amount of active ingredient could not be determined (based on assumption that TGAI was used in dosing). The reviewer calculated the amount of dose (based on a density of water) to be approximately 400 ug a.i./bee (0.4 mL/L = 0.4 g/L × 0.001 L/bee = 0.0004 g/bee = 400 ug a.i./bee). It is unclear what the control consisted of, since the Table reported the control as "CD (0.5%)".	Chandramani, P., B.U. Rani, C. Muthiah, S. Kumar. 2008. Evaluation of toxicity of certain insecticides to India honey bee, Apis cerana indica F. Pestology, 32(8):42-43.
NOEL≥ 0.125 µg a.i./L, the greatest test concentration without observed mortality	Imidacloprid (reference standard)	CHRONIC ADULT ORAL Test species: *Apis mellifera* and *Bombus terrestris* Application method: spiked sucrose was fed daily to bees at one of 10 doses for a total of 6 days Application dose: 0.08, 0.2, 0.51, 1.28, 3.2, 8, 20, 50, 125 µg/L	**Information from this study is also in the section:** **NON-APIS Tier I Chronic Adult Oral Trials** **REVIEW**: *Feeding rate:* Individual bumble bees consumed more syrup per day than honey bees, the rate of feeding responded to the dosage of imidacloprid only in bumble bees. The form of the dose–response relationship in bumble bees was affected by the presence of dietary acetonitrile (ANOVA: species × solvent, P = 0.02), but the mean feeding rate	Cresswell J.E., C.J. Page, M.B. Uygun, M. Holmbergh, Y. Li, J.G. Wheeler, I. Laycock, C.J. Pook, N.H. de Ibarra, N. Smirnoff, C.R. Tyler. 2012. Differential sensitivity of honey

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		(sometimes with the presence of acetonitrile at 100 µL/µg) Number of bees tested: *Honey bee:* caged in groups of 10 *Bumble bee:* individually caged Caste of bees tested: adults, age unknown Observation period: observations made 6 days after exposure began Effect parameters: feeding rate, locomotion and longevity	declined significantly with increasing dosage of imidacloprid whether acetonitrile was present or not. In bumble bees, the effect of dietary imidacloprid on feeding rate intensified over time, because feeding rates dropped progressively after the first day of exposure to the higher dosages of imidacloprid (ANCOVA, dose, $P < 0.001$). The magnitude of this effect depended on the presence of dietary acetonitrile (ANCOVA, dose × solvent, $P < 0.001$); in its absence, individuals exposed to the highest dosage of imidacloprid eventually fed at approximately half the rate of undosed bumble bees after > 24 h of exposure, but dietary acetonitrile accelerated this effect so that it occurred within the first day of exposure with little subsequent intensification. *Locomotion:* Individual honey bees walked further than bumble bees but locomotory activity responded to the dosage of imidacloprid only in bumble bees whose diet contained acetonitrile (ANCOVA: dose, $P = 0.001$; dose × species interaction, $P = 0.02$; dose × solvent, $P = 0.001$). In the presence of acetonitrile, mean locomotory rate declined significantly with increasing dosage of imidacloprid. *Longevity:* Bumble bees lived longer than honey bees but did not vary with the dosage of imidacloprid. **MAJOR UNCERTAINTIES**: Instead of effect levels for each species and each endpoint, results are provided comparing the response of one species to another. There is a low level of environmental relevance for the results with bees exposed to imidacloprid with acetonitrile. The data for longevity was highly variable in absence of acetonitrile making it difficult to discern a treatment related effect.	bees and bumble bees to a dietary insecticide (imidacloprid). Zoology 115: 365–371
No endpoints determined.	Imidacloprid (reference standard)	CHRONIC ADULT ORAL Test species: *Apis mellifera* Application method: spiked sucrose was fed to bees for a total of 8 days; treatments tested were control, continuous exposure,	**REVIEW:** *Feeding rate:* Honey bees exposed to dosed syrup for 8 days consumed an average of 2.2 ng imidacloprid per bee per day for a cumulative total ingestion of 17.4 ng imidacloprid/bee over the 8 days. Whole body residues were approximately 0.2 ng/bee (1.4 ng/g) which was not significantly different from controls.	Cresswell, J.E.,F.X. Robert, H. Florance, N. Smirnoff. 2013. Clearance of ingested neonicotinoid pesticide

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		pulsed exposure where spiked sucrose was fed for 3 days and then control sucrose fed for the remainder of experiment Application dose: 125 µg/L Number of bees tested: 10 bees/treatment, experiment repeated 3 times Caste of bees tested: adults, newly enclosed workers Observation period: observations made 8 days after exposure Effect parameters: feeding and clearance (removal of pesticide through metabolic degradation) rate	*Clearance rate:* The daily clearance was therefore estimated as approximately 100%. Mean per capita daily rates of feeding (t-test: t = 0.39) and mean level of activity (one-tailed t-test: t = 0.29) did not differ between dosed and undosed bees. **MAJOR UNCERTAINTIES:** No analytical confirmation of imidacloprid in the sucrose solution. Uncertainty whether whole body residues were adjusted for low percent recovery.	(imidacloprid) in honey bees (Apis mellifera) and bumble bees (Bombus terrestris). Pest Management Science, 70(2): 332-337. doi: 10. 1002/ps.3569.
NOEC: 24 ppb for winter bee 48 ppb for summer bee	*Chronic toxicity and initial PER tests:* imidacloprid (99.4%) 5-hydroxy-imidacloprid (99.4%) *Second PER tests:* imidacloprid (98%)	CHRONIC ADULT ORAL Test species: *Apis mellifera* Application method: *Chronic toxicity tests:* bees fed 33 µL/bee/day of spiked sucrose solution (500 g/L) for a total of 11 days *Proboscis extension reflex (PER):*after exposure for 12 days, bees mounted for conditioning and resulting PER testing Application dose: *Experiment 1:* *Imidacloprid:* 6 concentrations ranging from 1.5-48 µg/kg *5-hydroxy-imidacloprid:* 5 concentrations ranging from 7.5–240 µg/kg *Experiment 2:* *Imidacloprid:* 7 concentrations ranging from 1.5-96 µg/kg Number of bees tested:	**REVIEW**: *Chronic toxicity test:* *Experiment 1:* *Imidacloprid:* Winter bees had 11.6, 12.7, 3.0, 9.4, 11.1, 16.1 and 20.5% mortality in the control, 1.5, 3, 6, 12, 24, 48 µg/kg treatment. The highest dose tested at 48 µg/kg had significantly higher mortality than the control. *5-hydroxy-imidacloprid:* Winter bees had 17.2, 3.3, 13.3, 19.4, 10.5, 26.6 and 41% mortality in the control, 7.5, 15, 30, 60, 120 and 240 µg/kg treatment. The highest dose tested at 240 µg/kg had significantly higher mortality than control however, the control mortality was very high at 17.2%. *Experiment 2:* Summer bees had 3.3, 8.3, 8.3, 5, 7.2, 7.7, 9.4, and 17.7% mortality in the control, 1.5, 3, 6, 12, 24, 48 and 96 µg/kg treatment. The highest dose tested at 96 µg/kg had significantly higher mortality than the control. *Proboscis extension reflex (PER):* *Winter bees:* Had 52.4, 60, 44.7, 60, 55, 42, 36.6% reflex responses in the control, 1.5, 3, 6, 12, 24 and 48 µg/kg treatments *Summer bees:* Had 90.1, 81.9, 85.6, 78.6, 83.6, 80, 59 and 69.7%	Decourtye, A., E. Lacassie, M.H. Pham-Delegue. 2003. Learning performances of honey bees (Apis mellifera L) are differentially affected by imidacloprid according to the season. Pest Manag Sci 59: 269-278.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		Chronic toxicity tests: *Experiment 1:* total of 180 –360 bees *Experiment 2:* total of 180 bees *PER:* winter bees 68 –163 bees; summer bees 60 –66 bees; 5-hydroxy-imidacloprid 56-156 bees Caste of bees tested: adult, aged 14-15 days by end of exposure period *Experiment 1:* winter bees *Experiment 2:* summer bees Effect parameters: mortality and percent reflex response	reflex responses in the control, 1.5, 3, 6, 12, 24, 48 and 96 µg/kg treatments. Significantly lower responses were seen in the two highest doses of 48 and 69 µg/kg. *5-hydroxy-imidacloprid:*Had 61.5, 55.3, 57.5, 52.8, 40, 29.3 and 21.4% reflex responses in the control, 7.5, 15, 30, 60, 120 and 240 µg/kg treatments. Significantly lower responses were seen in the 3 highest doses 60, 120 and 240 µg/kg. **MAJOR UNCERTAINTIES:** The control mortality in the 5-hydroxy-imidacloprid tests was high at 17.2%. The stock solutions were stored in the freezer but removed at ambient temperature and allowed to defrost in daylight. Imidacloprid will photodegrade in daylight therefore it is possible that some degradation occurred prior to exposure to the test substance and may not be captured by the chemical analysis of the stock solution.	
No endpoints determined	Imidacloprid (purity not reported)	CHRONIC ADULT ORAL Test species: *Apis mellifera macedonica* Application method: newly emerged adult bees were fed sugar solution (33 % w/v) via gravity feeders and pollen pastry (700 g of pollen pellets with 300 g of sugar solution) *ad libitum* for up to 14 days in mesh sided cages (10cm × 10cm × 10 cm). Food provisions were changed every 3 or 4 days Application dose: 2.1 µg/kg imidacloprid in the sugar solution and 2.7 µg/kg imidacloprid in the pollen pastry (based on measured concentrations). An untreated control was tested. Number of bees tested: 60 honey bees were placed in each cage (16 cages were used in total) Caste of bees tested: adults, newly	**REVIEW:** Under laboratory conditions, feeding newly emerged honey bees ad libitum for 9 and 14 days with imidacloprid at 2.1 µg/kg in sugar solution and 2.7 µg/kg in pollen pastry, the HPGs were 14-16% smaller in treated bees than in the control. The respiratory pattern of abdominal ventilation movements was changed in treated honey bees. The mean duration of the bursts movements (quick release of CO2) was decreased by 56.99 %, and the inter-burst interval was increased by 59.4 %. **MAJOR UNCERTAINTIES:** Not a guideline study. Correlations between the measured parameters and typical environmental endpoints for risk assessment have not been established.	Hatjina F., C. Papaefthimiou, L. Charistos, T. Dogaroglu, M. Bouga, C. Emmanouil. G. Arnold. 2013. Sublethal doses of imidacloprid decreased size of hypopharyngeal glands and respiratory rhythm of honey bees in vivo. Apidologie (2013) 44: 467. doi:10.1007/s13592-013-0199-4

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		emerged Observation period: 14 days Effect parameters: mortality, food consumption, development of HPG, respiratory rhythm		
NOEC: < 4 µg a.i./L based on mortality	Imidacloprid (99.8% w/w)	CHRONIC ADULT ORAL Test species: *Apis mellifera ligustica* Application method: 500 g/L of sucrose solution/cage contained concentrations of either 4 or 8 µg imidacloprid/L and was renewed ever 1 –2 days for a total of 60 days or until all test bees died Application dose: 4 or 8 µg/L Number of bees tested: 50 bees/treatment cage, experiment repeated 2 times for each treatment and 3 times for the control Caste of bees tested: adults, newly emerged Observation period: observations made every 1 –2 days until all bees died Effect parameters: mortality and syrup consumption	**REVIEW:** *Syrup consumption* No significant difference of consumption was found among treatments on average over the cages. The mean consumption of syrup per bee and per day was 20 ± 0.95 µL. *Effect of imidacloprid on mortality* Imidacloprid at 4 and 8 µg/L increased the hazard of death of the caged bees. This study concluded that exposure to imidacloprid in a spiked sucrose solution at 4 or 8 µg/L did not affect the food consumption but caused an increased mortality of bees. **MAJOR UNCERTAINTIES:** The duration of exposure was not explicitly stated. There was no presentation of endpoints (i.e. LD50 or NOAEC values) but rather a graphical presentation of the mortality data without a tabular or textual description of what the endpoints assessed actually were. It was stated in the methods section that in some cases, the survival time of individuals could not be observed because honey bees either died accidentally or escaped from the cage during handling. There was no mention in the results section the frequency of this event or what percentage of the starting total of bees exposed per concentration that this occurred. It is unclear whether the effects presented were confounded by worker bees dying naturally.	Moncharmont, F.-X., D. A. Decourtye. 2002. Statistical Analysis of Honey bee survival after chronic exposure to insecticide. Environmental Toxicology and Chemistry. Vol.22: 3088-3094.
No endpoints determined.	Urea metabolite (> 95%) 6-chloronicotinic acid (> 95%)	CHRONIC ADULT ORAL Test species: *Apis mellifera* Application method: 0.8 –5 mL of spiked sucrose was fed to bees for a total of 10 days Application dose: 0.1, 1 and 10 µg/L Number of bees tested: 10	**REVIEW:** This study was conducted at multiple locations. *Urea:* Young bees were exposed to 0.004 –0.727 ng a.i./bee which resulted in 3-63% mortality. Control young bees ingested 31.7–65.2 µL/bee and mortality ranged from 0-10%. Old bees were exposed to 0.003-0.730 ng a.i./bee which resulted in 16–60% mortality. Control old bees ingested 45.3–99.2 µL/bee and mortality ranged from 20 –44%.	Schmuck, R. 2004. Effects of a Chronic Dietary Exposure of the Honey bee Apis mellifera (Hymenoptera: Apidae) to Imidacloprid. Arch.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		bees/treatment, experiment repeated 3 –5 times Caste of bees tested: adults, young 1 –17 days old OR old 22-45 days old Observation period: observations made every 24 -48 hours for 10 days Effect parameters: consumption and percent mortality	In general mortality levels were higher in older bees. *6-chloronicotinic acid:* Young bees were exposed to 0.004 –0.724 ng a.i./bee which resulted in 0-97% mortality. Control young bees ingested 31.7–65.2 µL/bee and mortality ranged from 0-10%. Old bees were exposed to 0.003 –0.806 ng a.i./bee and mortality ranged from 6-77%. Control old bees ingested 45.3–99.2 µL/bee and mortality ranged from 20 –44%. **MAJOR UNCERTAINTIES:** Quantification of test substance in the sucrose solutions were provided in terms of concentrations (µg a.i./L) but the mortality data was provided in terms of a dose in ng a.i./bee. Confirmation of ingested doses could not be conducted because ingestion rates were provided for controls at all facilities but not for the treatment groups. The Germany II test run was later invalidated by the study authors due lack of dose response, lack of randomization procedure when assigning bees to treatment groups, lack and reproducibility when repeating the run. The study at Germany I was prematurely termination on Day 4 because of increased control mortality (20%).	Environ. Contam. Toxicol. (2004) 47: 471-478.
NOEC: < 0.1 µg/L, based on mortality	Imidacloprid (≥ 97%) 5-hydroxy-imidacloprid (≥ 97%) Olefin (≥ 97%) 4,5-dihydroxy-imidacloprid (≥ 97%) 6-chloronicoti	CHRONIC ADULT ORAL Test species: *Apis mellifera* Application method: spiked sucrose was fed to bees for a total of 10 days Application dose: 0.1, 1 and 10 µg/L Number of bees tested: 30 bees/treatment, experiment repeated 3 times Caste of bees tested: adult, workers Observation period: observations made every 24 hours for 10 days Effect parameters: consumption and percent mortality	**REVIEW:** *Consumption:* It was determined that each honey bee ingested approximately 12 µl of contaminated sucrose solution per day. Therefore, each honey bee ingested 0.012, 0.12, and 1.2 ng of compound cumulatively during the 10 days of the test period in the 0.1, 1, and 10 µg/L test groups, respectively. The daily dose for each test group was calculated by the reviewer to be 0.0012, 0.012, 0.12 ng/bee/day. *Mortality:* Chronic oral test showed that imidacloprid and all studied metabolites were toxic. Bee mortality was induced only 72 h after the onset of intoxication. Imidacloprid and its metabolites exhibited similar long-term toxicity. For imidacloprid, toxicity was similar with concentrations of 1 and 10 µg /L, whereas with 0.1 µg /L of imidacloprid, the mortality rate was lower. With 5-hydroxyimidacloprid, mortality increased with the concentration. With the other metabolites,	Suchail, S., D. Guez, L.P. Bezunces. 2001. Discrepancy between acute and chronic toxicity induced by imidacloprid and its metabolites in Apis mellifera. Environmental Toxicology and Chemistry, Vol. 20, No. 11, pp. 2482–2486, 2001

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
	nic acid (≥ 97%) Desnitroimidacloprid (≥ 97%) urea (≥ 97%)		olefin, 4,5-dihydroxyimidacloprid, desnitroimidacloprid, 6-chloronicotinic acid, and urea, mortality was similar during 10 d for all concentrations tested. NOEL<0.1 µg/L (equivalent to <0.001 ng/bee/day) for imidacloprid and all metabolites tested. **MAJOR UNCERTAINTIES:** Schmuck et. al. (2004) repeated this study using a similar method and showed no chronic effect at tested doses for transition products, but the technical grade active ingredient was not tested. There was no measure of the amount of treated food consumed per day just an average reported and thus the levels at which bees were actually exposed to during the chronic experiment. An analyzed statistical endpoint for the chronic study was not provided.	
NON-APIS - Tier I Chronic Adult Oral Trials				
No endpoints determined.	Imidacloprid (reference standard)	CHRONIC ADULT ORAL Test species: *Apis mellifera* and *Bombus terrestris* Application method: spiked sucrose was fed daily to bees at one of 10 doses for a total of 6 days Application dose: 0.08, 0.2, 0.51, 1.28, 3.2, 8, 20, 50, 125 µg/L (sometimes with the presence of acetonitrile at 100 µL/µg) Number of bees tested: *Honey bee:* caged in groups of 10 *Bumble bee:* individually caged Caste of bees tested: adults, age unknown Observation period: observations made 6 days after exposure began Effect parameters: feeding rate, locomotion and longevity	**Information from this study is also in the section: APIS Tier I Chronic Adult Oral Trials** **REVIEW:** *Feeding rate:* Individual bumble bees consumed more syrup per day than honey bees, the rate of feeding responded to the dosage of imidacloprid only in bumble bees. The form of the dose–response relationship in bumble bees was affected by the presence of dietary acetonitrile (ANOVA: species × solvent, P = 0.02), but the mean feeding rate declined significantly with increasing dosage of imidacloprid whether acetonitrile was present or not. In bumble bees, the effect of dietary imidacloprid on feeding rate intensified over time, because feeding rates dropped progressively after the first day of exposure to the higher dosages of imidacloprid (ANCOVA, dose, P < 0.001). The magnitude of this effect depended on the presence of dietary acetonitrile (ANCOVA, dose × solvent, P < 0.001); in its absence, individuals exposed to the highest dosage of imidacloprid eventually fed at approximately half the rate of undosed bumble bees after > 24 h of exposure, but dietary acetonitrile accelerated this effect so that it occurred within the first day of exposure with little subsequent intensification. *Locomotion:*	Cresswell J.E., C.J. Page, M.B. Uygun, M. Holmbergh, Y. Li, J.G. Wheeler, I. Laycock, C.J. Pook, N.H. de Ibarra, N. Smirnoff, C.R. Tyler. 2012. Differential sensitivity of honey bees and bumble bees to a dietary insecticide (imidacloprid). Zoology 115: 365–371

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
			Individual honey bees walked further than bumble bees but locomotory activity responded to the dosage of imidacloprid only in bumble bees whose diet contained acetonitrile (ANCOVA: dose, P = 0.001; dose × species interaction, P = 0.02; dose × solvent, P = 0.001). In the presence of acetonitrile, mean locomotory rate declined significantly with increasing dosage of imidacloprid. *Longevity:* Bumble bees lived longer than honey bees but did not vary with the dosage of imidacloprid. **MAJOR UNCERTAINTIES**: Instead of effect levels for each species and each endpoint, results are provided comparing the response of one species to another. There is a low level of environmental relevance for the results with bees exposed to imidacloprid with acetonitrile. The data for longevity was highly variable in absence of acetonitrile making it difficult to discern a treatment related effect.	
No endpoints determined.	Imidacloprid (reference standard)	CHRONIC ADULT ORAL Test species: *Bombus terrestris* Application method: spiked sucrose was fed to bees for a total of 8 days; treatments tested were control, continuous exposure, pulsed exposure where spiked sucrose was fed for 3 days and then control sucrose fed for the remainder of experiment Application dose: 125 µg/L Number of bees tested: 33 bees/treatment, experiment repeated 3 times Caste of bees tested: adults, newly enclosed workers Observation period: observations made 8 days after exposure Effect parameters: feeding and clearance (removal of pesticide	**REVIEW:** *Feeding rate:* Bumble bees exposed to dosed syrup for 8 days consumed an average of 6.7 ng imidacloprid per bee per day for a cumulative total ingestion of 53.8 ng imidacloprid/bee. Whole body residues were approximately 2.4 ng/bee (12.9 ng/g) were reported between day 4 and 8. *Clearance rate:* The daily clearance was therefore estimated as approximately 88% on day one and 68% thereafter. Bumble bees exposed to 125 µg/L experienced statistically significant reductions in daily food consumption (p = 0.001) and locomotion (p = 0.002). Following three days exposure, bumble bees were significantly more active (locomotion) compared to controls (p = 0.001) and their feeding rate recovered to control levels by day 8. **MAJOR UNCERTAINTIES:** No analytical confirmation of imidacloprid in the sucrose solution. Uncertainty whether whole	Cresswell, J.E.,F.X. Robert, H. Florance, N. Smirnoff. 2013. Clearance of ingested neonicotinoid pesticide (imidacloprid) in honey bees (Apis mellifera) and bumble bees (Bombus terrestris). Pest Management Science, 70(2): 332-337. doi: 10. 1002/ps.3569.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		through metabolic degradation) rate	body residues were adjusted for low percent recovery.	
No endpoints determined.	Intercept WP 60%	CHRONIC ADULT ORAL Test species: *Bombus impatiens* Application method: pollen was mixed with honey and pesticide in a 5:1:1 ratio to get a concentration of 0.0192 mg/g pollen (19.2 mg/kg pollen); each group of bees received a 2 g ball, then 2 days later a 1 g ball that was replenished twice weekly for 30 days Number of bees tested: 3 bees from each colony/treatment, 10 treated micro-colonies and 20 control Caste of bees tested: adult, juvenile workers Observation period: observations made daily for at least 30 days Effect parameters: longevity, food consumption, time to oviposition for a dominant worker bee	**REVIEW:** *Longevity:* A significant reduction in life span was seen in the treatment group compared to the control; approximately a 3-fold reduction in life span from ~20 days vs. ~60 days in controls. *Food consumption:* A significant reduction in pollen consumption was seen in the treatment group compared to the control; 0.4 g pollen intake compared to 3.8 g in controls. *Time to oviposition for a dominant worker bee:* Three workers placed into a bioassay chamber and one became dominant and began laying eggs. Treatment group did not reach oviposition and therefore no larvae were produced. Control bees averaged 6 days before the first day of oviposition. **MAJOR UNCERTAINTIES:** No analytical confirmation of imidacloprid. High concentrations used.	Gradish, A.E., C.D. Scott-Dupree, L. Shipp, C.R. Harris, G. Ferguson. 2009. Effect of reduced risk pesticides for use in greenhouse vegetable production on Bombus impatiens (Hymenoptera: Apidae). Pest Management Science. 66: 142-146.
Brood production (pulsed after 14 days): EC_{50} = 1.44 ppb *Brood production (pulsed after 28 days):* EC_{50} > 98 ppb *Pollen*	Imidacloprid (technical standard)	CHRONIC ADULT ORAL Test species: *Bombus impatiens* Application method: *Experiment 1:* 2 mL of spiked sucrose solution was fed to micro-colonies *ad libitum* for 14 days, then fed untreated sucrose solution for the following 14 days; 9 doses were tested 0.06, 0.16, 0.4, 1.01, 2.52, 6.3, 15.75, 39.37, 98.43 ppb *Experiment 2:* micro-colonies were continuously fed for 28 days with 2 mL of a 98.46 ppb	**REVIEW:** Chronic Adult Oral Endpoints: *Experiment 1 (pulsed treatment for 14 days):* Brood production: During 'on-dose' period, fewer brood were produced as dosage increased up to 98 ppb imidacloprid. EC50 = 1.44 ppb Dosage did not significantly impact brood production during the 'off dose' period and total brood production was not significantly correlated with imidacloprid dosage EC50>98 ppb Oviposition: Where brood were produced, imidacloprid did not affect the timing of first ovipositon during the 'on dose' period, but it delayed oviposition in the subsequent 'off dose' period.	Laycock, I., J.E. Cresswell. 2013. Repression and Recuperation of Brood Production in Bombus terrestris Bumble Bees Exposed to a Pulse of the Neonicotinoid Pesticide Imidacloprid. PLoS One 8(11): e79872. doi: 10.1371/journal.pone.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
consumption (pulsed after 14 days): EC_{50} = 4.4 ppb *Syrup consumption (pulsed after 14 days):* EC_{50} > 98 ppb *Pollen consumption (pulsed after 28 days):* EC_{50} = 43.7 ppb *Syrup consumption (pulsed after 28 days):* EC_{50} > 98 ppb		treatment Number of bees tested: *Experiment 1:* 4 bees in each micro-colony per treatment *Experiment 2:* 4 bees in each micro-colony; 7 control and 5 treated micro-colonies Caste of bees tested: adult Observation period: observations made daily for 28 days Effect parameters: brood production, oviposition and food consumption	Food consumption: During pulsed exposure, dose-dependent reductions in the daily consumption of syrup and pollen were observed by colonies while they were 'on dose'. Reduced pollen consumption: EC50 = 4.4 ppb Reduced syrup consumption: EC50 >98 During the 'off dose' period for pulsed exposure, colonies showed dose-dependent recovery of both syrup and pollen consumption. For the entire 28-day pulsed exposure period, the quantity of syrup and pollen consumed in colonies decreased as imidacloprid dosage increased. Reduced pollen consumption: EC50 = 43.7 ppb for Reduced syrup consumption EC50 > 98 ppb *Experiment 2 (continuous treatment for 28 days):* Brood production: Colonies dosed at 98 ppb imidacloprid displayed significantly diminished brood production over 28 days compared to control colonies, however brood production did not vary between consecutive 14 day periods (days 1 –14 and days 15 –28) of continuous exposure. **MAJOR UNCERTAINTIES:** The pollen was not spiked, which is the main food item for the queen; the sucrose exposure route tested may not be the worst case scenario. The exposure levels were not high enough to show a clear response in the pulsed experiment. Long term effects of the endpoints in this study and colony effects were not clear since queen production, worker mortality, and homing ability were not investigated.	0079872
	Imidacloprid (purity not reported assume > 98%)	CHRONIC ORAL Test species: *Bombus terrestris* Application method: 3 different treatments in syrup (37% sucrose and 38% fructose + dextrose) and pollen (1-2 g pollen mixed with syrup balls dipped in wax) were provided *ad libitum* during the 85 day test: *treatment D1*: syrup and pollen contained 10 µg/kg and 6	**REVIEW:** Compared with the control, the averge survival rate of the bumble bee adults initially placed in the colony was significantly reduced in both treatments during the first 30 days of feeding period. However, the survival rate appeared to be similar among all three groups by the end of the experiment on day 85. During the first 2 weeks, 100% survival rate was observed in the control population, whereas the mortality increased in both treatments to 10% from day 3 to day 15. After 30 days the mortality rates were 16.0% in the control and 27.7% in both treatments.	Tasei, J.N., G. Ripault. 2000. Sub-lethal effects of imidacloprid on bumble bees. Bombus terrestis (Hymenoptera: Apidae) during a laboratory feeding test. Pest Manag Sci

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		µg/kg imidacloprid, respectively; *treatment D2:* syrup and pollen contained 25 µg/kg and 16 µg/kg imidacloprid, repsecitvely; *control*: untreated syrup and pollen. Number of bees tested: queenless microlonies of three bumble bee workers/treatment. 27, 30, and 29 micro-colonies were reared for control, D1 and D2 treatments, respectively Observation period: 85 days Caste of bees tested: adult worker, < 1 day Effect parameters: mortality, feeding rate, male emergence rate, brood production, Residues: in worker bees	At the end of 85 days, the brood production (measured as the mean number of adult males per colony), mean number of larvae produced per colony, and the mean number of ejected larvae per colony, were significantly reduced in the treatment with 10 ppb in syrup and 6 ppb in pollen. However in treatment at 25 ppb in syrup and 16 ppb in pollen, statistical signifincat difference was found on the number of ejected larvae, but not on the brood production and larvae production. No statisitical differerences were detected on the food consumption and duration of larvae development in any of the two treatments during the 85-day exposure period. **MAJOR UNCERTAINTIES:** It was noted that the study was conducted using small and queenless colonies. The test concentrations were not analysed. Although imidacloprid residues were not detected in any surviving workers at the end of study,, the level of detection was high at 20 µg/kg.	56:784-788
NON-APIS - Tier I Chronic Larvae Trials				
NOEC: 3 ppb in pollen LOEC: 30 ppb in pollen	Imidacloprid (technical 97.5%)	CHRONIC LARVAE Test species: *Osmia lignaria* Application method: eggs with pollen provisions were placed into culture plates and treated two ways: *Experiment 1:* pollen provisions were injected with 10 µL test solution containing imidacloprid at 0.1, 1, and 10 ppm (analytical concentration 0.112, 1.183 and 11.96 ppm), expected concentrations in pollen provision was 3,30,and 300 ppb respectively. *Experiment 2:* pollen provisions were removed and replaced with pre-mixed spiked pollen at doses	**REVIEW:** *Experiment 1 (own pollen provisions):* No significant differences in either males or females: - time to reach last larval stage - time to cocoon completion - time until emergence - adult bee weight - mortality Significant differences seen in females: - the time to darken a cocoon in the 10 ppm treatment was significantly faster than those in the 0 and 0.1 ppm treatments - the 1.0 ppm treatment was not significantly different from the 10, 0.1 or the 0 ppm treatments. LOAEC = 10 ppm (300 ppb), NOAEC = 1.0 ppm (30 ppb) *Experiment 2 (pre-mixed pollen provisions):* No significant differences in either males or females: - time to reach last larval stage	Abbott, V.A., J.L. Nadeau, H.A. Higo, and M.L. Winston. 2008. Lethal and sublethal effects of imidacloprid on Osmia lignaria and clothianidin on Megachile rotundata (Hymenoptera: Megachilidae). Journal of Economic Entomology, 101(3): 784-796.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		of 3, 30 and 300 ppb (analytical analysis confirmed 2.7, 35, 276 ppb was the exposure level) Number of bees tested: 24 bees/treatment, for each experiment Caste of bees tested: egg/first instar through to adult Observation period: observations made until emergence, approximately 30 days Effect parameters: larval development, emergence, adult bee weight, bee mortality, time in days to reach last larval stage, to spin a cocoon, to darken a cocoon, or to emerge from a cocoon	- time to cocoon completion - time to darken a cocoon - time until emergence - adult bee weight - the initiation date to reach the last larval stage - the initiation date of the time to darken a cocoon - mortality Significant differences seen in females: - the time until emergence was faster in 300 ppb than in the 0, 3, and 30 ppb individuals. Applies to females only, no effect on males. LOAEC = 300 ppb, NOAEC = 30 ppb **MAJOR UNCERTAINTIES:** Small sample sizes in lab due to difficulty rearing larvae for successful cocoon spinning. Statistical power was low as a result of small sample sizes. Chemical may not have been evenly distributed throughout the injected spiked pollen provision. The health of the solitary bees is unknown. Long-term effects were not investigated in the study. In the "own pollen", male bees in all treatment groups weighed significantly more than control bees. It is noted that this was not a dose response.	
NOEL: <0.0056 µg a.i./larva, the lowest test dose. Estiamted to be <0.0003 µg a.i./larva/day, <40 µg a.i./L	Imidacloprid (700 g a.i./L)	CHRONIC LARVAE Test species: *Melipona quadrifasciata anthidioides* Application method: eggs were placed in artificial rearing cells with 130 µL of spiked diet; doses tested were 0.0056, 0.014, 0.028, 0.037, 0.051, 0.056, 0.08, 0.112, 0.28, 0.37, 0.56, 1.12, 1.75, 3.50, 7.00, 14.00, 28.00 or 56 µg a.i./bee Number of bees tested: 24 bees/treatment, experiment repeated 5 times Caste of bees tested: larvae Observation period: observations	**REVIEW:** *Survival:* At 56 µg a.i./ bee, the larvae usually survive for less than five days. The survival curves at doses between 0.28 and 28 µg a.i./bee were similar and all of the worker larvae exposed to doses within this range died before reaching the pupa stage. Survival rates were above 50% only at the lowest imidacloprid dose used (0.0056 µg a.i./bee) and among the control (97% survival), with a negative correlation between the insecticide dose and the median survival time. *Developmental time and adult body mass of the surviving larvae:* Exposure of larvae to imidacloprid did not significantly affect developmental time from egg to adult emergence or adult body mass. **MAJOR UNCERTAINTY:** The use of the statistical test to	Tomé H.V., G.F. Martins, M.A. Lima, L.A. Campos, R.N. Guedes. 2012. Imidacloprid-induced impairment of mushroom bodies and behavior of the native stingless bee Melipona quadrifasciata anthidioides . PLoS ONE 7(6): e38406. doi:10.1371/journal.pone.0038406.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		made daily after exposure and through to 8 days after adult emergence Effect parameters: survival, development time, adult body mass	determine a "median survival time" is not as appropriate or as useful as a median lethal dose (LD50). No residue analysis was conducted on the bees or treated diet to confirm test exposure. The amount of diet consumed was not measured in total or over time.	DER: 2595538
APIS - Tier I Acute Larvae Trials				
D7 LD_{50}= 4.17 µg a.i./larva.	Imidacloprid (TGAI)	ACUTE LARVAE Test species: *Apis mellifera* Application method: in-vitro rearing method similar to OECD guideline 237. Single exposure on D4 and mortality observed at D5, D6 and D7 Number of bees tested: 36 larvae per treatment, 3 replicates/treatment (12 larvae in each replicate) Observation period: Mortality observed at D5, D6 and D7	**REVIEW:** The LC50 values on D7 for each tested pesticide were determined as follows: amitraz - 494.27 mg/L, chlorpyrifos - 15.39 mg/L, coumaphos - 90.01 mg/L, fluvalinate - 27.69 mg/L, and imidacloprid - 138.84 mg/L, The LD50 values on D7 for each tested pesticide were determined as as follows: 14.83 (amitraz), 0.46 (chlorpyrifos), 2.70 (coumaphos), 0.83 (fluvalinate) and 4.17 (imidacloprid) µg/larva. **MAJOR UNCERTAINTIES:** A standard positive reference control with dimethoate was not tested and there was slight difference in diet composition. However, the deviations are expected to have no significant impacts to the study outcomes as multiple pesticides were tested, and the validity criteria in the solvent control were met according to the OECD 237.	Dai, P., Jack C.J., Mortensen A.N., Ellis J.D..2017. Acute toxicity of five pesticides to Apis mellifera larvae reared in vitro.Pest Manag Sci. 2017 May 9. doi: 10.1002/ps.4608
APIS - Tier I Chronic Larvae Trials				
No endpoints determined	Imidacloprid (purity not reported) and other various pesticides	CHRONIC LARVAE Test species: *Apis mellifera* Application method: Pesticide concentrations dissolved in acetone were mixed with an artificial larval diet (0% royal jelly, 6% d-glucose, 6% d-fructose, 37% double distilled water, and 1% yeast extract) daily for 4 days. Larvae were fed 20 µL of diet at hours 108 and 132, 30 µL on hour 156, 40 µL on hour 180, and 50 µL on hour 204. Each	**REVIEW:** The level of cell death in the midgut increased from 10% in the control up to 61% in the imidacloprid treatment. **MAJOR UNCERTAINTIES:** Larva rearing method was similar to OECD Guidline 237 and Guidance 239 but with slight difference in diet composition and handling. Correlation between the level of midgut cell apoptosis and typical environment endpoints for risk assessment has not been established.	Gregorc, A. and J.D. Ellis. 2011. Cell death localization in situ in laboratory reared honey bee (Apis mellifera L.) larvae treated with pesticides. Pesticide Biochemistry and Physiology 99: 200–207

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		group of test larvae was treated with 1 of the following pesticide concentration: 1.6 ppm chlorpyrifos, 400 ppm imidacloprid, 400 ppm amitraz, 200 ppm fluvalinate, 100 ppm coumaphos, 400 ppm myclobutanil, 400 ppm chlorothalonil, 400 ppm glyphosate, and 400 ppm simazine. Two control groups: larvae feeding on diet containing acetone and larvae feeding on an untreated diet. Number of bees tested: Nine treatment groups of larvae were established in all, each group being composed of 12 treated larvae. Caste of bees tested: larvae, 2 day old Observation period: 6 days Effect parameters: cellular death using DNA fragmentation labeling and phosphatidylserine (PS) localization techniques,		
No endpoints determined.	Imidacloprid (95%)	CHRONIC LARVAE Test species: *Apis mellifera* Application method: newly laid eggs in brood comb were marked and 1 day after hatching, were provided with 1 μL of sucrose solution containing either 1, 10, 100 or 500 μg/L (ppb) into their cells daily for 4 days; this resulted in total doses of 0 (control), 0.004, 0.04, 0.4 and 2 ng/larva respectively.Pupae were removed	**REVIEW:** *Effects of sublethal levels of imidacloprid on micro-glomerulus (MG):* Over a period of time from 1 to 20 days after emergence, the MG density in the 20-d old adult bees varied over time regardless of treatment. However, compared with the control, the MG density in the adults that emerged from treated larvae was significantly reduced. In the 500 ppb treatment, the MG density was affected significantly in all regions of the calyces. In the lower imidacloprid treatments at 1, 10 or 100 ppb, the MGs density was decreased significantly but only in different parts of the calyces regions (collar, base ring and lip of the calyces).	Peng, Yi-Chan; Yang, En-Cheng. 2016. Sublethal Dosage of Imidacloprid Reduces the Microglomerular Density of Honey Bee Mushroom Bodies. Scientific Reports 6, Article number: 19298 (2016). DOI: 10.1038/srep19298

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		and placed into cell plates in an incubator for adult emergence rate observations and later, immunocytochemistry tests. Normal pollen forager bees sampled outside of the experiment were also used as a comparison. Number of bees tested: unknown number of larvae were fed; 20 adult bees of each cohort age (1 day, 10 day, 20 days and pollen foragers) were tested after emergence Caste of bees tested: exposed larvae through to adult emergence Observation period *Adult emergence rate:* adult emergence rate was monitored from day 6 after capping and onwards *Immunocytochemistry:* 20 day old adult bees were destructively sampled for staining Effect parameters: level of micro-glomerulus staining within a mushroom body	**MAJOR UNCERTAINTIES:** Non-guideline study. Larvae were reared in hive combs and fed with a fixed amount of chemical daily. Correlation between the level of MG density and typical environment endpoints for risk assessment has not been established.	
No endpoints determined.	Imidacloprid (not stated)	CHRONIC LARVAE Test species: *Apis cerana cerana* Application method: newly laid eggs in brood comb were marked and 3 days after hatching, were provided with 2 µL of 1M sucrose solution containing 20 µg/L (17.7 ppb) daily for 6 days; this resulted in a daily dose of 0.04 ng imidacloprid/bee and a total of 0.00024 µg/bee during larval development; on day 7 combs	**REVIEW**: *Adult emergence rate* Feeding larvae daily at 0.04 ng dose/bee for 6 days demonstrated no adverse effects on immature bee development (number of sealed cells or bees that emerged). On average, in the control and treatment group, the percentages of sealed cells were 91.0% and 85.7% respectively, and the percentages of adult emergence were 90.0 % and 85.0%, respectively. *Short-term memory* Control bees exhibited 2.5–4.8 fold higher learning acquisition than treated bees at 30 and 40 min after test. However there was no difference between the trials at times less than 30 min after the test.	Tan, K., W. Chen, S. Dong, X. Liu, Y. Wang and J. C. Nieh. 2015. A neonicotinoid impairs olfactory learning in Asian honey bees (Apis cerana) exposed as larvae or as adults. Scientific Reports 5: 10989. DOI: 10.1038/srep10989

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		were placed in an incubator for 10 days to monitor adult emergence; 7 day old adults were then subjected to PER tests Number of bees tested: 100 larvae/treatment were sourced from 3 colonies and fed; only 30 emerged bees/treatment (a total of 180 bees) were used in PER tests post-emergence Caste of bees tested: exposed larvae through to adult emergence Observation period: *Adult emergence rate:* adult emergence rate was monitored from day 10 −17 *PER:* observations made after 10, 19, 30 and 40 min to test short-term memory (STM) and after 1, 5, or 17 h to test longer-term memory (LTM) Effect parameters: adult emergence rate, learning response	*Longer-term memory* No treatment effect on the longer-term memory was detected in adult bees developed from the larvae that were exposed to imidacloprid at 0.04 ng dose/bee for 6 days. There was no significant interaction of trial*treatment. **MAJOR UNCERTAINTIES:** Capped larvae were placed in the incubator in frames containing food naturally stored in the combs. Unknown if the food was tested to be contaminate free. The PER test is not considered to be a typical environmental toxicity endpoint. Links between the PER endpoints to the typical environmental and/or colony-level endpoints has not been established.	
NOED/C=0.0004 µg a.i./larva/100 µg a.i./L for the capped-brood and pupation rates NOED/C=0.024 µg a.i./larva/60000 µg a.i./L for the adult emergence rates	imidacloprid (95%)	CHRONIC LARVAE Test species: *Apis mellifera* Application method: newly laid eggs in brood comb were marked and 3 days after hatching, were provided with 1 µL of sucrose solution containing either 0.0001, 0.006, 0.05, 0.5, 1.0, 1.5 and 2.0 µg/L into their cells daily for 4 days; this resulted in total doses of 0.0004, 0.024, 0.2, 2.0, 4.0, 6.0 and 8.0 µg/larva (nominal doses) respectively. On day 15, pupae were removed and placed into cell plates in an incubator for adult	**REVIEW**: Chronic Larvae Endpoints: *Larvae capped-brood rates:* Rates were 98, 91 and 88% for the treatment of 0.0004, 0.024 and 0.2 µg/larva respectively. The larvae capped-brood rates were 60, 39, 31 and 12% for the applied rate of 2.0, 4.0, 6.0 and 8.0 µg/larva respectively. Most of the dead larvae were removed by the nurse bees by day 2 or day 3 in the 2-8 µg/larvae treatments. The larvae capped-brood rates were reduced significantly in groups that received doses at 0.024 ng/larva and greater when compared to the controls. LD_{50} = 1.4 µg/larva NOED = 0.0004 µg/larva NOEC = 100 µg a.i./L *Pupation rate:* The pupation rates were 94, 88 and 87% for the treatment of	Yang E-C, Chang H-C, Wu W-Y, Chen Y-W. 2012. Impaired Olfactory Associative Behavior of Honey bee Workers Due to Contamination of imidacloprid in the Larval Stage. PLoS ONE 7(11): e49472. doi:10.1371/journal.pone.0049472

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		emergence rate observations and later, PER tests Number of bees tested: 30 –40 larvae/treatment were sourced from 4 colonies and fed; approximately 30 emerged bees/treatment were used in PER tests post-emergence Caste of bees tested: exposed larvae through to adult emergence Observation period *Adult emergence rate:* adult emergence rate was monitored from day 105 onwards *PER:* observations made after 20 minute testing period Effect parameters: larval capped-brood rates, pupation rates, adult emergence rate, learning response	0.0004,0.0 24 and 0.2 µg/larva respectively. The pupation rates were 56, 34, 28 and 9% respectively for the applied rate of 2.0, 4.0, 6.0 and 8.0 µg/larva, respectively. The pupation rates were reduced significantly in groups that received doses at 0.024 µg/larva and greater when compared to the controls. NOED = 0.0004 µg/larva NOEC = 100 µg a.i./L *Adult emergence rate:* The adult emergence rates were 89, 84 and 77 for the treated rate of 0.0004, 0.024 and 0.2 µg/larva respectively. The adult emergence rates were 51, 31, 25 and 9% for the applied dose of 2.0, 4.0, 6.0 and 8.0 µg/larva respectively. The adult emergence rates were reduced significantly in groups that received doses at 0.2 µg/larva and greater when compared to the controls. NOED = 0.024 µg/larva NOEC = 6000 µg a.i./L *PER test for learning and memory:* The bees treated with 0.00004 and 0.0004 µg a.i. had a reduced olfactory associative ability than the control bees. There was no difference in the olfactory associative ability between the treatment with 0.000004 µg/larvae imidacloprid or less and the control for the conditioning trials. **MAJOR UNCERTAINTIES:** Imidacloprid was applied once a day for 4 consecutive days (from 1 to 4 days old), but not on day 5 and day 6. The larvae were not exposed to imidacloprid during the entire larvae period, and the test may not represent the actual exposure scenario in the field to the larvae. Links between the PER endpoints to the typical environmental endpoints has not been established. This study design differs from the OECD draft guideline for the repeated exposure for honey bee larvae test.	

Table 3 Tier II Toxicity for *Apis* and non-*Apis* bees – Applicant Submitted Studies

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
Tunnel Seed treatment Honey bee	Test crop: summer rape and sunflower Test species: small honey bee hives Application rate: summer rape: 74.2 g a.i./ha (427.4 g a.i./L of 25 mL/kg seed, 181,000 seeds are in 1 kg seed = 0.05 mg a.i./seed) sunflower: 52.5 g a.i./ha (89.3 g/150,000 seeds = 0.60 mg a.i./seed) Number of hives tested: *summer rape & sunflower:* 1 control plot, 3 different seed variety treated plots; each plot had a tunnel with one hive: 5 hives total for each crop Exposure period: *summer rape*: 10 days *sunflower*: 10 days Observation period: *summer rape*: 10 days *sunflower*: 10 days Effect variables: flight and foraging intensity, returning forager frequency, bee behaviour, bee mortality, colony strength, brood status, population density, food stores Residue samples: leaves, pollen and nectar from bees, nectar from plants, pollen from plants, pollen from hives, soil Location: Germany Year: 1999	**REVIEW:** No treatment related-effects were seen in honey bee hives exposed to summer rape or sunflower plants grown from treated seed. Imidacloprid was detected at 7 ppb in sunflower leaves. **MAJOR UNCERTAINTIES:** Summer rape was grown from seed treated with a combination product that contained imidacloprid and beta-cyfluthrin as active ingredients. Some fields were previously treated with winter wheat or barley imidacloprid seed treatments and/or imidacloprid foliar sprays in the 1–2 years prior to this trial being conducted. Background residue was detected in all soils treated in the last two years up to 24.5 ppb in 0–20 cm soil. There were no true treatment replicates. The test hives were small in size and were intensively used as sampling tools.	1086418 1086423 2142791 2351157 2351163
Tunnel Seed treatment Honey bee	Test crop: summer rape and sunflower Test species: small honey bee hives Application rate: *summer rape:* 34.7 g a.i./ha (427.4 g a.i./L of 25 mL/kg seed, 181,000 seeds are in 1 kg seed = 0.05 mg a.i./seed) *sunflower:* 52 g a.i./ha (150 g a.i./150,000 seeds = 1 mg a.i./seed) Number of hives tested: *summer rape & sunflower*: 1 control plot, 4 different seed variety treated plots; each plot had a tunnel with one hive: 5 hives total per crop Exposure period: *summer rape*: 10 days	**REVIEW:** No treatment related-effects were seen in honey bee hives exposed to summer rape or sunflower plants grown from treated seed. Imidacloprid was detected at 6 ppb in sunflower leaves. **MAJOR UNCERTAINTIES:** Summer rape was grown from seed treated with a combination product that contained imidacloprid and beta-cyfluthrin as active ingredients. Some fields were previously treated with imidacloprid seed treatment. A trace amount of imidacloprid (< LOQ = 6 ppb) was reported in a field treated with imidacloprid three years ago, and up to 17 ppb in all soils treated in the last two years. The test hives were small in size and were	1086434 1086435 1086436 2142782 2142787 2351160

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
	sunflower: 10–15 days Observation period: *summer rape*: 10 days *sunflower*: 10–15 days Effect variables: bee mortality, hive weight, foraging activity, hive strength, number of honey bees, brood development, colony strength, population density, food stores, bee behaviour Residue samples: leaves, pollen from pollen pockets, nectar from plant, nectar from hives, soil Location: Germany Year: 1999	intensively used as sampling tools by removing adult bees and stored hive food from the small hive. There were no true treatment replicates	
Tunnel Seed treatment Honey bee	Test crop: sunflower Test species: small honey bee hives Application rate: 51.8 g a.i./ha (calculated as 0.58 U/ha x 89.3 g a.i./U; 150 g a.i./150,000 seeds = 1 mg a.i./seed) Number of hives tested: 1 control plot, 4 different seed variety treated plots; each plot had a tunnel with one hive: 5 hives total Exposure period: 10 days Observation period: 10 days Effect variables: bee behaviour, bee mortality, colony strength, brood development Residue samples: nectar and pollen from bees, nectar from flowers, pollen from flowers, pollen from hives, whole flowers, leaves, soil Location: Germany Year: 1999	**REVIEW:** No treatment related-effects were seen in honey bee hives exposed for 10 days to sunflower plants grown from treated seed. Imidacloprid was detected in leaves at 6 ppb. Imidacloprid and its metabolites were detected but not measurable in bee related matrices (LOQ = 5 ppb; LOD = 1.5 ppb). **MAJOR UNCERTAINTIES:** The soil in test field was contaminated with imidacloprid prior to the study. Imidacloprid was detected in 0–30 cm deep soil at 16 ppb at the beginning of study. The test hives were small in size and were intensively used as sampling tools by removing adult bees and stored hive food from the small hive. There were no true treatment replicates	2142793 2351166
Tunnel Seed treatment Honey bee	Test crop: summer rape Test species: small honey bee hives Application rate:53.8 g a.i./ha (428.2 g a.i./L of 5 kg seed/ha = 1070.5 g a.i./100 kg seed and181,000 seeds are in 1 kg seed = 0.06 mg a.i./seed) Number of hives tested: 1 control plot, 1 treated seed plot; each plot had a tunnel with one hive: 2 hives total Exposure period: 4 days Observation period: 4 days	**REVIEW:** No treatment related-effects were seen in honey bee hives exposed for 4 days to summer rape grown from treated seed. **MAJOR UNCERTAINTIES:** Imidacloprid and its metabolites were detected but not measurable in any samples however; the LOQ was very high at 10 ppb. There was a lack of documented pesticide use history. There were no true treatment replicates.	1086418 2142734 2351175

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
	Effect variables: bee behaviour, bee mortality, flight and foraging intensity Residue samples: nectar from honeybulb, nectar from flowers, pollen from pollen pockets of bees Location: Sweden Year: 1998		
Tunnel Seed treatment Honey bee	Test crop: summer rape Test species: small honey bee hives Application rate: 52.25 g a.i./ha (428.2 g a.i./L of 5 kg seed/ha = 1070.5 g a.i./100 kg seed and181,000[3] seeds are in 1 kg seed = 0.06 mg a.i./seed) Number of hives tested: 4 control subplot, 4 treated seed subplots; each plot had a tunnel with one hive: 2 hives total Exposure period:3 days Observation period: 3 days Effect variables: bee behaviour, bee mortality Residue samples: summer rape nectar and pollen collected by bees, nectar from flowers, whole flower blossoms Location: France Year: 1998	**REVIEW:** No treatment related-effects were seen in honey bee hives exposed for 3 days to summer rape grown from treated seed. **MAJOR UNCERTAINTIES:** Imidacloprid and its metabolites were detected but not measurable in any samples however; the LOQ was very high at 10 ppb. There was a lack of documented pesticide use history. There were no true treatment replicates.	1086419 2142789 2351172
Tunnel Seed treatment Honey bee	Test crop: canola Test species: honey bee hives Application rate: 800 g a.i./100 kg seed (181,000 seeds in 1 kg seed = 0.04 mg a.i./seed) Number of hives tested: 1 control plot, 1 treated seed plot; each plot had a tunnel with one hive: 2 hives total Exposure period: 14 days Observation period: 14 days Effect variables: foraging activity, bee mortality, survival of marked bees, brood effects, colony strength Residue samples: nectar and pollen from bees, nectar	**REVIEW:** No treatment related-effects were seen in honey bee hives exposed for 14 days to canola grown from treated seed. **MAJOR UNCERTAINTIES:** Residue analysis was not conducted to confirm level of exposure. Lack of methodology of marking bees (such as dates and status of bees when bees were marked) makes it difficult to interpret the results of adult cohort survivability. There were no true treatment replicates.	2351140

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
	from flowers were all collected but not analysed Location: Saskatchewan, Canada Year: 1999		
Tunnel Seed treatment Honey bee	Test crop: summer rape Test species: small honey bee hives Application rate: 50.95 g a.i./ha 428.2 g a.i./L of 5 kg seed/ha = 1070.5 g a.i./100 kg seed and181,000 seeds are in 1 kg seed = 0.06 mg a.i./seed) Number of hives tested: 1 control plot, 1 treated seed plot; each plot had a tunnel with one hive: 2 hives total Exposure period: 3 days Observation period: 3 days Effect variables: bee behaviour, bee mortality, flight and foraging intensity, returning forager frequency Residue samples: nectar and pollen from bees, nectar from flowers, whole flowers, soil Location: Britain, UK Year: 1998	**REVIEW:** No treatment related-effects were seen in honey bee hives exposed for 3 days to summer rape grown from treated seed. **MAJOR UNCERTAINTIES:** Plants were grown from seed treated with a combination product that contained imidacloprid and beta-cyfluthrin as active ingredients. Imidacloprid and its metabolites were detected but not measurable in all samples however; the LOQ was high at 10 ppb. There were no true treatment replicates**.**	2351169
Tunnel Seed treatment Honey bee	Test crop: winter rape Test species: small honey bee hives Application rate: *Treatment 1:* 14 g a.i./kg *Treatment 2:* 21 g a.i./kg (there was not enough information to convert to mg a.i./seed) Number of hives tested: 1 control plot, 1 treated seed plot; each plot had a tunnel with one hive: 2 hives total Exposure period: Unspecified (plants started flowering at 33 weeks after sowing of treatment seed) Observation period: up to 21 days Effect variables: pollen and honey storage, flower visits, bee behaviour, number of eggs, open and capped brood, bee mortality and colony strength Location: Germany Year: 1987	**REVIEW:** Increased number of dead bees at the edge of the tunnel were observed in the treatment (2 times higher than the control in the 14 g a.i./kg treatment, and 3 times higher in the 21 g a.i./kg treatment), though the numbers of dead bees were low in all groups. At the end of the exposure period colony strength was reduced in the highest treatment level compared to the control. No other treatment related-effects were seen in honey bee hives exposed to winter rape grown from seed for at least 21 days. **MAJOR UNCERTAINTIES:** There were no treatment replications, detailed methodology or statistical analysis. Residue analysis was not conducted to confirm level of exposure.	2364423 2364424
Tunnel	Test crop: winter rape Test species: small honey bee hives	**REVIEW:** No treatment related-effects were confirmed in honey bee hives exposed to winter rape grown from seed for 24 days.	2364427 2364428

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
Seed treatment Honey bee	Application rate: Treatment 1: 1050 g a.i./100 kg seed and 181,000 seeds are in 1 kg seed = 0.06 mg a.i./seed) Treatment 2: 2100 g a.i./100 kg seed and 181,000 seeds are in 1 kg seed = 0.12 mg a.i./seed Number of hives tested: 1 control plot, 1 treated seed plot; each plot had a tunnel with one hive: 2 hives total Exposure period: 24 days in tunnel (plants started flowering 237 days after sowing of treated seed) Observation period: 34 days (24 day confinement and 10 days after exposure) Effect variables: bee mortality, flower visits, food storage, brood development, number of eggs and empty cells Location: Germany Year: 1997	However, increased number of empty cells was found at 14 days after the start of exposure but not at 7 days after the start of exposure. The empty cells appeared to be filled with eggs in 10 days after removal from the test tunnel. **MAJOR UNCERTAINTIES:** Plants were grown from seed treated with a combination product that contained imidacloprid and beta-cyfluthrin as active ingredients. The length of time the bees were confined in a tunnel was considered long and may induce hive stress. Residue analysis was not conducted to confirm level of exposure.	
Tunnel Seed treatment Honey bee	Test crop: summer rape Test species: small honey bee hives Application rate: *Treatment 1:* 10.5 g a.i./1 kg seed and 181,000 seeds are in 1 kg seed = 0.06 mg a.i./seed) *Treatment 2:* 21 g a.i./1 kg seed and 181,000 seeds are in 1 kg seed = 0.12 mg a.i./seed Number of hives tested: 2 control plots, 2 plots per seed treatment rate; each plot had a tunnel with one hive: 6 hives total Exposure period: 21 days (plants started flowering 63 days and 56 days after sowing) Observation period: 21 days Effect variables: bee mortality, flower visits, hive weight, food storage, brood development Location: Germany Year: 1998	**REVIEW:** No treatment related-effects were seen in honey bee hives exposed for 10-13 days to summer rape grown from treated seed. **MAJOR UNCERTAINTIES:** Plants were grown from seed treated with a combination product that contained imidacloprid and beta-cyfluthrin as active ingredients. Residue analysis was not conducted to confirm level of exposure.	2364429 2364430
Tunnel Soil application OR	Test crop: field beans, summer rape, sunflower Test species: honey bee hives Application rate: *Soil application as granules in seed furrow:*	**REVIEW:** No treatment related-effects were seen in honey bee hives exposed for 14 days to field beans, summer rape or sunflowers that received granule in-furrow treatment or to field beans grown from seed.	2364425 2364426

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
Seed treatment Honey bee	Field bean: 0.0125, 0.025 g a.i./m Summer rape: 0.025, 0.5 g a.i./ha Sunflower: 0.05, 0.1 g a.i./m *Seed treatment:* Field bean: 140, 280 g a.i./100 kg seed Number of hives tested: 1 control plot, 1 plot per treatment; each plot had a tunnel with one hive: 9 hives total Exposure period: approximately 14 days during flowering Observation period: approximately 14 days during flowering Effect variables: bee mortality, flower visits, hive weight, brood development Location: Germany (presumed) Year: 1990	**MAJOR UNCERTAINTIES:** There was no detailed hive information provided, such as hive development or original colony size. The summer rape trial was discontinued after 4 days. Residue analysis was not conducted to confirm level of exposure. There were no true treatment replicates.	
Tunnel Foliar application Honey bee	Test crop: *Phacelia* Test chemical: Confidor SL 200 Test species: *Apis mellifera* Application rate: Foliar spray at 21 and 35 g a.i./ha, and 0 in water (control), PennCap M at 5 g /l as positive control Number of replicates: 4 Number of hives per replicate: 1 Exposure period: 4 days Observation period: 4 days Effect parameters: mortality, foraging, number of brood Location: Netherlands Year: 2002	**REVIEW:** One small honey bee hive was placed in each tent. Prior to the exposure, test bees were acclimated 4 days in the tents containing 36 pots of untreated flowering Phacelia. During the exposure, the plants were replaced with flowering Phacelia that were sprayed with Confidor SL 200 (containing 196 g/l imidacloprid) at 21 or 35 g a.i./ha conducted 24, 48 or 96 hr before the start of the exposure. Foraging activity and mortality of the honey bees were assessed during 4 days of the exposure period. Increased adult bee mortality and reduced foraging activity were detected for honey bees in tents containing potted flowering Phacelia that were sprayed with Confidor SL 200 (containing 196 g/l imidacloprid) at 21 or 35 g a.i./ha at 24, 48 or 96 hr previously. **MAJOR UNCERTAINTIES:** The test rates were low compared to Canadian label rates for foliar applications, but may be considered relevant for off-field spry drift. No residue analysis was conducted to characterize the level of exposure.	2523541
Tunnel Foliar application	Test crop: *Phacelia* Test chemical: Confidor SL 200 Test species: *Apis mellifera* Application rate: Foliar spray 14, 9 , 4 , 2, 1.2 and 0.6	**REVIEW:** One small honey bee hive was placed in each tent. Prior to the exposure, bees were acclimatized for 4 days in the tents containing 36 pots of untreated flowering Phacelia. During bee flight the flowering Phacelia plants were sprayed with Confidor SL	2636144

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
Honey bee	g i./ha, and 0 as control, PennCap M at 5 g /l as positive control. Number of replicates: 4 Number of hives per replicate: 1 Exposure period: 4 days Observation period: 4 days Effect parameters: mortality, foraging, brood Location: Netherlands Year: 2001	200 at nominal rates of 14, 9, 4, 2, 1.2 and 0.6 g a.i. imidacloprid/ha. Foraging activity of the honey bees was significantly reduced during the first two days of the application at 14.0 g a.i./ha, but the reduction was detected only at the same day of the treatments at 2.0, 4.0, and 9.0 g a.i./ha. The foraging activity was not reduced in any days in the treatments at 0.6 and 1.2 g a.i./ha. Within the 4 days of observation period, effect on honey bee mortality was not detected in any treatments ranging from 0.6-14 g a.i./ha. **MAJOR UNCERTAINTIES:** The test rates were low compared to Canadian label rates for foliar applications, but may be considered relevant for off-field spry drift. No residue analysis was conducted to characterize the level of exposure.	
Tunnel Soil application Bumble bee	Test crop: potted *Lobelia erinus* and *Erica gracilis* Test chemical: Imidacloprid WG 5 Test species: *Bombus terrestris* Application rate: soil application at 15 mg a.i./l soil substrate each treatment Treatment group A: 15 mg a.i./l soil substrate, application at full blossom, 130 treated *Lobelia erinus* and 90 untreated *Erica gracilis* in the tent Treatment group B: 15 mg a.i./l soil substrate, application at full blossom, 90 treated *Erica gracilis* and 130 untreated *Lobelia erinus* in the tent Treatment group C: 15 mg a.i./l soil substrate, application at full blossom, 22 treated *Lobelia erinus* and 160 untreated *Erica gracilis* in the tent Treatment group D: 15 mg a.i./l soil substrate, application at full blossom, 22 treated *Erica gracilis* and 198 untreated *Lobelia erinus* in a tent Control: Plants received no treatment, 90 untreated *Erica gracilis* and 130 *Lobelia erinus* in the tent. Number of replicates: 2 Number of hives per replicate: 1 Exposure period: 8 days Observation period: 8 days	**REVIEW:** Reduced flight activity, adult bee survival and brood development were detected in bumble bee colonies that were exposed for 8 days in tents to potted flowering ornamental plants that were soil treated with imidacloprid at 15 mg a.i./L soil. At the end of the exposure, there were a greater number of dead adults, less number of live bees and nectar cells in the treatments than that in the control. The colony weight was reduced in all test colonies, but more reduction was found in the controls. The test rate is comparable to the maximum Canadian label rate, 18 mg/6 in pot for relevant uses. The treatment-related adverse effects appeared to be clearly related to the ratio of treated to untreated plants. The effect was greater in the treatment groups with a greater proportion of ground surface covered by treated flowering plants. **MAJOR UNCERTAINTIES:** No residue analysis was conducted to characterize the level of exposure. No statistical analysis was conducted and there were only two replicates for each treatment. Flowering plants had been treated for 5 days before they were exposed to test bees.	2523558

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
	Effect parameters: mortality, foraging activity, colony conditions Location: Germany Year: 2001		
Tunnel Soil application Bumble bee	Test crop: potted *Lobelia erinus* Test chemical: Imidacloprid WG 5 Test species: *Bombus terrestris* Application rate: soil application at 15 mg a.i./l soil substrate each treatment. Treatment group A: 15 mg a.i./l soil substrate, pre-flowering application, 50% (115) treated and 50% (115) untreated plants in the tent Treatment group B: 15 mg a.i./l soil substrate, pre-flowering application plus application at full blossom, 50% (112) treated and 50% (115) untreated plants in the tent Treatment group C: 15 mg a.i./l soil substrate, pre-flowering application plus application at full blossom, 10% (23) treated and 90% (207) untreated plants in the tent Treatment group D: 15 mg a.i./l soil substrate, application at full blossom, 50% (115) treated and 50% (115) untreated plants in a ten Control K: Plants received no treatment Number of replicates: 2 Number of hives per replicate: 1 Exposure period: 14 days Observation period: 14 days Effect parameters: mortality, foraging activity, colony conditions Location: Germany Year: 2002	**REVIEW:** Potted *Lobelia erinus* were soil treated with Imidacloprid once at either pre-blooming (63 days prior to the start of exposure to bees) or during blooming period (exposure started immediately after the treatment), or twice at each of pre-blooming and during blooming periods. Bumble colonies were exposed 14 days to the flowering plants that were composed of various ratios of treated and untreated plants in tents. The single treatment at either pre-flowering (treatment A) or during flowering period (Treated D) is considered to be comparable to the Canadian registered uses. The study indicated that: - Soil application of imidacloprid on potted ornamental plants during pre-flowering period and/or during flowering at 15 mg a.i./L soil each time showed adverse effects to bumble bees during a 14 days of exposure period in tents in terms of increased number of individual dead adults outside of colonies, reduced foraging activity, and reduced number of live bees in colonies. The hive weight development was comparable in all treatments. - Less effect was shown in treatment during pre-flowering period than the treatment during flowering period. - Bumble bee colonies exposed to a higher ratio of treated plants to untreated plants (50%:50%) likely show more effects than those exposed to a lower ratio of treated and untreated plants (10%:90%). **MAJOR UNCERTAINTIES:** Treatment rates for groups A and D are compatible to Canadian labelled rates. Treatment B and C are greater than the Canadian labelled rate. No residue analysis was conducted to characterize the level of exposure. No statistical analysis was conducted and there were only two replicates for each treatment.	2523559
Tunnel Soil application Honey bee	Test crop: potted , *Lobelia erinus* and *Erica gracilis* Test chemical: Imidacloprid WG 5 Test species: Apis mellifera Application rate: soil application at 15 mg a.i./l soil substrate	**REVIEW:** The study investigated potential short-term effects of imidacloprid soil applications on honey bees. The result indicated that hat soil application of imidacloprid at 15 mg a.i./L soil on potted flowering ornamental plants increased the bee mortality (note: the absolute number of bee mortalities was not high, neither	2523561

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
	K: control: no treatment, 300 untreated *Lobelia erinus* (equivalent to 50%) and 300 untreated *Erica gracilis* (equivalent to 50%) in the tunnel A: 15 mg a.i./l soil substrate, 300 treated *Lobelia erinus* (equivalent to 50%) and 300 untreated *Erica gracilis* (equivalent to 50%) in the tunnel B: 15 mg a.i./l soil substrate, 300 treated *Erica gracilis* (equivalent to 50%) and 300 untreated *Lobelia erinus* (equivalent to 50%) in the tunnel C: 15 mg a.i./l soil substrate, 65 treated *Lobelia erinus* (equivalent to 10%)* and 535 untreated *Erica gracilis* (equivalent to 90%) in the tunnel D: 15 mg a.i./l soil substrate, 65 treated *Erica gracilis* (equivalent to 10%)* and 535 untreated *Lobelia erinus* (equivalent to 90%) in a tunnel Number of replicates: 2 Number of hives per replicate: 1 Exposure period: 16 days Observation period: 16 days Effect parameters: mortality, foraging activity Location: Germany Year: 2002	in the control nor in treatments), and reduced the flight activity of adult honey bees during 16 days of the exposure period in the tents. **MAJOR UNCERTAINTIES:** No residue analysis was conducted to characterize the level of exposure. No statistical analysis was conducted.	
Tunnel Seed treatment Bumble bee	Test crop: sunflower Test species: *Bombus terrestris* Application rate: Gaucho at 0.7 mg a.i./seed Number of hives tested: 1 colony with at least 76 foragers was introduced to greenhouse that contained 24 pots of sunflowers grown from untreated seed and 24 pots of sunflowers grown from treated seed Exposure period: 3 days Observation period: 3 days Effect variables: number of flowering heads, forager density and duration Location: France Year: 1998	**REVIEW:** No treatment related effects on foraging were seen in bumble bee colonies exposed to potted sunflower plants grown in a greenhouse from treated seed for an exposure period of 3 days. **MAJOR UNCERTAINTIES:** There was no information on the bumble bee colonies or the number of replicates. This trial was conducted in a greenhouse with plants in pots which can affect residue uptake when compared to field grown plants. Residue analysis was not conducted to confirm level of exposure.	2142738
Closed feeding	Test crop: tunnels were placed on untreated grass fields	**REVIEW:** No treatment related-effects were seen in honey bee hives exposed through artificially fed maize pollen for 38 days.	2142762 2351144

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
Artificially fed hives with maize pollen collected from plants grown from treated seeds were placed in tents containing grass for 38 days, untreated honey was provided in feeders Honey bee	Test species: small honey bee hives Application rate: pollen was collected from maize plants treated with 1 mg a.i./seed and fed to hives Number of hives tested: 2 control plots, 2 treated; each plot had a tunnel with one hive: 4 hives total Exposure period: 38 days Observation period: 38 days Effect variables: bee mortality, comb cell production, egg laying, brood success, food consumption, honey storage, bee behaviour, hive weight, hive strength, number of bees foraging on pollen feeder, honey feeder and tent roof Residue samples: pollen Location: Germany Year: 2000	**MAJOR UNCERTAINTIES:** In one of the two treated seed tunnels there were significantly higher numbers of bees by the pollen feeder however; these results were not related to treatment. Imidacloprid and its metabolites were detected but not measurable in maize pollen. The impact of confinement for such a long duration to the bee hives is unknown	
Closed feeding Artificially fed hives with maize pollen collected from plants grown from treated seeds were placed in tents containing oat for 45 days, untreated sunflower honey was provided in feeders Honey bee	Test crop: tunnels were placed on untreated oat fields Test species: small honey bee hives Application rate: pollen was collected from maize plants treated with 1 mg a.i./seed and fed to hives Number of hives tested: 3 control plots, 3 treated plots; each plot had a tunnel with one hive: 6 hives total Exposure period: 45 days Observation period: 52 days Effect variables: bee mortality, comb cell production, egg laying, brood success, food consumption, honey and pollen storage, bee behaviour, hive weight, hive strength, foraging activity Residue samples: pollen Location: Germany Year: 2001	**REVIEW:** Significantly higher numbers of dead bees found by the edge of the treated tunnels, but not in front of hives. Significantly higher pollen consumption was seen in the treated tunnels. However, no effects were detected on the number of comb cell production, egg laying, brood success, honey and pollen storage, uncapped and capped brood, hive strength, hive weight gain, honey consumption. It was considered that there were no treatment-related overall effects at colony level. **MAJOR UNCERTAINTIES:** The pollen texture used in the treatment and control was different and its impact on the pollen consumption and treatment effect is unknown. A low statistical detection power is expected due to the large data variability observed in the study and low number of replicates. The impact of confinement for such a long duration to the bee hives is unknown.	2142763 2351145
Closed feeding Artificially fed small hives with spiked maize pollen in tents containing oats for	Test crop: tunnels were placed on untreated oat fields Test species: honey bee hives Application rate: 10–30 g of maize pollen dosed with 2, 5, 10, and 20 ppb was provided in two locations within each hive and replaced every 10 days Number of hives tested: 1 control plot, 1 plot per treatment; each plot had a tunnel with one hive: 5	**REVIEW:** No treatment related-effects were seen in honey bee hives exposed through artificially fed maize pollen for 39 days. **MAJOR UNCERTAINTIES:** There were no replicates. The impact of confinement for such a long duration to the bee hives is unknown.	1086417 2142766 2351141

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
39 days, untreated sunflower honey was provided Honey bee	hives total Exposure period: 39 days Observation period: 39 days Effect variables: bee mortality, comb cell production, food consumption, storage behaviour, hive weight, egg laying, breeding success, colony strength, foraging intensity, bee behaviour Residue samples: pollen dose verification Location: Germany Year: 1998		
Closed feeding Artificially fed small hives with spiked sunflower honey in tents containing oats for 39 days, 10-30 g of untreated *Rosmarinus officinalis* (Mediterranean Bush) pollen was provided Honey bee	Test crop: tunnels were placed on untreated oat fields Test species: honey bee hives Dose rate: 2kg batches of sunflower honey was spiked with 2, 5, 10, and 20 ppb and provided in an elevated glass Petrie dish; honey was provided in portions that allowed 10% to be remaining before being replenished each 3rd day Number of hives tested: 1 control tunnel, 1 tunnel per treatment; 1 hive per tunnel: 5 hives total Exposure period: 39 days Observation period: 39 days Effect variables: bee mortality, comb cell production, hive weight, egg laying, breeding success, hive strength, foraging intensity, bee behaviour, pollen collection and consumption, honey storage Residue sample: honey dose verification Location: Germany Year: 1998	**REVIEW:** Pollen consumption and honey storage were found to be consistently reduced at the highest application rate (20 ppb in sunflower honey) tested. No other differences were detected in the treatment hives artificially fed sunflower honey for at least 39 days. **MAJOR UNCERTAINTIES:** There were no replicates. The impact of confinement for such a long duration to the bee hives is unknown.	1086416 2142781 2351142
Open feeding Artificially fed hives with a combination of spiked pollen and sugar solution in open field for 6 weeks	Test crop: not applicable, open field Test species: honey bee hives Dose rate: 50/50, 50/200, 200/50 and 200/200 ppb of spiked pollen/sugar was provided *ad libitum* for week 1, and 500 g of pollen substitute and/or 2000 mL of sugar solution for the remaining 5 weeks (bees seldom consumed the entire pollen patty) Number of hives tested: 9 hives per treatment, set up into 5 block locations within a field site: 45 hives total	**REVIEW:** Significant reduction was found in hive strength, pollen store, pollen consumption, and hive weight in the 50/50 ppb spiked pollen/sugar treatment. The 200/200 ppb and the 200/50 ppb both had reduced pollen consumption and pollen stores when compared to the control but the 200/50 ppb also had increased levels of bee mortality compared to control that was not seen in the 200/200 ppb, and the 200/200 ppb had decreased numbers of adult bees, larvae/pupae, egg production, hive weight and nectar stores that was not seen in the 200/50 ppb treatment.	2270888

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
Honey bee	Exposure period: 6 weeks Observation period: 4 months from 13 July to 23 November, 2012 Effect variables: frame coverage of bees nectar, pollen, eggs, larvae, capped brood, colony survival, hive weight, hive strength, pollen consumption and bee mortality Location: Montana, USA Year: 2012	There was a higher number of dead bees in the traps placed outside the pollen/sugar treatment hives of 200/50 ppb and 50/200 ppb during the course of study when compared to any other treatment. Prior to overwintering during a 23 November 2012 inspection the following hives died: 0 in control, 0 in 200/200 ppb high dose but 2 were noted as very weak, 1 in 50/50 ppb, 2 in 50/200 ppb and 1 in 200/50 ppb. **MAJOR UNCERTAINTIES:** This is an interim report submitted for this study, which was conducted as a pilot study for open field colony feeding study. The report is missing key details regarding the study site, hive preparation and residue analysis. Raw data was not provided and no statistical analysis was conducted. There is no final report. Residue analysis was not conducted to confirm level of exposure.	
Open feeding Artificially fed hives with either spiked pollen or sugar solution in an open field for 6 weeks Honey bee	Test crop: not applicable, open field Test species: honey bee hives Dose rate: *Spiked sugar solution:* 50 and 200 ppb (2 liter/week) *Spiked pollen patty:* 50 and 200 ppb (300 g/week) Number of hives tested: 5 hives per treatment (control sugar, 50 and 200 ppb sugar; control pollen, 50 and 200 ppb pollen), set up into 3 treatment groups per feeding regime (untreated, low dose and high dose) within a field site: 30 hives total Exposure period: 6 weeks Observation period: 4 months from 25 June to October 2012 Effect variables: bee mortality, number of adults, eggs, larvae, pupae, food stores, level of *Varroa* and *Nosema* infestations, colony strength Residue samples: bee bread, honey, pollen from pollen traps Location: North Carolina, USA Year: 2012	**REVIEW:** In the 200 ppb sugar fed hives, reduced food consumption, hive pollen stores, colony strength and total numbers of brood was detected. Reduced nectar stores were seen in the 50 ppb sugar fed hives. **MAJOR UNCERTAINTIES:** A low level of contamination in the sugar-fed control hives. All pollen fed hives were starved unintentionally which affected the quality of results. The study was conducted as a pilot, the author reported that there were issues with analytical analysis and that further examination would be conducted, however no further information was provided.	2270894 2287055
Open feeding Artificially fed	Test crop: not applicable, open field Test species: honey bee hives Dose rate: 5 and 20 ppb; 3 to 4 pollen patties that	**REVIEW:** No treatment-related effects were found regarding the number of queen cells, colony strength, capped brood, food storage (honey and bee bread) external pollen collection and internal	2142798

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
hives with spiked pollen patties in an open field for 63 day exposure period, untreated honey water was provided at stations located 200-500 m from the apiary Honey bee	were 80 g in size were provided weekly for 9 weeks Number of hives tested: 5 apiary locations had 6 small hives each (2 control, two at 5 ppb, two at 20 ppb); 10 colonies per treatment: 30 hives total Exposure period: 63 days (15 May to 6 August 2008) Observation period: 10 months (5 May 2008 to February 2009 (post overwintering)) Effect variables: foraging activity, hive strength, brood development, overwintering success, number of queen cells, queen failure, capped brood, egg laying activity and larval development, honey and bee bread, hive strength, external pollen collection, internal pollen patty consumption, number of foragers returning to hive, foraging success Residue samples: bees, bee bread Location: Maryland, USA Year: 2008	pollen patty consumption, number of foragers returning to hives, and foraging success in finding nectar sources. **MAJOR UNCERTAINTIES:** Imidacloprid was detected in control hives. Hives were potentially over-manipulated and did not have supers added in a timely manner during the study which may have caused hive stress. There was a high level of queen loss; 9/30 lost queens by early June that were then replaced and an additional 6 were lost by July and August. The overwintering part of the study did not provide any information since no test hives survived overwintering.	
Open feeding Artificially fed hives with spiked sugar solution in an open field for 1.5 hours Honey bee	Test crop: not applicable, open field Test species: honey bee hives Concentration rate: bees were trained to forage on an artificial feeder with 50% sucrose solution containing different concentrations: control, 40, 50, 100, 200, 400, 600, 800, 1200, 1600, 3000, 4000 and 6000 µg/L (50% sucrose solution has 1.2296 g/ml density, the test concentration would be converted to 32.5, 40.7, 81.3, 162.7, 325.3, 488.0, 650.6, 975.9, 1301.2, 2439.8, 3253.1 and 4879.6 ppb). Number of hives tested: 3 hives trained cohorts of bees to 13 different feeders with 13 different concentrations Exposure period: 1.5 hours Observation period: 1.5 hours Effect variables: foraging behaviour, food consumption, percentage of missing bees at feeder Location: Taiwan Year: May 2006–March 2007	**REVIEW:** Effects were noted as follows: 32.5 ppb: No effects 40.7 ppb and above: Increasingly abnormal foraging behaviour. 488.0 ppb and above: Increasing percentages of missing bees 3253.1 ppb and above: All the bees were missing **MAJOR UNCERTAINTIES:** No links have been established between the visit interval measured in this study and hive development. The normal foraging behaviour was defined in the study as the visit interval at the specific feeding site to be <300 seconds. This defined visit time interval was study specific and may not be generalized for other scenarios. Residue analysis was not conducted to confirm level of exposure.	2142777
Open feeding	Test crop: not applicable, open field Test species: honey bee hives	**REVIEW:** Compared with the control, in the imidacloprid treatment at 25 µg/L (23.3 ppb) and lower, no colony level effects	2463188 2474495

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
Artificially fed hives with spiked sugar solution in an open field for 42 days Honey bee	Dose rate: 1 L of 50% sugar solution was fed twice weekly at 12.5, 25, 50, 100 and 200 µg/L in spiked sugar solution (measured concentration: 11, 23.3, 46.7, 96.3, and 189.6 ppb respectively) Number of hives tested: 12 apiary locations had 7 hives each (2 controls, 1 at each treatment tested): 84 hives total Exposure period: 42 days Observation period: exposure period through to after overwintering (21 June 2013 - 24 March 2014) Effect variables: hive weight, number of individuals at different life stages in hive, hive honey and pollen stores and hive overwintering survival Residue samples: hive nectar, bee bread for dose verification Location: North Carolina, USA Year: 2014	were detected after overwintering; some transient effects at the colony level were detected about one month after the end of the six week exposure period but colony condition appeared to able to compensate and the colonies conditions became comparable after overwintering. The imidacloprid treatment at 50 µg/L (46.7 ppb) and greater resulted in reduced hive conditions compared to control after overwintering. Imidacloprid at 100 µg/L (96.3 ppb) and greater resulted in a reduction of the hive overwintering survival rate, and consistent reduction of the hive conditions during the course of study. After weighing the results of statistical analysis, biological significance and the natural seasonal changes of honey bee colonies, the NOEC and LOEC for this study were determined to be 23.3 ppb and 46.7 ppb, respectively. During the review of the study, it was found that the average imidacloprid concentrations measured in hive uncapped nectar and hive bee bread were 62.7% and 30.2%, respectively, of the concentrations in the spiked feeding solution. At the determined NOEC of 23.3 ppb treatment level, the average concentration in hive bee bread was 5.37 ppb (range: 1.45 –9.41 ppb) at three weeks after the start of artificial feeding, and 5.74 ppb (range: 4.89-6.4 ppb) at one week after the end of the 6-week feeding. At the determined LOEC of 46.7ppb treatment level, the average concentration in hive bee bread was 10.84 ppb (range: 4.2 –19.41 ppb) at three weeks after the start of artificial feeding, and 16.44 ppb (range: 14.37 –18.00 ppb) at one week after the end of the 6-week feeding). **MAJOR UNCERTAINTIES:** The exposure dilution was evident. Other pesticide contamination, likely due to applications in surrounding areas. Imidacloprid contamination was found in control hives. The overwintering mortality was higher in the control than in the lower test concentrations.	
Open feeding	Test crop: not applicable, open field Test species: honey bee hives	**REVIEW:** Imidacloprid treatment related effects were seen at 20 ppb and higher where frequency of recruiting waggling dances,	1086429 2142746

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
Artificially fed hives with spiked sugar solution in an open field for various lengths of time Honey bee	Dose rate: imidacloprid and olefin-imidacloprid at 10, 20, 50 and 100 ppb in 2M of sucrose solution Number of hives tested: 1 colony set-up in a two-frame observation hive; groups of bees were trained to different feeders located 500 m away Exposure period: various Observation period: various Effect variables: foraging activity at the feeding site, behaviour of returning foragers at the hive, probabilities of waggle dancing and tremble dancing and the directions of waggle dances Location: Germany Year: 1998	directional accuracy, and tremble dances were affected. At 100 ppb, the frequency of foragers visiting the imidacloprid feeders was reduced. Weak olefin-imidacloprid treatment related effects were seen at 20 ppb and higher where tremble dances increased. For bee communication behaviour in the field on imidacloprid: NOEC = 10 ppb LOEC = 20 ppb **MAJOR UNCERTAINTIES:** No links have been established between the bee communication behaviour in the field in this study and hive development. Residue analysis was not conducted to confirm level of exposure.	2142775 2142776
Open feeding Field feeding study Honey bee	Test crop: tested in flowering sunflower field Test chemical: Confidor SL Test species: *Apis mellifera* Application rate: 20 ppb imidacloprid in sugar syrup provided with a feeder 150 m away from the hive. Number of replicate: 1 Number of hives per replicate: 1 Exposure period: 8 days Observation period: 8 days Effect parameters: behaviour and food consumptions Location: Germany Year: 1998	**REVIEW:** Sugar solution spiked with imidacloprid at 20 ppb that was placed 150 m away from the test hives in flowering sunflower field showed no effects on the behaviour of the honey bee foragers and their food consumption at the feeder within 8 days of the test period. **MAJOR UNCERTAINTIES:** The level of exposure to test bees was not characterized. Important parameters such as bee mortality and hive conditions were not measured. No treatment replicates.	2523528

Table 4 Tier III Toxicity for *Apis* and non-*Apis* bees – Applicant Submitted Studies

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
Field study Seed treatment Honey bee	Test crop: sunflower Test species: honey bee hives Application rate: Gaucho at a rate of 0.7 mg a.i./seed (equivalent to 51.8 g a.i./ha; 74,000 seed/ha) and an additional field with Gaucho at 49 g a.i./ha (equivalent to 0.7 mg a.i./seed; 70,000 seed/ha)	**REVIEW:** No treatment related effects on honey bee hives were detected in seed-treated sunflower fields. **MAJOR UNCERTAINTIES:** Only 3% of trapped pollen was from sunflower. Residue analysis was not conducted to confirm level of exposure.	2364413 2364414

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
	Number of hives tested: 1 control field with 6 hives ,1 treatment field with 6 hives and 1 additional treated field with 4 hives: 16 hives total Exposure period:12 days Observation period: 12 days Effect variables: bee mortality, flower visit, hive weight, sunflower yield, pollen species collected Location: France Year: 1995		
Field study Seed treatment Honey bee	Test crop: sunflower Test species: honey bee hives Application rate: Gaucho 70 WS at 0.7 and 1.4 mg a.i./seed Number of hives tested: 1 control field and 1 field per treatment, each had 4 hives per field: 12 hives total Exposure period: 11−13 days Observation period: 11−13 days Effect variables: flower visits, return to beehive, hive weight, bee behaviour Location: South Africa Year: 1997−1998	**REVIEW:** No treatment related effects on honey bee hives were detected in seed-treated sunflower fields. **MAJOR UNCERTAINTIES:** Hive weights decreased in all treated and control. Residue or pollen collection analysis was not conducted to characterize exposure.	2364416
Field study Seed treatment Honey bee	Test crop: sunflower Test species: honey bee hives Application rate: Gaucho 70 WS at a rate of 0.7 mg a.i./seed Number of hives tested: 1 control field and 1 treatment field; each had 4 hives: 8 hives total Exposure period: 14 days Observation period: 14 days Effect variables: hive weight, bee mortality, foraging activity, number of bees returning with pollen Residue samples: bee honey sacs, bee bodies Location: Germany Year: 1998	**REVIEW:** There were no clear effects on bees. Potential treatment effects may not be excluded since the following differences were noted: Hive weight increased slightly in the control group while it was reduced in the treatment hives. There was a consistently higher number of foraging bees in the treatment field than in the control field. The average number of bees returning with pollen during the entire test period was higher in the treatment field than in the control field. However, the number of returning bees with pollen loads during day 2−3 after the start of exposure was lower in the treatment field than in the control field. The bee mortality was higher in the treatment than in the control (207 versus 147 in total). **MAJOR UNCERTAINTIES:** There was variation in plant	2351185

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
		conditions and germination levels between the treatment and control fields. Imidacloprid and metabolites were < LOD in honey sacs and bee bodies.	
Field study Seed treatment Honey bee	Test crop: sunflower Test species: honey bee hives Application rate: Gaucho 350 FS at a rate of 0.7 mg a.i./seed (0.3 L/150,000 seeds, 350 g a.i./L) Number of hives tested: 1 control field and 1 treatment field; each had 6 hives: 12 hives total Exposure period: 15 days Observation period: 15 days Effect variables: number of queen supersedures, foragers with pollen loads, average bee count entering hive, hive weight, abnormal bee behaviour, number of bees and brood covering (or inhabiting) comb, bee mortality Location: Hungary Year: 1999	**REVIEW:** Potential treatment effects of sunflowers grown from treated seed on honey bee hives could not be excluded since more queen supersedures, less hive weight gain, and smaller amounts of comb inhabited by bees was observed during the exposure period. Effects on brood appeared to be inconclusive. **MAJOR UNCERTAINTIES:** The hive conditions (for example: hive weight) appeared to be different between the control and treatment at the start of test. Non-test sunflower fields were within foraging range (2 km) of the experimental hives. The data was highly variable and there was no treatment replication making it difficult to conclude any treatment effect. Residue analysis was not conducted to confirm level of exposure.	2351147
Field study Seed treatment Honey bee	Test crop: sunflower Test species: honey bee hives Application rate: Gaucho at a rate of 0.2592 mg a.i./seed Number of hives tested: 1 control field and 1 treatment field; each had 8 hives: 16 hives total Exposure period: 12 days Observation period: extended to after overwintering (277 days from the beginning of exposure) Effect variables: hive weight, hive strength, bee mortality, brood development, hive food storage, hive diseases, foraging activity, pollen species collected, overwintering success Residue samples: honey, pollen, wax sunflower heads, soil Location: Argentina Year: 2000	**REVIEW:** Honey bees exposed to sunflowers grown from treated seed in Argentina showed no effects on overwintering success, hive weight, brood development or hive food storage compared to controls during bloom through to the post-overwintering period. **MAJOR UNCERTAINTIES:** The proportion of pollen collected was 20–30% from sunflower and there were different flowering conditions of the test plant and weeds in the control and treatment fields.	2351151

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
Field study Seed treatment Honey bee	Test crop: field beans Test species: honey bee hives Application rate: imidacloprid at a rate of 210 g a.i./100 kg seed Number of hives tested: 1 control field and 1 treated field, with 24 hives each: 48 hives total Exposure period: approximately 14 days during flowering Observation period: approximately 14 days during flowering Effect variable: number of flower visits Location: Germany Year: 1999	**REVIEW:** No treatment effects were seen in the amount of flowers visited between the control and fields grown from seed-treated field beans. **MAJOR UNCERTAINTIES**: No mortality or hive development data was collected or presented in this study. Residue analysis was not conducted to confirm level of exposure. The fields were treated with Pirimor (active ingredient pirimicarb) on 2 June 1990 due to an aphid infestation. It is unknown if this spray was applied before, during, or after bloom, or if it occurred during the experimental period.	2364425 2364426
Field study Seed treatment Honey bee	Test crop: oilseed rape Test species: honey bee hives Application rate: 31 g a.i./ha (1051.17 g a.i./100 kg seed, 181,000 seeds in 1 kg of seed = 0.06 mg a.i./seed) Number of hives tested: 1 control field and 1 treated field, each had 2 sets of 3 hives per field (3 for testing, 3 for pollen and honey collection): 12 hives total Exposure period:14 days Observation period: 47 days Effect variables: bee mortality, foraging activity, bee behaviour, brood production, hive weight, forager density, amount of food storage, hive strength Residue samples: comb and pollen nectar, flower nectar, honey from comb Location: Germany Year: 1999	**REVIEW:** After 10 days of exposure, honey bee hives exposed to oilseed rape fields grown from treated seed had less hive weight gain than those in the control field. This difference was not detected once hives were removed from treated fields. **MAJOR UNCERTAINTIES:** Plants were grown from seed treated with a combination product that contained imidacloprid and beta-cyfluthrin as active ingredients. The treatment hives appeared to have been stronger than control at the beginning of the experiment.	2351149
Field study Seed treatment Honey bee	Test crop: spring canola Test species: honey bee hives Application rate: Gaucho at a rate of 66–77 g a.i./ha (976 g a.i./100 kg seed, 181,000 seeds in 1 kg of seed = 0.05 mg a.i./seed) Number of hives tested: *For each location there*	**REVIEW:** No effects of canola seed treatment on honey bee hives in two North American field locations were detected. **MAJOR UNCERTAINTIES:** Lindane that is toxic to bees, was used in the control. Hive strength was not measured. There were differences in crop emergence rates and plant development	1086427 2142818 2142819 2351186

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
	were: 1 control field and 1 treated field, each had 4 hives per field: 8 hives total per location Exposure period: 30 days Observation period: 30 days Effect variables: number of sealed brood, bee mortality, honey production, bee behaviour, pollen species collected Residue samples: pollen from pollen traps, comb nectar Location: Ontario, Canada and Minnesota, USA Year: 2000	between treatment and control fields. The statistical analysis in the report can be improved.	
Field study Soil application Honey bee	Test crop: clover Test species: honey bee hives Application rate: soil application of Admire on potato field 3 years prior at a rate of 204 g a.i./ha Number of hives tested: 5 clover fields had 8 test hives: 40 hives total Exposure period: approximately 60 days in the field Observation period: approximately 60 days in the field Effect variables: number of supers, brood boxes, frames of bees, brood, honey, laying queens, the level of pests, diseases and aggressive behaviour Residue samples: clover flowers, wildflowers, uncapped honey, in-field soil and soil from field edge Location: PEI, Canada Year: 2001	**REVIEW:** No effects on honey bee colonies were detected 3 years after soil application of imidacloprid was applied on potato fields. Residues in clover flowers and wildflowers in the test fields were < LOQ but pollen and nectar were not sampled. Residues were detected in soil at 32 ppb 2 years after application and at a maximum of 24.6 ppb after 3 years. **MAJOR UNCERTAINTIES:** There was a high level of variation in hive conditions between the treatment and control at the beginning of the study that persisted until the end of the study; hive conditions were not equalized at the beginning of study. The test rate was 204 g a.i./ha, lower than the maximum registered rate in Canada (480 g a.i./ha for potato soil drench treatment).	2142811 2142736 2142810
Monitoring study Monitoring colonies exposed to canola grown from treated seed in Germany for pesticide residues (including	Test crop: canola and others Test species: honey bee hives Application rate: monitoring study Number of hives tested: over 7000 hives total each year (7,240 in 2004/2005; 7,168 in 2005/2006; 7,013 in 2006/2007 and 7,187 in 2007/2008) Exposure period: monitoring study, variable Observation period: monitoring study, variable Effect variables: new colony formation, migration,	**REVIEW:** No treatment-related correlations or effects were noted. A significant correlation was noted by the authors with higher autumn *Varroa* and virus infestations with a lower overwintering success rate in the treated fields monitored. The authors also noted a significant correlation of overwinter success with the age of the queen (young queens overwintered better) and colony size (larger colonies at less risk of winter losses)).	2142774

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
imidacloprid) and overwintering success rate Honey bee	*Varroa* control, colony size in autumn and spring, honey yield, *Varroa* infestation in autumn, infestation with bee viruses, and infestation with *Nosema* and amoebae Residue samples: nectar, honey, bee bread, pollen Location: Germany Year: 2004–2008	The authors stated that no difference was observed between sites on which canola was grown and sites where this crop was absent, either in terms of overwintering losses or the overwintering quotient (colony size in autumn compared to colony size in spring). This finding was based on 2,325 sets of data from the 2005/2006 and 2006/2007 project years. The colonies at the sites with canola tended to overwinter better than those at other sites. **MAJOR UNCERTAINTIES:** No raw data or detailed statistical analysis methodology were provided. There was a relatively low rate of colony losses over the 4 year of study. Experimental colonies were all from existing apiaries and subjected to a wide range of beekeeping management styles.	
Field study Seed treatment Bumble bee	Test crop: sunflower Test species: *Bombus terrestris* Application rate: Gaucho at 0.7 mg a.i./seed Number of hives tested: 1 control field and 1 treated field, with 10 hives each: 20 hives total Exposure period: 9 days Observation period: 26 days Effect variables: pollen species collected by nectar foragers and pollen foragers, marked worker count, number of new queens produced, population size and the mating ability of the queens Location: France Year: 1998	**REVIEW:** After exposure, no treatment effects were seen in bumble bee foraging behaviour in the control or treated sunflower fields. During the 9 day exposure period, the treated fields lost more marked workers (33.5%) compared to the control fields (23.1%) but these results were not significantly different. Confirmation of bumble bees foraging on sunflower nectar (98% for nectar foragers in both groups) and pollen (26 and 29% for pollen foragers for control and treated, respectively) was observed. **MAJOR UNCERTAINTIES:** Residue analysis was not conducted to confirm level of exposure.	2142738
Field study Soil treatment in potato field Bumble bee	Test crop: Potato Test chemical: Imidacloprid WG 5 Test species: *Bombus terrestris 100 bees/colonies* Application rate: in-furrow soil application at 180 g imidacloprid/ha + 375 g pencycuron/ha Number of replicates: 1 Number of hives per replicate: 6 Exposure period: 15 days Observation period: 39 days Effect parameters: foraging, mortality, colony development, residue in bee pollen, pollen	**REVIEW:** The field study was aimed to investigate the effect of imidacloprid in-furrow application on potato seed pieces on the bumble bee (*Bombus terrestris* L) colony development in the field. After 15 days of exposure to flowering potato crops, bumble bee colonies were relocated and monitored continuously for additional 24 days (total of 39 days after exposure started) until they entered the reproduction phase (approximately 1 week after the colonies first started showing reproduction of new queens). The study reported that: o Bumble bees foraged potato for pollen but with great variations (24.8–56.3% of total pollen in the treatment, none	2535875

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
	composition Location: Germany Year: 2014	in the control). The maximum imidacloprid residue detected in pollen carried by foragers was 1.4 ppb in the treatment, no detection in the control. o Statistically significant reductions of foragers were detected in the treatment field on two dates as well as overall, while statistically significant reductions of bees entering colonies were detected in the treatment field only on two dates, not overall. o There were no differences between the treatment and control at the end of study in the total number of alive bee stages (alive brood and adult bees), the total queen reproduction (alive larvae, pupae, adults), the total number of alive brood stages (eggs, larvae, pupae), the total number of alive adult bees (alive young queens, workers, males), and the number of nectar and pollen cells, as well as the weight of young queens, workers, males, and the colonies. **MAJOR UNCERTAINTIES:** There were no treatment replicates. Potential contamination of other pesticides in the exposure site and monitoring site was not characterized. There was a remarkable difference on the foraging of potato pollen between the treatment and control fields.	
Field study Soil treatment in potato field Bumble bee	Test crop: Potato Test chemical: Imidacloprid WG 5 Test species: *Bombus terrestris 100 bees/colonies* Application rate: in-furrow soil application at 180 g imidacloprid/ha + 375 g pencycuron/ha Number of replicates: 1 Number of hives per replicate: 6 Exposure period: 17 days Observation period: 50 days Effect parameters: foraging, mortality, colony development, residue in bee pollen, pollen composition Location: Germany Year: 2014	**REVIEW:** The field study was aimed to investigate the effect of imidacloprid in-furrow application on potato seed pieces on the bumble bee (*Bombus terrestris* L) colony development in the field. After 15 days of exposure to flowering potato crops, bumble bee colonies were relocated and monitored continuously for additional 24 days (total of 39 days after exposure started) until they entered the reproduction phase (approximately 1 week after the colonies first started showing reproduction of new queens). The study reported that: - Bumble bees foraged potato for pollen but with great variations (0-47.4% of the total pollen in the control, and 1.6–29.2% in the treatment). Out of three samples, the maximum imidacloprid residues detected in pollen carried by foragers were 0.7 ppb in the treatment, and < LOQ (0.6 ppb) in the control. - Compared with the control, the overall flight activity was statistically higher in the treatment in the crop field, but not at the	2535876

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
		hive entrance. Out of 7 days of measurement, statistical difference was shown only at one day in the crop field and at the hive entrance. It is unknown whether this is treatment-related. - Compared with the control, the mean numbers of dead adults in the treatment was lower during the exposure phase, but higher during monitoring phase. However, no difference was detected over the entire study period - There were no differences in the number of live young queens, live queen pupae between the treatment and control at the end of study. However, colonies in the treatment had a significantly lower number of live young queen larvae at the end of study. - No differences were detected in any others measured parameters at the end of study, including the number and weight of workers and drones, and the number of cells with either of eggs, larvae, pupae, pollen or nectar cells, the number of alive adult bees, the total number of brood and the total queen reproduction. **MAJOR UNCERTAINTIES:** There were no treatment replicates. Potential contamination of other pesticides in the exposure site and monitoring site was not characterized.	
Field study Soil treatment on potted Ornamental plants Bumble bee	Test crop: potted Ornamental plant, *Lobelia erinus* Test chemical: Imidacloprid WG 5 Test species: *Bombus terrestris bees/colonies* Application rate application in potted soil with ornamental plants at 0.015 g a.i./L soil (equivalent to 22.0588 kg a.i./ha) Number of replicates: 17 Number of hives per replicate: 1 Exposure period: 30 days* Observation period: 30 days* Effect parameters: adult mortality foraging/flight activity hive conditions Location: Germany Year: 2002 *Data observed after 30 days were not considered for the risk assessment due to severe moth	**REVIEW:** The field study was aimed at investigating the effect of imidacloprid soil treatment on potted ornamentals to bumble bees colonies. Ten ornamental plants, Lobelia erinus were potted as a group in the same container. The soil in the container was treated with Confidor WG 5 at 0.015 g imidacloprid a.i./l soil). In each garden, one bumble bee, *Bombus terrestris* , colony containing about 80–100 bees was placed together with five plant containers that were either treated or not treated as control. Bees were foraging in the garden freely for 47 days under the field conditions. The colony conditions were examined at the end of study. A severe infestation of the bee moth, Aphomia sociella, was observed after 30 day of exposure. The review of the study was focused on the time period (30 days) before the moth infestation was first observed. The study reported that compared with the control, a significant increase of foraging bumble bee mortality was found in the gardens containing potted ornamental plants that were soil treated with imidacloprid at 0.015 g	2523560

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
	infestation.	imidacloprid a.i./l soil, but no difference was found in the foraging activity measured in the test plants and flight activity measured at the colony entrance. **MAJOR UNCERTAINTIES:** There was lack of characterization of the level of exposure to imidacloprid. Potential contamination of other pesticides to test bees could not be characterized. Information on the bumble bee colony development stages, such as whether or not the colonies were producing new queens were not provided.	
Field study Soil drench on outdoor Ornamental plants Honey bee, Bumble bee	Test crop: Ornamental shrub *Rhododendron* Test chemical: Imidacloprid WG 70 Test species: *Bombus terrestris* and *Apis mellifera* Application rate: 4.3 g a.i./m plant size (2.58 g a.i./shrub) or 2.15 g a.i./m plant size (1.29 g/shrub), 126 days before sampling Number of replicates: 1 Number of hives per replicate: 1 Exposure period: 11 days Observation period: 11 days Effect parameters: adult mortality, foraging/flight activity, hive conditions Location: Germany Year: 2006	**REVIEW:** The study was aimed at investigating the residues and effect of imidacloprid to honey bees and bumble bees after soil application on field grown ornamentals. Rhododendron plants received a soil drench treatment 126 days before the start of sampling of blossoms for residues analysis. The test plants were surrounded in a field by a composition of ornamental plant species. One honey bee hive and three bumble hives were placed next to the test plants during blooming and observed for 11 days (20 May-2 June 2005). The study reported that: The soil treatment was conducted with Imidacloprid® WG 70 at either 4.3 g a.i./m plant size (2.58 g a.i./shrub) or 2.15 g a.i./m plant size (1.29 g/shrub) and resulted in blossom residues of up to 1.996 mg imidacloprid/kg or 0.812 mg imidacloprid/kg, respectively. No mortality or behavioral abnormalities was observed on foraging bumble bees and honey bees at individual level. No colony conditions were examined during the entire study. **MAJOR UNCERTAINTIES:** The study was conducted with an incomparably high test rate compared with the Canadian label rates. There were no study replicates. The study was conducted in very small test area and alternative untreated flowering plants were provided in the test area. The honey bees and likely the bumble bees as well had alternate sources of pollen and nectar than the test plants. Dilution of exposure had likely occurred. The hive conditions at colony level were not measured. Level of residue was not reported in pollen and nectar of the flowers, or in bees or hives.	2542276

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
Field study Soil drench on outdoor Ornamental plants Honey bee, Bumble bee	Test crop: Ornamental shrub *Rhododendron, Hibiscus syriacus* Test chemical: Imidacloprid WG 70 Test species: *Bombus terrestris* and *Apis mellifera* Application rate: *Rhododendron*: 4.3 g a.i./m (5.2 g a.i./shrub) 35 days before sampling. *Hibiscus syriacus*: 4.3 g a.i./m 4.3 g a.i./shrub), 106-117 days before sampling Number of replicates: 1 Number of hives per replicate: 1 for honey bee, 2 for bumble bees. Exposure period: 11 days Observation period: 11 days Effect parameters: adult mortality, foraging/flight activity, hive conditions Location: Germany Year: 2006	**REVIEW:** The study was aimed to investigate the residues and effect of imidacloprid to honey bees and bumble bees after soil application on field grown ornamentals. The soil treatment was conducted for Rhododendron 35 days before starting of sampling and 106-117 days before sampling started for Hibiscus. Untreated bee-attractive flowering ornamental plants were placed in between the rows of treated and untreated plants. During blooming period of the test plants, one honey bee hive and two bumble bee colonies were placed nearby (20-25 m) the treated fields for approximate 10 days. The study demonstrated that soil treatment of imidacloprid product on field grown Rhododendron at 4.3 g a.i./m of average plant width (5.2 g a.i./shrub), or Hibiscus at 4.3 g a.i./m plant height (4.3 g a.i./shrub) resulted in high concentrations of imidacloprid residues in blossoms and dead bees collected from the treatment field. The mean of imidacloprid residues was 0.267 mg/kg with a maximum of 0.79 mg/kg in Rhododendron 35 DAT. The mean of imidacloprid residues was 2.98 mg/kg with a maximum of 5.01 mg/kg in Hibiscus at DAT 106-117. Imidacloprid residues were detected in almost all dead bees found in the treatment field up to 1.663 mg/kg bee. Hydroxy- and olefin-imidacloprid were also detected in majority of samples of blossom and dead bees but at a level in orders of magnitude less than the parent. There was an increased mortality of bumble bees and honey bees at individual level In the treatment plots. However, no colony level effects were found for honey bees. It is unclear but possible that the bumble bee colony health was compromised by the treatment. **MAJOR UNCERTAINTIES:** The study was conducted with an incomparably high test rate compared with the Canadian label rates. There were no study replicates. The study was conducted in very small test area and alternative untreated flowering plants were provided in the test area. The honey bees and likely the bumble bees as well had alternate sources of pollen and nectar	2542277

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
		than the test plants. Dilution of exposure had likely occurred. Bees from the Rhododendron study were continuously used for the Hibiscus study. As such, bees were already exposed to imidacloprid in the Hibiscus study. The colony conditions of bumble bee and honey bee hives were not examined and unknown after the Rhododendron study and before the Hibiscus study. All bumble bee colonies died at the end of study in both treatment and control. Level of residue was not reported in pollen and nectar of the flowers, or in bees or hives.	
Field study Soil treatment on cotton Honey bee	Test crop: Cotton, *Gossypium barbadense L. at least* 12 ha each field Test chemical: Gaucho® 600 Flowable for seed treatment, and Admire® Pro Systemic for the in-furrow and foliar applications. Test species: *Apis mellifera* Application rate: The target seasonal application rate was 0.5 lb. imidacloprid/acre, equivalent to 0.56 kg imidacloprid/ha and untreated control. Various application methods (air, drip, and ground applications), rates (ranging 0.06–0.931 lb/ac) and days between the last treatment and start of exposure (ranging 1–30 days) were conducted among test sites. Number of replicates: 3 for the control, 4 in the treatment (was targeted to have 5 replicates for each treatment and control) Number of hives per replicate: 8 for honey bee hives for biological observation and addition one for residue monitoring Exposure period: 6 weeks Observation period: May 2015-–March 2016 Measured parameters: Residues in soil and hives pre-treatment. Residues in plant pollen nectar and hives during study period. Hive colonies conditions, hive weight, overwintering hive survival, queen conditions, and *Nosema* and *Varroa* infestation. Number of Non-*Apis* bees and species Location: California, USA	**REVIEW:** Honey bee hives in the cotton field treated with imidacloprid at various application methods and rates ranging from 0.06–0.45 lb/ac showed no detected adverse effects in terms of number of adults, brood cells and bee bread cell, hive weight gains and queen supersedure. In this study the hives were exposed to the treated cotton 18–30 days after the last application of imidacloprid. However, compared with the control, the hive mortality was higher in the treatment after overwintering by the end of study, indicating potential effects on the hive overall survival after overwintering. No treatment related effects were detected on other non-*Apis* bees in terms of species richness and abundance. **MAJOR UNCERTAINTIES:** The study likely has limited detection power of treatment effects due to the multiple limitation/uncertainties identified. These limitations include high background contamination of other toxic pesticides, high contamination of imidacloprid itself during the entire study period (detected in plant and hive matrices), variation of treatment methods and rates and interval between the last application and initiation of exposure, and low number of replicates.	2737113 (final report) 2592246 (interim report)

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
	Year: 2015–2016		
Field study Soil drench on pumpkin Honey bee, Bumble bee	Test crop: Pumpkin, *Curcubita pepo pep*. Approximately 40 ha each field Test chemical: Admire® Pro Systemic, Test species: *Bombus terrestris* and *Apis mellifera* Application rate: sub-surface side dress at 0.43 kg/ha, at six true leaf stage (BBCH16), and untreated control Number of replicates: 5 Number of hives per replicate: 9 for honey bee, and 9 for bumble bee. Exposure period: 6 weeks Observation period: Aug 2015- Spring 2016 Measured parameters: Residues in soil and hives pre-treatment. Residues in plant pollen nectar and hives during study period. Hive colonies conditions, hive weight, overwintering hive survival, queen conditions, and *Nosema* and *Varroa* infestation. Bumble hive survival. Number of other Non-*Apis* bees and species Location: South Dakota, USA Year: 2015–2016	**REVIEW:** No treatment related effects were detected for honey bee colonies in flowering pumpkin fields that treated with soil application of imidacloprid at 0.43 kg/ha at the six true leaf stage (BBCH16), with respect to honey bee colony conditions, hive weight, overwintering colony survival, and queen condition. It was not possible make any determinations regarding effects on bumble bee colonies based on the available data. No treatment related effects were detected on non-*Apis* bees in terms of species richness and abundance. **MAJOR UNCERTAINTIES:** There was background contamination of other toxic pesticides. Imidacloprid contamination was detected in the plants and hive matrices in the control during the entire study period.	2593970 (interim) 2757276 (final)

Table 5 Tier II and III Toxicity for *Apis* and non-*Apis* bees – Additional Information from Scientific Literature

Study type / Application method / Species	Study Methodology	Review Comments	Reference
APIS - Tier II Trials			
Tunnel study Seed treatment Honey bee	Test crop: sunflower Test species: *Apis mellifera ligustica* queens mated with *Apis mellifera caucasia* (small honey bee hive) Application rate: Gaucho at a rate of 0, 28 and 56 g a.i./ha or 0, 0.35, 0.7 mg a.i./seed and a tunnel filled with half untreated and	**REVIEW:** This article also has a Tier 3 component. Sunflower plants were grown from seed and contained in 4 tunnels; a control, a 0.7 mg a.i./seed treatment (N), a 0.35 mg a.i./seed treatment (N/2) and a mixed tunnel with half untreated seed and half treated with 0.7 mg a.i./seed. At the beginning of the in-tunnel phase, the average foraging activity was slower in the treated tunnels N and N/2 than in the control tunnels. By the end of the in-tunnel phase, foraging activity in the treatment	Ambolet B, J.F. Crevat, H.W. Schmidt. 1997. Research on secondary effects of seed treatment with imidacloprid on the

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	half 0.7 mg a.i./seed treated seed (based on seeding rate of 80,000 seeds/ha: 0, 28 and 56 g a.i./ha) Number of hives tested: 1 control tunnel and 1 tunnel for each treatment, 1 hive per tunnel: 4 hives total Exposure period: approximately 14 days Observation period: approximately 14 days Effect parameters: flower fertilization, foraging activity, bee mortality, number of bees per hive, hive weight, bee behaviour Location: France Year: 1995	tunnels N and N/2 exceeded that in the control tunnels. Normal bee behaviour was reported on the crop and at the hive entrance. All hives increased the number of bees per hive over the experimental duration. The percent increase in the number of bees was 42% in the 0.35 mg a.i./seed, 29.7% in the 0.7 mg a.i./seed, 13.2% in the control and 11.8% in the mixed tunnel. Effects were noted as follows: No treatment related-effects were seen in honey bee foraging activity, bee mortality, hive population, hive weight, or crop pollination success in hives exposed to sunflower plants grown from seed treated with 0.35–0.7 mg a.i./seed over an exposure period of 14 days. **MAJOR UNCERTAINTIES:** Key information on this study is missing since information was drawn from conference proceedings and there is no evidence that the study has undergone a scientific peer review. The raw data was not presented. All plots were treated with pirimicarb on 15 June 1995, just before tunnel installation which occurred on 23 July 1995. No statistical analysis was conducted. No residue analysis was conducted to characterize exposure level. Long-term effects were not investigated in the study.	behaviour of honey bees on flowers of sunflower. Proceedings of the fourth international conference on pests in agriculture; 6-8 January 1997; Montpellier, France; Association Nationale pour la Protection des Plantes (ANPP).
Tunnel study Seed treatment Honey bee	Test crop: sunflower Test species: Honey bee (assumed by reviewer to be *Apis mellifera*) Application rate: Gaucho at 0.35 to 1.05 mg a.i./seed Number of hives tested: 1 control tunnel and 1 treated tunnel, 6 hives per tunnel: 12 hives total per year Exposure period: unknown Observation period: unknown Effect parameters: flower visits, foraging activity, bee behaviour Location: France Year: 1995 and 1997	**REVIEW:** This study presents a summary of different research trials conducted by the authors (Tier 2 – tunnel studies), and other published sources (Tier 2 – open feeding and Tier 3) regarding the effects on honey bee health after exposure to sunflower treated with Gaucho seed dressing. Below are the details of the Tier 2 tunnel study. A total of 3 tunnel studies were conducted from 1995-1997 where sunflowers were grown from treated seed at a rate of 0.35 to 1.05 mg a.i./seed. Effects were noted as follows: The flower fertilisation rate was the same at both sites in both testing years. No treatment-related effects on foraging behaviour were seen in honey bee colonies exposed to sunflowers grown from seed treated with 0.35-1.05 mg a.i./seed for an unknown exposure period. **MAJOR UNCERTAINTIES:** This article is lacking details on the bloom time, the date of hive introduction into the tunnels and the exposure and observation period. No description of the experimental	Cure G., H.W. Schmidt, R. Schmuck. 1999. Results of a comprehensive field research programme with the systemic insecticide imidacloprid (Gaucho). Hazards of pesticides to bee. Ed. INRA. Paris 2001.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		colonies was provided (for example the size, genetics, if they were screened for optimum colony health). There were no treatment replicates but the study was repeated in two different years. It is unknown what the seed treatment rates were only a rate range was available. Residue analysis was not conducted to confirm level of exposure. Long-term effects were not investigated in the study.	
Tunnel study Foliar spray Honey bee	Test crop: oilseed rape Test species: *Apis mellifera* (small honey bee hive) Application rate: Confidor SL 200 at 0.6, 1.2, 2.0, 4.0, 9.0 and 14.0 g a.i./ha Number of hives tested: unknown Exposure period: 4 days Observation period: 4 days Effect parameters: foraging activity, bee mortality Location: Germany Year: 2001 and 2002	**REVIEW:** This study evaluated the effects of simulated deposition of seed dressing particles on oilseed rape plants by spraying rape plants in blossom with various rates of Confidor SL 200. There was no increase in mortality at any foliar applications tested. Effects were noted as follows: < 2 g a.i./ha: No effects 4-9 g a.i./ha: Reduction in foraging on day of treatment, restored in 24 hours 14 g a.i./ha: Significant reduction in foraging that lasted 48 hours **MAJOR UNCERTAINTIES:** There was limited information in the methods and results section. There was no information on the performance of the control hives. There was no information on duration and frequency of foraging or monitoring endpoints. Very little information provided about the source of bees, husbandry, and overall health of the hives. There was no information presented on the methods of statistical analysis. Residue analysis was not conducted to confirm level of exposure. Potential effects over longer periods are unknown.	Schnier H.F., G. Wenig, F. Laubert, V. Simon, R. Schmuck. 2003. Honey bee safety of imidacloprid corn seed treatment. Bulletin of Insectology. 56 (1): 73-75.
Tunnel study Seed treatment Honey bee	Test crop: *Phacelia tanacetifolia* Test species: Honey bee (assumed by reviewer to be *Apis mellifera*); small honey bee hive Application rate: Gaucho at 5 mg a.i./m^2 (50 g a.i./ha) Number of hives tested: 1 control tunnel and 1 treated tunnel, 1 hive per tunnel: 2 hives total Exposure period: 5 days Observation period: 8 days Effect parameters: foraging activity, flight orientation, bee mortality, honey sac weight, toxic effects on larvae	**REVIEW:** This study was conducted in France where treated and untreated *P. tanacetifolia* seeds were planted the end of April. During flowering, bee-tight tents were established each covering 120 m^2. Seven days after bloom began, a 5-frame colony was placed inside of each of the tent. Effects were noted as follows: No treatment related-effects were seen in honey bee foraging activity, orientation, mortality, honey sac weight, or brood effects in hives exposed to *P. tanacetifolia* plants grown from seed treated with 50 g a.i./ha over an exposure period of 5 days. Residues in honey sacs and bee bread were < LOQ and < LOD respectively although, the LOQ was high at 10 ppb. **MAJOR UNCERTAINTIES:** There were no replicates in the study	Wallner, K. 2001. Tests regarding effects of imidacloprid on honey bees. Hazards of pesticides to bees. Avignon (France), September 07-09, 1999.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	Residue samples: honey sac, bee bread Location: France Year: 1998	(one tunnel per test group and one hive per tunnel) and thus statistical analysis could not be completed. It is not known how much imidacloprid was applied. Gaucho was applied at 0.005 g a.i./m^2 as a seed treatment but it was not stated how much a.i was on each seed, nor was a seeding rate provided to calculate this information. Consequently, the amount of imidacloprid applied is unclear. The LOD and LOQ (3 and 10 ppb) are markedly higher than observed in other studies (LOQ as low as 1 ppb). Long-term effects were not investigated in the study.	
Closed feeding Study on individual bee effects may also be considered as a Tier I study Artificially fed hives with spiked sugar solution for 1 hour each day for a total of 2-3 days Honey bee	Test crop: not stated what was in tunnel Test species: Honey bee (assumed by reviewer to be *Apis mellifera*) Application Dose: bees were trained to feed at a sucrose feeder that contained spiked solutions: 3, 25, 50, 100 ppb and possibly other doses Number of hives tested: 1 control tunnel and 1 treated tunnel, 1 hive per tunnel: 2 hives total Exposure period: 1 hour each day for a total of 2-3 days Observation period: 1 hour each day for a total of 2-3 days Effect parameters: amount of sucrose syrup consumed; and duration of the frequentation of the feeding station Location: presumed to be France Year: unknown, paper published in 1999	**REVIEW:** This study evaluated the effects of exposure on honey bee feeding behavior in observation hives in mesh tunnels. Observation hives were used containing 500–1000 bees with brood, pollen and honey from unspecified established hives. Bees were trained to a feeder 10 m away from the hive that contained sucrose spiked with varying concentrations of imidacloprid. Effects were noted as follows: After 1 hour feeding on sucrouse solution spiked with 50 ppb imidacloprid, there were fewer numbers of bees returning to the feeder relative to the controls. Oral exposure to 25 ppb imidacloprid for 1 hour reduced the consumption of sucrose as measured by the proportion of total sucrose consumed over the 2-hour trial period. However, the total amount of sucrose consumed was not reported in this study. Bees exposed to concentrations ranging from 3 to 100 ppb imidacloprid stopped feeding within 46 to 153 minutes. **MAJOR UNCERTAINTIES:** No information was provided on the purity or source of imidacloprid, the health or source of colonies, it was unclear what the doses were on a per bee basis, the information on total amount of treated sucrose consumed was lacking and no statistical analysis of the data was completed. There was no analytical confirmation on the exposure concentrations. Non-standard plexi-glass observation hives were used. Long-term effects were not investigated in the study.	Colin M.E., Y. Le Conte, J.P. Vermendere. 1999. Managing nuclei in insect-proof tunnel as an observation tool for foraging bee: sublethal effects of deltamethrin and imidacloprid. Hazard of pesticides to bees. Ed. INRA, Paris, 2001.
Closed feeding study in sucrose	Test crop: N/A Test species: *Apis mellifera,* sister queens each year. Application rate: New queen in rearing cage	**REVIEW:** A satisfactory queen acceptance over 65% was achieved in the control. Negative effects of the combined stressors of imidacloprid and Nosema on queens were detected in both years.	Dussaubat C., Maisonnasse A., Crauser D., Tchamitchian S.,

Study type / Application method / Species	Study Methodology	Review Comments	Reference
solution Honey bee	with 30 nursing bees were provided with 0.7 µg/l imidacloprid with 0.1% (w/v) DMSO in 50% (w/v) sucrose *ad libitum* for 10 hr per day for 8 days in the laboratory. The theoretical dose of imidacloprid was 0.0083 ng a.i./bee/day for (I) and 0.0095 ng a.i./bee/day for (NI). Feeders were replaced every day. Newly emerged queens were individually inoculated with 2 µl of 50% (w/v) of sucrose water solution containing 100,000 spores/ µl in suspension <u>Treatments:</u> (i) inoculated with spores of *N. ceranae* at emergence (N), (ii) exposed to a sublethal dose of imidacloprid from emergence until they were 8-days-old (I), (iii) both inoculated with *N. ceranae* spores and exposed to the pesticide (NI), (iv) Neither inoculated with spores nor exposed to the pesticide as control (C). Treated queen individuals were moved into a mating nucleus that contained approximately 400 g of bees that were placed in the open field. <u>Number of hives tested:</u> 10 queens/nuclei per treatment per year for each of four treatments and two years <u>Exposure period:</u> 8 days <u>Observation period:</u> 3 months <u>Effect parameters:</u> Queen survival; eggs and brood, presence of drone cells, dead larvae, brood pattern, worker behaviour and signs of disease or	The impact of each stressor alone varied between the two years. In 2010, I, N and NI had similar queen survivorship between them, but were all significantly lower than C. In 2012, C, I and N were statistically similar, but only NI was significantly lower from control. 50% of the queens from NI group were dead 45 and 15 days after introduction in the nuclei, respectively, in 2010 and 2012. Median lifespan (T50) was 75 days in both years in I group and in 2010 in N group. Increased enzyme activities related to protective responses to xenobiotics were detected in imidacloprid and parasite alone or combined treatments (catalase [CAT] and glutathione-S-transferase [GST] in the heads). Stressors also alter the activity of two other enzymes involved in metabolic and detoxification functions (carboxylesterase alpha [CaE α] and carboxylesterase para [CaE p] in the midguts). **MAJOR UNCERTAINTIES:** Lack of standard study methodology for honey bee queen studies. Lack of correlation between enzyme activity and typical environmental effect endpoints. Exposure to queen was achieved indirectly by feeding 30 nursing bees with 0.7 ug a.i./L ad libitum for 10 hr per day for 8 days. The actual level of exposure to bees was not known. The study was conducted with very small hives (400 g bees/hive). The impact of hive size on the detected queen effects is uncertain, e.g in large commercial hives. Different genetic background of the sister queens used in two years may have impacts on the results.	Bonnet M., Cousin M., Kretzschemer A., Brunet J-L., and Conte Y. 2016. Combined neonicotinoid pesticide and parasite stress alter honey bee queen's physiology and survival. Scientific reports/6:31430/DOI:10.1038?srept31430.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	pests; Enzymatic activities measured in the 2nd year for catalase (CAT) in head tissue, glutathione- S-transferase (GST) in midgut and head tissue and carboxylesterase alpha and para (CaE α and CaE p) in midgut tissue. Location: France Year: 2010, 2012		
Closed feeding Study on individual bee effects may also be considered as a Tier I study Artificially fed observation hives where individual bees were captured and force fed spiked sugar solution then observed foraging at a feeder with various sucrose concentrations (50%, 30%, 10% and 3% w/w, presented in this order and for 25min each) Honey bee	Test crop: not applicable, colonies in observation hives and trained to feeders Test species: *Apis mellifera ligustica* Application rate: 7 µL of 24 ppb (0.21 ng a.i./bee) was fed to bees for 1 hour and then they were released to observation hive Number of hives tested: 2 observation hives; total of 65 individual bees tested Exposure period: 1 hour Observation period: 2 days Effect parameters: nectar unloading wait time, number of dance circuits made by forager Location: California, USA Year: May–August, 2011	**REVIEW:** The study was conducted in two parts, the PER results are presented in Tier I and below are the results from the foraging experiment. Two colonies were housed in three-frame observation hives and kept in a temperature-controlled room. Trials were conducted every day from 9 am to 12 pm in May—August. A trial consisted of a 2-day process capturing bees and feeding them 7 µL of control (pure sucrose) or treatment (24 ppb) solution on day 1. After 1 hour, bees were released back to the hive, and on day 2 each bee was observed for the number of visits made to a decreasing series of sucrose concentrations (50%, 30%, 10% and 3% w/w) where each concentration was available for 25 minutes. Effects were noted as follows: Significantly fewer waggle dance circuits were seen in the treated bees (24 ppb; 0.21 ng a.i./bee) compared to the control when exposed to 50 and 30% sucrose solution. Nectar unloading times were not affected and no bees performed waggle dance circuits regardless of treatment if the sucrose solution was ≤ 30%. Residue analysis was not conducted to confirm level of exposure. **MAJOR UNCERTAINTIES:** Residue analysis was not conducted on control or treatment solutions to confirm the reported nominal concentrations tested. It is unclear if the entire dose was consumed. Non-standard observation hives were used. Long-term effects were not investigated in the study.	Eiri, D.M., J.C. Nieh. 2012. A nicotinic acetylcholine receptor agonist affects honey bee sucrose responsiveness and decreases waggle dancing. The Journal of Experimental Biology. 215(12): 2022-2029
Closed feeding study	Test crop: tunnels were places on untreated oat fields	**REVIEW:** This study presents the same data as PMRA 1086416. The review for both is below.	Schmuck,R., R. Schöning, A. Strok,

Study type / Application method / Species	Study Methodology	Review Comments	Reference
Artificially fed small hives with spiked sunflower honey in tents containing oats for 39 days, untreated pollen was provided Honey bee	Test species: honey bee hives Dose rate: 2, 5, 10, and 20 ppb in sunflower honey Number of hives tested: 1 control tunnel, 1 tunnel per treatment; 1 hive per tunnel: 5 hives total Exposure period: 39 days Observation period: 39 days Effect parameters: bee mortality, comb cell production, hive weight, egg laying, breeding success, hive strength, foraging intensity, bee behaviour, pollen collection and consumption, honey storage Residue sample: honey dose verification Location: Germany Year: 1998	The study was conducted with small hives in tunnels cropped with oats for a total of 39 days. The hives were fed exclusively with spiked sunflower honey and non-spiked pollen. Effects were noted as follows: Pollen consumption and the honey storagewere all consistently reduced at the highest application rate (20 ppb in sunflower honey) tested. No other treatment related-effects on mortality comb cell production, hive weight, egg laying activity, breeding success, colony strength, foraging intensity and behavioral anomalies were seen in honey bee hives exposed to artificially fed sunflower honey for at least 39 days. Analytical verification of residues in honey was conducted and within an expected range; no detect, < LOQ, 5.4-6.3 ppb, 10.5–12.0 ppb and 20.1–21.1 ppb for the 0, 2, 5, 10 and 20 ppb doses respectively. **MAJOR UNCERTAINTIES:** The study was conducted without any replicates. The study duration of 39 days covers about one life cycle of the honey bee development. The study tested a single exposure route through contaminated honey. Potential exposure through contaminated pollen that also likely exists in the field was not studied concurrently. Potential effects over longer periods are unknown.	). Schramel. 2001. Risk posed to honey bees (Apis mellifera L, Hymenoptera) by an imidacloprid seed dressing of sunflowers. Pest Management Science 57: 225-238. PMRA 1086438, 2142760
Closed feeding Study on individual bee effects may also be considered as a Tier I study Artificially fed hives with spiked sugar solution were trained to a feeder inside a foraging cage for 10 training trips Honey bee	Test crop: not applicable, colonies were contained in a foraging cage for experiment Test species: *Apis cerana* Application rate: 10, 20 and 40 mg/L (8.6, 17.2, and 34 ppb) in sugar solution Number of hives tested: 1 hive per treatment: 3 hives total Exposure period: 10 trained foraging trips Observation period: 10 trained foraging trips + 1 hour of observation Effect parameters: whether bees chose feeder with or without tethered hornet Location: China Year: 2013	**REVIEW:** This study provides sublethal imidacloprid effects data on the Asiatic honey bee *Apis cerana*, a species not found in North America. Bees were trained to sucrose feeders located 130 m away that contained different concentrations of imidacloprid. Feeders were then moved to a foraging cage. A captured *Vespa velutina* hornet was tethered 10 cm above half of the feeders to mimic a dangerous scenario. The other feeders without the hornet were considered a safe scenario. Individual bees were released into the foraging cages for a choice test. Effects were noted about predator avoidance after feeding on spiked sugar solution: At 10 and 20 mg/L (8.6 and 17.2 ppb) in sucrose solution: No effect on hornet avoidance compared to control. At 40 mg/L (34 ppb) in sucrose solution: reduced hornet avoidance; only 65% chose the feeder without the hornet as compared to 85% in control. It is unknown if this behaviour is relatable to the field since bees were isolated from hives and exposed to a predator that was tethered.	Tan K., W. Chen, S. Dong, X. Liu, Y. Wang, J.C. Nieh. 2014. Imidacloprid alters foraging and decreases bee avoidance of predators. PLoS ONE 9(7):e102725.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		MAJOR UNCERTAINTIES: This study was conducted on individual bees that were given a choice of feeders in a foraging cage. It is unknown if this behaviour is relatable to the field since bees were isolated from hives and exposed to a predator that was tethered. Bees were allowed back into their hives between tests. Exposure was not quantified at the hive; no residue analysis was conducted. The age of bees used in this trial is not uniform. This could affect results because the age of a bee determines their learning and it is not clear if predator (or in this case hornet) avoidance is a learned or innate behaviour in *A. cerana*. Long-term effects were not investigated in the study. Residue analysis was not conducted to confirm level of exposure.	
Closed feeding study in sucrose solution Honey bee	Test crop: N/A Test species: *Apis mellifera carnica* colonies with non-sister queens, 2 kg bees/hive. Application rate: each hive was provided with 1L of 50% sucrose solution containing imidacloprid (98.7% purity) at 0 (control), 50, 200 or 1000 µg/L, per day for 5 days in tents (4x5 m enclosures containing no flowering plants). After the exposure period, hives were equally placed outside in three apiaries nearby agricultural areas for observations. Number of hives tested: 9 hives per control and treatment (11 frames + 1 queen + 2 kg bees/hive) (36 hives total). Exposure period: 5 days Observation period: 8–64 days after the end of exposure (summer, autumn and next spring) for primary parameters Effect parameters: Number of adult bees, open and capped brood, and pollen and nectar store, overwintering colony survival and hive strength, and multiple other physiological parameters. Residues: imidacloprid, imidacloprid-5-	**REVIEW:** There was also an observed reduction of solution uptake with increasing imidacloprid concentration which may suggest that high concentrations of imidacloprid in food lead to an avoidance by worker bees. After exposure for 5 days, imidacloprid was detected only in hive honey in the autumn (41-64 days after exposure) with the mean concentrations of 0.37, 7.93 and 3.17 µg/kg respectively, for the treatments of 50, 200 and 1000 µg/L. In the summer the hive queen was lost in one out of 9 imidacloprid treated colonies at 1000 or 200 µg/L but none in the 50 µg/L and control. Honey production and total number of bees were significantly affected in the treatments (effect concentrations were not specified in the report). After overwintering all colonies survived in the control, but one out of 9 imidacloprid treated colonies was lost in each of the three imidacloprid treatments. After overwintering the hive strength (number of bees found in April) was significantly reduced in the imidacloprid treatment at 50 and 200 µg/L. The highest test concentrations of imidacloprid appeared to have less effect on the overwintering strength. The reviewer noted that the measured imidacloprid residues in hive honey in the highest level of the imidacloprid treatment were lower than that in the medium level treatment. The study also found that the apiary had significant effects on the hive strength after overwintering. **MAJOR UNCERTAINTIES:** There are uncertainties in extrapolation of the study results to various field exposure scenarios, in terms of exposure duration, exposure dose, as well as the test concentrations. In the study, the exposure to hives was short for only 5	Wegener, J., Ruhnke, H., Milchreit, K., Kleebaum, K., Franke, M., Mispagel, S., Bischoff, G., Kamp, G., Bienefeld, K. 2016. Secondary biomarkers of insecticide-induced stress of honey bee colonies and their relevance for overwintering strength. Ecotoxicology and Environmental Safety 132: 379–389

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	hydroxyl and imidacloprid-olefin in honey samples (LOQ 1.0 µg/kg) Location: Germany Year: unknown	days, with 1L sucrose solution per day (total of 5 L per hive containing 2 kg of bees in each hive). Potential contamination of other pesticides and foraging food sources in surrounding area is unknown. Although it was the study purpose, currently there is no correlation established for the risk assessment between the physiological parameters measured in this study with the typical environmental toxicity endpoints.	
Open feeding study Artificially fed hives with one time application of spiked sugar solution in open field for unspecified exposure Honey bee	Test crop: open field not applicable Test species: *Apis mellifera carnica* Application Dose: 3.55 × 10-3 µg a.i./L (0.00355 µg/L × 350 mL = 1.2 ppb) in sugar solution Number of hives tested: 4 fields, 1 control hive and 1 treated hive per field: 8 hives total Exposure period: one time dose to hive Observation period: 5 months Effect parameters: foraging activity, bee mortality, numbers of bees and capped brood, hive weight Location: Belgium Year: 2008	**REVIEW:** A large-scale experiment was conducted at four distinct locations in Belgium. Colonies were thoroughly monitored from the beginning of July 2009 until December 2009. For each location four similar sized colonies (~18,000 bees) were fed 350 mL of sucrose solution containing either fenoxycarb, imidacloprid, or indoxacarb. The dose of imidacloprid was low at 1.2 ppb and it was only administered once directly inside of hives at the beginning of the study. This is not reflective of the feeding concerns for the risk assessment where bees collect pollen and honey from outside sources and bring them into the hives; where the exposure could continue for a number of weeks Effects were noted as follows: No treatment-related effects were seen in honey bee colonies exposed once, for a short period to 1.2 ppb in sugar solution. **MAJOR UNCERTAINTIES:** this exposure scenario is not considered relevant for risk assessment. There was a lack of replication. The amount of sucrose consumed was not quantified. There was no residue analysis conducted, therefore exposure was not adequately confirmed. Long-term effects were not investigated in the study.	Belien, T., J. Kellers, K. Heylen, W. Keulemans, J. Billen, L. Arckens, R. Huybrechts, B. Gobin. 2009. Effects of sublethal doses of crop protection agents on honey bee (Apis mellifera) global colony vitality and its potential link with aberrant foraging activity. Communications in Agricultural and Applied Biological Sciences. 74/1. Pp 245-253.
Open feeding study Hives were artificially fed weekly with 660 mL of sugar water that was spiked with 0.006 µg imidacloprid/mL; half were treated	Test crop: N/A Test species: *Apis mellifera* Application rate: hives were fed with 660 mL/week for 13 weeks (92 days) with sugar water spiked with 0.006 µg a.i./mL; half of the hives received miticide treatments; the following treatments were tested: (V-, I+): miticide treatment, imidacloprid exposure (V-, I-): miticide treatment, no imidacloprid exposure (V+, I+): no miticide, imidacloprid exposure	**REVIEW:** Hives were artificially fed weekly with 660 mL of sugar water that was spiked with 0.006 µg imidacloprid/mL; half were treated with miticides to control *Varroa* infestations. Hives were allowed to freely forage. Effects on flight were noted as follows: The flight distances and flight times were reduced for pollen forager bees that were raised in colonies exposed to both imidacloprid (I+) at 0.006 µg a.i./mL for 13 weeks and Varroa mite infections (V+). Bees that were exposed to imidacloprid (I+) and Varroa mites (V+) weighed significantly more than the bees that were only exposed to *Varroa* mites. No treatment effects were detected on average or maximum flight speed.	Blanken L.J., van Langevelde F., and C. van Dooremalen. 2015. Interaction between Varroa destructor and imidacloprid reduces flight capacity of honey bees. Proc. R. Soc. B 282: 20151738. http://dx.doi.org/10.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
with miticides to control *Varroa* infestations. Hives were allowed to freely forage in addition to provided test concentration. Honey bee	(V+, I-): no miticide, no imidacloprid exposure Number of hives tested: 40 colonies were fed (V-, I+): 10 hives (V-, I-): 10 hives (V+, I+): 10 hives (V+, I-): 10 hives Body mass and wing length: 32 bees Flight analysis: 54 flights from 32 bees (some flew twice) Exposure period: 13 weeks (92 days; 20 June–20 September 2013) Observation period: 11 months (June 2013–April 2014) Effect parameters: *Measurements:* forewing length and body mass *Pollen forgers tethered to a flight mill:* flight distance, flight time, average and maximum speed Location: Wageningen, Netherlands Year: 2013–2014	**MAJOR UNCERTAINTIES:** Key descriptive information was missing from this article such as: hive conditions between treatment groups at study initiation, and the overwintering colony survival in each treatment group. The reviewer assumed without confirmation that there were 10 colonies per treatment group. Potential sources of contamination to other pesticides (i.e surrounding flowers were not described, use history within foraging range) during the study were not stated. The selection of pollen foragers for the flight test was not described; bees that failed to fly during the test were not included in the data analysis. Impact of such data exclusion to the treatment effect was unknown, since failure of flying may be related to the treatment itself. Test bees were collected during a large time window from August to October. Test bees were likely in different ages and of physiological status. Potential impact of ages and physiological status on the flights is unknown. Miticides were used in the control of *Varroa* infections in test hives. However the effect of miticides on the flight behaviour was unknown. Flight behaviour is not considered to be a typical endpoint and links with the flight behaviour and typical environmental endpoints have not been established.	1098/rspb.2015.1738"
Open feeding Study on individual bee effects may also be considered as a Tier I study Artificially fed hives with spiked sucrose solution in open field for unspecified exposure Honey bee	Test crop: not applicable Test species: *Apis mellifera* Application Dose: 100, 500 and 1000 ppb in sucrose solution Number of hives tested: 1 hive with bees trained to a feeder, different cohorts of 30 bees were then exposed to control or different dosed solution Exposure period: not reported Observation period: 25 hours after release Effect parameters: homing and foraging activity, bee behaviour Location: presumed to be Italy Year: 2002	**REVIEW:** This study tested the homing and foraging behaviour of trained honey bee foragers to a feeder containing contaminated sucrose solution with different concentrations of imidacloprid. The feeder was located 500 m away from the hive. Effects were noted as follows: In the 100 ppb treatment where homing ability and foraging activity was inhibited for 24 hours. Exposure to the 500 and 1000 ppb treatment caused the bees to appear intoxicated and disoriented immediately after feeding which then led to complete disappearance of the trained foragers (dead or alive) either at the hive or the feeder for up to 24 hours after the test. **MAJOR UNCERTAINTIES:** There were no replicates in the study. The exposure duration was not specified. Residue analysis was not conducted to confirm level of exposure. The 500 and 1000 ppb are known to be lethal to bees after 48 hours. Alternative sources of forage	Bortolotti, L., R. Montanari, J. Marcelino, P. Medryzycki, S. Maini, C. Porrini. 2003. Effects of sub-lethal imidacloprid doses on the homing rate and foraging activity of honey bees. Bulletin of Insectology 56 (1): 63-67.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		were not described. Long-term effects were not investigated in the study.	
Open feeding Study on individual bee effects may also be considered as a Tier I study Artificially fed hives with spiked sugar solution in an open field for various lengths of time Honey bee	Test crop: not applicable, open field Test species: honey bee hives Dose rate: olefin-imidacloprid and imidacloprid at 10, 20, 50 and 100 ppb in spiked sugar solution Number of hives tested: 1 colony set-up in a two-frame observation hive; groups of bees were trained to different feeders located 500 m away Exposure period: various Observation period: various Effect parameters: foraging activity at the feeding site, behaviour of returning foragers at the hive, probabilities of waggle dancing and tremble dancing and the directions of waggle dances Location: Germany Year: 1998	**REVIEW:** This study presents a summary of different research trials conducted by the authors (Tier 2 – tunnel studies), and other published sources (Tier 2 – open feeding and Tier 3) regarding the effects on honey bee health after exposure to sunflower treated with Gaucho seed dressing. Below are the details of the Tier 2 open feeding study which presented similar data as the registrant submitted study PMRA# 1086429. The review for both is below. The effects of sublethal doses of imidacloprid and the metabolite olefin-imidacloprid were studied in the field on foraging communication behaviours. Groups of individually marked bees were trained to visit an artificial food source located 500m from the observation hive. At the feeder 2 M sucrose solution was provided. Effects were noted as follows: Imidacloprid treatment related effects were seen at 20 ppb and higher where frequency of recruiting waggling dances, directional accuracy, and tremble dances were affected. At 100 ppb, the frequency of foragers visiting the imidacloprid feeders was reduced. Weak olefin-imidacloprid treatment related effects were seen at 20 ppb and higher where tremble dances increased. For bee communication behaviour in the field on imidacloprid: NOEC= 10 ppb LOEC= 20 ppb **MAJOR UNCERTAINTIES:** No links have been established between the bee communication behaviour in the field in this study and hive development. The exposure and observation periods were not well defined. Residue analysis was not conducted to confirm level of exposure.	Cure G., H.W. Schmidt, R. Schmuck. 1999. Results of a comprehensive field research programme with the systemic insecticide imidacloprid (Gaucho). Hazards to of pesticides to bee. Ed. INRA. Paris 2001.
Open feeding study Artificially fed hives with spiked sucrose and pollen patties in an open field for	Test crop: not applicable, open field Test species: *Apis mellifera* hives Dose rate: hive was fed with 500 ml of sugar solution twice/week + 250 g pollen patty once/week. It was reported that bees consumed all provided food during the next days. Control: food with no imicloprid spiked	**REVIEW:** No lethal effects to adults at individual level in all treatment groups. However, after feeding colonies 40 days, the number of brood cells in hives was reduced at both treatment levels, and the number of adults was reduced at the high treatment level. It was found that the higher the concentration of imidacloprid the smaller the acini diameter of the HPG. The mean gland sizes after exposure were 155, 148 and 138 μm in the control, low and high treatments, respectively.	De Smet L, F. Hatjina, P. Ioannidis, A. Hamamtzoglou, K. Schoonvaere, F. Francis, I. Meeus, G. Smagghe, D.C. de Graaf. 2017.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
40 days Honey bee	Low treatment: 5 ppb (measured 3.1 µg/kg in pollen patties combined with 5.1 µg/kg in sugar solution) High treatment: 200 ppb (measured to be 206.7 µg/kg in pollen patties combined with 176.2 µg/kg in in sugar solution) Number of hives tested: 10 colonies/treatment group Exposure period: 40 days (2 brood cycles) Observation period: 40 days Effect parameters: number of brood cells and adult bees, hypopharyngeal gland size, total RNA, gene expression profiles (immunity and detoxification genes) and quantification Residue samples: none Location: Nea Moudania, Greece Year: not specified	**MAJOR UNCERTAINTIES:** There were statistical difference among three treatment groups on the number of brood cells and adult at the beginning of the study. Information was not available to allow characterizing the contamination of other pesticides to test hives. Residues in the hives were not measured.	Stress indicator gene expression profiles, colony dynamics and tissue development of honey bees exposed to sub-lethal doses of imidacloprid in laboratory and field experiments. PLoS ONE 12(2)
Open feeding study Artificially fed hives with spiked pollen patties in an open field for 63 days after exposure period, untreated honey water was provided at stations located 200-500 m from the apiary Honey bee	Test crop: not applicable, open field Test species: honey bee hives Dose rate: 5 and 20 ppb Number of hives tested: 5 apiary locations had 6 small hives each (2 control, two at 5 ppb, two at 20 ppb); 10 colonies per treatment: 30 hives total Exposure period: 63 days (15 May to 6 August 2008) Observation period: 10 months (5 May 2008 to February 2009 (post overwintering)) Effect parameters: foraging activity, hive strength, brood development, overwintering success, number of queen cells, queen failure, capped brood, egg laying activity and larval development, honey and bee bread, hive strength, external pollen collection, internal pollen patty consumption, number of foragers returning to hive, foraging success	**REVIEW:** These two journal articles presented similar data as the registrant submitted study PMRA# 2142798. The review for all three is below. The sublethal effect of imidacloprid was studied in 2008 in five apiaries. Each apiary had six small honey bee colonies. The colonies were provided 63 days' worth of pollen patties that were spiked with imidacloprid at 5 or 20 ppb. Ten colonies of each treatment were randomly assigned with two colonies in each apiary. Effects were noted as follows: No clear treatment-related effects were confirmed in the study regarding queen cells, colony strength, capped brood, food storage (honey and bee bread), external pollen collection, internal pollen patty consumption, number of foragers returning to hives, and foraging success. However the following observations were noted: A small portion of marked returning foragers returned to the wrong hives after 63 days of exposure. This included bees in the control and 20 ppb treatment but none in the 5 ppb treatment. Fewer foragers were found at the untreated honey water feeders after exposure at 5 ppb treatment, but not the 20 ppb treatment. This difference in reduction may interact with apiary sites. Little bee bread was stored during and	Dively, G.P., M. Embrey, and J. Pettis. 2009. Assessment of sublethal effects of imidacloprid on honey bee and colony health. Department of Entomology, University of Maryland. North American Pollinator Protection Campaign. AND Pettis, J. S., D.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	Residue samples: bees, bee bread Location: Maryland, USA Year: 2008	after the 63 day exposure period. Queen cells were produced and removed in 18/30 colonies and queen failure occurred in 5 control colonies, 7 hives at 5 ppb, and 3 at 20 ppb. No consistent treatment effects were found on queen health, egg laying activity, or larval development. All test hives, including controls, did not survive through overwintering. Residue verification indicated that the actual test concentrations of imidacloprid in spiked pollen patties were 0, 8.7, and 15.7 ppb in correspondence with the nominal concentrations in control, 5 and 20 ppb, respectively. After 63 days of exposure, the imidacloprid concentration was detected at 0.6, 1.6, 3.7 ppb in bees, and 0.2, 1.6 and 3.5 ppb in bee bread, in the control, 5 and 20 ppb treatments respectively. Bees and bee bread in the control were both contaminated with imidacloprid. **MAJOR UNCERTAINTIES:** There was imidacloprid contamination in the control hives. Small hives were used that became congested due to the limited space within nucleus boxes, particularly during early June following the spring honey flow, and no super was added to release the congestion. Hives were potentially over-manipulated during the study (e.g., removing brood frames, queen cells, changing test hive size) which may have caused undue stress and affected results. There was a high level of queen loss; 9/30 lost queens by early June that were then replaced and an additional 6 were lost by July and August. The overwintering part of the study did not provide any information since no test hives survived overwintering.	Vanengelsdorp, J. Johnson, G. Dively. 2012. Pesticide exposure in honey bees results in increased levels of the gut pathogen Nosema. Naturwissenschaften 99:153-158.
Open feeding study Artificially fed hives with spiked pollen in open field for 12 weeks (2009 & 2010), hives fed with either spiked pollen or sugar solution in open fields for 6 weeks	Test crop: not applicable Test species: *Apis mellifera* Application Concentration: *2009 & 2010:* Admire Pro at a rate of 5, 20 and 100 ppb in pollen patty *2011:* 40 µg of imidacloprid per week in a pollen patty (100 ppb) or in sucrose solution (20 ppb) Number of hives tested: *2009:* 5 apiary locations, each apiary had 2 control hives, 2 hives per treatment; there were 10 hives per treatment tested overall: 40 hives total *2010:* 7 apiary locations, each apiary had 1	**REVIEW:** This three-year study was conducted to assess chronic sublethal effects on whole honey bee colonies. In 2009 and 2010 colonies were fed four, 80g pollen patties weekly containing imidacloprid at 5, 20 and 100 ppb over multiple brood cycles. In 2011 colonies were fed either spiked diet pollen patties (100 ppb) or spiked sucrose syrup (20 ppb) with the same amount of active ingredient (40 µg/kg) to compare and determine the fate of imidacloprid residues from different exposure routes. New colonies were used for each experimental year. 2009 & 2010 Consumption: The measured pollen patty consumption was reported as 265.3–277.2 g pollen patty/week/hive in 2009 and 411.6–431.9 g pollen patty/week/hive in 2010. The 2010 value is higher than the amount of	Dively, G.P., M.S. Embrey, A. Kamel, D.J. Hawthorne, J.S. Pettis. 2015. Assessment of chronic sublethal effects of imidacloprid on honey bee colony health. PLoS ONE 10(3): e011874.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
(2011) Honey bee	control hive and 1 hive per treatment; there were 7 hives per treatment tested overall: 28 hives total *2011:* 4 apiary locations, each had 2 control hives, 2 hives per treatment; there were 8 hives per treatment: 24 hives total Exposure period: *2009 & 2010*: 84 days *2011*: 42 days Observation period: *2009 & 2010:* approximately 10 months *2011:* 42 days Effect parameters: colony performance (percentage of frame area covered with bees, capped brood, older larvae, eggs, bee bread, capped honey and empty cells, presence of laying queen, drone cells, dead larvae, abnormal bee behaviour and signs of pests or diseases), foraging behavior, queen supersedures Residue samples: dose verification of sucrose solution and pollen patties, royal jelly, bees, larvae, bee bread, honey Location: Maryland, USA Year: 2009, 2010 and 2011	pollen patty provided which was 320 g pollen patty/week/hive; this leads to uncertainty of exposure level and comparison between the two years. 2009 & 2010 Effects noted on honey bees fed pollen patties: 5 ppb: No effects (2009 and 2010) 20 ppb: No effects (2010) 100 ppb: Increased *Varroa* infestation (2009) Increased queen supersedures (2009) Decreased overwintering survival (2009) No effects (2010) OVERALL NOEL AND LOEL While the pollen feeding dose of 20 ppb is considered a no observed effect level for 9–12 weeks of pollen feeding exposure, it is noted that there is wide dose spacing between 20 ppb (NOEL) and 100 ppb (LOEL), and the effects observed at 100 ppb were not consistent in all years. Therefore, there is some uncertainty associated with this pollen feeding NOEL and LOEL in the risk assessment. 2011: Results from the 2011 within hive fate experiment indicated that there were more positive residue detections in all matrices sampled (bees, larvae, bee bread, honey and royal jelly) as well as correlated colony effects in the hives treated with 40 µg of imidacloprid incorporated into pollen patties than compared to hives treated with sucrose solution containing the same amount of imidacloprid. Effects were seen at the end of the exposure period where colonies fed with the spiked pollen diet patties had 14–26% fewer frames of adult bees than the control colonies or the colonies fed with spiked sucrose at the same dose. Residues were detected more frequently in pollen fed hives (100 ppb) than compared to sucrose fed (20 ppb). Royal jelly samples from the pollen fed hives had 8/8 positive detections and 0/8 in the sucrose-fed. High concentrations of imidacloprid were detected in honey (up to 13.4 ppb) in the hives fed with pollen patties. **MAJOR UNCERTAINTIES:** In 2009 the level of *Varroa* and *Nosema* infestations was above the treatment thresholds for Ontario and no pest control treatments were applied. It is unclear if pest levels	

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		had an effect on the results. The author's noted that in 2010 several control and treated colonies contained less than 6 kg of stored honey going into winter; this statement could not be verified with raw data. This may have predisposed them to overwintering poorly. Also in 2010 the quantified amount of pollen patty consumed was greater than (411.6 – 431.9 g pollen patty/week/hive) the amount of pollen patty provided (320 g pollen patty/week/hive). A description of the individual apiary locations was not included. Crops within the foraging range of about 3 km of the apiaries included field corn, where a portion of the corn acreage was seed-treated at the low rate (Poncho 250 (0.25 mg a.i./kernel) or Cruiser 5FS (0.25 mg a.i./kernel)) with other neonicotinoids. Pollen was collected in traps but not identified or analyzed to consider other exposures in the field that foragers may have encountered. No weather data was provided for comparing additional parameters which may have impacted hives.	
Open feeding study Artificially fed hives with spiked sugar solution in open field for 35 days Honey bee	Test crop: open field not applicable Test species: *Apis mellifera* Application Dose: 0.5 and 5 µg/L in sugar solution Number of hives tested: 8 control hives with no artificial feeding, 9 control hives, 8 hives treated with 0.5 µg/L and 8 hives treated with 5 µg/L: 33 hives total Exposure period: 35 days Observation period: approximately 8 months Effect parameters: bee mortality, flight activity, pollen collection, hive strength and weight, mean capped brood area, presence of eggs and queen cells, pest and disease symptoms, hive swarming and overwintering "score" Residue samples: foundation wax, pollen loads, bees, dose verification in sugar solution Location: France Year: 2000	**REVIEW:** This study was conducted in an open field in France where 33 ten-frame hives were fed three times per week for a total of five weeks (July 12-Aug 14). The hives were fed with 1 liter each of sucrose syrup spiked with imidacloprid. All of the feeding solution was consumed by the test hives during the study. An additional control group was included in which hives were not artificially fed with any sugar solution during the exposure period. Hives were observed prior to the exposure period, during exposure, after exposure and then the following year after the overwintering period Effects were noted as follows: No treatment-related colony-level effects were seen on adult mortality, hive development, hive weight, or level of pathogen infestation (*Varroa* or Nosema) in honey bee hives exposed to sucrose solution spiked with 0, 0.5 or 5 µg/L for an exposure period of 35 days. Effects were noted on pollen foraging; the higher the imidacloprid concentration in syrup, the more frequent were the days when bees were seen carrying pollen during the exposure period. After the feeding period these differences were no longer observed. Whether this resulted in a difference in pollen storage in hives was not provided. The sugar solution was sampled just after preparation and found the concentration of total imidacloprid residues to be 4.65 µg/L, which is very close to the 5 µg/L target concentration; however, no residues were found after 24 hrs at ambient temperature. No residues were	Faucon, J.P., C. Aurières, P. Drajnudel, L. Mathieu, M. Ribière, A.C. Martel, S. Zeggane, M.P. Chauzat, M. F.A. Aubert. 2005. Experimental study on the toxicity of imidacloprid given in syrup to honey bee (Apis mellifera) colonies. Pest Manag Sci 61: 111-125.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		detected in the 0.5 µg/L sucrose solution. **MAJOR UNCERTAINTIES:** Residue analysis results of sucrose solutions raises uncertainties about exposure level; analysis of the foundation wax showed the presence of tau-fluvalinate and sulfur. Authors did not state if feeder was shielded from sunlight. Flowering conditions surrounding the test hives were unknown. Different methodology was used for brood measurements before and after overwintering. During and after the feeding period the number of colonies that surely or probably swarmed was 2, 3, 1 and 0 in the non-fed, control, 0.5 and 5 ppb, respectively.	
Open feeding Study on individual bee effects may also be considered as a Tier I study Individual foragers were trained to a feeder, captured, fed spiked sugar solution, tagged and released away from hives and monitored for up to 3 days after capture Honey bee	Test crop: N/A Test species: *Apis mellifera* Application rate: individual pollen foragers were captured, fed 49 µL of sucrose solution containing 1 µL of either clothianidin (2.5 ng/bee; 25 ppb) or imidacloprid (7.5 or 11.25 ng/bee; 75 or 112.5 ppb) for 90 minutes Number of hives tested: 1 hive (containing > 30,000 bees) was used to sample bees; total number of bees tested was 98 in 2011 and 110 in 2012 Exposure period: 90 min Observation period: up to 3 days after capture Effect parameters: number of bees that did not fly, delayed start to flying, return flight to hive, vector flight, homing flight Location: Germany Year: 2011 and 2012	**REVIEW:** Individual foragers were trained to a feeder, captured, fed sugar solution with 7.5 or 11.25 ng imidacloprid/bee, or 2.5 ng clothianidin/bee, tagged and released away from hives and monitored for up to 3 days after capture. Effects noted as follows: Results showed that both imidacloprid treatments significantly increased the number of bees failing to return to the hive, that the bees exposed to the highest imidacloprid treatment (112.5 ppb) had significantly shorter vector flights (although duration was not statistically affected by any treatment) and that the direction and the number of directional changes of these vector flights was significantly different when compared to the control in both the imidacloprid treatments. This suggests the bees were relying on the sun compass more than their current memory stores. Clothianidin results indicated that this treatment resulted in a significant difference in the direction of the bees compared to the control for the vector flights. This also suggests the bees were relying on the sun compass more than their current memory stores. During homing flights, the total flight path had a significantly longer length and increased duration in bees treated with 25 ppb clothianidin. This suggests that activating remote memories and acquiring new information during orientation flights were affected in clothianidin treated bees. **MAJOR UNCERTAINTIES:** Only 1 hive per year was used to sample test bees and the sample size was very low (15-20 bees). The	Fischer J., T. Müller T., Spatz A.-K., U. Greggers , B. Grünewald, and R. Menzel. 2014. Neonicotinoids interfere with specific components of navigation in honey bees. PLoS ONE 9(3): e91364

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		number of test bees in the 11.25 ng/bee imidacloprid treatment is very low since it was only tested in 2011; the higher dose was omitted in 2012. This resulted in a lower number of tested individuals for this dose and an uneven treatment study design. As the imidacloprid doses were notably high compared to currently available Tier I data, it is unclear whether these bees suffered mortality and this was not reported. No description of the surrounding vegetation within a 2-5km radius of the hives was provided to account for foraging exposure outside of the trained feeders. It's not clear if experiments were run on different days (which may have led to different environmental and colony conditions that could have affected flight and bee behaviour), or if all of the test bees were collected over the course of one day in 2011 and one day in 2012. The 2011 and 2012 data was pooled despite slightly different hive locations and no mention of any statistical test to determine if pooling data was appropriate. The authors only mentioned that they did not observe any differences in the flight behaviors between the years as a justification for pooling. It was assumed by the reviewer that the bees consumed the entire 1 µL allotment. The reviewer assumed that these colonies were in excellent health prior to the experiment. Nothing was noted by the authors about the quality of the hives prior to the test.	
Open feeding Study on individual bee effects may also be considered as a Tier I study Free-flying foragers from hives were trained to outdoor feeders that resembled artificial flowers and were located 50 m away from	Test crop: not applicable, colonies were trained to outdoor feeders that resembled artificial flowers Test species: *Apis mellifera anatoliaca* Application Dose: after being trained to a feeder, bees were captured for 30 min and force-fed via pipette a 5 µL droplet of sucrose solution containing either 0, 0.00036, 0.00072, 0.0018, 0.0072 µg imidacloprid. Bees were then released at the feeders that resembled artificial flowers. Number of bees tested: A total of 187 bees were used in 47 trials. *0 µg a.i. (control):* 93 bees *0.00036:* 23 bees *0.00072:* 22 bees	**REVIEW:** Free-flying foragers from hives were trained to outdoor feeders that resembled artificial flowers and were located 50 m away from the hives. After the training phase, bees were captured and force-fed via pipette a 5 µL droplet of sucrose solution containing either 0, 0.00036, 0.00072, 0.0018, 0.0072 µg imidacloprid. The estimated test concentrations ranged 64-1274 ppb by assuming the volume density of 1 M sucrose to be 1.13 g/ml. Bees were held for 30 min before being released. Effects notes as follows: The percentage of bees that successfully returned to foraging on the artificial flower patches decreased with increased imidacloprid dose. Imidacloprid dose did not disrupt the selection of flowers. Imidacloprid at sub-lethal doses did not impact the selection of honey bee nectar foragers; instead the selection was impacted by the concentration (1M vs 2M)of sugar in flowers. 0.0072 µg a.i./bee: None of the bees returned to the artificial flower patch after being released.	Karahan, A., I. Cakmak, J. Hranitz, I. Karaca and H. Wells. 2015. Sublethal imidacloprid effects on honey bee flower choices when foraging. Ecotoxicology. November 2015, Volume 24(9): 2017-2025.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
the hives. After the training phase, bees were captured and force-fed via pipette a 5 µL droplet of sucrose solution containing either 0, 0.00036, 0.00072, 0.0018, 0.0072 µg imidacloprid. Bees were held for 30 min before being released. Honey bee	*0.0018:* 38 bees *0.0072:* 11 bees Exposure period: 30 min Observation period: 30 min + 30 min + 45 min + 45 min = 2 h 30 min Effect parameters: number of bees that returned to forage on imidacloprid treatment, dose-response: number of flowers visited, number of trips made, bee return rate Location: Wageningen, Netherlands Year: 2013	All doses: bees that were fed any dose of imidacloprid made about 15% fewer foraging trips **MAJOR UNCERTAINTIES:** The reviewer noted that only half of the test bees (94 out of 187 bees) that completed the three parts in the flight test were analyzed in the study. Bees that did not return or did not complete the three test phases were excluded from the data analysis. However, failure of returning may have been treatment-related and resulted in a bias with regard to the overall treatment effects. Imidacloprid was force-fed to bees who were then held for 30 min prior to release; it is unknown if any regurgitation occurred during the pesticide phase. The study was conducted outside and bees were allowed to freely forage. Impact of the surround food sources to the treatment was unknown.	
Open feeding study Artificially fed hives with spiked sucrose solution in open field for 91 days Honey bee	Test crop: open field not applicable Test species: *Apis mellifera* Application Dose: 258 µg a.i. in 1.9 L of sugar water/week (Assuming 50% sucrose solution was used, which is expected to have 1.2296 g/ml density, the test concentration would be converted to 110.4 ppb.) Number of hives tested: 3 apiary locations, each had 4 hives (2 fed sucrose water - 1 untreated, 1 treated; 2 fed high-fructose corn syrup – 1 untreated, 1 treated): 12 hives total Exposure period: 91 days Observation period: approximately 10 months Effect parameters: brood rearing production, numbers of frames containing bees and capped brood, bee cluster size, bee mortality and the level of *Varroa* mites Location: Massachusetts, USA Year: 2012	**REVIEW:** In this study, 18 colonies were fed sucrose solution containing 258 µg of imidacloprid in 1.9 liter of sugar solution (110 ppb) per week over a 91 day exposure period in Central Massachusetts, USA. The authors estimated that bees were exposed to 0.74 ng a.i./bee/day based on an assumption that there were 50,000 bees/hive. Based on a revised estimate of adult bee numbers, our review indicated that the exposure dose was approximately 2.5 ng a.i./bee/day which is similar to the most sensitive acute oral LD_{50} value and much higher than what was estimated by the study authors (0.74 ng a.i./bee/day). Effects were noted as follows: No treatment-related effects on mortality, number of capped brood or the occurrence of *Varroa* mites were seen in honey bee colonies exposed to sucrose solution spiked with 110 ppb per week for the 91 day exposure period. Significant effects were seen after overwintering when the number of adult bees was lower in the treated hives than the control and that more of the treated hives died during the overwintering period than the control. **MAJOR UNCERTAINTIES:** The calculated consumption rate was corrected from 0.74 ng a.i./bee/day to 2.5 ng a.i./bee/day. All hives	Lu, C., K. M. Warchol, R. A. Callahan. 2014. Sub-lethal exposure to neonicotinoids impaired honey bees winterization before proceeding to colony collapse disorder. Bulletin of Insectology 67 (1): 125-130.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		may have been lacking sufficient food sources. Observations taken over the winter may have had adverse effects on the trial results. Potential exposure from pesticides other than the neonicotinoid treatments from foraging on the surround areas was not provided. Residue analysis was not conducted to confirm level of exposure.	
Open feeding study Individual foragers were trained to a feeder, captured, fed sucrose solution spiked with either clothianidin or imidacloprid, tagged and released away from hives and monitored for up to 48 hours after capture Honey bee	Test crop: N/A Test species: *Apis mellifera* Application rate: trained worker bees were captured a at a training feeder located 7 m away, and were individually exposed to 10 µL of a 2 M sucrose solution containing either 0.00005, 0.0005, 0.001 and 0.002 µg clothianidin/bee or 0.00015, 0.0015, 0.003 and 0.006 µg imidacloprid/bee. They were then kept in isolation for 20 min prior to being released. Bees were monitored with RFID tracking tags for return to the hive for up to 48 hours after exposure. Number of hives tested: 1 nucleus bee hive/year containing 6 mini combs and approximately 2000 bees; maximum of 12 bees/treatment were tested; 8 trials were repeated for clothianidin and 2 trials were repeated for imidacloprid Exposure period: 20 min Observation period: up to 48 hours after capture Effect parameters: number of feeder visits, length of time for a foraging trip, time to feeder, at feeder, and to hive, interval between foraging trips, time inside the hive Location: Oberursel, Germany Year: 2009 and 2010	**REVIEW:** This study was conducted during the summer of 2009 and 2010 at a research facility in Germany. Each trial included training foragers to consume contaminated sucrose from feeders located 7 m away from the experimental hives and a subsequent observation period of up to 48 hours. One week was needed to conduct a single test. Bees were labeled with radio frequency identification (RFID) tags to track foraging activity. *Clothianidin:* At 3 hours after exposure, a trend of declining in proportion of bees that returned to the hive and the number of feeder visits was seen with the increase of treatment doses from 0.05 – 2 ng/bee. During 3 hours of exposure to 0.5, 1 and 2 ng/bee, there were significant increases in the time duration of foraging trip, time to feeder, time at feeder, time to hive, and the interval inside the hive between trips. Some of these effects persisted up until 24 hours after wards: increased foraging trip duration, increased time to hive, and interval between foraging trips. Number of feeder visits and time to feeder were not significantly affected 24 hours after. *Imidacloprid:* At 3 hours after exposure, a trend of declining in proportion of bees that returned to the hive and the number of feeder visits was seen with the increase of treatment doses from 0.15 – 6 ng/bee. At 6 ng/bee, 25% bees returned to the hive and no bees returned to the feeder within 24 hours. During 3 hours of the exposure to 1.5 and 3 ng/bee, there were significant increases in the time duration of foraging trip, time to feeder, time at feeder, time to hive, and the interval inside the hive between trips. The majority of effects were not significantly different after 24 hours except the interval between foraging trips and time to feeder. **MAJOR UNCERTAINTIES:** There were large variations in measured parameters which may be related to the small sample size,	Schneider CW, Tautz J, Grünewald B and Fuchs S. 2012. RFID tracking of sublethal effects of two neonicotinoid insecticides on the foraging behavior of Apis mellifera. Plos One 7(1):e30023.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		particularly for imidacloprid. Two trials was ran for imidacloprid as a means for validation and calibration of the test methods whereas 8 trials were run for clothianidin. No information was provided on other factors that could potentially confound the results, such as husbandry of the colonies, pathogens (Nosema) and parasites (Varroa) and other viral diseases prior to or during the experimental phase.	
Open feeding Study on individual bee effects may also be considered as a Tier I study Artificially fed hives with spiked sucrose solution were trained to a feeder for 10 training trips Honey bee	Test crop: not applicable Test species: *Apis cerana* Application Dose: 10, 20 and 40 mg/L (8.6, 17.2, and 34 ppb) in sucrose solution Number of hives tested: 1 hive per treatment: 3 hives total Exposure period: 10 trained foraging trips Observation period: 10 trained foraging trips + 1 hour of observation Effect parameters: feeder foraging behaviour, average volume of sucrose solution collected Location: China Year: 2013	**REVIEW:** This study provides sublethal imidacloprid effects data on the Asiatic honey bee *Apis cerana*, a species not found in North America. Bees were trained to sucrose feeders located 130 m away that contained different concentrations of imidacloprid. The bees were allowed to sample the treatment feeder and then it was recorded which bees subsequently returned to this feeder. Effects were noted as follows: Significant effects were seen in the decreasing amount of sucrose solution collected by bees; 46% and 63% for 17.2 ppb and 34 ppb imidacloprid solutions, respectively, as compared to the control. Fewer bees returned to the 34 ppb feeder when compared to the other treatments. Based upon the average nectar volume collected per trip, each bee collected (but did not necessarily absorb into its haemolymph) 0.27, 0.39, and 0.52 ng of 10, 20, and 40 mg a.i./L, respectively. **MAJOR UNCERTAINTIES:** Bees were allowed back into their hives between tests. Exposure was not quantified at the hive; no residue analysis was conducted. The age of bees used in this trial is not uniform. Long-term effects were not investigated in the study.	Tan K., W. Chen, S. Dong, X. Liu, Y. Wang, J.C. Nieh. 2014. Imidacloprid alters foraging and decreases bee avoidance of predators. PLoS ONE 9(7):e102725.
Open feeding study in sucrose solution Honey bee	Test crop: N/A Test species: *Apis mellifera, Sister queens. 3 hive sizes (1500, 3000 and 7000 bees/hive).* Application rate: colonies were fed with 50% sucrose solution spiked with imidacloprid at 0 (served as control), 10, 20, 50, and 100 ppb (measured concentrations were 0, 6.4, 32.9, 57.7 and 94.2 ppb respectively). Fed with 80, 160 and 320 mL for 1500-, 3000-, and 7000-bee colonies, respectively. Syrup was replenished every other day for 3 weeks. Bees were permitted	**REVIEW:** At the end of 3 weeks exposure period (D23) and repeated in three years, no effects were detected on the number of adults and nectar store in all treatments. However, reduction was detected for various parameters including the number of eggs, larvae and pupae and pollen store in the small and medium size colonies at 10 ppb treatment or greater. However, no effects were detected in the large colonies, except for the hive pollen store at 10 ppb and higher and the number of eggs at 10 ppb treatment only. The author suggested that larger colony populations may act as a buffer to pesticide exposure. However, there is an uncertainty on the actual level of exposure related to this speculation since imidacloprid residues in bees collected from the large colonies were much lower than that collected from the medium and small colonies.	Wu-Smart, J. and Spivak. 2016. M. Sub-lethal effects of dietary neonicotinoid insecticide exposure on honey bee queen fecundity and colony development. Sci. Rep. 6, 32108; doi: 10.1038/srep32108

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	to forage freely in an agricultural and residential area. Number of hives tested: three or four replicates each year for three years, 8–20 colonies per treatment in total, and totaled 79 colonies over three years. Exposure period: 3 weeks Observation period: 3 weeks Effect parameters: *Queen behaviors, work bee behaviour, hive conditions, egg laying.* Location: MN, USA Year: 2012–2014	During the 3 weeks of exposure period, similar effects were detected on the reduction of queen activity at 10 ppb treatment and greater among the three sizes of colonies. Similar effects were observed on the worker bee activity between the medium and large size colonies. A dose-response correlation was detected between the level of treatment concentrations and the amount of imidacloprid residues detected in either bees or in hive nectar/honey store at the end of exposure period. The reviewer noticed that the amount of residues in bees collected from the large colonies was much lower compared with that from the small and medium colonies. It is unknown how this would occur. **MAJOR UNCERTAINTIES:** The relevance of the level of exposure and exposure duration compared to the field and other test scenarios. Potential contamination of other pesticides and foraging food sources in surrounding area is unknown. Impacts to the hive conditions following the 3 week exposure period were not studied. There were some control bees with imidacloprid residues detected.	
Open feeding Study on individual bee effects may also be considered as a Tier I study Artificially fed hives with spiked sugar solution in an open field for 1.5 hours Honey bee	Test crop: not applicable, open field Test species: honey bee hives Concentration rate: bees were trained to forage on an artificial feeder with 50% sucrose solution containing different concentrations: control, 40, 50, 100, 200, 400, 600, 800, 1200, 1600, 3000, 4000 and 6000 µg/L (50% sucrose solution has 1.2296 g/ml density, the test concentration would be converted to 32.5, 40.7, 81.3, 162.7, 325.3, 488.0, 650.6, 975.9, 1301.2, 2439.8, 3253.1 and 4879.6 ppb). Number of hives tested: 3 hives trained cohorts of bees to 13 different feeders with 13 different concentrations Exposure period: 1.5 hours Observation period: 1.5 hours Effect parameters: foraging behaviour, meal consumption, percentage of missing bees Location: Taiwan	**REVIEW:** This study was also reviewed under PMRA 2142777. The review for both is below. This study measured the time interval between two visits of honey bees at an artificial feeding site that was filled with spiked sugar solution and located 35 m away from the hive. The study demonstrated that sublethal doses of imidacloprid change the foraging behaviour of the bees. The bee's ability to recover decreased when the concentration of imidacloprid increased. Effects were noted as follows: 32.5 ppb: No effects 40.7 ppb and above: Increasingly abnormal foraging behaviour. 488.0 ppb and above: Increasing percentages of missing bees 3253.1 ppb and above: All the bees were missing **MAJOR UNCERTAINTIES:** There is a lack of information on the test species and strain as well as basic hive conditions. No links have been established between the visit interval measured in this study and hive development. The normal foraging behaviour was defined in the study as the visit interval at the specific feeding site to be < 300 seconds. This defined visit time interval was study specific and should	Yang, E.C., Y.C. Chuang, Y.L. Chen, L.H. Chang. 2008. Abnormal foraging behavior induced by sub-lethal dosage of imidacloprid in the honey bee. Journal of Economic Entomology, 101(6): 1743-1748.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	Year: May 2006–March 2007	not be generalized for other scenarios. Residue analysis was not conducted to confirm level of exposure.	
APIS - Tier III Trials			
Field study Various field studies with different application methods were reviewed for this article. Honey bee	REVIEW ARTICLE Test crop: various Test species: *Apis mellifera*, *Bombus* spp. and other non-Apis species Application rate: various exposure routes, levels and active ingredients were tested across the different articles reviewed Criteria to compare the effects of pesticides ingestion at sublethal concentrations, included: - active ingredients of neonicotinoids (IMI, COD, THE) - bee species (honey bees and bumble bees) - study type (laboratory or field). The available NOEC and LOEC data from published laboratory and field studies were extracted wherever possible and transferred to concentration unit µg/kg of diet. Number of hives tested: various Exposure period: various Observation period: various Effect parameters: various tested depending on purpose of each study in the review article Location: compiled from all over the world Year: the various studies were conducted over different years	**REVIEW:** This is a review article looking at reconciling laboratory data with field study data. The authors concluded that after comparing NOEC and LOEC values for IMI, COD and THE for honey bees and bumble bees under laboratory and field conditions: Laboratory NOEC's are relatively higher than field NOEC in most cases. An explanation for this difference is that the detected residues in most neonicotinoid seed-treated field crop studies are found to be trace in pollen and/or nectar. Depending on the detected residues in pollen and nectar in the seed-treated crops, the field-realistic concentrations of these pesticides were assumed to be 1–10 µg/kg. Comparing LOEC values under realistic field conditions were higher than under laboratory conditions in most cases. The authors suggest this indicates that further long-term field research is required with consideration to sublethal exposure. **MAJOR UNCERTAINTIES:** This is a review article that surveyed several laboratory and field studies (Tier II and III-style field studies) that examined very different methodologies, guidelines and parameters tested. These differences make comparing and contrasting studies very difficult and therefore, this must be taken into consideration when using these results in the risk assessment. Furthermore, various factors should be considered during the risk assessment process such as exposure duration, the season, castes, age, and developmental stage of the bees that was not considered in this review article.	Alkassab, A.T and W.H. Kirchner. 2017. Sublethal exposure to neonicotinoids and related side effects on insect pollinators: honey bees, bumble bees, and solitary bees. J. Plant. Dis. Prot. 124: 1-30. DOI 10.1007/s41348-016-0041-0
Field study Seed treatment Honey bee	Test crop: sunflower Test species: *Apis mellifera caucasia* Application rate: Gaucho at a rate of 0.7 mg a.i./seed (based on seeding rate of 74,000 seeds/ha: 52 g a.i./ha) Number of hives tested: 1 control field and 1 treated field, 6 hives per field: 12 hives total	**REVIEW:** This article has a Tier 2 component. Sunflower plants were grown from seed in two 1.5 ha fields; one control field and one treated field planted with 0.7 mg a.i./seed. Six honey bee hives were placed in the centre of the fields at the beginning of bloom. Effects were noted as follows: Flower fertilization was faster, more foragers were observed, yield was	Ambolet B, J.F. Crevat and H.W. Schmidt. 1997. Research on secondary effects of seed treatment with imidacloprid on the

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	Exposure period: approximately 12 days Observation period: approximately 12 days Effect parameters: flower fertilization, foraging activity, hive weight, sunflower yield, bee behaviour Residue samples: nectar from foragers Location: France Year: 1995	higher and the number of bees entering the hive per minute was higher in the treated fields. However, there was a difference in irrigation in the treated vs. the control field that most likely contributed to these differences. No other treatment related effects were noted in honey bee hives exposed to sunflowers grown from treated seed for an exposure period of 12 days. **MAJOR UNCERTAINTIES:** There was an irrigation issue in the control field that most likely led to yield and crop quality differentials between the control and treated plots. Key information on this study is missing since information was drawn from conference proceedings and there is no evidence that the study has undergone a scientific peer review. All plots were treated with pirimicarb on 16 June 1995, just before tunnel installation which occurred on 22 July 1995. No residue analysis was conducted to characterize exposure level but a bioassay using nectar collected from foragers was conducted on aphids. Long-term effects were not investigated in the study.	behaviour of honey bees on flowers of sunflower. Proceedings of the fourth international conference on pests in agriculture; 6-8 January 1997; Montpellier, France; Association Nationale pour la Protection des Plantes (ANPP).
Field study Seed treatment Honey bee	Test crop: sunflower Test species: honey bee hives Application rate: Gaucho at a rate of 0.7 mg a.i./seed (equivalent to 51.8 g a.i./ha; 74,000 seed/ha) and an additional field with Gaucho at 49 g a.i./ha (equivalent to 0.7 mg a.i./seed; 70,000 seed/ha) Number of hives tested: 1 control field with 6 hives ,1 treatment field with 6 hives and 1 additional treated field with 4 hives; each had 4 hives: 16 hives total Exposure period:12 days Observation period: 12 days Effect parameters: bee mortality, flower visit, hive weight, sunflower yield, pollen species collected Location: France Year: 1995	**REVIEW:** This study presents a summary of different research trials conducted by the authors (Tier 2 – tunnel studies), and other published sources (Tier 2 – open feeding and Tier 3) regarding the effects on honey bee health after exposure to sunflower treated with Gaucho seed dressing. Below are the details of the Tier 3 field study which presented the same data as the registrant submitted study PMRA# 2364413, 2364414. The review for both is below. Two sunflower fields that were 1.5 ha in size with an unknown distance between the two fields were sown in the Sologne area of France on 22 May 1995. The seeds of one field were treated with Gaucho at 0.7 g a.i./seed (equivalent to 58 g a.i./ha). A nearby field of 9.2 ha that was treated with Gaucho at 49 g a.i./ha was included as an addition to the trial. When the test fields started flowering (22 July, 1995, 61 days after sowing), six honey bee hives were installed in the middle of each field. In the additional field, four hives were placed at the edge of the field. During the 12 days of exposure and observation period, no treatment-related effects were observed on bee mortality, flower visit, hive weight, and sunflower yield. **MAJOR UNCERTAINTIES:** Exposure was low, only 3% of trapped	Cure G., H.W. Schmidt, R. Schmuck. 1999. Results of a comprehensive field research programme with the systemic insecticide imidacloprid (Gaucho). Hazards to of pesticides to bee. Ed. INRA. Paris 2001.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		pollen was from sunflower. The time of day when foraging measurements were taken was not provided. There was potential cross contamination with bees foraging on both treated and untreated fields. There was a lack of sufficient hive information at study initiation for interpreting foraging activity. Residue analysis was not conducted to confirm level of exposure. The long-term effects of imidacloprid were not investigated.	
Field study Seed treatment Honey bee	Test crop: oilseed rape Test species: *Apis mellifera* hives Application rate: oilseed rape seeds were treated with Cruiser (thiamethoxam 280 g/L) and planted in 2013 (153 ha) and 2014 (135 ha) in an area of France where neonicotinoids are currently prohibited Number of hives tested: 17 colonies (10-frame Dadant hives) were set-up at various distances to cover a range of exposure levels; hives were fitted with radio frequency identification (RFID) readers to monitor the life history of a total of 46 cohorts of 100–250 honey bees during the oilseed rape flowering period (6847 bees were monitored for their entire lifecycle) Exposure period: *2013:* 18 April - (approximately 5 weeks during flower bloom period) *2014:* 25 March - (approximately 5 weeks during flower bloom period) Observation period: *2013:* 18 April – (approximately 6-8 weeks after flower period was over; hives were not moved original location) *2014:* 25 March – (approximately 6-8 weeks after flower period was over; hives were not moved from original location) NOTE: Bees were released into colonies approximately 1 week before flowering NOTE: RFID bees were monitored for 18	**REVIEW:** The study was initially designed to produce a gradient of real-field exposure to oilseed rape grown from seeds treated with thiamethoxam. However, an unexpected concomitant exposure to imidacloprid, was detected both in the nectar of experimental oilseed rape treated with thiamethoxam, and in the dietary nectar ingested by foragers. Therefore, the studied field exposure level referred to in this study actually represents a gradient of combined exposure to both neonicotinoid products. Effects were noted as follows: - Thiamethoxam residues in nectar brought back to hive increased with the experimental field exposure unit level o Residues were undetected in fields in the ≤ 8 exposure unit category. o However, imidacloprid residues were also detected in nectar therefore it is unknown if effects are correlated with imidacloprid or thiamethoxam. - Individual bees disappeared at faster rates with an increase in field exposure unit; this increased over time throughout the 18–20 day monitoring period while oilseed rape was in bloom. o This rise in mortality was mainly seen in the > 8 experimental exposure unit fields (determined as “high” exposure level by the authors). - Precocious foraging was not seen in the 20 day tracking and monitoring period of the RFID labelled bees. - No change was seen in the colony dynamic parameters both before and after bloom. - During flowering, the most exposed colonies tended to invest more in worker brood production at the expense of drone brood production. Drone brood development was delayed in exposed colonies; after flowering, drone brood production followed the field exposure gradient, being significantly higher in the more exposed hives. This	Henry M, N. Cerrutti, P. Aupinel, A. Decourtye, M, Gayrard, J-F. Odoux, A. Pissard, C. Rüger and V. Bretagnolle. 2015. Reconciling laboratory and field assessments of neonicotinoid toxicity to honey bees. Proceedings of The Royal Society B Biological Sciences, Published 18 November 2015.DOI: 10.1098/rspb.2015.2110

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	days for forager bees and 20 days for just-emerged bees Effect parameters: disease inspections, worker, drone and brood population size, honey reserve size; RFID tracked mortality rate, frequency of flight activity, precocious behavioural maturation Residue analysis: forager collected nectar, nectar from oilseed flowers Location: LTER Zone Atelier Plaine & Val de Sèvre area, France Year: 2013–2014	was speculated by the authors to have occurred because colonies with needs to replace their foraging workforce, may have sacrificed drone brood production since they are more costly in terms of energy inputs to maintain and do not provide any function (other than reproduction) to maintaining the hive like worker bees do. **MAJOR UNCERTAINTIES:** The exact exposure level, seeding rate and duration of bloom was not stated. It was not stated whether the test bees were free from previous pesticide exposure. It was stated that colonies exposed to less than 8 exposure units were considered "low exposure" while those exposed from 8 to 63 as "high exposure," although the rationale for these groupings was not provided. There was no control - colonies in this study, but only those with "low" exposure denoted as having 8 exposure units or less. Although it was stated that these colonies had no detectable residues of thiamethoxam, it was not stated the number of these colonies, nor was it stated whether these colonies were also devoid of imidacloprid residues, which were detectable in over 75% of the surveyed colonies. The authors reported that there was high variability in the response data for the colony component such that a power analysis indicated that a difference of less than 31% was not detected. Although the study was apparently conducted over two years, there was no mention of overwintering success of the test colonies.	
Field study Seed treatment Honey bee	Test crop: 2010: winter oilseed rape 2012: spring oilseed rape Test species: *Apis mellifera carnica* and *Apis mellifera caucasica* Application rate: Imidacloprid : Chinook Plus 500 FS 2010: 420 g/L, dose 5 ml/kg seed on winter oilseed rape, Chinook 200 FS 100 g/L on spring oilseed rape, dose 20 ml/kg seeds on pring rape; Thiamethoxam: Cruiser OSR 322FS, 280 g/l dose 11.25 ml/kg seeds on winter oilseed rape and spring rape. Clothianidin: Modesto 480 FS, 400 g/l, dose 12.5 ml/ kg Seeds on pring rape.	**REVIEW:** In this study the effects of imidacloprid seed treatment were studied in the field on winter rape in 2010 and spring rape in 2012 in Poland. Beta-cyfluthrin was also applied to the seeds at a rate of 100 g/L. All seed treated plants were also sprayed with a suite of foliar products including thiacloprid and deltamethrin during the growing period. Ten colonies were placed in the vicinity of the treated fields (35 ha in 2010 and 17 ha in 2012) during the flowering period for about 3 weeks. One control group for each of winter rape and spring rape were located in an area where no rape grew. Hives were observed for a period of time including after overwintering in 2010 and until September in 2012. Effects were noted as follows: No treatment-related effects regarding the occurrence of diseases, adult bee mortality, hive strength and brood coverage, and honey and pollen	Pohorecka, K., P. Skubida, A. Miszczak, P. Semkiw, P. Sikorski, K. Zagibajlo, D. Teper, Z. Koltowski, M. Skubida, D. Zdanska and A. Bober. 2012. Residues of neonicotinoid insecticides in bee collected plant

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	Number of hives tested: *For each year/crop:* 1 control field with 15 hives (10 for effects, 5 for pollen load collection) ,1 treatment field with 15 hives: 30 hives total Exposure period: approximately 21 days Observation period: 2010: one year; 2012: four months Effect parameters: occurrence of diseases, bee mortality, hive strength, brood coverage, honey and pollen collecting, pollen species collected Residue samples: nectar from plant, pollen from pollen traps, bee bread, honey, bees Location: Poland Year: 2010 (winter oilseed rape) and 2012 (spring oilseed rape)	collections were seen in honey bee colonies exposed to winter or summer oilseed rape grown from treated seed over an exposure period of 21 days. *Imidacloprid*: Treated hives had positive detections of imidacloprid in nectar and honey, but not in pollen or bees sampled. In samples collected in two years in the treatment, imidacloprid had 21% positive detections in flower nectar, hive nectar and honey samples with a mean of 0.6 ppb (LOD = 0.2 ppb, LOQ = 1 ppb), 0% detections in pollen and bee bread (LOD = 0.8 ppb, LOQ =3 ppb) and 0% detection in bees (LOD = 0.5 ppb, LOQ = 2 ppb). For the treatment on winter rape, imidacloprid was detected 100% samples of hive comb nectar (mean = 0.6 ppb) and hive honey (mean = 0.8 ppb). For the treatment on spring rape, imidacloprid was detected in 10% of hive nectar samples at mean of 0.4 ppb. No detection in any other samples. *Thiamethoxam*: In samples collected in two years in the treatment, thiamethoxam had 65% positive detections in flower nectar, hive nectar and honey samples with a mean of 4.2 ppb (LOD = 0.1 ppb, LOQ = 0.3), 37% detections in pollen and bee bread) with a mean of 3.8 ppb (LOD = 0.3 ppb, LOQ = 1.5 ppb. For the treatment on winter rape, thiamethoxam was detected 100% samples of hive comb nectar (mean = 2.4 ppb) and hive honey (mean = 1.8 ppb). For the treatment on spring rape , thiamethoxam was detected in 100% samples of plant nectar, hive nectar, honey, pollen load , and bee bread at 5.4, 10.3, 7.7, 6.6, and 3.6 ppb respectively. *Clothianidin*: In samples collected in two years in the treatment, clothianidin had 17% positive detections in flower nectar, hive nectar and honey samples with a mean of 2.3 ppb (LOD = 0.5 ppb, LOQ = 2), 11% detections in pollen and bee bread) with mean of 1.8 ppb (LOD = 1 ppb, LOQ = 3). For the treatment on spring rape, clothianidin was detected in 50–100% samples of plant nectar, hive nectar, honey, pollen load, and bee bread at means of 2.6, 1.3, 3.4, 0.6, and 2.2 ppb respectively. **MAJOR UNCERTAINTIES:** Other toxic pesticides were also applied to the treatment fields. The different detection sensitivity of	materials from oilseed rape crops and their effect on bee colonies. Journal of Apicultural Science. 56(2): 115-133.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		each measured chemicals (LOD and LOQ) is expected to impact the detection frequency of the chemicals. The control colonies had high levels of contamination of other pesticides including other neonicotinoids (thiacloprid and acetamiprid). In addition, thiamethoxam was found in samples collected from imidacloprid and clothianidin treatment fields. Imidacloprid was detected in samples that were designed for the thiamethoxam treatment.	
Field study Seed treatment Honey bee	Test crop: corn Test species: *Apis mellifera* Application rate: *2011:* Gaucho 600 FS; 83.3 mL product per 50,000 seeds (600 g a.i./L converts to 1 mg a.i./seed) *2012:* Courase 350 FS; 150 mL product per 50,000 seeds (350 g a.i./L converts to 1.05 mg a.i./seed) Number of hives tested: *For each year/field:* 1 control field with 10 hives,1 treatment field with 15 hives (10 for effects observations, 5 for pollen load collection): 25 hives total Exposure period: approximately 21 days Observation period: *2011:* one year *2012:* four months Effect parameters: number of combs covered by bees and brood, bee mortality, overwintering status, pollen species collected Residue samples: pollen, bee bread Location: Poland Year: 2011–2012	**REVIEW:** This seed treatment field study was conducted in Poland on maize in 2011 and 2012. In 2011 a 36 ha field was treated with imidacloprid at 1 mg a.i./seed. In 2012 a 30 ha maize field was planted with imidacloprid at 1.05 mg a.i./seed. Additionally, all seeds were treated with fungicides and all crops were sprayed one to two months prior to blooming with herbicides. In both years, the blooming period lasted for 21 days. The test fields were adjacent to other flowering agriculture crops. It was not stated how large the control fields were in either year. Effects were noted as follows: No treatment-related effects were significantly different between the control and treated fields for the overall exposure period and follow-up observation period that lasted until after overwintering in the 2011 trial, and until late summer in the 2012 trial. There may have been minimal foraging on corn pollen (a maximum of 2.2% of was collected in bee bread) and exposure to maize pollen appeared low since residue analysis of all matrices tested over both years were below the level of detection (0.8 ppb in pollen). Control samples were contaminated with other neonicotinoids; specifically acetamiprid 0.8-1.7 ng/g, LOD=0.2 ng/g and LOQ=1.0 ng/g and thiacloprid 0.4-1.4 ng/g, LOD=0.4ng/g and LOQ=2.0 ng/g were detected at 60% (1.4 ng/g) and 25% (0.4 ng/g) respectively. **MAJOR UNCERTAINTIES:** Minimal exposure through foraging. A description of the adjacent foraging areas was not provided. Two fungicides, metalaxyl and fludioxinil were seed dressed along with imidacloprid. Metalaxyl is systemic in	Pohorecka, K.,P. Skubida, P. Semkiw, A. Miszczak, D. Teper, P. Sikorski, K. Zagibajlo, M. Skubida, D. Zdanska, A. Bober. 2013. Effects of Exposure of Honey Bee Colonies to Neonicotinoid Seed-Treated Maize Crops. Journal of Apicultural Science. 57 (2) pgs. 199-208. doi: 10.2478/jas-2013-0029.
Field study Seed treatment	Test crop: sunflower Test species: *Apis mellifera* Application rate: Gaucho at 0.24 mg a.i./seed	**REVIEW:** This field study was conducted in sunflower fields grown from seed treated with Gaucho at a rate of 0.24 mg a.i./seed in Buenos Aires, Argentina. Foraging honey bee hives were exposed to sunflowers once 10% of the flowers were in bloom for a total	Stadler, T., D. Martinez-Ginés, M. Buteler. 2003. Long-term toxicity

Study type / Application method / Species	Study Methodology	Review Comments	Reference
Honey bee	Number of hives tested: 1 control field with 8 hives,1 treatment field with 8 hives: 16 hives total Exposure period: 10 days Observation period: 226 days Effect parameters: hive weight, percentage of cells with honey, pollen or brood, bee mortality, foraging activity, pollen loads carried, plant density, amount of plants with pollen Residue samples: soil, sunflower heads, pollen, honey and wax Location: Argentina Year: unknown, paper published in 2003	experimental duration of 10 days. Afterwards the hives were removed from exposure fields and observed for an additional 216 days. This published article seems very similar to the registrant submitted study PMRA# 2351151 that was conducted by the same author. The results have been described separately since it is unclear if this is the same dataset or not. All results from this journal article were presented in either graphical format or as a direction of effect with no numerical value associated with a given parameter. Effects noted as follows: No treatment related adverse effects were observed in the short (10 and 28 days) or in the long-term (216 days) analysis, on the hives exposed to the sunflower plot treated with imidacloprid with seed treatment. The hives in the treatment field had increased average hive weight, honey production, foraging activity, and worker brood and comb foundation probably due to the better physiological state of the treated crop compared to the control. After overwintering the differences in the hives remained the same as during the exposure and observation periods. No residues of imidacloprid (LOD = 1.5, LOQ = 5 ppb) or of olefin-imidacloprid (LOD = 3, LOQ = 10 ppb) and hydroxy-imidacloprid (LOD = 1.5, LOQ = 5 ppb) were detected (< 1.5 ppb) in any of the components of the beehives analyzed 10 days after their exposure to the treated sunflower. No quantifiable levels of imidacloprid residues (< 5 ppb) were found either in soil samples obtained prior to exposure or in pollen, honey and wax after exposure. **MAJOR UNCERTAINTIES:** Summary and numerical data was not reported, only the statistical findings. No information was provided to determine the performance of control hives. Text and statistical summary results are unclear for certain endpoints. Nectar samples were not collected or analysed for exposure.	assessment of imidacloprid to evaluate side effects on honey bees exposed to treated sunflower in Argentina. Bulletin of Insectology 77-81.
Hive monitoring 4 apiaries were monitored: 3 located in a citrus growing area with some fruit orchards and	Test crop: N/A Test species: *Apis mellifera* hives Application rate: guanidine neonicotinoids, including imidacloprid, were temporarily banned in EU during the test period in 2014. It is unclear whether they were actually applied or not in and near the test areas during the test period.	**REVIEW:** Four apiaries in Eastern Spain were monitored: 3 located in a citrus growing area with some fruit orchards and natural vegetation, 1 located in an area with 70% agriculture cover of citrus, peach and farm land. Effects were noted as follows: During the flowering period of peach and plum trees (Between January and the beginning of March), a slight increase of mortality was found in 3/4 apiaries. Increased bee mortality was observed during the citrus	Calatayud-Vernich P., Calatayud, F., Simó, E., Suarez-Varela, M.M., Picó Y. 2015. Influence of pesticide use in fruit orchards during blooming on

Study type / Application method / Species	Study Methodology	Review Comments	Reference
natural vegetation, 1 located in an area with 70% agriculture cover of citrus, peach and farm land Honey bee	Number of hives tested: 2 hives (10 frame Dadant size) with dead bee traps were placed per apiary location Exposure and observation period: from January to June in 2014, including blooming season Effect parameters: mortality Residue analysis: dead honey bees Location: Eastern Spain Year: 2014	flowering (between March and May). However, at the end of citrus blooming season, honey bee mortality decreased below the natural death rate in all apiaries. Pesticide residues were detected in 8/34 dead honey bee samples collected in the traps. Coumaphos, an acaricide used against *Varroa* was the most frequently detected, found in 94% of the samples. Residues of chlorpyrifos and dimethoate, common insecticides usually applied to citrus crops, were detected in 79% and 68% of the samples. Imidacloprid was the 4th most common detected pesticide (LOD = 0.3 ng/g; LOQ=1 ng/g). It was detected in 32% of the samples with an average of 53 ng/g of bee and the maximum of 223 ng/g of bee. Clothianidin was not screened during the study. Thiamethoxam (LOD = 1.3 ng/g; LOQ = 3.9 ng/g) was analyzed but no residues were reported, it is likely it was not detected during the study. There was no confirmation of exposure or positive detections of thiamethoxam. **MAJOR UNCERTAINTIES:** The study did not provide pesticide use information for the test area or the surrounding landscape. Lack of such information makes it difficult to justify its relevance to Canadian use patterns. Citrus, appeared to be a dominate crop in the test areas which is not grown in Canada. The study did not state whether hive building materials or food provisions were tested for pesticide residues before being used in the experiment. The size and pedigree of the test hives was not stated.	honey bee mortality in 4 experimental apiaries. Science of the Total Environment, 541: 33-41. http://dx.doi.org/10.1016/j.scitotenv.2015.08.131
Hive monitoring Honey bee	Test crop: various (cotton, apple, almond, pumpkin, blueberry, alfalfa, cantaloupe, corn) Test species: *Apis mellifera* hives Application rate: not specified, commercial application Number of hives tested: 9-10 queen right colonies in each crop Exposure period: monitoring study, variable Observation period: not reported Effect parameters: number of adult bees, number of worker bees leaving the colony Residues: multipesticide (175) analysis were	**REVIEW:** Changes in the field force populations and in-hive colony adult populations were measured pre- and post-pollination period in association with eight different crops at one location per crop in Pennsylvania, California, and Maine in USA. All colonies were owned and operated by commercial beekeepers except those assessed during apple pollination, that were established from 3-pound packages one month prior to being moved to a commercial apple orchard. A total of 53 different pesticide residues were identified in samples collected across eight crops. Fungicide residues were detected frequently and often were found at higher levels than insecticides. The highest level of imidacloprid was detected in the apple field at 15.9 ppb in trapped pollen along with many other pesticides.	Frazier, M.T., C.A. Mullin, J.L. Frazier, S.A. Ashcraft, T.W. Leslie, E.C. Mussen, and F.A. Drummond. 2015. Assessing Honey Bee (Hymenoptera: Apidae) Foraging Populations And The Potential Impact Of Pesticides On Eight

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	conducted from samples of trapped pollen, dead bees, returning foragers, blooms from in-field crops and off-field plants Location: Pennsylvania, California, and Maine, U.S.A Year: 2009–2010	It was found that the number of departing foragers (the number of worker bees leaving the colony in 3 mins) changed over time during the pollination foraging period in all crops except almonds; General foraging activity patterns included declines (cotton), noticeable peaks and declines (alfalfa, blueberries, cotton, corn, and pumpkins), and increases (apples and cantaloupes). The number of adult bee frames decreased after pollination in cotton and alfalfa fields, but increased or remained stable in all other crops. All colonies in the study were confirmed to be queen-right at the beginning and end of the assessment period. **MAJOR UNCERTAINTIES:** Pesticide use information in the monitoring areas was not available. Contribution of single pesticide to the observation cannot be separated. As a monitoring study there was no control.	U.S. Crops. J. Econ. Entomol. 108(5): 2141–2152 (2015); DOI: 10.1093/jee/tov195
Hive monitoring Colonies were placed in maize fields, 13.2% of the total maize area was treated with imidacloprid Honey bee	Test crop: maize Test species: Honey bee (assumed by reviewer to be *Apis mellifera*) Application rate: monitoring study Number of hives tested: 16 apiaries had 3 hives monitored: 48 hives total Exposure period: monitoring study, variable Observation period: one year Effect parameters: overwintering mortality Residue analysis: honey, wax, bees Location: Belgium Year: 2004–2005	**REVIEW:** This article presented a field monitoring study where 16 apiaries were selected in the southern region of Belgium. In each apiary, 3 hives were randomly selected and visited every 2 months for a year. All treated and untreated maize fields and flowering crops were catalogued in a 3 km radius from the hives. A survey of the area indicated 13.2% of the total maize in a 3 km radius was treated with imidacloprid. Beekeepers were interviewed about their practices and problems and observations were made on colony mortality. Effects were noted as follows: No treatment-related effects were seen in colonies overwintering within a maize growing region of Belgium that had 13.2% of fields grown from treated seed. There were four positive detections of imidacloprid which all came from honey samples that were less than the LOQ value of 0.5 ppb but above the LOD. Residue analysis was not conducted on pollen or bee bread which was expected to be the main route of exposure. **MAJOR UNCERTAINTIES:** The study lacks measurements on imidacloprid contamination of hive pollen (measurement of exposure) and what other sources of forage may be available for the bees near each apiary (as opposed to listing other attractive crops). Experimental colonies were all from existing apiaries and subjected to a wide range of beekeeping management styles. Maize does not produce nectar, yet	Nguyen, B.K., C. Saegerman, C. Pirard, J. Mignon, J. Widart, B. Thirionet, F.J. Verheggen, D. Berkvens, E. De Pauw, E. Haubruge. 2009. Does imidacloprid seed-treated maize have an impact on honey bee mortality? J. Econ. Entomol. 102(2): 616-623.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		the study authors only measured residues in honey, wax, and bees, and simply related pollen loads to those measured in a previous study. The study authors effectively introduce considerable uncertainty in the conclusions of the data by the lack of bee bread and pollen sampling which was expected to be the main source of potential hive contamination. The use of the study is limited given differences in agricultural systems in Canada versus southern Belgium. The exposure level was unclear, in the test area 13.2% of the maize fields were treated with imidacloprid which correlates to only 0.05 to 2.48% of the potential foraging area.	
Hive monitoring Colonies were placed in fields for pollination services in almond, apple, blueberry, cranberry, cucumber, pumpkin and watermelon fields Honey bee	Test crop: almond, apple, blueberry, cranberry, cucumber, pumpkin, and watermelon Test species: *Apis mellifera* Application rate: monitoring study Number of hives tested: 3 fields per crop with 3 hives on each field, 7 different crops: 63 hives total Exposure period: monitoring study, variable Observation period: 3–10 days Effect parameters: pollen species collected Residue samples: pollen Location: USA Year: unknown, paper published in 2013	**REVIEW:** This study surveyed the pollen species and pesticide residues in pollen collected from pollen traps attached to honey bee hives. Hives were placed to provide pollination services at the edge of seven crop fields: almond, apple, blueberry, cranberry, cucumber, pumpkin, and watermelon in the USA. For each crop there were three fields separated by at least 3.2 km from each other. Effects noted as follows: Treatment-related effects were not surveyed in this monitoring study. Honey bees collected a majority of pollen from weeds and wildflowers. Honey bees did collect ≥ 70% of pollen from target crop when placed in almond and apple orchards. Imidacloprid was detected only from apple orchards at a maximum of 36.5ppb (average was 2.8 ppb). **MAJOR UNCERTAINTIES:** There were no controls in this study but rather it was a descriptive study surveying the loads of pesticides in pollen. The study does not relate pollen residues to specific pesticide applications in the target crops. The authors did not sample pollen from nearby blooming weeds to determine the residue levels of where the bees were foraging for the majority of the time. The results of this monitoring study did not take into account the various levels of attractiveness or amount of flowers blooming within each crop. Pollen collection may have occurred not during peak crop bloom. Experimental colonies were all from existing apiaries and subjected to a wide range of beekeeping management styles.	Pettis, J., E. Lichtenberg, M. Andres, J. Stitzinger, R. Rose, D. van Engelsdorp. 2013. Crop pollination exposes honey bees to pesticides which alters their susceptibility to the gut pathogen Nosema ceranae. Plos One, 8, pp 1-9.
Hive monitoring Honey bee, bumble bee and	Test crop: Winter sown oilseed rape Test species: 1. Honey bees and 2. Bumble bees (*audax* (UK) or	**REVIEW:** Honey bees, bumble bees and *Osmia bicornis* were exposed to flowering winter sown oilseed rape treated with either clothianidin, thiamethoxam or a control, in three different locations (Hungary, United Kingdom and Germany) and examined for colony	Woodcock B.A., Bullock, J.M., Shore, R.F., Heard, M. S, Pereira, M.G,

Study type / Application method / Species	Study Methodology	Review Comments	Reference
Osmia bicornis were placed in oilseed rape fields during bloom (from treated seed) in Germany, Hungary and United Kingdom) to examine effects on the colony (reproduction and survival), and also expression of residues. This study assessed interactions between locations, seed treatment and residues. Honey bee, Bumble bee, Solitary bee	*impatienss* (Hungary and Germany), and 3. Solitary bees (*Osmia bicornis*) Application rate and sites: Each block contained 3 sites. Sites were as follows: 1. Clothianidin, Modesto (field application of 11.86 g a.i./ha in UK, 18.05 g a.i./ha in Germany and 17.71 g a.i./ha in Hungary. 2. Thiamethoxam, Cruiser (field application of 10.07 g a.i./ha in UK, 10.61 g a.i./ha in Germany and 11.14 g a.i./ha in Hungary. 3. Control which received oilseed rape with thiram and dimethomorph (Germany and Hungary), or thiram and prochloraz (UK). NOTE: Modesto is combined with fungicide (Thiram and prochloraz and pyrethroid, beta-cyfluthrin), and Cruiser is combined with fungicides fludioxonil and metalaxyl-M. All treatments received lamda-cyhalothrin or tau-fluvalinate and fertilizer. No other oilseed rape fields were within 1.5 km of hives. Number of sites: Germany (9), Hungary (12) and United Kingdom (12) Supplemental feeding and varroa treatment: Yes. Hives were fed a sucrose solution "depending on typical practice in area" and also treated for varroa. Plot size: Sites were separated by 5.47 km and blocks were separated by > 10 km. Number of hives per site:	effects and residues. Residues in bee collected pollen and nectar were variable and typically not correlated to seed treatment. In addition to detection of imidacloprid (which was not part of the seed treatment), control contamination was found at most sites. Compared to Germany and Hungary, the UK honey bees had a narrower diet breadth and there was a shorter flowering period for oilseed rape. For honey bees, the study found both negative (Hungary and United Kingdom) and positive (Germany) effects during crop flowering. In Hungary, negative effects on honey bees (associated with clothianidin) persisted over winter and resulted in smaller colonies in the following spring (24% declines). In the UK, almost all colonies (in control and treatment) died after overwintering (except for one colony which increased in size from a thiamethoxam treated colony). There was a higher incidence of varroa (before overwintering) in the UK sites. In Germany, there were more brood at thiamethoxam and clothianidin treated sites, and more workers at thiamethoxam treated sites. In bumble bees, there were no effects on queen production related to seed treatment or country (Hungary, UK and Germany). However, there was a negative correlation ($p = 0.03$) between queen production and peak nest combined residues (clothianidin, thiamethoxam and imidacloprid). Queen production still remained significant when excluding sites with imidacloprid, suggesting that effects could have been attributed to thiamethoxam plus clothianidin. Regarding worker and colony weight, neonicotinoid (combined clothianidin, thiamethoxam and imidacloprid) exposure had a positive effect on colony size; and drone production was higher from exposure to thiamethoxam in Germany, and lower from exposure to thiamethoxam in United Kingdom ($p = 0.04$). For *Osmia bicornis*, in Hungary, UK and Germany, no effects related to seed treatment or country were noted for egg cell production. However, there was a negative correlation ($p = 0.04$) with peak nest	Redhead, J., Ridding, L., Dean, H, Sleep, D., Henrys, P., Peyton, J., Hulmes, S., Humes, L., Saraspataki, M., Saure, C., Edwards, M., Genersch, E, Knabe, S., and R.F. Pywell. 2017. Country-specific effects of neonicotinoid pesticides on honey bees and wild bees. Science 356, 1393-1395.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	For honey bees: 6 hives per site. For bumble bees: 12 colonies per site. Colonies were clustered into multi-hives (3 colonies in same box). For *Osmia bicornis*: 50 cocoons per site (equal ratio of males to females). Cocoons were in protected release cages next to artificial trap nests (wooden boxes). Number of bees per hives: Honey bees: In Germany (10683 worker bees) and Hungary (8993 worker bees), the same 1 year old colonies were used. In the UK (3294 worker bees) had a different source, with new nuclei colonies produced from young queens. Bumble bees: In Germany colony size was 102.2 workers, in Hungary the colony was 81.2 workers and in UK the colony was 93.6 colonies. *Osmia bicornis*: 50 cocoons per site. Residue collection: pollen and nectar in combs (or individual cells for *osmia*) and collected by honey bees was measured for clothianidin, thiamethoxam and imidacloprid. Pollen identification: yes Exposure period: UK (3 weeks), Germany (6 weeks) and Hungary (6 weeks). Observation period: flowering period of oilseed rape (April to June 2015 – starting 4-7 days after deployment) and again post-winter (March 2016). NOTE: peak counts reflected responses to the oilseed rape crop the first sampling round (undertaken at 4-7 days) was ignored. NOTE: No *Osmia* reproductive cells were produced at 3 sites therefore no samples for residues could be determined for those	combined residues (clothianidin, thiamethoxam and imidacloprid). When excluding sites with imidacloprid, egg cell production was not significantly affected, suggesting that the sum of clothianidin and thiamethoxam residues did not contribute to the effects. **MAJOR UNCERTAINTIES:** Bee hives in the Germany and Hungarian study sites were the same, but bees from the UK site were different, and from new nuclei. Starting hives from UK only had 3294 bees. For bumble bees, a different species was used at the UK sites compared to Hungary and Germany. UK had a higher level of varroa mite infection, and fewer plant species represented by pollen samples. Most hives (from control and treatment hives) from the UK died after overwintering. In addition, the exposure period was shorter in UK owing to the shorter flowering time (3 weeks compared to 6 weeks at other two locations). Therefore, in the study, multiple factors may have affected the bees. Residues collected by bees (for honey bees, bumble bees and osmia) for some control sites had residues of either thiamethoxam and/or clothianidin and/or imidacloprid. In addition, treated sites contained other actives, not applied at those sites. Analysis was done to assess residues and effects. Effects were assessed against the sum of maximum residue concentrations (not minimum or mean values). Overall, the results of the residue portion of the study suggest that there are residues in soil (from previous years use) which translocate to successional growing crops. **It is noted that some scientific criticisms indicate that data was omitted from the article. The review of this study is based on submitted data and the article.**	

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	particular sites. NOTE: A Limit of Quantification (LoQ) for both pollen and nectar samples of 0.53 ng g–1 (Limit of Detection (LoD) = 0.38 ng g–1) was obtained for samples from the honey bee and B. impatiens. For O. bicornis the LoQ was 0.52 ng g–1 (LoD = 0.37 ng g–1). Residues below the LoQ were defined in the data set to be half LoD. Effect parameters: For honey bees: Using the liebefeld count for worker, egg cell, larvae, pupae, male brood and combined storage cells (pollen and nectar), overwintering survival and colony strength. For bumble bees: The first 6 colonies (2 multihives) were collected at the end of the oilseed rape flowering period (UK: 20/5/2015; Hungary: 18-19/5/2016; Germany: 30/5/2015 – 1/6/2016) in order to measure neonicotinoid residues in stored hive products (pollen and nectar). In addition, pollen was collected from the pollen baskets of workers returning to multihives. The remaining six colonies were collected after 51–60 days following their exposure to the treated crop (UK: 9-11/6/2015; Hungary: 17-18/6/2016; Germany: 20-21/6/2016) in order to measure effects on reproductive success. Each colony was dissected and the total number of workers, queens and drones were counted. *Osmia bicornis*: Hives were placed at edge of field. At end of flowering period (June 2015), the 2 trap nests were dissected and counts of number of cells were made. Locations: UK, Hungary and Germany		

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	Year: 2014–2015 (August to March). The final colony assessment in the oilseed rape flowering period was undertaken on 21/5/2015 in the UK, 12/5/2016 in Hungary and 8/6/2016 in Germany. Land survey: Within a 1.5 km radius of each site, a land survey was conducted. Statistical analysis: First the study tested whether continuous covariates describing between site variations in environmental conditions (landscape structure) and neonicotinoid exposure risk explained additional variation over that seen for a country only model. This was done separately for covariate describing neonicotinoid residues in the nests (natural logs of NNImedian and NNIMax), neonicotinoid residues expressed in the oilseed rape crop (natural logs of NNIMax) and landscape percentage cover of oilseed rape and arable crops.		
Field brood/queen study Standard Langstroth frames with the center removed (22x11cm) were implanted with comb blocks of low or high levels of pesticide residues and	Test crop: N/A Test species: *Apis mellifera* hives Application rate: 17 frames were constructed with sections of a contaminated brood comb beside control brood comb and placed into experimental hives; various pesticides at different exposure levels were present in the contaminated brood comb Number of hives tested: 3 hives were used to host 28 experimental frames supporting the paired comb blocks Exposure and observation period: pupation recorded on day 12 and 19, adult emergence from brood comb recorded daily from day	**REVIEW:** Standard Langstroth frames with the center removed (22x11cm) were implanted with comb blocks of low or high levels of pesticide residues and placed in hives with caged queens. Effects were noted as follows: Delayed development of brood reared on the contaminated comb was observed and total larval mortality increased in both the contaminated and control sections of the comb with the repeated use of the experimental frames. Worker bees lived longer when reared on control comb and adult emergence was delayed when reared on contaminated comb. Only 1/13 brood comb samples contained residue levels for clothianidin, imidacloprid and thiamethoxam with LOD=20; levels were 35 ng/g, 45 ng/g, and 38 ng/g, respectively. Pesticide residue transfer from contaminated to control was confirmed with chemical analysis over time.	Wu JY, Anelli CM, and Sheppard WS. 2011. Sub-lethal Effects of Pesticide Residues in Brood Comb on Worker Honey Bee (Apis mellifera) Development and Longevity. PLoS ONE 6(2): e14720.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
placed in hives with caged queens. Honey bee	20 until completion Effect parameters: egg eclosion, larval mortality and development (time from egg to pupae), pupation, adult emergence, adult longevity, signs of pests and diseases Residue analysis: brood comb Location: Beltsville, Maryland Year: May 2008–August 2009	**MAJOR UNCERTAINTIES:** This study did not isolate the effect of residues from thiamethoxam, clothianidin and imidacloprid but with several pesticide residues that were detected in the brood combs. Even though, the residue levels of thiamethoxam, clothianidin and imidacloprid were determined to be 35 ng/g, 45 ng/g, and 38 ng/g, respectively, with LOD = 20 ng/g, the sublethal effects of these insecticides were not solely quantified. It should be noted that the effects were potentially attributed to the residues which were also detected in high amounts in the control combs (coumaphos, coumaphos oxon and fluvalinate). The control brood comb sections had pesticide residues present. Increased brood mortality may have been due to newly drawn combs which lack exuviae that contains brood pheromone cues, the mortality could have also been due to effects on the queen as she lay eggs under exposure. There is overall uncertainty surrounding the crops and exposure scenarios that led to these levels of pesticides in the combs.	
NON-APIS - Tier II Trials			
Tunnel study Imiacloprid: foliar application in greenhouse Bumble bee	Test crop: tomato plant Test species: *Bombus terrestis* (small bumble bee hives with 30 workers + unknown number of pupae + queen) Application rate: four treatments were tested; T1: Untreated check (control). T4: Imidacloprid foliar application, 1 application of 15 g a.i./ha. Number of hives tested: 1st introduction: 1 hive/treatment placed on 9 March – 26 April; 2nd introduction: 1 hive/treatment placed on April 27– 7 June Exposure period: *1st introduction:* T4 applied on 11 March; *2nd introduction:* T4 applied on 29 April; approximately 6 weeks for each introduction Observation period: approximately 6 weeks for each introduction Effect parameters: count of flowers	**REVIEW:** Bumble bee hives were placed in a greenhouse growing tomato crops before foliar applications of 15 g a.i./ha were made twice over the experimental exposure period. This study also looked at effects of thiamethoxam in a different set of colony treatments. Only the imidacloprid results are presented below. Effects were noted as follows: After 6 weeks of exposure, no significant effects were detected in any of the colony parameters in the imidacloprid foliar treatment at 15 g a.i./ha. However, the pollination activity in the treated colonies was reduced based on the fruit set and pollination rate of the tomato plants. Sugar water consumption of the colonies was numerically much lower in the treatment than in the control. **MAJOR UNCERTAINTIES**: For the second hive introduction, carried out in the third month of the crop, it was more difficult to differentiate between the effect of the treatments and the normal decline of hive activity. The pollination activity was very irregular due to a reduction in the flower set, and therefore the results are not as conclusive as for the first hive introductions. In the second	Alarcón AL, Cánovas M, Senn R and Correia R. 2005. The safety of thiamethoxam to pollinating bumble bees (Bombus terrestris L.) when applied to tomato plants through drip irrigation. Commun Agric Appl Biol Sci 70(4):569-579.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	pollinated, fruit setting and fruit development, lifespan of the colony, mortality, sugar water consumption, number and weight of life stages and nest post exposure Location: Spain Year: 2004	introduction, the control hives performed worse than the reference toxicant imidacloprid hives. Statistical analysis was conducted for the pollination rate but there was no mention on what method of statistical analysis was used. Other foliar chemicals were used during the study for pest control which may have affected bees	
Tunnel study foliar spray Bumble bee	Test crop: Tall fescue with 25-50% flowering white clover coverage Test species: *Bombus impatiens* colonies Application rate: Merit 75 WP at a rate of 0.3 lbs a.i./A (336 g a.i./ha) Number of hives tested: 8 control plots, 8 treated plots; 1 hive per plot: 16 hives total Exposure period: 28 days Observation period: 28 days Effect parameters: hive, worker and queen weight, number of workers, brood chambers, honey pots and foraging activity Location: Kentucky, USA Year: 1999	**REVIEW:** Two tunnel studies examined lethal and sublethal effects on *Bombus impatiens* colonies after granular or foliar applications of imidacloprid were applied to weedy turf grass that had blooming white clover. Below is a discussion of the foliar results only. Foliar applications were applied to weedy turf and either irrigated immediately after application with 1.5 cm of water, or allowed to air dry. One day after treatment, colonies containing a fertile queen, 20-25 workers and brood were placed into the tunnels and provisioned with dry bee pollen. Colonies were exposed for 28 days and during that period the total rainfall was 10.1 cm. Effects were noted as follows: Significant reductions were seen in the colony weight, worker weight, number of workers, number of brood chambers, number of honey pots, and foraging activity in the tunnels that received a foliar spray without irrigation being applied afterwards. No effects were seen on the exposed bumble bee colonies for 28 days after a foliar application was followed by irrigation. By following the label directions and irrigating with 1.5 cm of water after foliar application, all lethal and sublethal effects were reduced to unsignificant levels when comparing control colonies to treated colonies. The amount of dead bees found clinging to the side of the tunnel was significantly higher (13.2 ± 2.3) in the non-irrigated treated tunnels when compared to the irrigated (1.0 ± 0.7) and the control (0). No effect on queen weights were seen in the irrigated, non-irrigated or control treatments. **MAJOR UNCERTAINTIES:** Residue levels in white clover pollen and nectar were not measured. There was no information provided on whether spray application equipment was calibrated to ensure proper application rates. There was no information on the source of the bumble bee colonies (for example, the colony genetics, were they healthy and disease-free).	Gels, J., D.W. Held, D.A. Potter. 2002. Hazard of Insecticides to bumble bee Bombus impatiens (Hymenoptera Apidea) Foraging on flowering White Clover Turf. Journal of Economic Entomology. 95(4): 722-728.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
Tunnel study seed treatment Bumble bee	Test crop: sunflower Test species: *Bombus terrestris* Application rate: Gaucho at 0.7 mg a.i./seed Number of hives tested: 1 colony with at least 76 foragers was introduced to greenhouse that contained 24 pots of sunflowers grown from untreated seed and 24 pots of sunflowers grown from treated seed Exposure period: 3 days Observation period: 3 days Effect parameters: number of flowering heads, forager density and duration Location: France Year: 1998	**REVIEW:** This study was also reviewed under registrant submitted studies (PMRA#: 2142738) and has a Tier 3 component as well. Sunflower plants were grown in pots in a greenhouse (3× 6 m) from treated seed. The pots were watered with drip irrigation and bumble bee colonies were introduced to the greenhouse when the plants started to bloom. Effects were noted as follows: No treatment related effects on flower development or foraging were seen in bumble bee colonies exposed to potted sunflower plants grown in a greenhouse from seed treated with 0.7 mg a.i./seed for an exposure period of 3 days. **MAJOR UNCERTAINTIES:** There was no information on the bumble bee colonies or the number of replicates. No residue analysis was conducted to characterize exposure level. This trial was conducted in a greenhouse with plants in pots which can affect residue uptake when compared to field grown plants. Long-term effects were not investigated in the study.	Tasei, J.N., G. Ripault, E. Rivault. 1999. Effects of Gaucho seed coating on bumble bees visiting sunflower. Hazards of pesticides to bees. Avignon (France), September 07 - 09, 1999. Ed. INRA, Paris, 2001 (Les Colloques. no 98)
Tunnel study granular application by hand Bumble bee	Test crop: Tall fescue with 25-50% flowering white clover coverage Test species: *Bombus impatiens* Application rate: Merit 0.5 G at a rate of 0.4 lbs a.i./ A (448.3 g a.i./ha) Number of hives tested: 5 control plots, 5 treated plots; 1 hive per plot: 10 hives total Exposure period: 30 days Observation period: 30 days Effect parameters: hive, worker and queen weight, number of workers, brood chambers, honey pots and foraging activity Location: Kentucky, USA Year: 1999	**REVIEW:** Two tunnel studies examined lethal and sublethal effects on *Bombus impatiens* colonies after granular or foliar applications of imidacloprid were applied to weedy turf grass that had blooming white clover. Below is a discussion of the granular results only. Granular applications were applied by hand to tall fescue with 25-50% flowering white clover coverage and then irrigated almost immediately with 1.5 cm of water. Cages or “tunnels” were put into place in either five control or five treated plots. Seven days after treatment, bumble bee colonies were added. Colonies had a fertilized queen, brood, and 40-50 workers. They were also supplemented with store-bought pollen placed directly into the hives. Over the 30 day exposure period 7.0 cm of rain fell. Effects were noted as follows: No treatment related-effects were seen in colony weight, worker weight, queen weight, number of workers, number of brood chambers, number of honey pots and foraging activity of bumble bee colonies exposed for 30 days to white clover treated with a granular application of 448.3 g a.i./ha followed by irrigation.	Gels, J., D.W. Held, D.A. Potter. 2002. Hazard of Insecticides to bumble bee Bombus impatiens (Hymenoptera Apidea) Foraging on flowering White Clover Turf. Journal of Economic Entomology. 95(4): 722-728.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		MAJOR UNCERTAINTIES: Residue levels in white clover pollen and nectar were not measured. Therefore it is unknown what amount of imidacloprid and what length of time the chemical translocated to pollen and nectar from the granular application. The granular treatment was applied with a gloved hand, and the applicator attempted to achieve equal application but the amount was not sufficiently quantified. The granular application rates used in this study were below the maximum allowed rates permitted in the United States and Canada. There was no information on the source of the bumble bee colonies (for example, the colony genetics, were they healthy and disease-free).	
Open feeding study Artificially fed newly emerged solitary bees were provisioned with spiked pollen Mason bee NOEC: 3 ppb in pollen LOEC: 30 ppb in pollen	Test crop: not applicable, open field Test species: *Osmia lignaria* Application Dose: imidacloprid technical at a rate of 3, 30 and 300 ppb in pollen Number of individuals tested: 3 cohorts of emerging adults were released in batches of ≤ 1000; it is unknown the number of individuals per treatment Exposure period: approximately 30 days Observation period: approximately 30 days Effect parameters: larval development, emergence, bee weight, bee mortality, time in days to reach last larval stage, to spin a cocoon, to darken a cocoon, or to emerge from a cocoon Location: BC, Canada Year: 2005	**REVIEW:** The lethal and sublethal effects of imidacloprid on orchard mason bees (*Osmia lignaria)* were examined in the laboratory and field. Only the field results are discussed below. The study was conducted from April to June 2005, where *O. lignaria* cocoons were placed in mesh cages and incubated until emergence. Emerging adults were released in three staggered batches of up to 1,000 per batch on 27 April, 29 Apriland 11 May 2005 near nest boxes set up adjacent to highbush blueberry fields in BC, Canada. Nests were monitored daily for eggs. The pollen provisions adjacent to newly laid eggs were injected with 10 µL of imidacloprid at 0, 0.1, 1, and 10 ppm (expected concentration in pollen provision to be 0 (control), 3, 30 or 300 ppb respectively) in the field. The eggs were then left in the field to develop under environmental conditions. Effects were noted as follows: No lethal effects of imidacloprid at any of the treatment were detected for *O. lignaria*. Significant differences were seen in the length of time to darken a cocoon in both male and female bees exposed to the 30 ppb pollen treatment. Effects were noted on larval development in *O. lignaria*: 3 ppb in pollen: No effects 30 ppb and 300 ppb in pollen: Delayed time to reach last larval stage in females, and to finishing darkening of cocoons in both males and females. 300 ppb in pollen: Delayed time to reach last larval development stage in males. No treatment-related effects were seen in the time to emerge from cocoon or in weight difference of emerged bees exposed to spiked pollen provisions.	Abbott, V.A., J.L. Nadeau, H.A. Higo, and M.L. Winston. 2008. Lethal and sublethal effects of imidacloprid on Osmia lignaria and clothianidin on Megachile rotundata (Hymenoptera: Megachilidae). J. Econ Entomol. 101(3):784-796.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		MAJOR UNCERTAINTIES: The statistical power was low as a result of small sample sizes. Injected imidacloprid may not have been evenly distributed throughout the spiked pollen provisions. Residue analysis was not conducted to confirm level of exposure. The health of the solitary bees is unknown. Long-term effects were not investigated in the study.	
Closed feeding studies Microcolonies were fed artificially with sugar water spiked with 20 µg imidacloprid/L in 500 mL of sugar water for 11 weeks (77 days); untreated pollen was provided and replaced twice/week. Bumble bee NOEC: <20 ppb in sugar solution, the only test concentration	Test crop: not applicable, colonies were contained in a laboratory Test species: *Bombus terrestris* Application Dose: *Without Foraging Experiment:* 500mL of sugar water containing 20 µg a.i./L was provided for 11 weeks to closed off microcolony nests *With Foraging Experiment:* 500mL of sugar water containing 20 µg a.i./L was provided for 11 weeks to microcolony nests that allowed foraging in a plastic box Number of hives tested: 8 microcolonies (5 workers)/treatment were tested in both the with and without foraging experiments Exposure and observation period: 11 weeks (77 days) Effect parameters: mortality, number and weight of emerged drones Location: reviewer presumed Belgium Year: unknown	**REVIEW:** Bumble bee microcolonies were fed artificially with sugar water spiked with 20 µg imidacloprid/L in 500 mL of sugar water for 11 weeks (77 days); untreated pollen was provided and replaced twice/week. Effects were examined in colonies that were allowed to forage and in those that were not. Effects were noted as follows: After 77 days, survival rates were around 90% for bumble bees exposed to 20 µg imidacloprid/L without foraging access.These results were not statistically different than the untreated control. Numerically, the number of drones produced was lower (42.9) in the microcolonies exposed to imidacloprid without foraging access than those exposed to the control (58.6). Drone weight was not significantly different between the imidacloprid and control treatments. After 77 days, survival rates were around 70% for bumble bees exposed to 20 µg imidacloprid/L with foraging access and not statistically different (but numerically lower) than the untreated control which had about 90% survival rate. Based on visual estimation of a figure, drone production was numerically less (35) in the microcolonies exposed to imidacloprid and foraging accesscompared to the control (60). Drone weight was significantly lower in the bees exposed to imidacloprid when compared to the control. Therefore, after 77 days of exposure in an enclosed chamber, survival rates, bumble bee drone production and drone body weights were reduced in the experimental microcolonies that had access to foraging in a flight arena compared to the microcolonies that did not have flight access. **MAJOR UNCERTAINTIES:** Imidacloprid was only included as a positive control for this study and therefore, only one concentration was tested, precluding the ability to observe whether a dose response was present. Food consumption from the imidacloprid treatment was not recorded. This study utilized microcolonies instead of queen right	Barbosa WF, De Meyer L, Guedes RN, Smagghe G. Lethal and Sublethal Effects of azadirachtin on the Bumble Bee Bombus terestris. Ecotoxicology. 2015 Jan; 24(1):130-42. doi: 10.1007/s10646-014-1365-9

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		bumble bee colonies. It is unclear the overall sensitivity of the colony for certain response variables between a queen-right vs. queenless microcolony. A repellency assay with individual workers as well as effects on ovarian development (from the dominant bumble bee workers within the microcolony) and sperm length of drones was also included but results were not described for the imidacloprid positive control. The reviewer assumed that these colonies were in excellent health prior to the experiment. Nothing was noted by the authors about the quality of the hives prior to the test.	
Closed feeding study Study on individual bee effects may also be considered as a Tier I study Artificially fed colonies with spiked sucrose and untreated pollen were located in wooden next boxes with two chambers inside a laboratory for 42 days Bumble bee NOEC:<10 ppb in sugar solution, the only test concentration	Test crop: not applicable, colonies contained in wooden nest boxes in a laboratory Test species: *Bombus terrestris* Application Dose: 10 ppb spiked sucrose solution was fed to bees inside the colonies every 2-3 days for a total of 42 days; untreated pollen was also provided Number of colonies tested: 8 colonies/treatment Caste of bees tested: adult, workers Exposure and Observation period: observations made daily for 42 days Effect parameters: mean cumulative mortality, mean cumulative worker production Location: Presumed to be in UK Year: unknown, paper published in 2013	**REVIEW:** Bumble bee colonies were artificially fed with sucrose solution containing 10 ppb of imidacloprid and untreated pollen and were located in wooden next boxes with two chambers inside a laboratory for 42 days. In the first week, 10 mL of sucrose solution was provided that was increased by 2 mL for each subsequent week so 20 mL was provided by the 6th and final week. Effects were noted as follows: The growth of the control colonies over time was larger than the growth seen in the treated colonies. Initial mean size of control colonies was 6.5 bees and increased to 49.9 bees. Initial mean size of the treated colonies was 8.3 and increased the mean colony size to 14.3. Mean cumulative mortality was the same between the control colonies (14.6 bees) and the treated (14.3 bees). **MAJOR UNCERTAINTIES:** This study was conducted to generate data for mathematical modelling. High control mortality was seen in some of the test colonies.	Bryden,, J., R.J. Raine and Gill., R A A. Mitton, N.E. Raine, V.A.A. Jansen. 2013. Chronic sublethal stress causes bee colony failure. Ecology Letters, 16: 1463-1469.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
Closed feeding study Artificially fed hives with spiked sucrose solution in the laboratory for 13 days, untreated pollen was provided Bumble bee	Test crop: not applicable, colonies were contained in a controlled environment in a laboratory over the winter months (November 2010 – March 2011) Test species: *Bombus terrestris* Application Concentrations: 0.08, 0.2, 0.51, 1.28, 3.20, 8.0, 20, 50, and 125 µg/L Number of hives tested: 328 workers from 3 colonies were used to create microcolonies of 4-5 workers: total number of microcolonies not stated Exposure period: 13 days Observation period: 14 days Effect parameters: worker fecundity, mean oocyte size in workers, number of mature oocytes, number of eggs laid, size of worker bees, daily pollen and syrup feeding rates Location: Britain, UK Year: 2010–2011	**REVIEW:** The effects of imidacloprid on the reproduction of *Bombus terrestris* were examined using microcolonies of queenless workers. In three trials, 328 workers was randomly grouped to form microcolonies each consisting of four to five workers. The microcolonies were fed over a course of 13 days with a range of imidacloprid concentrations (0.08–125 µg/L) in sucrose solution. Pollen balls without contamination of imidacloprid were provided during the exposure. Consumption was measured daily. All test concentrations in the sugar solution were confirmed by chemical analysis to be reasonably achieved. NOTE: An Erratum to this article was published (2012, 21:1946) that noted some of the µg/L to ppb conversions in the results section were incorrect. The results below include the corrected ppb amounts which do not line up exactly with the application concentrations. Effects were noted as follows: Results showed that no treatment-related adult mortality was detected. The daily feeding rates of the workers on both syrup and pollen declined with increasing imidacloprid concentration. Significant reproductive effects were seen in bumble bee workers that were raised in microcolonies in a laboratory in the absence of a queen and artificially fed sucrose solution of 0.08–125 µg/L over 13 days. Worker fecundity declined with increasing dose of dietary imidacloprid. 0.8 ppb: 42% reduction in worker fecundity ≤ 16 ppb: Developed ovaries and were capable of laying eggs 39 ppb: Developed ovaries but did not lay eggs 98 ppb: Workers did not develop ovaries or lay eggs **MAJOR UNCERTAINTIES:** This study was conducted in a laboratory in a controlled environment during the winter months. This could have caused undue stress to the bees since they could not forage freely and this was temporally not a time when they are naturally active. This study was conducted on worker bumble bees that in the absence of a queen started laying eggs. This may not be representative of actual effects of imidacloprid on colony health or reproduction. The pollen balls provided as a food source were not dosed but were also not tested for any pesticide residues. Long-term effects were not	Laycock I., K.M. Lenthall, A.T. Barratt, J.E. Cresswell. 2012. Effects of imidacloprid, a neonicotinoid pesticide on reproduction in worker bumble bees (Bombus terrestris). Ecotoxicology, 21: 1937—1945.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		investigated in the study.	
Closed feeding study Artificially fed hives with spiked sucrose solution located in a feeder in a greenhouse, untreated pollen was provided Bumble bee NOEC: 2 ppb in sugar solution LOEC: 10 ppb in sugar solution	Test crop: not applicable, colonies contained in a greenhouse Test species: *Bombus terrestris* Application Dose: *Experiment 1:* spiked sucrose solution with Confidor SC (imidacloprid 20%) was fed to micro-colonies at doses 0.2, 2, 10, 20 and 200 ppm and 10 and 20 ppb for 11 weeks (77 days) *Experiment 2:* bees were initially trained to forage to a feeder within an enclosed area that was then filled with spiked sucrose solution with Confidor SC (imidacloprid 20%) at doses 0.2, 2, 10, 20 and 200 ppm and 10 and 20 ppb fed to the micro-colonies for 11 weeks (77 days) *Experiment 3:* 2L of sucrose solution in a feeder tested doses of 2, 10 and 20 ppb Number of colonies tested: *Experiment 1 & 2:* 5 bees in each micro-colony, 4 micro-colonies/treatment; experiment repeated two times *Experiment 3:* three hives/treatment, the experiment was repeated twice Exposure period: 14 days Observation period: *Experiment 1 & 2:* observations made every 3 days for the first 3 observations then weekly for the remainder of the 11 week period *Experiment 3:* 14 days Effect parameters: mortality, hive weight, consumption, foraging activity, drone production Location: Belgium Year: unknown, paper published in 2012	**REVIEW:** Three different types of experiments were conducted in order to assess potential effects of pesticides on bees. Experiment 1 (chronic effects without foraging): spiked sucrose solution was fed to micro-colonies that did not have access to foraging Experiment 2 (chronic effects with foraging): micro-colonies were initially trained to forage to a feeder within an enclosed area that was then filled with spiked sucrose solution Experiment 3: was conducted on full-size colonies placed in a greenhouse exposed for 14 days Effects were noted as follows: *Experiment 1 (without foraging):* 100% mortality was seen after a few hours, 14, 28 and 49 days in the 200, 20, 2 and 0.2 ppm treatments, respectively. 0 and 15% mortality was seen in the 10 and 20 ppb treatments. LC_{50}=59 ppb (estimated by reviewer to be equivalent to 16.3 ng a.i./bee/day) Sublethal effects were evaluated and in the nests exposed to concentrations of imidacloprid up to 0.2 ppm the production of drones was significantly lower. Imidacloprid at 20 and 10 ppb did not pose sublethal effects on the nest reproduction as the respective numbers of drones were not significantly lower. *Experiment 2 (with foraging):* 100% mortality was seen after a few hours, 7, 14 and 49 days in the 200, 20, 2 and 0.2 ppm treatments, respectively. 0% mortality in 10 ppb and 50% in the 20 ppb after 49 days. LC_{50}=20 ppb (estimated by reviewer to be equivalent to 5.54 ng a.i./bee/day). Significant sublethal effects were observed in the nests treated with imidacloprid where at 200, 20, 2 and 0.2 ppm and 20 ppb, 0 ± 0, 0 ± 0, 0 ± 0, 4.8 ± 4.0 and 7.0 ± 6.4 drones were observed, respectively. The total loss with 200, 20 and 2 ppm was due to the high worker mortality. For imidacloprid at 0.2 ppm and 20 ppb, significantly lower numbers of drones were produced as a consequence of the high worker mortality in these nests. In the lowest concentration tested, 10 ppb, significantly lower numbers of drones were observed compared to the controls. *Experiment 3 (with full-size colonies):*	Mommaerts, V., S. Reynders, J. Boulet, L. Besard, G. Sterk, G. Smagghe. 2010. Risk assessment for side-effects of neonicotinoids against bumble bees with and without impairing foraging behavior. Ecotoxicology 19: 207-215.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		Mortality was higher in the 20 ppb (62%) and 10 ppb (92%) treatments compared to the 2 ppb (0%) and control (0%). Total loss of reproduction occurred in the 20 and 10 ppb treatments. No significant differences in hive weight gain, number of workers produced, total amount of brood, amount of sucrose consumed, dead larvae or foraging behaviour was seen between the 2 ppb and control treatments. Residue analysis was not conducted to confirm level of exposure. **MAJOR UNCERTAINTIES:** Large amount of stress may have been put on test organisms due to limited foraging over 11 weeks within a plastic box. The use of workers to test reproductive effects may not be representative of queen behaviour. Long-term effects were not investigated in the study. Residue analysis was not conducted to confirm level of exposure.	
Closed feeding study Artificially fed hives with spiked pollen in the laboratory for 42 days or longer, untreated sucrose solution was pviroded Bumble bee NOEC: 7 ng/g pollen LOEC:30 ng/g in pollen	Test crop: not applicable, colonies were contained in a laboratory Test species: *Experiment 1: Bombus occidentalis* *Experiment 2: Bombus impatiens* Application Dose: *Experiment 1:* 7 ng/g imidacloprid in pollen *Experiment 2:* 7 and 30 ng/g imidacloprid in pollen for both experiments fed twice weekly ad libitum Number of hives tested: *Experiment 1 and 2:* 6 hives per control or treatment tested: 12 hives total Exposure period: *Experiment 1:* assumed to be 82 days *Experiment 2:* assumed to be 42 days Observation period: *Experiment 1:* 82 days *Experiment 2:* assumed to be 42 days Effect parameters: number of workers, brood, queens and males, pollen consumption, weight of newly emerged workers, number of successful flower visits Location: BC, Canada Year: 2001	**REVIEW:** This study was conducted in a laboratory in B.C., Canada on bumble bees. It consisted of two experiments. Experiment 1 looked at the effects of spiked pollen on *Bombus occidentalis* colony health. Each colony had a queen and approximately 5-10 workers that were housed in plastic containers and provided sucrose solution ad libitum and imidacloprid spiked pollen at 7 ng/g provided twice weekly for about 82 days. Experiment 2 looked at the effects of spiked pollen on foraging ability of *Bombus impatiens* on artificial flowers in addition to the colony health conditions. Colonies were fed with pollen spiked with imidacloprid at 7 or 30 ng/g fresh pollen two times per week for about 42 days. Artificial flowers were set up with 1.5 mL microtubes filled with sucrose solution to collect foraging data in the laboratory. Effects were noted as follows: Results showed that in Experiment 1, the mean daily pollen consumption per bee for *Bombus occidentalis* was not significantly different between treatments (0.042 g/bee/day in control; 0.043 g/bee/day in 7 ng/g). No treatment-related effects were seen in the weight of emerged worker bees, number of workers, number of brood, number of queens or males. In Experiment 2, *Bombus impatiens* foragers fed with 30 ng/g in pollen took significantly longer handling time (4.6 seconds) than bees in the control (3.0 seconds) in order to access the nectar at the bottom of the artificial flowers. The foraging rate for bees in the imidacloprid 30 ng/g treatment was 3.07 flowers/minute, significantly less than the foraging rates in the control (4.04 flowers/minute). No effects on the hive conditions were detected.	Morandin L.A., M.L. Winston. 2003. Effects of Novel Pesticides on Bumble Bee (Hymenoptera: Apidae) Colony Health and Foraging Ability. Environmental Ecology; 32 (3), 555-563

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		MAJOR UNCERTAINTIES: It is unknown what impact a long confinement in a laboratory could have had on the hives (at least 42 days). The duration of both experiments is unclear. Details on the queen and number of workers in Experiment 2 were not stated. The use of artificial floral arrays could have affected foraging behaviour. The concentrations of imidacloprid were not analytically verified in the pollen. Only the statistical results were presented instead of the means for all endpoints. Foraging observations took place in late October and November, presumably when the bees were preparing for overwintering. Long-term effects were not investigated in the study.	
Closed feeding study Hives were fed 3 times a week for a total of 77 days with 50% sugar syrup spiked with imidacloprid at rates of 0, 10, 20, 50, 100 ppb; supplemental pollen collected from honey bee pollen traps was combined with a sugar supplement to create a paste that was provided weekly. Bumble bee NOEC: <10 ppb (measured 14 ppb) in sugar solution, the lowest test	Test crop: not applicable, colonies placed in nest boxes attached to flight cages in a greenhouse Test species: *Bombus impatiens* Application rate: hives were fed 50% sugar syrup solution that was contaminated with 0, 10, 20, 50, 100 ppb of either imidacloprid or clothianidin; solution was replenished 3 times a week for a total of 11 weeks (77 days); supplemental pollen collected from honey bee pollen traps was combined with a sugar supplement to create a paste that was provided weekly Number of hives tested: 162 hives (queen + 30–50 workers) were constructed in two attached cages, one for foraging and one for colony development that had a see-through lid; for each dose for both imidacloprid and clothianidin, 8 hives were tested (except for 0 ppb clothianidin where 9 hives were tested; the whole experiment was repeated twice Exposure and observation period: *Imidacloprid:* 1st trial 6 July to 15 September 2011 and 2nd trial 14 September to 23 November 2011 *Clothianidin:* 1st trial 18 January to 30 March 2012 and 2nd trial 12 March to 25	**REVIEW:** *Imidacloprid:* *Queen and brood effects:* Queen effects were noted in queens after 6 and 11 weeks of exposure to 50–100 and 20–100 ppb respectively. Exposure levels are uncertain since no queens were ever observed in the flight box with feeders and the levels of recovered imidacloprid residues from syrup stored in wax cells was lower than target doses. Total brood (alive and dead) was significantly reduced at 50 and 100 ppb treatments and by week 11, the amount of alive brood was significantly reduced at 20-100 ppb when compared to control. No treatment-related effects were noted on daughter queens. *Worker bee and colony effects:* Worker bee movement significantly slowed down at the 20 and 50 ppb treatment and at all treatments, less males were produced. No treatment-related effects were seen in the number of female workers produced, or bee weight. By week 11, colony weight was significantly reduced in all treatments. *Residues and food consumption:* Dose verification confirmed that exposure levels were actually 0, 14, 16, 71 and 127 ppb instead of 0, 10, 20, 50 and 100 ppb. Sugar consumption was significantly lower in all treatments in weeks 2, 6 and 8; but significantly higher in the 0 and 10 ppb treatments in week 4. The weight of the syrup and the number of wax pots added was significantly reduced in the 50 and 100 ppb. *Clothianidin:* *Queen and brood effects:*	Scholer, J and V. Krischik. 2014. Chronic Exposure of Imidacloprid and Clothianidin Reduce Queen Survival, Forgaing, and Nectar Storing in Colonies of *Bombus impatiens*. Published: March 18, 2014 http://dx.doi.org/10.1371/journal.pone.0091573

Study type / Application method / Species	Study Methodology	Review Comments	Reference
concentration	May 2012 Effect parameters: queen status, worker and queen movement (colony was in a box with a see-through plastic lid), syrup consumption, colony weight, number of wax pots and amount of syrup they contained, adult bee and brood counts of alive and dead, forager weight over time Residue analysis: dose verification of sugar syrup and pollen paste, sugar syrup from wax pots Location: Minnesota, USA Year: 2011–2012	Queen effects were noted in queens after 6 and 11 weeks of exposure to 50–100 and 20–100 ppb respectively. Exposure levels are uncertain since no queens were ever observed in the flight box with feeders and the levels of recovered clothianidin residues from syrup stored in wax cells was lower than target doses. Total brood (alive and dead) was significantly reduced at 50 and 100 ppb treatments and by week 11, the amount of alive brood was significantly reduced at 50-100 ppb when compared to control. No treatment-related effects were noted on daughter queens but a decreasing trend was seen. *Worker bee and colony effects:* Worker bee movement significantly slowed down at the 20 and 50 ppb treatment, at 50 and 100 ppb, less males were produced and at 20 ppb, bee weight was significantly lower. No treatment-related effects were seen in the number of female workers produced. By week 11, colony weight was significantly reduced in 20–100 ppb. *Residues and food consumption:* Dose verification confirmed that exposure levels were actually 0, 9, 17, 39 and 76 ppb instead of 0, 10, 20, 50 and 100 ppb. Sugar consumption was significantly lower in all treatments in weeks 2, 6 and 8; but significantly higher in all treatments in week 4. The weight of the syrup and the number of wax pots added was significantly reduced in all clothianidin treatments. **MAJOR UNCERTAINTIES:** Variability in the measured test solutions was observed. It appears that the results of both trials, which were conducted at two different times, were combined for statistical analysis as well as in the presentation of the data in the figures. Given the variability measured in the test solutions, there is uncertainty in the actual doses received between these two trials, and the appropriateness of combining datasets. The limit of quantification or detection (LOQ/LOD) in the stock or test solutions or the syrup in the wax pots was not reported. The study authors state that the colonies were fed untreated sugar syrup for two weeks prior to the start of the study. The reviewer is uncertain what was removed or what had been added prior to this two weeks. The reviewer is uncertain as to why feed consumption was not evaluated past week 8 for an 11 week study. The 100 ppb treatment was removed from the chronic dose effect on worker behaviour analysis as there were too few bees to quantify movement.	

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		The removal of an entire treatment group will affect the overall result analysis. Without the raw data, this data set cannot be re-analyzed properly to include the missing treatment group. The nominal vs measured dose - the differences between these two resulted in a wide exposure range which brings the analysis into question (especially those looking at clothianidin exposure through the wax pots on queen effects where exposure was assumed to be through wax pots only and the recovered residue amount was 0 ppb from the pots for the 50 and 100 ppb nominal treatments). The details on what the bumble bees were foraging on away from the nest are not provided. The reviewer assumed the foraging was contained within the greenhouse on a crop (tomato being the most common) however; there are periods throughout the winter when even a greenhouse crop will not bloom under supplemental light and watering regimes. Trials on clothianidin were conducted during these periods when no bloom is expected in a greenhouse.	
Closed feeding study in sucrose solution Bumble bee	Test crop: tomato *Solanum lycopersicum* Test species: *Bombus impatiens* hives. Application rate: Foraging bees were individually fed with 10 ul of 1M sugar solution containing 0.0515, 0.515, or 5.15 ng of imidacloprid per bee, equivalent to 5.51, 55.1, 551ug/L respectively (estimated to be 4.56, 45.6, 456 ppb by assuming the volume density of the solution to be 1.13 g/ml). Number of bees tested: There were only 15, 23, 5 and 1 bees Exposure period: short, feeding of 10 ul of test solution Observation period: 28 days Effect parameters: sonication behaviors (wingbeat frequency, sonication frequency, or length of sonication) with a shotgun microphone Location: Unknown Year: 2015	**REVIEW:** Bumble bees that consumed 0.515 or 5.15 ng of imidacloprid per bee significantly reduced sonication compared with the control. No effects on sonication behaviour (wingbeat frequency, sonication frequency, or length of sonication) or the likelihood of sonication were found at the treatment of 0.0515 ng imidacloprid per bees on the sonication behaviour compared to the control. Effects on sonication behaviour at 0.515 and 5.15 ng of imidacloprid per bee could not be assessed because there was not a large enough sample size since the bees in these two groups rarely showed buzzing pollination after the treatments. **MAJOR UNCERTAINTIES: low** number of replicates; short exposure period; lack of standard test methodology; the impact of marking and handling bees on the sonication behavior of foragers is unknown.	Switzer, C.M., and Combes, S.A. 2016. The neonicotinoid pesticide, imidacloprid, affects Bombus impatiens (bumble bee) sonication behavior when consumed at doses below the LD50. Ecotoxicology. 25 (6):1150-9. doi: 10.1007/s10646-016-1669-z

Study type / Application method / Species	Study Methodology	Review Comments	Reference
Open feeding study Artificially fed hives *ad libitum* with spiked pollen and sucrose solution in the laboratory prior to being placed in open field for 14 days Bumble bee NOEC: <6 ppb in pollen + 0.7 ppb in sugar solution, the only test concentration	Test crop: not applicable Test species: *Bombus terrestris* Application Dose: 6 ppb in pollen, 0.7 ppb in sugar water Number of hives tested: 3 control hives, 3 treated hives: 6 hives total Exposure period: 14 days Observation period: 28 days Effect parameters: lifespan of a bee, amount and efficiency of nectar and pollen collecting, duration of foraging bouts, weight of pollen collected Location: Scotland, UK Year: 2012	**REVIEW:** In this study bumble bee colonies were fed in the laboratory for 14 days with 6 ppb of imidacloprid in pollen and 0.7 ppb in sugar water prior to being placed outside. Different cohorts were outfitted with Radio Frequency Identification (RFID) tags after a 24 h acclimation period and again 14 days later. Foraging activity was assessed over a four week activity. Effects were noted as follows: Significant sublethal effects were seen in bumble bee pollen forager behaviour after exposure to 6 ppb in pollen and 0.7 ppb in sugar. Treated bees were significantly less likely to return to the nest carrying pollen, the accumulated weight of pollen collected was lower and foraging was less efficient when compared to the untreated bumble bees. There were no treatment-related effects seen in the amount or the efficiency of nectar collecting. Residue analysis was not conducted to confirm level of exposure. **MAJOR UNCERTAINTIES:** Residue analysis was not conducted to confirm level of exposure. Potential of exposure to other pesticides through offsite foraging was not determined. Details about the pollen source were not provided. Long-term effects were not investigated in the study.	Feltham, H., K. Park and D. Goulson. 2014. Field realistic doses of pesticide imidacloprid reduce bumble bee pollen foraging efficiency. Ecotoxicology (2014) 23:317–323.
Open feeding study Artificially fed hives with spiked sucrose solution in open field for unspecified 28 days Bumble bee NOEC: <10 ppb in sugar solution, the only test	Test crop: open field not applicable Test species: *Bombus terrestris* Application Dose: spiked sucrose treatment of 10 ppb was applied every 2 days at the same time of day Number of hives tested: *July and September*: 5 blocks with 1 hive per treatment each: 20 hives total Exposure period: 28 days Observation period: 28 days Effect parameters: size of pollen loads, duration of pollen bout, foragers returning to the wrong colony or getting lost, recruitment of workers into foraging activities, sucrose solution consumption, number of workers, larvae and pupae, bee mortality, queen loss	**REVIEW:** This study exposed 40 bumble bee colonies over 28 days to four different treatments: 1) 10 ppb imidacloprid in sucrose solution administered by a gravity feeder every 2-3 days incrementally increasing in volume, 2) λ-cyhalothrin sprayed on filter paper near feeders and re-applied weekly, 3) A mix of both 1. and 2., and 4) Control. The study employed a split block design due to 20 colonies being tested in July and 20 colonies tested in September 2011. Two-chambered nest boxes containing a queen and on average four workers were used for each colony. The rear chamber housed the nest and the front chamber was used for supplemental feeding. Nest boxes were kept in the laboratory but connected to the outside environment to allow natural foraging. Effects were noted as follows: Significantly greater recruitment of workers into foraging activities, lower worker and combined larvae + pupae production by the end of the experiment, and there was a higher percentage of workers getting	Gill, R.J., O. Ramos-Rodriguez, and N.E. Raine. 2012. Combined pesticide exposure severely affects individual- and colony-level traits in bees. Nature. doi:10.1038/nature11585

Study type / Application method / Species	Study Methodology	Review Comments	Reference
concentration	and presence of pests and diseases Location: Britain, UK Year: 2011	lost in the hives treated with 10 ppb in sucrose solution . Effects were noted in that pollen foraging efficiency was lower in bumble bee colonies exposed to imidacloprid spiked sucrose solution. Queen loss occurred in 14/40 colonies and *Crithidia bombi* was found in 22/40 colonies. **MAJOR UNCERTAINTIES:** The number of larvae and eggs at the study initiation was not reported or analyzed. Lack of such information may impact the accuracy of post-exposure hive condition assessments based on brood. The parasite *Crithidia bombi* was found in some colonies but there was no correlation between infection status and treatment. Residue analysis was not conducted to confirm level of exposure. Long-term effects were not investigated in the study.	
Open feeding study Artificially fed hives with spiked sucrose solution in open field for unspecified 28 days Bumble bee	Test crop: open field not applicable Test species: *Bombus terrestris* Application Dose: spiked sucrose treatment of 10 ppb was applied every 2 days at the same time of day Number of hives tested: *July and September*: 5 blocks with 1 hive per treatment each: 20 hives total Exposure period: 28 days Observation period: 28 days Effect parameters: size of pollen loads, duration of pollen bout, foragers returning to the wrong colony or getting lost, recruitment of workers into foraging activities, sucrose solution consumption, number of workers, larvae and pupae, bee mortality, queen loss and presence of pests and diseases Location: Britain, UK Year: 2011	**REVIEW:** This paper is a follow-up published analysis of the same dataset as was presented in Gill et al. 2012. This study examined the temporal dynamics of how foraging behaviour and performance changed throughout the course of the experiment, specifically looking at acute vs. chronic effects. Effects were noted as follows: Effects were noted that over the 28 day (4-week-long) study, pollen efficiency and colony health parameters slowly declined over time and most effects were not statistically significant until the end of the experimental period. Queen loss occurred in 14/40 colonies and *Crithidia bombi* was found in 22/40 colonies. The authors also made note that as control foragers got older and more experienced, they brought back significantly larger pollen loads however for the imidacloprid foragers there was a significant negative trend between pollen load size and age. There was no significant difference in worker body size between pre-workers and eclosed workers for control or imidacloprid treated bees. **MAJOR UNCERTAINTIES:** The number of larvae and eggs at the study initiation was not reported or analyzed. Lack of such information may impact the accuracy of post-exposure hive condition assessments based on brood. The parasite *Crithidia bombi* was found in some colonies but there was no correlation between infection status and treatment. Residue analysis was not conducted to confirm level of exposure. Long-term effects were not investigated in the study.	Gill R.J., N.E. Raine. 2014. Chronic impairment of bumble bee natural foraging behaviour induced by sublethal pesticide exposure. Funct Ecol 28(6):1459-1471.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
Open feeding study Colonies were artificially fed with 1500 mL of sugar syrup for 43 days that contained either 150 nM chlorpyrifos, 10 nM of imidacloprid, a combination of both, or an untreated control. Colonies could freely forage. Bumble bee NOEC: <2.1 ppb of imidacloprid in sugar syrup, the only test concentration, Reduced nest growth, living bees, brood cell counts	Test crop: not applicable, colonies were placed within a wilderness, enriched grassland habitat Test species: *Bombus terrestris audax* Application Dose: *Experiment 1:* all colonies were provided with 1500 mL of sugar syrup containing one of three treatments: (1) untreated, (2) 150 nM of chlorpyrifos, (3) 150 nM of chlorpyrifos and 10 nM (2.1 ppb) of imidacloprid. and observed after 48 days *Experiment 2:* all colonies were provided with 1500 mL of sugar syrup containing one of three treatments: (1) untreated, (2) 10 nM of imidacloprid and 150 nM of chlorpyrifos, (3) 10 nM of imidacloprid, and observed after 43 days Number of colonies tested: 6 hives/treatment; 3 hives were placed in a Tripol box Exposure period: Unknown Observation period: *Experiment 1:* 48 days (25 April–11 June 2014) *Experiment 2:* 43 days (28 June–9 August 2014) Effect parameters: at the end of the experiment colony mass, total live number of bees, average bee mass, number of healthy brood cells and condition of nest Location: Scotland Year: 2014	**REVIEW:** This study also presents a Tier I acute oral trial which is summarized in the Tier I open literature table. Only the Tier II results are presented below. There were two field experiments conducted in this study but only experiment two contained an imidacloprid only treatment. The data was pooled from both field experiments in the following analyses. In all cases, the authors reported there was no significant impact of chlorpyrifos on the effect parameters. For assessing colony performance, generalized linear mixed models were used and statistically, the interaction between chlorpyrifos and imidacloprid was not significant at the 5% level for any of the analyses, and therefore the authors fit the models without interaction with two exceptions. In 2 cases, number of live bees and final nest mass the interaction was significant at the 10% level, providing weak evidence that the effect of imidacloprid was greater in the presence of chlorpyrifos. Effects were noted as follows: Bumble bee colonies exposed to 2.1 ppb of imidacloprid in sugar syrup, showed reduced nest growth, living bees and brood cell counts after the end of a 43–48 day exposure. There were no differences in the average bee mass for any treatment group. In some of the imidacloprid treatments 150 nM of chlorpyrifos was added to the sugar syrup to try and enhance the acetylcholine exposure and it resulted in interaction effects between the two active ingredients in some parameters tested. Our review suggests this interaction and the fact that data was pooled between two different field experiments separated in time, creates a large amount of uncertainty with this data set. **MAJOR UNCERTAINTIES:** The data analysed for the results was pooled from both experiments despite differences in the treatments (i.e. experiment 1 tested control, chlorpyrifos and a chlorpyrifos/imidacloprid treatment and experiment 2 tested control, imidacloprid and a chlorpyrifos/ imidacloprid treatment). The seasonal timing of the two experiments was different (i.e. experiment 1 from April to June and experiment 2 from June to August) which may have affected what forage was available and the state of the colonies. The nest conditions of the imidacloprid treated hives were severely	Moffat,C., Pacheco,J.G., Sharp,S., Samson,A.J., Bollan,K.A.., Huang,J., Buckland,S.T., Connolly,C.N. 2015. Chronic exposure to neonicotinoids increases neuronal vulnerability to mitochondrial dysfunction in the bumble bee (Bombus terrestris). FASEB J. 29: 2112–2119. doi:10.1096/fj.14-267179

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		compromised by fungal pathogens and some were overrun by wasps (*Vespula vulgaris*); this may or may not have been treatment related. The purpose of adding chlorpyrifos to imidacloprid was to mimic enhanced exposure to acetylcholine however, as noted in the results section, chlorpyrifos may have had a treatment effect in some areas but not all. The location of the study area was typically wet and windy, and there was little garden or commercial forage available. These small deficits in foraging efficiency, compounded over time, may have had a high impact on the test colonies. In addition the duration of feeding provided to the colonies were not specified.	
Open feeding study Hives located in 5 different test locations were fed *ad libitum* sugar syrup spiked with 2.5 ppb of imidacloprid, clothianidin or thiamethoxam over 5 weeks. For the results presented in Table 1 of the study, a quasi-Poisson model with log link function (live bees, brood number and number of queens), a gamma error distribution	Test crop: there were 5 different test locations that ranged from: 1. Wester Ross (the Highlands) a pristine wilderness/enriched grassland habitat 2. University of Dundee Botanic Garden 3. Aberfeldy, near a livestock farming area 4. Perthshire and Fife, an intensively arable landscape Test species: *Bombus terrestris audax* Application rate: sugar syrup was presumed to be fed *ad libitum* for 5 weeks spiked with 2.5 ppb of imidacloprid, clothianidin or thiamethoxam Number of hives tested: 75 colonies were placed at 5 different locations; colonies produced a total of 5884 bees, 5365 brood and 727 queens Exposure and observation period: reviewer assumed 35 days (5 weeks) Effect parameters: nest mass, number of live bees, brood cells and queens at the end of the experiment, weight, cast of bees and male and female proportions at the end of the experiment, queen size estimate (Number of bees >535 mg in size was determined to be a queen) Location: Scotland, UK Year: 2015	**REVIEW:** In this study, the authors compared all three EU-suspended neonicotinoids, IMD, THE and COD, for effects on bumble bees (Bombus terrestris audax) to determine whether they act consistently and in predictable ways, where COD would be expected to be the most toxic, given its higher potency and THE requiring metabolism to COD to exert an identical toxic effect. Based on data collected in the field, a model was then used to estimate percent reduction of live bees for each neonicotinoid. From the results presented, estimates from the model indicate: *Thiamethoxam* • Thiamethoxam fed to the hive in sucrose solution (presumed *ad libitum*) at a dose of 2.5 ppb significantly reduced the number of live bees present at the end of the 5 week exposure period by 38% compared to the control, significantly reduced the number of brood cells at the end of the 5 week exposure period by 70% compared to the control. • The change in nest mass was significantly lower in the thiamethoxam fed hives after a 5 week exposure period by 10% compared to the control. • The proportion of females was significantly lower in the thiamethoxam fed hives by 49% compared to the control at the end of the 5 week exposure period. *Clothianidin* • Clothianidin fed to the hive in sucrose solution (presumed *ad libitum*) at a dose of 2.5 ppb significantly increased the number of queens produced by 266% by the end of the 5 week exposure period when compared to the control. *Imidacloprid*	Moffat C., Buckland S.T., Samson A.J., McArthur R., Pino V.C., Bollan K.A., Huang J.T.J. and C.N. Connolly. 2016. Neonicotinoids target distinct nicotinic acetylcholine receptors and neurons, leading to differential risks to bumble bees. Scientific Reports. 6: 24764. DOI: 10.1038/srep24764

Study type / Application method / Species	Study Methodology	Review Comments	Reference
and log link function (normalized change in nest mass) or a quasi-binomial model with a logit link function (proportion females) was used. Bumble bee NOEC: < 2.5 ppb of imidacloprid in sugar syrup, the only test conentration, reduced number of brood cells .		• Imidacloprid significantly reduced the number of brood cells at the end of the 5 week exposure period by 46% compared to the control. Results indicate that the thiamethoxam treatment is estimated to reduce the number of live bees by 38%, although the corresponding confidence interval only just excludes no effect. There is strong evidence that both IMD and THE significantly reduced number of brood cells (estimated reductions of 46% and 70% respectively). The only apparent effect on the number of queens is a significant increase under treatment COD, relative to the control. **MAJOR UNCERTAINTIES**: There were some Tier I laboratory test results presented in this paper but the materials and methods are not well documented and therefore, are not presented in this data evaluation report. The amount of sugar syrup provided to the hives was not stated, nor was how often the syrup was replenished (for the purpose of this review, we have presumed it was provided *ad libitum*). The size of each apiary location, the distance between them, the number of hives per location and the vegetation details within the foraging range were not provided by the authors. No other colony details for the field study (i.e. source of colonies, health parameters, etc.) were provided by the authors. Colonies were placed in fields from June – September and would have had access to very different forage based on the differences in timing. The authors stated that the estimates of colony performance are likely to be underestimates given the poor performance of the control colonies in 2015 which was attributed to cold weather.	
Open feeding study Artificially fed bumble bee colonies with spiked pollen and sucrose solution for 14 days, colonies were fed	Test crop: open field not applicable Test species: *Bombus terrestris* Application Dose: *Low:* 6 ppb (pollen), 0.7 ppb (nectar) *High:* 12 ppb (pollen) 1.4 ppb (nectar) Number of hives tested: 3 control hives, 3 treated hives: 6 hives total Exposure period: 14 days in lab Observation period: 42 day observation in the field	**REVIEW:** In this study 75 bumble bee colonies were fed for 14 days and divided up into 3 different treatments; untreated, low (6 ppb pollen and 0.7 ppb sugar solution) or high (12 ppb pollen and 1.4 ppb sugar solution) and then placed outside for a 42 day observational period. Effects were noted as follows: Significant effects were seen in the size of bumble bee colonies and the number of queens produced in the hives exposed to both the low (6 ppb pollen and 0.l7 ppb sugar solution) and high (12 ppb pollen and 1.4 ppb sugar solution) treatments compared to the control. Effects were also noted in the lower number of empty pupal cells in the treated hives	Whitehorn, P. R., S. O'Connor, F. L. Wackers, D. Goulson. 2012. Neonicotinoid Pesticide Reduces Bumble Bee Colony Growth and Queen Production. Science 336: 351-

Study type / Application method / Species	Study Methodology	Review Comments	Reference
in the lab and later placed and observed in the field Bumble bee NOEC: < 6 ppb in pollen + 0.7 ppb in sugar solution, the lowest test concentration	Effect parameters: colony weight, number of queens, males, workers, pupae and empty pupal cells Location: England, UK Year: unknown, paper published in 2012	compared to the control. No treatment-related effects were seen in the number of males, workers or pupae exposed to the low or high dose pollen and nectar feeding regimes over a 14 day period. Residue analysis was not conducted to confirm level of exposure. **MAJOR UNCERTAINTIES:** Residue analysis was not conducted to confirm level of exposure. Long-term effects were not investigated in the study.	352.
NON-APIS - Tier III Trial			
Various field studies with different application methods were reviewed for this article.		See non-Apis and Apis information from this study in the section: *Tier III Apis Trials*	Alkassab, A.T and W.H. Kirchner. 2017. Sublethal exposure to neonicotinoids and related side effects on insect pollinators: honey bees, bumble bees, and solitary bees. J. Plant. Dis. Prot. 124: 1-30. DOI 10.1007/s41348-016-0041-0
Hive monitoring Wild bumble bees were collected in five farms and five urban landscapes in East Sussex	Test crop: *Agricultural land:* predominant crops were oilseed rape, winter wheat, spring barley, pasture *Urban land:* ornamental public garden and parks surrounded by houses with private gardens Test species: wild bumble bees: *Bombus hortorum, B. pascuorum, B. terrestris, B. lapidarius* and	**Review:** The EU moratorium on the use of neonicotinoid insecticides started on1 December 2013. Therefore the oilseed rape crops that were in bloom in spring 2014 were sown with seed-treated neonicotinoids. The remaining crops in the agricultural land were assumed to be planted neonicotinoid-free. The use of imidacloprid, clothianidin and thiamethoxam on ornamental plants has been banned since December 2013 so the source of the detected high levels of neonicotinoids in urban garden bees (imidacloprid in particular) was unclear.	Botías, C., A. David, E.M. Hill and D. Goulson. Quantifying exposure of wild bumble bees to mixtures of agrochemicals in agricultural and

Study type / Application method / Species	Study Methodology	Review Comments	Reference
(South-East England, UK), all sites being at least 2 km apart from each other. Bees were collected at three time points: spring (27/04/14 - 14/05/14), early summer (5/06/14 - 23/06/14) and midsummer (15/07/14 - 2/08/14). Bumble bee	*B. pratorum* Application rate: various exposure routes, levels and active ingredients were tested across the different bee species Number of bees tested: 150 bumble bees collected from five farms and five urban landscapes. Exposure period: various Observation period: bumble bee samples were taken 27 April to 14 May 2014 (spring), 5-23 June 2014 (early summer) and 15 July to 2 August 2014 (midsummer). Residues: Ranges, frequencies and average levels of neonicotinoid and fungicide residues detected in wild bumble bee samples Location: South-East England, UK Year: 2014	The residue results show evidence that wild bumble bees are frequently exposed to mixtures of agrochemicals (total over 3 sampling periods: imidacloprid 7.3% detects, thiamethoxam (6%) and clothianidin (1.3%)) when they forage in arable and urban habitats, with peak concentrations decreasing in midsummer. Higher residue levels and more detection frequencies of neonicotinoids were captured from bumble bees exposed to urban gardens (9.3% detection; 10 ng/g of imidacloprid, 2.35 ng/g of thiamethoxam and 1.4 ng/g of clothianidin) than from exposure to agricultural land (2.7% detection). Among the five bumble bee species *B. pratorum*, the species with the smallest body mass and tongue length, had lower residue levels than the other four species. The majority (71.4%) of bees with pesticide detections had more than one compound detected. Many (55.6%) of the bumble bees had detections of neonicotinoids + DMI-fungicides together. DMI-fungicides can act as synergists by inhibiting the detoxification system in bees and thus the insecticide residues are metabolised or eliminated more slowly. **Major Uncertainties:** This study was conducted in UK. Extrapolation of the study to Canadian exposure scenario is uncertain because of the EU moratorium on neonicotinoid use, and because of potential differences in use patterns compared to Canada. It is hard to determine what doses the bees had been exposed to since pesticides are metabolized at varying rates (and we do not know the time of exposure). Therefore the residues we detected represent an unknown proportion of the dose received and actual exposures may have been higher.	urban landscapes, Environmental Pollution (2017), http://dx.doi.org/10.1016/j.envpol.2017.01.001
Field study Seed treatment Bumble bee	Test crop: oilseed rape Test species: *Bombus terrestris audax* Application rate: *Site A:* seed not treated, nearby fields not treated *Site B:* seed treated with Modesto (containing 80 g/L beta- cyfluthrin and 400 g/L clothianidin) at a rate of 0.0225 mg	**REVIEW:** The UK Food and Environment Research Agency (FERA) published a study in 2013 investigating the effects of neonicotinoid seed treatments on bumble bee (*Bombus terrestris*) colonies under field conditions. The study was specifically commissioned in response to the publication of Whitehorn et al. (2012), which described an 85% drop in queen production in bumble bee colonies exposed for 2 weeks to field-realistic levels of imidacloprid. During the exposure phase of the Whitehorn study, the bees were confined and thus had no choice but to	FERA. 2013. Effects of neonicotinoid seed treatments on bumble bee colonies under field conditions. Sand Hutton, York YO41

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	clothianidin/seed; nearby fields within 1 km planted with oilseed rape seed treated with clothianidin or thiamethoxam *Site C:* seed treated with Chinook (containing 100 g/L beta- cyfluthrin and 100 g/L imidacloprid) at a rate of 0.009 mg imidacloprid/seed; nearby fields within 1 km planted with oilseed rape seed treated with clothianidin or thiamethoxam Number of hives tested: *Site A:* 20 colonies; mean of 21 bees/colony *Site B:* 20 colonies; mean of 24 bees/colony *Site C:* 20 colonies; mean of 16 bees/colony Exposure period: *Site A:* 13 April–2 June (50 days) *Site B:* 13 April–2 June (50 days) *Site C:* 26 April–11 June (46 days) Observation period: *Site A:* 60 days *Site B:* 61 days *Site C:* 63 days Effect parameters: foraging activity, forager and nest pollen, colony weight, worker, drone, brood and queen weight was measured at the end of the experiment, nectar and pollen storage cells were measured at the end of the experiment, presence of *Nosema bombi* and/or *Crithidia bombi* in queens at the end of the experiment Residue analysis: nectar and pollen from colonies, nectar and pollen from nearby honey bee colonies, Location: England, UK Year: winter-sown in 2012, experiment in 2013	feed on treated food; the FERA study was an attempt to improve the realism of the experimental design by conducting the exposure phase with free-flying bees in the field. The study concluded that there was no clear relationship between the bumble bee colony performance and the pesticide exposure in the field. This study was subsequently reviewed thoroughly by EFSA (2013) and Goulson (2015) with different conclusions from the study author. As neonicotinoid residues were detected in colonies at all three sites an alternative approach (Residue-based analysis) was used to assess the effects of exposure to residues of thiamethoxam and clothianidin. *Site-based analysis* There were no treatment replicates for treatments in this study. The numbers of colonies within each test site were considered as pseudo replicates for various measurements. *Colony mass over time* There were significant changes in colony mass both between sites and between sites over time. The change in colony mass over time after placement in the field included a significant difference at Site C (imidacloprid mean peak mass = 0.885 kg) compared with Sites A (untreated: 1.130 kg) and B (clothianidin = 1.119 kg) from week 3 onwards. *Foraging activity over time* There was a significantly different pattern of foraging activity between sites and between sites over time with significant differences between colonies at site C and those at the other two sites in weeks 1-3 after placement on the field. The study author stated that the local climatic conditions (Site C flowered later than Sites A and B) during the foraging and colony mass assessment at each site may in part account for these differences. *Colony structure* Site C (imidacloprid) had significantly lower numbers of single occupancy larvae, drone/worker pupae, maximum brood mass increase and brood nest mass at colony dissection when compared to both Site A (untreated) and B (clothianidin). Site B (clothianidin) had significantly lower numbers of workers and nectar cells when	1LZ: Food & Environment Research Agency. Available at http://FERA.co.uk/ccss/documents/defraBumblebeeReportPS2371V4a.pdf AND European Food Safety Authority. 2013. Evaluation of the FERA study on bumble bees and consideration of its potential impact on the EFSA conclusions on neonicotinoids. EFSA Journal 11(6):3242. AND Goulson, D. 2015. Neonicotinoids impact bumble bee colony fitness in the field; a reanalysis of the UK's Food & Environment Research Agency 2012 experiment. Peer J 3:e854

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		compared to the control Site A. *Pollen analysis* Site A: 26% oilseed rape Site B: 20% oilseed rape Site C: 13% oilseed rape *Residue analysis* Pollen and nectar samples taken from colonies. (LOD=0.5 in pollen and 0.025-0.05 µg/kg in nectar) *Thiamethoxam:* Site A (0.885 µg/kg in nectar, 0.730 µg/kg in pollen); Site B (2.397 in nectar, 0.718 in pollen); Site C (no detects in nectar or pollen) *Clothianidin:* Site A (0.057 in nectar, no detects in pollen); Site B (0.204 in nectar, no detects in pollen); Site C: (0.036 in nectar, no detects in pollen) *Imidacloprid:* Site A (no detects in nectar or pollen); Site B (no detects in nectar or pollen); Site C (0.061 in nectar, no detects in pollen) Field samples collected from honey bee colonies. (LOD = 0.5 in pollen and 0.025-0.05 µg/kg in nectar) *Thiamethoxam:* Site A (no detects in nectar, 2.301 µg/kg in pollen); Site B (< LOD in nectar, 2.723 in pollen); Site C (< LOD in nectar and pollen) *Clothianidin:* Site A (no detects in nectar, <LOD in pollen); Site B (0.053 in nectar, 0.718 in pollen); Site C: (0.131 in nectar, < LOD in pollen) *Imidacloprid:* Site A (no detects in nectar, <LOD in pollen); Site B (0.450 in nectar, < LOD in pollen); Site C (0.133 in nectar, < LOD in pollen) <u>*Residue-based analysis*</u> *Thiamethoxam residues in pollen* In 90% and 75% of the simulations there was a significant relationship between the concentration of thiamethoxam in pollen and the final weight of colonies, dropping to 36 and 0% respectively when two "high leverage" colonies were removed. Goulson (2015) challenged the data exclusion and considered that the removal of two colonies of "high leverage" in the analysis not justified since the data points were	

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		not outliers in the formal statistical sense. *Thiamethoxam residues in nectar* Based on the non-parametric approach a significant relationship was identified between residues in nectar and colony mass at the time of sampling but not at the end of the study. Using a parametric approach there was no strong evidence of any relationship with thiamethoxam residues in nectar and colony mass at the time of sampling suggesting the relationship identified was due to differences seen between the sites or in the initial colony sizes. *Clothianidin residues in nectar* Based on the non-parametric approach there was evidence of a relationship between residues in nectar and colony mass at the time of sampling. However, using the parametric approach there was no evidence of any relationship with clothianidin residues in nectar and colony mass at the time of sampling suggesting the relationship was due to differences seen between the sites or in the initial colony sizes. *Queen production* Considering the outcome of parametric and non- parametric approaches, the study author claimed that neither the non-parametric nor the parametric approaches showed evidence of a relationship between queen production and residues of thiamethoxam or clothianidin in nectar or thiamethoxam in pollen. *EFSA review:* Due to the weaknesses of the study design, in particular the lack of an unexposed control, and uncontrolled covariates, EFSA determined that the study did not allow conclusions to be drawn on the effects of neonicotinoid exposed bumble bee colonies, and that the outcome of this study did not impact their previously drawn conclusions on the three neonicotinoid insecticides. EFSA also raised concerns regarding the elaboration and interpretation of the study results prepared by the study author. *Goulson review:* Goulson (2015) published his review of this study using the raw data	

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		provided by the study author and re-analysed using Generalized Linear Models. Goulson viewed the "Site-based analyses" as not informative and the "Residue-based analysis" as not accurately represented and interpreted by the study author. Opposite to the study interpretation made by FERA (2013), based on the outcome of the statistical analysis, Goulson (2015) concluded that the study provided clear evidence that colonies of free-flying bumble bees exposed to neonicotinoids used as part of normal farming practice suffered significant impacts in terms of reduced colony growth and queen production. The data also demonstrated that bumble bees in farmland are exposed to a cocktail of clothianidin and thiamethoxam in both nectar and pollen. **MAJOR UNCERTAINTIES:** The test seed treatment rates were much lower (more than 4 times lower) than the registered rates in Canada on canola for imidacloprid but not for clothianidin. There was a lack of replication. Significant site effects were identified in the study - there was only one site for each treatment and control. There is no true control in the study. Multiple neonicotinoids were detected in the control colonies. The level of contamination in the control was even greater than that in the imidacloprid treatment in many cases. Colonies placed in site C were significantly smaller than that in Site A and B; and the colonies were placed two weeks later in Site C than in Sites A and B due to the late flowering of test crops in the sites. Such differences at the beginning of the study are expected to confound the comparison on the colony development between sites/treatments. The analytical method for thiamethoxam was not validated. The reliability of reported thiamethoxam residues is questionable. The statistical analysis of the results was debated in the published literature.	
Field study Seed treatment Bumble bee	Test crop: sunflower Test species: *Bombus terrestris* Application rate: Gaucho at 0.7 mg a.i./seed Number of hives tested: 1 control field and 1 treated field, with 10 hives each: 20 hives total Exposure period: 9 days Observation period: 26 days Effect parameters: pollen species collected by nectar foragers and pollen foragers,	**REVIEW:** This study was also reviewed under registrant submitted studies (PMRA#: 2142738) and has a Tier 2 component as well. This trial was conducted in West Centre, France where imidacloprid treated sunflower seed was restricted except in one experimental area where 90% of sunflower acreage was treated. This area of 3 km radius contained 440 ha of sunflower and the experimental treated field of 16 ha was in its centre. The control field was 18 ha in size, 20 km away from the treated field, and was in the centre of a 420 ha area of non-treated sunflower plants. On 8 July, 10 July colonies that contained at least 50 workers that were marked were placed in each treated and	Tasei, J.N., G. Ripault and E. Rivault. 1999. Effects of Gaucho seed coating on bumble bees visiting sunflower. Hazards of pesticides to bees. Avignon (France),

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	marked worker count, number of new queens produced, population size and the mating ability of the queens Location: France Year: 1998	untreated field when crops were flowering, and foraging activity was observed. Hives were moved into the lab on 19 July and fed with uncontaminated syrup and pollen paste. Effects were noted as follows: No treatment effects were seen in bumble bee foraging behaviour 9 days after exposure occurred in the control or treated sunflower fields. Bumble bees did forage on sunflower nectar and pollen. Results showed that nectar foragers foraged almost exclusively on sunflower (98% of nectar foragers carried sunflower pollen) while pollen gatherers did not (26% in control, 28% in treated). Colonies in the treated field lost more marked workers (33.5%) than in the control field (23.1%) over 9 days but the difference was not significant. There were no sigficant differences after 26 days of observation in population increase, new queens produced or mating ability of the queens. **MAJOR UNCERTAINTIES:** There was no information on the bumble bee colonies or the number of replicates. There was no statistical analysis. There was potential cross contamination in the control hives and exposure dilution was evident when examining the pollen collected by pollen foragers (but not nectar foragers). No residue analysis was conducted to characterize exposure level. Long-term effects were not investigated in the study.	September 07 - 09, 1999. Ed. INRA, Paris, 2001 (Les Colloques. no 98)
Hive monitoring Honey bee, bumble bee and *Osmia bicornis* were placed in oilseed rape fields during bloom (from treated seed) in Germany, Hungary and United Kingdom) to examine effects on the colony		See non-Apis and Apis information from this study in the section: *Tier III Apis Trials*	Woodcock B.A., Bullock, J.M., Shore, R.F., Heard, M. S, Pereira, M.G, Redhead, J., Ridding, L., Dean, H, Sleep, D., Henrys, P., Peyton, J., Hulmes, S., Humes, L., Saraspataki, M., Saure, C., Edwards, M., Genersch, E, Knabe, S., and R.F. Pywell. 2017. Country-specific

Study type / Application method / Species	Study Methodology	Review Comments	Reference
(reproduction and survival), and also expression of residues. This study assessed interactions between locations, seed treatment and residues. Honey bee, Bumble bee Solitary bee			effects of neonicotinoid pesticides on honey bees and wild bees. Science 356, 1393-1395.

Appendix VI Tier I Default Risk Assessment for Pollinators for Imidacloprid and Its Transformaton Products for Foliar Application, Soil application and Seed Treatment

Table 1 Tier I Default Assessment for imidacloprid Parent

Application method	Application rate (Kg a.i./ha)	Bee stage	Exposure route		Exposure estimate for bees (µg a.i./bee/day)*	Toxicity Endpoint (µg a.i./bee)**	RQs***	Exceed LOC?****
Foliar	0.28125 (Maximum)	adults	Contact	acute	0.675000	0.043	15.7	**Y**
			Oral	acute	8.048250	0.0038	2118.0	**Y**
				chronic	8.048250	0.00016	50301.6	**Y**
		larvae	Oral	acute	3.417750	4.17	0.8	**Y**
				chronic	3.417750	0.0018	1898.8	**Y**
	0.0244 (Minimum)	adults	Contact	acute	0.058560	0.043	1.4	**Y**
			Oral	acute	0.698230	0.0038	183.7	**Y**
				chronic	0.698230	0.00016	4363.9	**Y**
		larvae	Oral	acute	0.296509	4.17	0.1	N
				chronic	0.296509	0.0018	164.7	**Y**
Soil	0.5869 (Maximum)	adults	Oral	acute	0.046250	0.0038	12.2	**Y**
				chronic	0.046250	0.00016	289.1	**Y**
		larvae	Oral	acute	0.019640	4.17	0.0	N
				chronic	0.019640	0.0018	10.9	**Y**
	0.0205 (Minimum)	adults	Oral	acute	0.001615	0.0038	0.43	**Y**
				chronic	0.001615	0.00016	10.1	**Y**
		larvae	Oral	acute	0.000686	4.17	0.0	N
				chronic	0.000686	0.0018	0.38	N
Seed Treatment	0.246	adults	Oral	acute	0.292000	0.0038	76.8	**Y**
				chronic	0.292000	0.00016	1825.0	**Y**
		larvae	Oral	acute	0.124000	4.17	0.0	N
				chronic	0.124000	0.0018	68.9	**Y**

*Exposure estimate for bees (µg a.i./bee):
For contact exposure route: application rate (kg a.i./ha) x 2.4 µg a.i./bee per kg a.i./ha
For oral exposure route:
For foliar application: Application rate (kg a.i./ha)×98 µg a.i./g) ×consumption rate (0.292 g/day for adult bee, 0.124 g/day for larvae)
For soil application: Application rate (kg a.i./ha) ×(Briggs EEC) × consumption rate (0.292 g/day for adult bee, 0.124 g/day for larvae), Log KOW=0.57, KOC=85, 20th% of all 27 KOC values
For seed treatment: (1 µg a.i./g) × consumption rate (0.292 g/day for adult bee, 0.124 g/day for larvae)
**Toxicity Endpoint (µg a.i./bee): LD50 for acute exposure; NOEL for chronic exposure.
***RQ=Exposure estimate for bees / Toxicity Endpoint .
****LOC for bees is set at 0.4 for acute exposure, 1 for chronic exposure. " Y" indicates RQ≥LOC, and risk is identified , "N" indicates RQ>LOC, and risk is not identified.

Table 2 Tier I Default Assessment for Imidacloprid Transformation Products

Chemical	Application method	Application rate (Kg a.i./ha)	Bee stage	Exposure route		Exposure estimate for bees (µg a.i./bee/day)*	Toxicity Endpoint (µg a.i./bee)**	RQs***	Exceed LOC?****
Hydroxy-imidacloprid	Foliar	0.28125	adults	Oral	acute	8.048250	0.151	53.3	**Y**
		0.0244	adults	Oral	acute	0.698230	0.151	4.6	**Y**
	Soil	0.5869	adults	Oral	acute	0.046250	0.151	0.3	N
		0.0205	adults	Oral	acute	0.001615	0.151	0.0	N
	Seed Treatment	0.246	adults	Oral	acute	0.292000	0.151	1.9	**Y**
Olefin-imidacloprid	Foliar	0.28125	adults	Oral	acute	8.048250	0.023	349.9	**Y**
		0.024	adults	Oral	acute	0.698230	0.023	30.4	**Y**
	Soil	0.5869	adults	Oral	acute	0.046250	0.023	2.0	**Y**
		0.0205	adults	Oral	acute	0.001615	0.023	0.1	N
	Seed Treatment	0.246	adults	Oral	acute	0.292000	0.023	12.7	**Y**

*Exposure estimate for bees (µg a.i./bee):
For oral exposure route:
For foliar application: Application rate (kg a.i./ha)×98 µg a.i./g) ×consumption rate (0.292 g/day for adult bee, 0.124 g/day for larvae)
For soil application: Application rate (kg a.i./ha) ×(Briggs EEC) × consumption rate (0.292 g/day for adult bee, 0.124 g/day for larvae), Log KOW=0.57, KOC=85, 20th% of all 27 KOC values

For seed treatment: (1 µg a.i./g) × consumption rate (0.292 g/day for adult bee, 0.124 g/day for larvae)
**Toxicity Endpoint (µg a.i./bee): LD50 for acute exposure.
***RQ=Exposure estimate for bees / Toxicity Endpoint .
****LOC for bees is set at 0.4 for acute exposure. " Y" indicates RQ≥LOC, and risk is identified , "N" indicates RQ>LOC, and risk is not identified.

Table 3. Tier I Default Assessment for Bees for Imidacloprid Off-field Exposure on Plant Surfaces After Foliar Application at the Maximum Labelled Single Application Rate for each applciation method.

Application method (Drift deposition adjustment factor, %)	Maximum label rate (Kg a.i./ha) for foliar application method (crop)	Estimated maximum off-field rate from spray drift (at 1 m down-wind (kg a.i./ha)	Bee stage	Exposure route		Exposure estimate for bees (µg a.i./bee/day)*	Toxicity Endpoint (µg a.i./bee)**	RQs***	Exceed LOC?****
Airblast-Early Season (74)	0.0912 (pome fruit)	0.067488	adults	Contact	acute	0.161971	0.043	3.8	**Y**
				Oral	acute	1.931237	0.0038	508.2	**Y**
					chronic	1.931237	0.00016	12070.2	**Y**
			larvae	Oral	acute	0.820114	4.17	0.2	N
					chronic	0.820114	0.0018	455.6	**Y**
Airblast-Late Season (59)	0.0912 (pome fruit)	0.053808	adults	Contact	acute	0.129139	0.043	3.0	**Y**
				Oral	acute	1.539770	0.0038	405.2	**Y**
					chronic	1.539770	0.00016	9623.6	**Y**
			larvae	Oral	acute	0.653875	4.17	0.2	N
					chronic	0.653875	0.0018	363.3	**Y**
Aerial (26)	0.049 (potato and soybean)	0.01274	adults	Contact	acute	0.030576	0.043	0.7	**Y**
				Oral	acute	0.364568	0.0038	95.9	**Y**
					chronic	0.364568	0.00016	2278.5	**Y**
			larvae	Oral	acute	0.154816	4.17	0.0	N
					chronic	0.154816	0.0018	86.0	**Y**
			adults	Contact	acute	0.074250	0.043	1.7	**Y**

Application method (Drift deposition adjustment factor, %)	Maximum label rate (Kg a.i./ha) for foliar application method (crop)	Estimated maximum off-field rate from spray drift (at 1 m down-wind (kg a.i./ha)	Bee stage	Exposure route		Exposure estimate for bees (µg a.i./bee/day)*	Toxicity Endpoint (µg a.i./bee)**	RQs***	Exceed LOC?****
Ground Field Sprayer (11)	0.28125 (turf)	0.0309375		Oral	acute	0.885308	0.0038	233.0	**Y**
					chronic	0.885308	0.00016	5533.2	**Y**
			larvae	Oral	acute	0.375953	4.17	0.1	N
					chronic	0.375953	0.0018	208.9	**Y**

*Exposure estimate for bees (µg a.i./bee):

For contact exposure route: application rate (kg a.i./ha) x 2.4 µg a.i./bee per kg a.i./ha

For oral exposure route: application rate (kg a.i./ha)×98 µg a.i./g) ×consumption rate (0.292 g/day for adult bee, 0.124 g/day for larvae)

**Toxicity Endpoint (µg a.i./bee): LD_{50} for acute exposure.

***RQ=Exposure estimate for bees / Toxicity Endpoint .

****LOC for bees is set at 0.4 for acute exposure. " Y" indicates RQ≥LOC, and risk is identified , "N" indicates RQ>LOC, and risk is not identified.

Appendix VII Foliar Application: Tier I Acute and Chronic Risk Assessment to Different Honey Bee Castes and Tier II comparison between Measured Residues and Endpoints Determined from Available Colony Feeding Studies for Honey Bees and Bumble Bees for Different Exposure Routes.

		Residues					Tier I Risk Assessment						Tier II Risk Assessment					
		Measured maximum Residues (ppb)		Measured highest mean residue (ppb)		Estimated residues in bee bread (ppb)**	Did acute risk exceeding the LOC (0.4) (acute RQ)			Did chronic risk exceeding the LOC (1.0) (chronic RQ)			Potential for risk for honey bees?			Potential for risk for bumble bees?		Reference (PMRA#)
Application methods	Treatment and residue sampling scenarios	Pollen	Nectar	Pollen	Nectar		Forager	Nurse bee	Larvae	Forager	Nurse bee	Larvae	Pollen route	Nectar Route	Bea bread route	Pollen	Nectar	
Foliar application, during bloom	Cotton, foliar spray during bloom (1 × 71 g a.i./ha). Soil applications in previous years (2 × 140 g a.i./ha per year for 2 years) Sampled 6 days after last foliar application. Pollen residue was not reported in this study, the pollen residues reported in PMRA 2474499 (tested with a similar single foliar application rate) was used for risk assessment	53	61.5	24.8	52.2	69.9	**Yes (4.7)**	**Yes (2.4)**	No (0.0)	**Yes (95.3)**	**Yes (47.2)**	**Yes (3.5)**	**NOEC (Yes)** LOEC (No)	**Yes**	**NOEC (Yes)** LOEC (No)	**Yes**	**Yes**	2287070
foliar application, during bloom	Clover, directly spray on flowering clovers in turf field at 0.45 kg a.i./ha, clover flower nectar hand sampled 1 day after the application	0	7817	0.0	6588.0	7411.5	**Yes (600.7)**	**Yes (288.0)**	No (0.2)	**Yes (12023.1)**	**Yes (5764.5)**	**Yes (439.2)**	NOEC (No) LOEC (No)	**Yes**	**NOEC (Yes)** **LOEC (Yes)**	No	**Yes**	Larson et al. 2015
foliar application, during bloom	Clover, re-blooming clover flower in turf field 1─2 weeks after a spray application at 0.45 kg a.i./ha and irrigated and mowed . Hand collected nectar from clover	0	36	0.0	26.0	29.3	**Yes (2.8)**	**Yes (1.3)**	No (0.0)	**Yes (47.5)**	**Yes (22.8)**	**Yes (1.7)**	NOEC (No) LOEC (No)	**Yes**	**NOEC (Yes)** LOEC (No)	No	**Yes**	Larson et al. 2015
Foliar application, during bloom	Cotton, foliar spray during bloom (3 × 64 g a.i./ha, seasonal of 192 g a.i./ha). Soil applications in previous years (370 g a.i./ha per year for 2 years) Same treatment in two consecutive years, with sampling after each treatment.	1448.8	164	1212.3	147.0	711.3	**Yes (12.6)**	**Yes (9.7)**	No (0.0)	**Yes (268.6)**	**Yes (201.4)**	**Yes (12.2)**	**NOEC (Yes)** **LOEC (Yes)**	**Yes**	**NOEC (Yes)** **LOEC (Yes)**	**Yes**	**Yes**	2548345
Foliar application, during bloom after a soil application	Cotton*, total seasonal rates of 0.55 to 0.57 kg a.i./ha (soil application at 0.37 to 0.38 kg a.i./ha followed by 3 during flowering foliar applications (3 × 0.063 - 0.067 kg a.i./ha), DALA,5 days after the last foliar application, hand-collected floral nectar, extrafloral nectar, pollen. Greater residue values between the extra-floral nectar and floral	43.4	2774.5	258.0	561.5	747.9	**Yes (213.2)**	**Yes (102.3)**	No (0.1)	**Yes (1024.8)**	**Yes (506.8)**	**Yes (37.9)**	**NOEC (Yes)** **LOEC (Yes)**	**Yes**	**NOEC (Yes)** **LOEC (Yes)**	**Yes**	**Yes**	2637324

Application methods	Treatment and residue sampling scenarios	Residues					Tier I Risk Assessment						Tier II Risk Assessment					Reference (PMRA#)
		Measured maximum Residues (ppb)		Measured highest mean residue (ppb)		Estimated residues in bee bread (ppb)**	Did acute risk exceeding the LOC (0.4) (acute RQ)			Did chronic risk exceeding the LOC (1.0) (chronic RQ)			Potential for risk for honey bees?			Potential for risk for bumble bees?		
		Pollen	Nectar	Pollen	Nectar		Forager	Nurse bee	Larvae	Forager	Nurse bee	Larvae	Pollen route	Nectar Route	Bea bread route	Pollen	Nectar	
	nectar was used as nectar residues in the risk assessment. Combination of multiple application methods is not registered for imidacloprid in Canada.																	
Foliar application, during bloom after a soil application	Cotton*, total seasonal rates of 0.55 to 0.57 kg a.i./ha (soil application at 0.37 to 0.38 kg a.i./ha followed by 3 during flowering foliar applications (3 × 0.063 -0.067 kg a.i./ha), DALA,14 days after the last foliar application, hand-collected floral nectar, extrafloral nectar, pollen. Greater residue values between the extra-floral nectar and floral nectar was used as nectar residues in the risk assessment. Combination of multiple application methods is not registered for imidacloprid in Canada.	43.4	127	5.6	21.2	26.4	**Yes (9.8)**	**Yes (4.8)**	No (0.0)	**Yes (38.7)**	**Yes (18.9)**	**Yes (1.4)**	NOEC (No) LOEC (No)	No	**NOEC (Yes)** LOEC (No)	No	**Yes**	2637324
Foliar application, during bloom after a soil application	Tomatoes*, total seasonal rates of 0.55 to 0.56 kg/ha (one soil application at 0.42 to 0.43 kg a.i./ha after transplantation, followed by 2 during flowering foliar applications (2 × 0.065 - 0.070 kg a.i./ha). DALA, 6 days after the last foliar application, pollen collected by Bumble bees (Bombus impatiens) confined in tunnels during flowering period. No nectar data from the study.	1762.5	0	593.2	0.0	267.1	No (0.0)	**Yes (4.5)**	No (0.0)	No (0.2)	**Yes (35.6)**	**Yes (1.2)**	**NOEC (Yes) LOEC (Yes)**	No	**NOEC (Yes) LOEC (Yes)**	**Yes**	No	2637325
Foliar application, during bloom after a soil application	Tomatoes*, total seasonal rates of 0.55 to 0.56 kg/ha (one soil application at 0.42 to 0.43 kg a.i./ha after transplantation, followed by 2 during flowering foliar applications (2 × 0.065 -0.070 kg a.i./ha). DALA, 19 days after the last foliar application, pollen collected by Bumble bees (*Bombus impatiens*) confined in tunnels during flowering period. no nectar data from the study.	354	0	79.0	0.0	35.6	No (0.0)	**Yes (0.9)**	No (0.0)	No (0.0)	**Yes (4.7)**	No (0.2)	**NOEC (Yes)** LOEC (No)	No	**NOEC (Yes)** LOEC (No)	**Yes**	No	2637325
Foliar application, post-bloom	Cherry, Applied at 5 × 112 g a.i./ha post-bloom at intervals of 8-10 days. (seasonal rate 560 g a.i./ha) Year 1 applied in fall after cherry harvest: sampled 205-219 DALA Pollen and nectar from flower	965.4	7.8	509.0	3.4	233.0	**Yes (0.6)**	**Yes (2.7)**	No (0.0)	**Yes (6.3)**	**Yes (33.5)**	**Yes (1.2)**	**NOEC (Yes) LOEC (Yes)**	No	**NOEC (Yes) LOEC (Yes)**	**Yes**	**Yes**	2486614
Foliar application, post-bloom	Cherry, Applied at 5 ×112 g a.i./ha post-bloom at intervals of 8-10 days. (seasonal rate 560 g a.i./ha) Year 2 applied in summer before	50.8	1.3	20.3	1.0	10.3	No (0.1)	No (0.2)	No (0.0)	Yes (1.8)	**Yes (2.1)**	No (0.1)	**NOEC (Yes)** LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	No	2486614

Application methods	Treatment and residue sampling scenarios	Residues					Tier I Risk Assessment						Tier II Risk Assessment					Reference (PMRA#)
		Measured maximum Residues (ppb)		Measured highest mean residue (ppb)		Estimated residues in bee bread (ppb)**	Did acute risk exceeding the LOC (0.4) (acute RQ)			Did chronic risk exceeding the LOC (1.0) (chronic RQ)			Potential for risk for honey bees?			Potential for risk for bumble bees?		
		Pollen	Nectar	Pollen	Nectar		Forager	Nurse bee	Larvae	Forager	Nurse bee	Larvae	Pollen route	Nectar Route	Bea bread route	Pollen	Nectar	
	cherry harvest: sampled 274 – 303 DALA Pollen and nectar from flower																	
Foliar application, post-bloom foliar after a post-bloom soil drip	Apple*, total seasonal rates of 0.56-0.58 kg a.i./ha, (one soil drip application at 0.43-0.44 kg a.i. /ha followed by 2 airblast foliar applications each at 0.07 kg a.i./ha), DALA, 131-287, hand-collected plant nectar and pollen. Combination of multiple application method is not registered for imidacloprid in Canada. Residues resulted from either the soil application or the foliar spray applications only could not be separated.	100	36	24.0	3.0	14.2	**Yes (2.8)**	**Yes (1.6)**	No (0.0)	**Yes (5.5)**	**Yes (4.1)**	No (0.2)	**NOEC (Yes)** LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	**Yes**	2603451
Foliar application, pre-bloom	Sugar melon plants, 4 × 100 g a.i./ha pre-bloom foliar applications, DALA 7 days. Honey bees as additional sampling tools, maximum residues measured in bees nectar and comb pollen	119	14	15.3	5.9	13.5	**Yes (1.1)**	**Yes (0.8)**	No (0.0)	**Yes (10.8)**	**Yes (6.1)**	No (0.4)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	**Yes**	2652475
Foliar application, pre-bloom	Sugar melon plants, 4 × 100 g a.i./ha pre-bloom foliar applications, DALA 5 days. Honey bees as additional sampling tools, maximum residues measured in bees nectar and comb pollen	2.3	1.8	1.5	1.2	2.0	No (0.1)	No (0.1)	No (0.0)	**Yes (2.2)**	**Yes (1.2)**	No (0.1)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2652476
Foliar application, pre-bloom	Soybean (Glycine max.), 2 × 100 g a.i./ha pre-bloom foliar applications, DALA 16 days, honey bees as additional sampling tools, maximum residues measured in bees nectar and comb pollen	0.65	0.65	0.4	0.4	0.6	No (0.0)	No (0.0)	No (0.0)	No (0.7)	No (0.4)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2693159
Foliar application, pre-bloom	Soybean (Glycine max.), 2 × 100 g a.i./ha pre-bloom foliar applications, DALA 26 days, Honey bees as additional sampling tools, maximum residues measured in bee nectar and comb pollen	4.9	2.2	2.8	1.2	2.6	No (0.2)	No (0.1)	No (0.0)	**Yes (2.1)**	**Yes (1.2)**	No (0.1)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2693160
Foliar application, pre-bloom	Citrus, pre-bloom foliar spray (2 × 280.5 g a.i./ha), sampled 3-44 DALA, pollen and nectar from flower.	3705	409	2878.0	301.0	1634.7	**Yes (31.5)**	**Yes (24.4)**	No (0.0)	**Yes (550.1)**	**Yes (436.1)**	**Yes (25.8)**	**NOEC (Yes)** **LOEC (Yes)**	**Yes**	**NOEC (Yes)** **LOEC (Yes)**	**Yes**	**Yes**	2479562
Foliar application, pre-bloom after a seed treatment	Cotton, Foliar spray pre-bloom (5 × 68 g a.i./ha at intervals of 5─8 days, seasonal of 340 g a.i./ha), with the last application at bloom onset. Cotton grown from seed treated with imidacloprid (54 g a.i./ha) Sampled 13─50 DALA. Pollen and nectar from flower.	53	36.9	24.8	27.1	41.7	**Yes (2.8)**	**Yes (1.5)**	No (0.0)	**Yes (49.5)**	**Yes (25.2)**	**Yes (1.9)**	**NOEC (Yes)** LOEC (No)	**Yes**	**NOEC (Yes)** LOEC (No)	**Yes**	**Yes**	2474499
Foliar	Clover,	8.2	2	1.6	1.0	1.8	No (0.2)	No (0.1)	No (0.0)	**Yes**	No (1.0)	No (0.1)	NOEC	No	NOEC (No)	No	No	2474

Application methods	Treatment and residue sampling scenarios	Residues					Tier I Risk Assessment						Tier II Risk Assessment					Reference (PMRA#)
		Measured maximum Residues (ppb)		Measured highest mean residue (ppb)		Estimated residues in bee bread (ppb)**	Did acute risk exceeding the LOC (0.4) (acute RQ)			Did chronic risk exceeding the LOC (1.0) (chronic RQ)			Potential for risk for honey bees?			Potential for risk for bumble bees?		
		Pollen	Nectar	Pollen	Nectar		Forager	Nurse bee	Larvae	Forager	Nurse bee	Larvae	Pollen route	Nectar Route	Bea bread route	Pollen	Nectar	
application, rotational crop	Treated cotton seed planted in 2012 (54 g a.i./ha) followed by foliar applications in 2012 (5 x 68 g a.i./ha). Sampled clover in 2013 at 405─447 DALA. pollen from bees, nectar from flowers									**(1.8)**			(No) LOEC (No)		LOEC (No)			499

* Total imidacloprid (sum of imidacloprid, 5-OH imidacloprid and olefin imidacloprid) is available from the study and is used in the risk calculation for the crop.
** Estimated mean residue in bee bread is calculated using measured highest mean residues from pollen and nectar by: Concentration in fresh bee bread= [0.55 × Concentration in pollen/0.916 + 0.45 × Concentration in Nectar/0.3] × 0.75
DALA = days after last application, LOC = level of concern, RQ = risk quotient.
Text in bold indicate potential for risk.
-For Tier I risk assessment:

- Acute RQ = Acute estimated daily dose (EDD) exposure)/acute toxicity endpoint
  - Acute EDD = nectar dose [nectar consumption rate (mg/day) ×x maximum nectar residue (µg/kg)/ 1.0 × 106] + pollen dose [pollen consumption rate (mg/day) x maximum pollen residue (µg/kg)/1.0 × 106]
  - The honey bee acute oral LD50 = 0.0038 µg a.i./bee for adult, and 4.17 µg a.i./bee for larva.
  - Maximum residues are used for acute risk calculation. For measurement of < LOD or < LOQ, estimated standardized value of ½ LOD or ½ (LOD + LOQ) are used.
- Chronic RQ = Chronic estimated daily dose (EDD) exposure/chronic toxicity endpoint
  - Chronic EDD = nectar dose [nectar consumption rate (mg/day) × highest mean nectar residue (µg/kg)/ 1.0 × 106] + pollen dose [pollen consumption rate (mg/day) x highest mean pollen residue (µg/kg)/1.0 ×106]
  - 10-d NOEL for adults = 0.00016 µg a.i./bee/day for adult worker bees; 21-d NOEL for larvae = 0.0018 µg a.i./larvae/day for bee larvae for TGAI
  - Mean residues are used for chronic risk calculation. For measurement of < LOD or < LOQ, estimated standardized value of ½ LOD or ½ (LOD +LOQ) are used.
- Daily consumption rate for Tier I assessment:
  - Adult worker bees foraging for nectar: 292 mg/day nectar; 0.041 mg/day pollen; 292 mg/day total
  - Adult nurse bees: 140 mg/day nectar; 9.6 mg/day pollen; 149.6 mg/day total
  - Bee larvae: 120 mg/day nectar; 3.6 mg/day pollen; 124 mg/day total

-For Tier II risk assessment:

- Measured imidacloprid concentrations in pollen and nectar and estimated residues in bee bread are compared with the critical colony feeding study effects values for pollen and nectar. “Yes” indicates the measured residue level is greater than the critical effects value and poses potential risk to honey bees; “No” indicates that measured residue level is less than the critical value and likely not pose risk to honey bees. The The highest mean residue values are used.
- The following critical colony effects values are used in the risk assessment after consideration of all available colony feeding studies:
  - For honey bees:
    - Pollen: 20 ppb (NOEC) and 100 ppb (LOEC); values greater than the NOEC are considered to pose potential risk; However, the wide spacing between the NOEC and LOEC and the inconsistent effects observed at the LOEC result in limitations regarding potential effects at the NOEC; thus the pollen LOEC is also used in the pollen risk characterization for pollen exposure route and bee bread exposure route.
    - Nectar: 23.3 ppb (NOEC) and 46.7 ppb (LOEC); values greater than the NOEL are considered to pose potential risk.
  - For bumble bees:
    - Pollen: 6 ppb (LOEC). Effect was detected in a feeding study exposed to a combination of pollen at 6 ppb and 0.7 ppb in nectar (Feltham et al., 2014, Whitehorn et al., 2012).
    - Nectar: 2.5 ppb (LOEC). Effect was reported for exposure to 2.5 ppb imidacloprid in sugar solution after 5 weeks of exposure under open feeding conditions (Moffat et al., 2016).

Appendix VIII Soil Application: Tier I Acute and Chronic Risk Assessment to Different Honey Bee Castes and Tier II comparison between Measured Residues and Endpoints Determined from Available Colony Feeding Studies for Honey Bees and Bumble Bees for Different Exposure Routes.

Application methods	Treatment and residue sampling scenarios	Residues					Tier I Risk Assessment						Tier II Risk Assessment					Reference (PMRA#)
		Measured maximum Residues (ppb)		Measured highest mean residue (ppb)		Estimated residues in bee bread (ppb)**	Did acute risk exceeding the LOC (0.4) (acute RQ)			Did chronic risk exceeding the LOC (1.0) (chronic RQ)			Potential for risk for honey bees?			Potential for risk for bumble bees?		
		Pollen	Nectar	Pollen	Nectar		Forager	Nurse bee	Larvae	Forager	Nurse bee	Larvae	Pollen route	Nectar Route	Bea bread route	Pollen	Nectar	
Soil application, rotational crop	Clover, In-furrow treatment in potato in 1999 at 204 g a.i./ha sampling in 2001 pollen and nectar from bees. (All residues were all < LOQ)	1	1	1.0	1.0	1.6	No (0.1)	No (0.0)	No (0.0)	**Yes (1.8)**	No (0.9)	No (0.1)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2142736
Soil application	Potato . In-furrow treatment at 180 g a.i./ha. Pollen samples collected by free-flying bumble bees during potato flowering period, DALA 68–77 days	1.4	0	0.9	0.0	0.4	No (0.0)	No (0.0)	No (0.0)	No (0.0)	No (0.1)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2535876, 2535875
Soil application	Tomato (coarse textured soil) In-furrow at 1 × 422 g a.i./ha sampled 31–77 DALA, pollen from bees	226	0	185.0	0.0	83.3	No (0.0)	**Yes (0.6)**	No (0.0)	No (0.0)	**Yes (11.1)**	No (0.4)	**NOEC (Yes)** LOEC (Yes)	No	**NOEC (Yes)** LOEC (No)	**Yes**	No	2548347
Soil application	Tomato (medium textured soil), In-furrow at 1 × 422 g a.i./ha sampled 31─77 DALA, pollen from bees	111	0	103.7	0.0	46.7	No (0.0)	No (0.3)	No (0.0)	No (0.0)	**Yes (6.2)**	No (0.2)	**NOEC (Yes) LOEC (Yes)**	No	**NOEC (Yes)** LOEC (No)	**Yes**	No	2548347
Soil application	Tomato (fine textured soil), In-furrow at 1 × 422 g a.i./ha sampled 31─77 DALA, Pollen form anther	162.3	0	101.0	0.0	45.5	No (0.0)	Yes (0.4)	No (0.0)	No (0.0)	**Yes (6.1)**	No (0.2)	**NOEC (Yes) LOEC (Yes)**	No	**NOEC (Yes)** LOEC (No)	**Yes**	No	2548347
Soil application	Tomato (medium textured soil), Chemigation at 1 × 202 g a.i./ha sampled 79–102 DALA,	48.7	0	41.3	0.0	18.6	No (0.0)	No (0.1)	No (0.0)	No (0.0)	**Yes (2.5)**	No (0.1)	**NOEC (Yes)** LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	No	2287073
Soil application	Tomato (heavy soil [fine textured soil]), Chemigation at 2 × 140 g a.i./ha sampled 79–102 DALA, Pollen form anther	26.7	0	23.8	0.0	10.7	No (0.0)	No (0.1)	No (0.0)	No (0.0)	**Yes (1.4)**	No (0.0)	**NOEC (Yes)** LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	No	2287073
Soil application	Melon (medium textured soil), Drip irrigation at 1 × 404 g a.i./ha sampled 125 DALA, pollen and nectar from hive	28.8	6.4	15.0	3.7	10.8	**Yes (0.5)**	No (0.3)	No (0.0)	**Yes (6.7)**	**Yes (4.1)**	No (0.3)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	**Yes**	2287080
Soil application	Melon (heavy soil [fine textured soil]) Drip irrigation at 1 × 404 g a.i./ha sampled at 118 DALA pollen from bees, nectar from in-hive	8.3	2.7	7.5	1.9	5.5	No (0.2)	No (0.1)	No (0.0)	**Yes (3.4)**	**Yes (2.1)**	No (0.1)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	No	2287080
Soil application	Pumpkin Transplant water at 1 × 422 g a.i./ha; sampled approx. 35 DALA pollen and nectar from flower	86.6	11.9	60.9	7.4	35.7	**Yes (0.9)**	**Yes (0.7)**	No (0.0)	**Yes (13.5)**	**Yes (10.1)**	No (0.6)	**NOEC (Yes)** LOEC (No)	No	**NOEC (Yes)** LOEC (No)	**Yes**	**Yes**	Dively and Kamel, 2012
Soil application	Pumpkin Transplant water at 1 × 211 g a.i./ha followed by drip irrigation at 1 × 211 g	101	16	80.2	11.2	48.7	**Yes (1.2)**	**Yes (0.8)**	No (0.0)	**Yes (20.5)**	**Yes (14.6)**	No (0.9)	**NOEC (Yes)** LOEC	No	**NOEC (Yes)** LOEC (No)	**Yes**	**Yes**	Dively and

Application methods	Treatment and residue sampling scenarios	Residues					Tier I Risk Assessment						Tier II Risk Assessment					Reference (PMRA#)
		Measured maximum Residues (ppb)		Measured highest mean residue (ppb)		Estimated residues in bee bread (ppb)**	Did acute risk exceeding the LOC (0.4) (acute RQ)			Did chronic risk exceeding the LOC (1.0) (chronic RQ)			Potential for risk for honey bees?			Potential for risk for bumble bees?		
		Pollen	Nectar	Pollen	Nectar		Forager	Nurse bee	Larvae	Forager	Nurse bee	Larvae	Pollen route	Nectar Route	Bea bread route	Pollen	Nectar	
	a.i./ha; sampled 14 DALA, pollen and nectar from flower												(No)					Kamel, 2012
Soil application	Pumpkin, Transplant water at 1 × 280 g a.i./ha; sampled 35 DALA pollen and nectar from flower	40.1	7.3	36.7	6.1	23.4	**Yes (0.6)**	No (0.4)	No (0.0)	**Yes (11.1)**	**Yes (7.5)**	No (0.5)	**NOEC (Yes)** LOEC (No)	No	**NOEC (Yes)** LOEC (No)	**Yes**	**Yes**	Dively and Kamel, 2012
Soil application	Pumpkin, Soil drench 1 × 30 g a.i./ha; sampled 35 DALA, pollen and nectar from flower (test rate is much less than the maximum Canadian label rate for pumpkin soil application, 280 g a.i./ha), The test rate is lower than almost all Canadian label rates.	6.7	0.5	4.9	0.4	2.7	No (0.0)	No (0.0)	No (0.0)	No (0.7)	No (0.6)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	Dively and Kamel, 2012
Soil application	Squash, Surface spray 358–411 g a.i./ha one day before transplanting, 37–61 DALA, hand-sampled plant pollen and nectar from plant.	28	14	14.0	10.0	17.6	**Yes (1.1)**	**Yes (0.6)**	No (0.0)	**Yes (18.3)**	**Yes (9.6)**	No (0.7)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	**Yes**	
Soil application	Strawberry (light textured soil [coarse soil]), Soil treatment at 1 × 560 g a.i./ha, pollen from plant, -DALA not specified	260.2	0	231.0	0.0	104.0	No (0.0)	**Yes (0.7)**	No (0.0)	No (0.1)	**Yes (13.9)**	No (0.5)	**NOEC (Yes) LOEC (Yes)**	No	**NOEC (Yes) LOEC (Yes)**	**Yes**	No	2287084
Soil application	Strawberry(medium textured soil), Soil treatment at 1 × 560 g a.i./ha, pollen from plant, - DALA not specified	6.5	0	6.4	0.0	2.9	No (0.0)	No (0.0)	No (0.0)	No (0.0)	No (0.4)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	No	2287084
Soil application	Blueberry, Post-bloom band application at 1 × 561 g a.i./ha; post-harvest; sampled 200 DALA, pollen from bees, nectar from hive	38.5	13.8	14.8	7.5	15.1	**Yes (1.1)**	**Yes (0.6)**	No (0.0)	**Yes (13.7)**	**Yes (7.5)**	No (0.5)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	**Yes**	2486615
Soil application	Citrus, Various application scenarios including soil drench at 1 × 280 or 1 × 560 g a.i./ha. Samples taken following year 200-233 pollen and nectar from hive	6.58	54.1	6.2	29.9	36.4	**Yes (4.2)**	**Yes (2.0)**	No (0.0)	**Yes (54.6)**	**Yes (26.5)**	**Yes (2.0)**	NOEC (No) LOEC (No)	**Yes**	**NOEC (Yes)** LOEC (No)	**Yes**	**Yes**	2287076
Soil application	Cotton (coarse textured soil), In-furrow application at 1× 370 g a.i./ha. Sampling at 70–95 DALA pollen from flower, nectar from hive	42.5	123.4	40.2	80.9	109.1	**Yes (9.5)**	**Yes (4.7)**	No (0.0)	**Yes (147.7)**	**Yes (73.2)**	**Yes (5.5)**	**NOEC (Yes)** LOEC (No)	**Yes**	**NOEC (Yes) LOEC (Yes)**	**Yes**	**Yes**	2548345
Soil application	Cotton (medium textured soil), In-furrow application at 1 × 370 g a.i./ha. Sampling at 70–95 DALA pollen and nectar from flower	1	17.1	0.6	17.1	19.5	**Yes (1.3)**	**Yes (0.6)**	No (0.0)	**Yes (31.2)**	**Yes (15.0)**	**Yes (1.1)**	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	**Yes**	2548345
Soil application	Cotton (fine textured soil), In-furrow application at 1 × 370 g a.i./ha. Sampling at 70-95 DALA pollen from flower, nectar from hive	1.3	1.5	0.8	1.5	2.0	No (0.1)	No (0.1)	No (0.0)	**Yes (2.7)**	**Yes (1.4)**	No (0.1)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2548345
Soil application	Melon (medium textured soil). Seed-line soil drench in cantaloupe in 2009 at 1 × 258 g a.i./ha + 1 × 314 g a.i./ha and 2010 at 1 × 314 g a.i./ha. No imidacloprid use in 2011. Sampling in 2011 at 199 DALA, pollen from traps, nectar form in-hive	9.6	0.3	9.2	0.3	4.4	No (0.0)	No (0.0)	No (0.0)	No (0.5)	No (0.8)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	No	2287080

Application methods	Treatment and residue sampling scenarios	Residues					Tier I Risk Assessment						Tier II Risk Assessment					Reference (PMRA#)
		Measured maximum Residues (ppb)		Measured highest mean residue (ppb)		Estimated residues in bee bread (ppb)**	Did acute risk exceeding the LOC (0.4) (acute RQ)			Did chronic risk exceeding the LOC (1.0) (chronic RQ)			Potential for risk for honey bees?			Potential for risk for bumble bees?		
		Pollen	Nectar	Pollen	Nectar		Forager	Nurse bee	Larvae	Forager	Nurse bee	Larvae	Pollen route	Nectar Route	Bea bread route	Pollen	Nectar	
Soil application and foliar applications (average of post-bloom in two years)	Cherry, plum, apricot and peach*, Post-bloom application (average of two-year data using post-harvest and pre-harvest treatments), total seasonal rates of 0.56–0.57 kg a.i./ha (one soil drip application at 0.42 to 0.43 kg a.i. /ha followed by 2 airblast foliar applications each at 0.065 to 0.071 kg a.i./ha). DALA, 133–323, hand-collected plant nectar and pollen. *Residue resulting from soil application or foliar application alone could not be separated. Combination of multiple application method is not registered for imidacloprid in Canada.	340	34	50.0	5.0	28.1	**Yes (2.6)**	**Yes (2.1)**	No (0.0)	**Yes (9.1)**	**Yes (7.4)**	No (0.4)	**NOEC (Yes)** LOEC (No)	No	**NOEC (Yes)** LOEC (No)	**Yes**	**Yes**	2603450
Soil application and foliar applications, all post harvesrt application	Cherry, plum, apricot and peach*, Post-bloom (Post-fruit harvest); total seasonal rates of 0.56–0.57 kg a.i./ha (one soil drip application at 0.42 to 0.43 kg a.i. /ha followed by 2 airblast foliar applications each at 0.065 to 0.071 kg a.i./ha). DALA, 133–160, hand-collected plant nectar and pollen. *Residue resulting from soil application or foliar application alone could not be separated. Combination of multiple application method is not registered for imidacloprid in Canada.	340	34	69.0	7.0	38.9	**Yes (2.6)**	**Yes (2.1)**	No (0.0)	**Yes (12.8)**	**Yes (10.3)**	No (0.6)	**NOEC (Yes)** LOEC (No)	No	**NOEC (Yes)** LOEC (No)	**Yes**	**Yes**	2603450
Soil application and foliar applications, all pre-harvesrt application	Cherry, plum, apricot and peach*, Post-bloom (Pre-fruit harvest); total seasonal rates of 0.56–0.57 kg a.i./ha (one soil drip application at 0.42 to 0.43 kg a.i. /ha followed by 2 airblast foliar applications each at 0.065 to 0.071 kg a.i./ha). DALA, 211–291, hand-collected plant nectar and pollen. *Residue resulting from soil application or foliar application alone could not be separated. Combination of multiple application method is not registered for imidacloprid in Canada.	190	11	33.0	2.0	17.1	**Yes (0.8)**	**Yes (0.9)**	No (0.0)	**Yes (3.7)**	**Yes (3.7)**	No (0.2)	**NOEC (Yes)** LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	No	2603450
Soil application and seed treatment, rotational crops	Phacelia, Mustard, and Maize. 87.3 g a.i./ha soil application plus 85.8 g a.i./ha seed treatment with barley 10 days after soil application. DALA: 288–394 days after soil, confined honey bees as additional sampling tools in tunnel of rotation crop for pollen and nectar.	5.1	3.9	2.2	2.1	3.3	No (0.3)	No (0.2)	No (0.0)	**Yes (3.7)**	**Yes (1.9)**	No (0.1)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2513416

Application methods	Treatment and residue sampling scenarios	Residues					Tier I Risk Assessment						Tier II Risk Assessment					Reference (PMRA#)
		Measured maximum Residues (ppb)		Measured highest mean residue (ppb)		Estimated residues in bee bread (ppb)**	Did acute risk exceeding the LOC (0.4) (acute RQ)			Did chronic risk exceeding the LOC (1.0) (chronic RQ)			Potential for risk for honey bees?			Potential for risk for bumble bees?		
		Pollen	Nectar	Pollen	Nectar		Forager	Nurse bee	Larvae	Forager	Nurse bee	Larvae	Pollen route	Nectar Route	Bea bread route	Pollen	Nectar	
Soil application, drench/drip	Tomatoes*, total seasonal rates of 0.55 to 0.56 kg/ha (one soil application at 0.42 to 0.43 kg/ha after transplantation, followed by 2 foliar during flowering: 2 × 0.065 - 0.070 kg/ha). DALA, 62 between soil application and sampling before 1st foliar application), Pollen collected by Bumble bees (Bombus impatiens) confined in tunnels during flowering period. no nectar data from the study.	138.3	0	40.4	0.0	18.2	No (0.0)	No (0.3)	No (0.0)	No (0.0)	**Yes (2.4)**	No (0.1)	**NOEC (Yes)** LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	No	2637325
Soil application, wildflowers	Wildflowers (off-field) In-furrow treatment in potato 2000 at 204 g a.i./ha sampling in 2001 , + in-furrow treatment in potato in 2001 at 204 g a.i./ha sampling in 2001 (residues in flowers. All residues were all < LOQ)	1	0	1.0	1.0	1.6	No (0.0)	No (0.0)	No (0.0)	Yes (1.8)	No (0.9)	No (0.1)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2142736
Soil application, **drench**	Sugar melon plants. Drench at 210 g imidacloprid a.s./ha, DALA, 27–40 days, Honey bees as additional sampling tools in tunnel, residues in nectar from bees (greater than in comb nectar) and comb pollen were used in RQ calculation	27	9	11.9	3.9	9.7	**Yes (0.7)**	No (0.4)	No (0.0)	**Yes (7.1)**	**Yes (4.1)**	No (0.3)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	**Yes**	2652475
Soil application, **drench**	Sugarmelon plants. Drench at 210 g imidacloprid a.s./ha, DALA, 26–37 days, Honey bees as additional sampling tools in tunnel, residues in nectar from bees (greater than in comb nectar) and comb pollen were used in RQ calculation	1.9	1.8	1.0	1.3	1.9	No (0.1)	No (0.1)	No (0.0)	**Yes (2.4)**	**Yes (1.2)**	No (0.1)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2652476
Soil application, drench/drip	Cotton*, total seasonal rates of 0.55 to 0.57 kg a.i./ha (soil application at 0.37 to 0.38 kg a.i./ha followed by 3 during flowering foliar applications (3 × 0.063 -0.067 kg a.i./ha, DALA, 81 (between soil application and sampling before 1st foliar application), hand-collected floral nectar, extrafloral nectar, pollen. *Residues in floral nectar was used as nectar residues in the RA calculation,as it is greater than that in the extrafloral nectar. Combination of multiple application method is not registered for imidacloprid in Canada.	43.4	127	5.6	21.2	26.4	**Yes (9.8)**	**Yes (4.8)**	No (0.0)	**Yes (38.7)**	**Yes (18.9)**	**Yes (1.4)**	NOEC (No) LOEC (No)	No	**NOEC (Yes)** LOEC (No)	No	**Yes**	2637324
Soil application, drench/drip	Tomatoes*, total seasonal rates of 0.55 to 0.56 kg/ha (one soil application at 0.42 to 0.43 kg/ha after transplantation, followed by 2 during flowering foliar applications (2 × 0.065 - 0.070 kg/ha). DALA, 48 between soil application and sampling before 1st foliar application), pollen collected by Bumble bees (*Bombus impatiens*) confined in tunnels during flowering period, no nectar data from the study.	679.2	0	106.9	0.0	48.1	No (0.0)	**Yes (1.7)**	No (0.0)	No (0.0)	**Yes (6.4)**	No (0.2)	**NOEC (Yes) LOEC (Yes)**	No	**NOEC (Yes)** LOEC (No)	**Yes**	No	2637325

Application methods	Treatment and residue sampling scenarios	Residues					Tier I Risk Assessment						Tier II Risk Assessment					Reference (PMRA#)
		Measured maximum Residues (ppb)		Measured highest mean residue (ppb)		Estimated residues in bee bread (ppb)**	Did acute risk exceeding the LOC (0.4) (acute RQ)			Did chronic risk exceeding the LOC (1.0) (chronic RQ)			Potential for risk for honey bees?			Potential for risk for bumble bees?		
		Pollen	Nectar	Pollen	Nectar		Forager	Nurse bee	Larvae	Forager	Nurse bee	Larvae	Pollen route	Nectar Route	Bea bread route	Pollen	Nectar	
Soil application, **dripping**	Sugarmelon plants, Dripping at 210 g imidacloprid a.s./ha, DALA, 27–40 days, Honey bees as additional sampling tools in tunnel, residues in nectar from bees (greater than in comb nectar) and comb pollen were used in RQ calculation	27	16	10.6	4.8	10.2	**Yes (1.2)**	**Yes (0.7)**	No (0.0)	**Yes (8.8)**	**Yes (4.8)**	No (0.3)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	**Yes**	2652475
Soil application, **dripping**	Sugarmelon plants. Dripping at 210 g imidacloprid a.s./ha, DALA, 26–37 days, Honey bees as additional sampling tools in tunnel, residues in nectar from comb (greater than in bees) and comb pollen were used in RQ calculation	1.1	2.4	0.9	1.4	2.0	No (0.2)	No (0.1)	No (0.0)	**Yes (2.6)**	**Yes (1.3)**	No (0.1)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2652476
Soil application	Pumpkin*, Residues from a field effect study. Soil treated at 0.43 kg/ha at six true leaf stage (BBCH16). Plant pollen and nectar sampled from flowers. DALA: 26–82 days	15.8	5.1	5.7	2.1	4.9	No (0.4)	No (0.2)	No (0.0)	**Yes (3.8)**	**Yes (2.2)**	No (0.2)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2757276
Soil application	Cotton* Residues from a field effect study. Various application methods (air, drip, and ground applications), rates (ranging 0.07–0.50 kg a.i./ha). Plant pollen and nectar sampled from flowers. DALA: 18-30 days (excluding a mistreated site)	8.7	36.3	3.5	12.9	16.1	**Yes (2.8)**	**Yes (1.4)**	No (0.0)	**Yes (23.5)**	**Yes (11.5)**	No (0.9)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	**Yes**	2737113
Soil application, rotational crop	Rotational crops (phacelia, mustard or corn), Soil application at 95.4 g a.i./ha or 173.4 g a.i./ha + winter barley seed treatment at 0.014–0.023 mg a.i./seed (62.5–63.2 g a.i./ha), pollen from in hive, nectar from bees	1	0.63	0.8	0.5	1.0	No (0.0)	No (0.0)	No (0.0)	No (1.0)	No (0.5)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2535897

* Total imidacloprid (sum of imidacloprid, 5-OH imidacloprid and olefin imidacloprid) is available from the study and is used in the risk calculation for the crop.
** Estimated mean residue in bee bread is calculated using measured highest mean residues from pollen and nectar by: Concentration in fresh bee bread = [0.55 × Concentration in pollen/0.916 + 0.45 × Concentration in Nectar/0.3] × 0.75
DALA = days after last application, LOC = level of concern,, RQ = risk quotient.
Text in bold indicate potential for risk.

-For Tier I risk assessment:
- Acute RQ = Acute estimated daily dose (EDD) exposure)/acute toxicity endpoint
  - Acute EDD = nectar dose [nectar consumption rate (mg/day) × maximum nectar residue (µg/kg)/ 1.0 × 106] + pollen dose [pollen consumption rate (mg/day) × maximum pollen residue (µg/kg)/1.0 × 106]
  - The honey bee acute oral LD50 = 0.0038 µg a.i./bee for adult, and 4.17 µg a.i./bee for larva.
  - Maximum residues are used for acute risk calculation. For measurement of < LOD or < LOQ, estimated standardized value of ½ LOD or ½ (LOD + LOQ) are used.
- Chronic RQ = Chronic estimated daily dose (EDD) exposure/chronic toxicity endpoint
  - Chronic EDD = nectar dose [nectar consumption rate (mg/day) x highest mean nectar residue (µg/kg)/ 1.0 × 106] + pollen dose [pollen consumption rate (mg/day) × highest mean pollen residue (µg/kg)/1.0 × 106]
  - 10-d NOEL for adults = 0.00016 µg a.i./bee/day for adult worker bees; 21-d NOEL for larvae = 0.0018 µg a.i./larvae/day for bee larvae for TGAI
  - Mean residues are used for chronic risk calculation. For measurement of < LOD or < LOQ, estimated standardized value of ½ LOD or ½ (LOD +LOQ) are used.
- Daily consumption rate for Tier I assessment:
  - Adult worker bees foraging for nectar: 292 mg/day nectar; 0.041 mg/day pollen; 292 mg/day total
  - Adult nurse bees: 140 mg/day nectar; 9.6 mg/day pollen; 149.6 mg/day total
  - Bee larvae: 120 mg/day nectar; 3.6 mg/day pollen; 124 mg/day total

-For Tier II risk assessment:
- Measured imidacloprid concentrations in pollen and nectar and estimated residues in bee bread are compared with the critical colony feeding study effects values for pollen and nectar. “Yes” indicates the measured residue level is greater than the critical effects value and poses potential risk to honey bees; “No” indicates that measured residue level is less than the critical value and likely not pose risk to honey bees. The The highest mean residue values are used.
- The following critical colony effects values are used in the risk assessment after consideration of all available colony feeding studies:
  - For honey bees:

- Pollen: 20 ppb (NOEC) and 100 ppb (LOEC); values greater than the NOEC are considered to pose potential risk; However, the wide spacing between the NOEC and LOEC and the inconsistent effects observed at the LOEC result in limitations regarding potential effects at the NOEC; thus the pollen LOEC is also used in the pollen risk characterization for pollen exposure route and bee bread exposure route.
- Nectar: 23.3 ppb (NOEC) and 46.7 ppb (LOEC); values greater than the NOEL are considered to pose potential risk.

- For bumble bees:
  - Pollen: 6 ppb (LOEC). Effect was detected in a feeding study exposed to a combination of pollen at 6 ppb and 0.7 ppb in nectar (Feltham et al., 2014, Whitehorn et al., 2012).
  - Nectar: 2.5 ppb (LOEC). Effect was reported for exposure to 2.5 ppb imidacloprid in sugar solution after 5 weeks of exposure under open feeding conditions (Moffat et al., 2016).

Appendix IX Seed Treatment Tier I Acute and Chronic Risk Assessment to Different Honey Bee Castes and Tier II comparison between Measured Residues and Endpoints Determined from Available Colony Feeding Studies for Honey Bees and Bumble Bees for Different Exposure Routes.

		Residues					Tier I Risk Assessment						Tier II Risk Assessment					
		Measured maximum Residues (ppb)		Measured highest mean residue (ppb)		Estimated residues in bee bread (ppb)**	Did acute risk exceeding the LOC (0.4) (acute RQ)			Did chronic risk exceeding the LOC (1.0) (chronic RQ)			Potential for risk for honey bees?			Potential for risk for bumble bees?		Reference (PMRA#)
Application methods	Treatment and residue sampling scenarios	Pollen	Nectar	Pollen	Nectar		Forager	Nurse bee	Larvae	Forager	Nurse bee	Larvae	Pollen route	Nectar Route	Bea bread route	Pollen	Nectar	
seed treatment	Soybean (Glycine max.), 120 g a.i./100 kg seeds, sowing rate of 90 kg seeds/ha, DALA 61 days, Honey bees as additional sampling tools, maximum residues measured in bees nectar and comb pollen	2	1.2	1.1	0.7	1.2	No (0.1)	No (0.0)	No (0.0)	**Yes (1.2)**	No (0.7)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2693159
seed treatment	Soybean (Glycine max.), 120 g a.i./100 kg seeds, sowing rate of 90 kg seeds/ha. DALA 63 days, Honey bees as additional sampling tools, maximum residues measured in bees nectar and comb pollen	2.8	1	1.7	0.6	1.4	No (0.1)	No (0.0)	No (0.0)	**Yes (1.0)**	No (0.6)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2693160
seed treatment	Canola, Applied at 50 and 78 g a.i./ha, 0.02 to 0.05 mg a.i./seeds. DALA 55 to 65 days, pollen and nectar from hive	7.6	0.81	7.6	0.8	4.3	No (0.1)	No (0.0)	No (0.0)	**Yes (1.5)**	**Yes (1.2)**	No (0.1)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	No	1086427
seed treatment	Corn, Applied at 133.28 g a.i./ha, 1.34 mg a.i./seed. Year 1 applied in 2012 sampled 58–68 DAP pollen from plant	19.46	0	11.3	0.0	5.1	No (0.0)	No (0.0)	No (0.0)	No (0.0)	No (0.7)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	No	2474497
seed treatment	Corn, Applied at 133.28 g a.i./ha, 1.34 mg a.i./seed. Year 2 applied in 2012 and 2013: sampled in 2013 59 to 72 DAP pollen from plant	38.5	0	21.9	0.0	9.9	No (0.0)	No (0.1)	No (0.0)	No (0.0)	**Yes (1.3)**	No (0.0)	**NOEC (Yes)** LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	No	2474497
seed treatment	Corn, Applied at 1.0 mg/seed pollen from plant	0.5	0	0.5	0.0	0.2	No (0.0)	No (0.0)	No (0.0)	No (0.0)	No (0.0)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	Donnarumma et al 2011
seed treatment	Sweet Pepper, Applied at 1.0 mg/seed. Sampled 99 to 124 DAP.sample of whole flower	2.4	2.4	0.5	0.5	0.8	No (0.2)	No (0.1)	No (0.0)	No (0.9)	No (0.5)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	1856875
seed treatment	Melon, Applied at 50 and 78 g a.i./ha, 0.02 to 0.05 mg a.i./seed. Sampled 55 to 65 DAP.sample of whole flower. Residues in hive pollen and nectar were < LOQ (1 ppb)	7.9	7.9	3.4	3.4	5.4	**Yes (0.6)**	No (0.3)	No (0.0)	**Yes (6.2)**	**Yes (3.2)**	No (0.2)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	**Yes**	1856879

Application methods	Treatment and residue sampling scenarios	Residues					Tier I Risk Assessment						Tier II Risk Assessment					Reference (PMRA#)
		Measured maximum Residues (ppb)		Measured highest mean residue (ppb)		Estimated residues in bee bread (ppb)**	Did acute risk exceeding the LOC (0.4) (acute RQ)			Did chronic risk exceeding the LOC (1.0) (chronic RQ)			Potential for risk for honey bees?			Potential for risk for bumble bees?		
		Pollen	Nectar	Pollen	Nectar		Forager	Nurse bee	Larvae	Forager	Nurse bee	Larvae	Pollen route	Nectar Route	Bea bread route	Pollen	Nectar	
Seed treatment	Seed treatment of cotton and soybean, Seed treated at 0.78 g a.i./ kg for soybean and 0.375 mg a.i./ seed for cotton. Pollen and nectar separated from hand collected cotton flowers, flowers from soybean, bee pollen carried by foragers returning to hives, sampled during flowering. Highest detection among all these matrices was used in the risk calculation	2.9	0.5	2.9	0.5	1.9	No (0.0)	No (0.0)	No (0.0)	No (0.9)	No (0.6)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	Steward et al., 2014
seed treatment, rotational crop	Clover, Treated corn seed planted in 2012 at 133.28 g a.i./ha or 1.34 mg a.i./seed. Clover sampled > 400 DALA in corn. Pollen nectar from plant	3.4	0.9	2.0	0.4	1.3	No (0.1)	No (0.0)	No (0.0)	No (0.7)	No (0.4)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2474497
Seed treatment, rotational crop	Winter oilseed rape, Phacelia, and Maize grown in soil with seed treatment in previous years DALA: >= 1 year Confined honey bees as additional sampling tools in tunnel of rotation crop for pollen and nectar.	2.5	0.4	1.5	0.3	1.0	No (0.0)	No (0.0)	No (0.0)	No (0.5)	No (0.3)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2535892
Seed treatment, wild flowers	Wildflowers near seed treatment field of cotton and soybean, Seed treated at 0.78 g a.i./ kg for soybean and 0.375mg a.i./ seed for cotton. Wild flowers adjacent to planted fields, and was collected within 7 days after planting. Residues in pollen and nectar were not available, whole flower is used as surrogate pollen and nectar in the risk assessment	48	48	1.1	48	54.5	**Yes (3.7)**	**Yes (1.9)**	No (0.0)	**Yes (87.6)**	**Yes (42.1)**	**Yes (3.2)**	NOEC (No) LOEC (No)	**Yes**	**NOEC (Yes)** LOEC (No)	No	**Yes**	Steward et al., 2014
Seed treatment, rotational crop	Phacelia and maize grown in soil with seed treatment in previous years DALA: >= 1 year Confined honey bees as additional sampling tools in tunnel of rotation crop for pollen and nectar.	1.2	0.4	0.8	0.3	0.7	No (0.0)	No (0.0)	No (0.0)	No (0.5)	No (0.3)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2535895
Seed treatment, rotational crop	Winter oilseed rape, grown in soil with seed treatment in previous years DALA: >= 1 year Confined honey bees as additional sampling tools in tunnel of rotation crop for pollen and nectar.	1.3	0.7	0.9	0.5	0.9	No (0.1)	No (0.0)	No (0.0)	No (0.8)	No (0.4)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2535893
Seed treatment, Rotational crop	Phacelia and maize grown in soil with seed treatment in previous years DALA: >= 1 year Confined honey bees as additional sampling tools in tunnel of rotation crop for pollen and nectar.	5.7	3.5	0.3	1.9	2.2	No (0.3)	No (0.1)	No (0.0)	**Yes (3.4)**	**Yes (1.6)**	No (0.1)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2535894

** Estimated mean residue in bee bread is calculated using measured highest mean residues from pollen and nectar by: Concentration in fresh bee bread= [0.55 ×Concentration in pollen/0.916+ 0.45 × Concentration in Nectar/0.3]×0.75
DALA = days after last application, LOC: level of concern, RQ = risk quotient.
Text in bold indicates potential for risk
-For Tier I risk assessment:

- Acute RQ = Acute estimated daily dose (EDD) exposure)/acute toxicity endpoint
  - Acute EDD = nectar dose [nectar consumption rate (mg/day) × maximum nectar residue (µg/kg)/ 1.0 × 106] + pollen dose [pollen consumption rate (mg/day) × maximum pollen residue (µg/kg)/1.0 × 106]
  - The honey bee acute oral LD50 = 0.0038 µg a.i./bee for adult, and 4.17 µg a.i./bee for larva.
  - Maximum residues are used for acute risk calculation. For measurement of < LOD or < LOQ, estimated standardized value of ½ LOD or ½ (LOD +LOQ) are used.
- Chronic RQ = Chronic estimated daily dose (EDD) exposure/chronic toxicity endpoint
  - Chronic EDD = nectar dose [nectar consumption rate (mg/day) × highest mean nectar residue (µg/kg)/ 1.0 × 106] + pollen dose [pollen consumption rate (mg/day) × highest mean pollen residue (µg/kg)/1.0 × 106]
  - 10-d NOEL for adults = 0.00016 µg a.i./bee/day for adult worker bees; 21-d NOEL for larvae = 0.0018 µg a.i./larvae/day for bee larvae for TGAI
  - Mean residues are used for chronic risk calculation. For measurement of < LOD or < LOQ, estimated standardized value of ½ LOD or ½ (LOD +LOQ) are used.
- Daily consumption rate for Tier I assessment:
  - Adult worker bees foraging for nectar: 292 mg/day nectar; 0.041 mg/day pollen; 292 mg/day total
  - Adult nurse bees: 140 mg/day nectar; 9.6 mg/day pollen; 149.6 mg/day total
  - Bee larvae: 120 mg/day nectar; 3.6 mg/day pollen; 124 mg/day total

-For Tier II risk assessment:

- Measured imidacloprid concentrations in pollen and nectar and estimated residues in bee bread are compared with the critical colony feeding study effects values for pollen and nectar. “Yes” indicates the measured residue level is greater than the critical effects value and poses potential risk to honey bees; “No” indicates that measured residue level is less than the critical value and likely not pose risk to honey bees. The The highest mean residue values are used.
- The following critical colony effects values are used in the risk assessment after consideration of all available colony feeding studies:
  - For honey bees:
    - Pollen: 20 ppb (NOEC) and 100 ppb (LOEC); values greater than the NOEC are considered to pose potential risk; However, the wide spacing between the NOEC and LOEC and the inconsistent effects observed at the LOEC result in limitations regarding potential effects at the NOEC; thus the pollen LOEC is also used in the pollen risk characterization for pollen exposure route and bee bread exposure route.
    - Nectar: 23.3 ppb (NOEC) and 46.7 ppb (LOEC); values greater than the NOEL are considered to pose potential risk.
  - For bumble bees:
    - Pollen: 6 ppb (LOEC). Effect was detected in a feeding study exposed to a combination of pollen at 6 ppb and 0.7 ppb in nectar (Feltham et al., 2014, Whitehorn et al., 2012).
    - Nectar: 2.5 ppb (LOEC). Effect was reported for exposure to 2.5 ppb imidacloprid in sugar solution after 5 weeks of exposure under open feeding conditions (Moffat et al., 2016).

Appendix X Monitoring Data: Tier I Acute and Chronic Risk Assessment to Different Honey Bee Castes and Tier II comparison between Measured Residues and Endpoints Determined from Available Colony Feeding Studies for Honey Bees and Bumble Bees for Different Exposure Routes.

Treatment and residue sampling scenarios	Residues					Tier I Risk Assessment						Tier II Risk Assessment					Reference (PMRA#)
	Measured maximum Residues (ppb)		Measured highest mean residue (ppb)		Estimated residues in bee bread (ppb)**	Did acute risk exceeding the LOC (0.4) (acute RQ)			Did chronic risk exceeding the LOC (1.0) (chronic RQ)			Potential for risk for honey bees?			Potential for risk for bumble bees?		
	Pollen	Nectar	Pollen	Nectar		Forager	Nurse bee	Larvae	Forager	Nurse bee	Larvae	Pollen route	Nectar Route	Bea bread route	Pollen	Nectar	
Ornamental flowering plants from retail stores*. No application information available. Hand collected plant pollen and nectar.	228.9	225.9	14.5	21.3	30.5	**Yes (17.4)**	**Yes (8.9)**	No (0.0)	**Yes (38.9)**	**Yes (19.5)**	**Yes (1.4)**	NOEC (No) LOEC (No)	No	**NOEC (Yes)** LOEC (No)	**Yes**	**Yes**	2666438
Ornamental flowering plants from retail stores*. No application information available. Hand collected plant pollen and nectar.	44.9	353.5	9.5	19.2	25.9	**Yes (27.2)**	**Yes (13.1)**	No (0.0)	**Yes (35.0)**	**Yes (17.4)**	**Yes (1.3)**	NOEC (No) LOEC (No)	No	**NOEC (Yes)** LOEC (No)	**Yes**	**Yes**	2666439
Ornamental plants from retail stores*, re-bloom following transplant to the field. No application information available. Hand collected plant pollen and nectar.	42.2	1.5	6.7	1.5	4.7	No (0.1)	No (0.2)	No (0.0)	**Yes (2.7)**	**Yes (1.7)**	No (0.1)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	**Yes**	No	2666439
Maize seed treatment field coated at 1 mg/seed and planted in organic farm field. Pollen collected by hand and by hive pollen traps during flowering	18	0	2.1	0.0	0.9	No (0.0)	No (0.0)	No (0.0)	No (0.0)	No (0.1)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	Bonmatin et al., 2005
Monitoring for multiple pesticide residues over 3 years (2002-2005) in honey bee hives in France where the main honey typeswere sunflower, canola, chestnut, and local mixed flower honey. Sampled pollen in pollen trap, honey bees, hive wax and honey as well. Maximum residue in nectar is not reported. Mean is used for RQ calculation	5.7	0.7	0.9	0.7	1.2	No (0.1)	No (0.0)	No (0.0)	**Yes (1.3)**	No (0.7)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	Chauzat et al., 2006, 2009.

Treatment and residue sampling scenarios	Residues					Tier I Risk Assessment						Tier II Risk Assessment					Reference (PMRA#)
	Measured maximum Residues (ppb)		Measured highest mean residue (ppb)		Estimated residues in bee bread (ppb)**	Did acute risk exceeding the LOC (0.4) (acute RQ)			Did chronic risk exceeding the LOC (1.0) (chronic RQ)			Potential for risk for honey bees?			Potential for risk for bumble bees?		
	Pollen	Nectar	Pollen	Nectar		Forager	Nurse bee	Larvae	Forager	Nurse bee	Larvae	Pollen route	Nectar Route	Bea bread route	Pollen	Nectar	
A 2-year survey in honey bee hives located in urban and suburban areas of 4 US states (Florida, Michigan, California and Texas), 15 hives/state.	41.9	12.5	1.0	0.6	1.2	**Yes (1.0)**	**Yes (0.6)**	No (0.0)	**Yes (1.2)**	No (0.6)	No (0.0)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2754585
A 2-year survey in honey bee hives located in urban and suburban areas of 4 US states (Florida, Michigan, California and Texas), 15 hives/state, risks estimation was calculated with the maximum 90th percentile detected in 4 states for acute and mean for chronic risk (California).	4.22	1.36	1.7	0.9	1.7	No (0.1)	No (0.1)	No (0.0)	**Yes (1.6)**	No (0.8)	No (0.1)	NOEC (No) LOEC (No)	No	NOEC (No) LOEC (No)	No	No	2754585

* Total imidacloprid (sum of imidacloprid, 5-OH imidacloprid and olefin imidacloprid) is available from the study and is used in the risk calculation for the crop.

** Estimated mean residue in bee bread is calculated using measured highest mean residues from pollen and nectar by: Concentration in fresh bee bread= [0.55 × Concentration in pollen/0.916 + 0.45 × Concentration in Nectar/0.3] × 0.75

LOC = level of concern, RQ = risk quotient.

Text in bold indicate potential for risk.

-For Tier I risk assessment:

- Acute RQ = Acute estimated daily dose (EDD) exposure/acute toxicity endpoint
  - Acute EDD = nectar dose [nectar consumption rate (mg/day) x maximum nectar residue (µg/kg)/ 1.0 × 106] + pollen dose [pollen consumption rate (mg/day) × maximum pollen residue (µg/kg)/1.0 × 106]
  - The honey bee acute oral LD50 = 0.0038 µg a.i./bee for adult, and 4.17 µg a.i./bee for larva.
  - Maximum residues are used for acute risk calculation. For measurement of < LOD or < LOQ, estimated standardized value of ½ LOD or ½ (LOD +LOQ) are used.
- Chronic RQ = Chronic estimated daily dose (EDD) exposure/chronic toxicity endpoint
  - Chronic EDD = nectar dose [nectar consumption rate (mg/day) x highest mean nectar residue (µg/kg)/ 1.0 x 106] + pollen dose [pollen consumption rate (mg/day) x highest mean pollen residue (µg/kg)/1.0 × 106]
  - 10-d NOEL for adults = 0.00016 µg a.i./bee/day for adult worker bees; 21-d NOEL for larvae = 0.0018 µg a.i./larvae/day for bee larvae for TGAI
  - Mean residues are used for chronic risk calculation. For measurement of < LOD or < LOQ, estimated standardized value of ½ LOD or ½ (LOD +LOQ) are used.
- Daily consumption rate for Tier I assessment:
  - Adult worker bees foraging for nectar: 292 mg/day nectar; 0.041 mg/day pollen; 292 mg/day total
  - Adult nurse bees: 140 mg/day nectar; 9.6 mg/day pollen; 149.6 mg/day total
  - Bee larvae: 120 mg/day nectar; 3.6 mg/day pollen; 124 mg/day total

-For Tier II risk assessment:

- Measured imidacloprid concentrations in pollen and nectar and estimated residues in bee bread are compared with the critical colony feeding study effects values for pollen and nectar. “Yes” indicates the measured residue level is greater than the critical effects value and poses potential risk to honey bees; “No” indicates that measured residue level is less than the critical value and likely not pose risk to honey bees. The highest mean residue values are used.
- The following critical colony effects values are used in the risk assessment after consideration of all available colony feeding studies:
  - For honey bees:

- Pollen: 20 ppb (NOEC) and 100 ppb (LOEC); values greater than the NOEC are considered to pose potential risk; However, the wide spacing between the NOEC and LOEC and the inconsistent effects observed at the LOEC result in limitations regarding potential effects at the NOEC; thus the pollen LOEC is also used in the pollen risk characterization for pollen exposure route and bee bread exposure route.
- Nectar: 23.3 ppb (NOEC) and 46.7 ppb (LOEC); values greater than the NOEL are considered to pose potential risk.

- For bumble bees:
  - Pollen: 6 ppb (LOEC). Effect was detected in a feeding study exposed to a combination of pollen at 6 ppb and 0.7 ppb in nectar (Feltham et al., 2014, Whitehorn et al., 2012). Nectar: 2.5 ppb (LOEC). Effect was reported for exposure to 2.5 ppb imidacloprid in sugar solution after 5 weeks of exposure under open feeding conditions (Moffat et al., 2016).

Appendix XI Risk assessment for bees via water exposure route

The North American *Guidance for Assessing Pesticide Risks to Bees* does not include a method for assessing the potential risk to bees from exposure through water, as it is not thought to be a primary exposure route. However, as some Canadian beekeepers and researchers have raised potential concerns around exposure to neonicotinoids through water sources used by honey bees, this exposure route will be explored despite the lack of formal guidance. Information on exposure through the water route including surface water and plant guttation liquid, residues measured in potential bee water sources, and risk estimation is described below.

There is high water turnover in honey bee hives due to the needs for hive thermoregulation on hot days by evaporative cooling, and for preparation of food from concentrated stored honey by nurse bees to produce jelly for larval brood and queens (Kühnholz and Seeley, 1997[4]; Nicolson, 2009[5]). Unlike honey bees, individual bumble bees are unlikely to drink water for their own water needs and it is not clear whether solitary bees drink water (Nicolson, 2009). Therefore, based on the large water fluxes in honey bee hives at the colony level, the honey bee can be considered to be a conservative surrogate for bumble bees and other non-*Apis* bees for potential pesticide exposure via contaminated water, particularly since it is unclear whether non-*Apis* bees utilise water sources at all. EFSA also took the approach of using honey bees as a conservative surrogate (2014)[6].

For honey bees, water is obtained indirectly from food, mostly from nectar as fresh pollen is relatively dehydrated, and directly by water foraging. Honey bees have been observed collecting water from a variety of sources, including streams, ponds, lakes, creeks, marshes and puddles, and moist soils. Bees have also been observed collecting water from grass and plant stalks (Gary et al. 1978,[7] Seeley 1995,[8] Kühnholz and Seeley 1997, Schmaranzer, 2000[9]). Unlike pollen and nectar, water is not stored within the hive, and water collection was regulated based on hive demand (Kuhnholz and Seeley, 1997). After collecting water, water foragers pass the water through regurgitation and trophallaxis to other bees. Nursing bees then distribute water to cells for cooling and processing for feeding the brood and queen. Therefore there is potential for pesticide exposure to bees when such water sources are contaminated.

Water consumption of honey bee adults

EFSA (2014) estimated that the water consumption for an adult bee was 11.4 µL/bee/day. This estimate was the maximum water consumption measured in honey bee adults that were confined in cages under laboratory conditions at 35°C (Free and Spencer-Booth, 1958)[10]; it is noted that

4 Kühnholz, S. and T.D. Seeley. 1997. The control of water collection in honey bee colonies. Behavioral Ecology and Sociobiology. 41: 407 – 422.

5 Nicolson SW, 2009. Water homeostasis in bees, with the emphasis on sociality. Journal of Experimental Biology. 212: 429-434; doi: 10.1242/jeb.022343

6 EFSA. 2014. Guidance on risk assessment on bees. https://www.efsa.europa.eu/en/efsajournal/pub/3295, accessed on 2017, August, 2.

7 Gary, N.E., P.C. Witherell, K. Lorenzen. 1978. Distribution of Honey bees During Water Collection. Journal of Apicultural Research. 18, 26-29.

8 Seeley, T. 1995. The Wisdom of the Hive: the Social Physiology of Honey Bee Colonies. Harvard University Press, Cambridge, MA. 295 pp.

9 Schmaranzer, S. 2000. Thermoregulation of water collecting honey bees (Apis mellifera). Journal ofInsect Physiology. 46, 1187-1194.

10 Free JB and Spencer-Booth Y, 1958. Observations on the temperature regulation and food consumption of honey bees (Apis mellifera). Journal of Experimental Biology, 35, 93-937.

the range of water consumption values was 5.8 – 11.4 µL/bee/day, with a mean of 9.6 µL/bee/day. This temperature is similar to the temperature inside the core of honey bee hives. The same study also showed that water consumption was very low (≤ 0.8 µL/bee/day) at 30°C and less. However, at an extreme ambient temperature of 40 °C the maximum water consumption can reach up to 29.7 µL/bee/day with a mean of 19.72 µL/bee/day. Since the in-hive temperature linearly decreased from the core to the periphery of hives (Becher et al., 201011), the majority of bees are under a temperature of no more than 35°C inside hives, and 11.4 µL/bee/day is considered to be a conservative water consumption rate for adult bees.

Two methods of estimating water consumption of adult bees were proposed in a white paper (2011)[12] that was authored by USEPA, PMRA and California Department of Pesticide Regulation and presented to a FIFRA Science Advisory Panel (SAP). The first estimate was 450–1800 µL/bee/day, based on the behaviour of honey bee water foragers, including the estimated number of trips per day, the average amount of water collected per trip, and the estimated proportion of water consumed by water foraging bees. It was acknowledged that there was a high degree of variation in each of the parameters used in the calculation. Consumption rates for other adult bees in hives (such as nurse bees, nectar and pollen foragers) were not considered. The second estimate was 47 µL/bee/day, based on water consumption of the brown paper wasp used as a surrogate for honey bee. The consumption was estimated by subtracting the total water needs by what was provided from the food diet sources (e.g. nectar). There was a large difference between these two estimates, and the white paper considered that the estimate of 47 µL/bee/day represented a more reliable estimate for honey bees. As described in *Guidance for Assessing Pesticide Risks to Bees*, further work is being done to investigate the importance of exposure through consumption of drinking water relative to the dietary and contact routes, considering FIFRA SAP recommendations.

The PMRA also considered additional information indicating that under field conditions, honey bees consumed an average of 9.2 µL/bee/day with the maximum of 35.5 µL/bee/day. This value was calculated based on a study that was conducted in the spring and summer in Wisconsin and Colorado in 1921 and 1924 as part of a thesis (Boggs, 1924)[13]. In this study, six hives were placed in the field and water consumption was measured daily and hive adult bees were weighed three times during the study. Data was corrected for water evaporation. The calculation was conducted by the PMRA based on the assumptions that average bee weight was 128 mg/bee and daily hive weight was normalized linearly between two weight measurements. The reported water consumption at the colony level in the field appeared to be similar to what was measured in the lab by Free and Spencer-Booth (1958).

Considering all above information, the water consumption rate that will be used for estimating potential water exposure for honey bee adults is 11.4 µL/bee/day.

[11] Becher MA, Hildenbrandt H, Hemelrijk CK and Moritz RFA, 2010. Brood temperature, task division and colony survival in honey bees: A model. Ecological Modelling, 221, 769-776.

[12] EPA, PMRA and CDPR. 2011. White Paper in Support of the Proposed Risk Assessment Process for Bees. https://www.regulations.gov/document?D=EPA-HQ-OPP-2012-0543-0004 accessed on 3 August 2017

[13] Boggs, N. 1924. Water consumption in the bee colony and the proportion of sugar and water for simulative feeding in the spring. Thesis submitted for the degree of master of science, Colorado Agricultural College, Fort Collins, Colorado, 26 August 1924. Accessed online: http://digitool.library.colostate.edu///exlibris/dtl/d3_1/apache_media/L2V4bGlicmlzL2R0bC9kM18xL2FwYWNoZV9tZWRpYS84MDcxNw==.pdf

Water consumption of honey bee larvae

EFSA (2014) estimated water consumption for honey bee larvae based on the conservative assumption that all larvae food is diluted with contaminated water. It is assumed that no degradation of the residues in the source surface water occurs in the hive prior to larval consumption. It is expected that the estimate of larval water consumption is highly conservative.

The EFSA (2014) estimated value for water consumption of honey bee larvae was 111 µL/bee over 5 days of their development period. This was based on conservative assumptions that a honey bee worker larva needs 59.4 mg sugar and 1.5–2 mg pollen for five days (EFSA, 2014). The total food consumption is 60.9 mg dry material over the five days if the lowest pollen value is used (59.4 mg + 1.5 mg = 60.9 mg dry material in their food). Also EFSA assumed that water content of larvae food is 73.51% for young larvae within the first two days and 64.9% for older larva from days 3 to 5, and the corresponding dry matter percentages are 26.49% for young larvae and 35.1% for old larvae (Haydak, 1943[14]). The amount of water over five days is then calculated as 169 mg (60.9 mg/26.49 *73.51) or 112.6 mg (60.9 mg/35.1 * 64.9) for young and old larva, respectively. After taking into consideration the water provided from honey (assuming honey is uncontaminated and the water content of honey is 18%), the consumption of contaminated water was calculated to be 138.6 mg and 92.3 mg over 5 days for young and old larvae. This equates to 55.4 mg water for the first two days and 55.38 mg water for the last 3 days, totalling 110.82 mg water over the 5 day larval development period. Therefore, the estimated total consumption of water by larvae over their 5-day development period was considered to be 111 mg water from outside sources (surface water).

No other water consumption estimates for honey bee larvae are available. EFSA's estimate of 111 µl per bee for 5 days is used to estimate the potential water exposure for larvae.

Surface water exposure route

Residues in surface water sources

The levels of neonicotinoids in surface water sources near bee hives were assessed using monitoring data available to PMRA from Canada and the US as of January 2016. Based on available data, neonicotinoids, primarily clothianidin, thiamethoxam and imidacloprid, were detected in potential drinking water sources for bees including puddle water and, to a lesser extent, in other surface water sources near bee hives.

Monitoring data on the presence of neonicotinoids in water sources which could potentially serve as drinking water for bees were available from the provinces of British Columbia, Manitoba, Ontario, Quebec, and Nova Scotia, as well as the State of Maryland, U.S.A. The sources of available data consisted of monitoring conducted by the PMRA in 2013 and 2014 (PMRA# 2548877 and 2548876) and published literature studies by Samson-Robert *et al*., 2014 (PMRA# 2526146), Schaafsma *et al*., 2015 (PMRA# 2526184), Johnson and Pettis, 2014 (PMRA# 2538821) and Johnson, 2012 (PMRA# 2373072).

[14] Haydak HM, 1943. Larval food and development of castes in the honey bee. Journal of Economic Entomology, 36, 778-792.

All of the Canadian water samples, relevant for pollinators, were collected in or around agricultural fields. The majority of samples were collected from puddles, but water was also collected from sources such as ditches, culverts, drains, ponds, creeks, and streams. Health Canada's PMRA, in collaboration with Health Canada's Regions and Programs Bureau and the help of the appropriate provincial agencies, conducted detailed inspections of bee mortality incidents reported across Canada in 2012 to 2016. In addition to the incident inspections, a hive monitoring project was conducted in 2014 and 2015. Water samples were collected during the hive monitoring project, and in some cases during honey bee mortality incident inspections. All samples collected from the bee mortality incidents and hive monitoring project were taken within a reasonable distance from the associated bee yard which was reported or monitored. Samson-Robert *et al*., 2014 (PMRA# 2526146) sampled puddles of water at a maximum distance of 1 km from commercial apiaries in Quebec. Samples collected by Schaafsma *et al*., 2015 (PMRA# 2526184) were in two Ontario experimental fields which had an apiary within a 3 km radius.

There were also water samples taken from water sources in urban, suburban, and rural settings in the United States; however, these were analyzed for imidacloprid only (Johnson and Pettis, 2014 (PMRA# 2538821) and Johnson, 2012 (PMRA# 2373072)). Samples from this study were collected from sources such as bird baths, fountains, and fish ponds, and puddles, as well as small waterbodies such as creeks, streams, and rivulets. Bee hives were present either at or within 0.5 miles (0.8 km) of each sampling site.

An overall summary of available monitoring data for neonicotinoids in potential drinking water sources for bees that will be used in the risk estimation is presented in Table 1; a more detailed summary of the monitoring data by sites is found in Table 4. The various potential drinking water sources for bees were grouped into either 'puddles' or 'other potential sources'. The 'puddles' group includes all puddles sampled, regardless of location. The 'other potential sources' includes all other water sources which were considered available for bees to drink. Approximate overall numbers of samples, detections, and detection frequencies were calculated based on data available to get a general sense of the presence of neonicotinoids in water available to bees. It is recognized that the overall detection frequencies provided could dilute site-specific patterns. In addition, the single maximum detections and maximum means presented in Table 1 should not be used to draw conclusions about the contribution of various land uses to the presence of neonicotinoids in various potential drinking water sources for bees. The sampling was mainly conducted in and around agricultural fields, corn in particular; and does not reflect all areas potentially treated with neonicotinoids. Also, these single detections do not provide a complete description of the variability in the levels of neonicotinoids in potential drinking water sources for bees.

Based on available data, neonicotinoids, particularly clothianidin, thiamethoxam and imidacloprid, have been detected in puddle water and to a lesser extent, in other potential drinking water sources where bee hives are present. Among these other sources, detections were observed in a water tank, small pools, a drainage ditch, a rivulet, ponds, and a stream. Overall, there was no apparent difference in levels detected amongst the various 'other potential sources' sampled. From culverts to ponds, rivulets to streams, ditches to irrigation pipes, samples ranged from having no detections to relatively higher concentrations with no particular pattern. In general, maximum neonicotinoid levels were higher in puddles than in 'other potential sources' of drinking water for bees, as seen in Table 1 and detailed in Table 4. The majority of puddle samples were taken in agricultural areas where corn and soybeans were grown.

Clothianidin and thiamethoxam were the two neonicotinoids most often detected in potential drinking water sources for bees (88-91% detection in puddles, many of which were in and around corn fields, and 44% detection in other water sources). The maximum concentrations of clothianidin and thiamethoxam in potential sources of drinking water for bees were 55.7 µg/L and 63.4 µg/L, respectively, from puddles located in Quebec corn fields sampled during planting (Samson-Robert *et al*., 2014 (PMRA# 2526146)).

Imidacloprid was also detected in potential drinking water sources for bees (less than10% detection in puddles and other water sources). The maximum concentration of imidacloprid in potential drinking water for bees was detected in urban areas in Maryland, U.S. (Johnson and Pettis, 2014 (PMRA# 2538821) and Johnson, 2012 (PMRA# 2373072)). There is uncertainty surrounding the concentrations measured in the water samples as the levels reported differed depending on the test method used. Furthermore, the use pattern in the United States may not be relevant for Canada. These data will not be considered further in the pollinator risk assessment for Canadian use patterns. From agricultural settings, the highest detection of imidacloprid was 0.19 µg/L based on a puddle sample collected outside a corn field in Ontario, Canada (2015; PMRA# 2526184).

Data on transformation products were available only for imidacloprid from puddles located in corn fields in Quebec sampled after seeding. Only one of the imidacloprid transformation products, imidacloprid-urea, was detected in three of the 34 samples at low levels, with the maximum of 0.005 µg/L. Imidacloprid-guanidine and imidacloprid-olefin were not detected in any samples (Samson-Robert *et al*., 2014 (PMRA# 2526146)). Because of the low or lack of detections, transformation products of imidacloprid were not considered further.

Water samples can contain more than one neonicotinoid. Two or more neonicotinoids, generally including clothianidin and thiamethoxam, were present together in 80% to 99% of water samples collected in or around corn fields. Based on available data, the maximum cumulative concentration was 44.38 µg/L from a puddle in a corn field in Ontario. The individual maximum detections of clothianidin and thiamethoxam were higher than this maximum cumulative concentration; therefore a cumulative assessment was not conducted.

Samson-Robert *et al*., 2014 (PMRA# 2526146) noted that neonicotinoid concentrations in puddles located in corn fields were higher during corn planting (from drifting and deposition of dust) compared to after planting, which is consistent with PMRA's evaluation of the bee mortality incidents (Health Canada, Update on Neonicotinoid Pesticides and Bee Health, 2014).

Similarly, Schaafsma *et al*., 2015 (PMRA# 2526184) found that the concentration of total neonicotinoid (reported as clothianidin + thiamethoxam) residues in water within Ontario corn fields increased significantly during the first five weeks after planting, and returned to pre-plant levels seven weeks after planting. However, concentrations in water sampled from outside the fields were similar throughout the sampling period.

In conclusion, neonicotinoids, particularly clothianidin, thiamethoxam and imidacloprid, have been detected in puddle water and to a lesser extent, other sources of water near bee hives. In general, neonicotinoid levels were higher in puddles than in other sources of water near bee hives. All sampling from Canada was from agricultural areas, primarily in corn growing regions

of Ontario and Quebec. Neonicotinoid concentrations in puddles located in corn fields were highest during corn planting likely as a result of drifting and deposition of dust.

Table 1 Overall summary of neonicotinoids in potential drinking water sources for bees based on data from Canada.

Chemical	Potential drinking water source for bees	Total number of detections[1]	Total number of samples[1]	% Detection	Maximum mean concentration in µg/L	Maximum concentration in µg/L	Crop or land use; water type
Clothianidin	Puddles	157	172	91	7.92	55.7	corn
	Other potential sources	59	134	44	1.87	16.2	corn; drains, ditches
Thiamethoxam	Puddles	152	173	88	7.7	63.4	corn
	Other potential sources	59	134	44	1.06	7.5	corn; drains, ditches
Imidacloprid	Puddles	10	147	7	0.0080	0.19	corn
	Other potential sources	12	134	9	0.0018	0.066	corn; pond, creek, stream, culvert
Imidacloprid-urea	Puddles	3	34	9	0.005	0.005	corn
	Other potential sources	No data	No data	No data	No data	No data	No data
Imidacloprid-guanidine	Puddles	0	34	0	ND	ND	corn
	Other potential sources	No data	No data	No data	No data	No data	No data
Imidacloprid-olefin	Puddles	0	34	0	ND	ND	corn
	Other potential sources	No data	No data	No data	No data	No data	No data
Cumulative neonicotinoids	Puddles	92	97	95	8.81	44.38	corn
	Other potential sources	25	36	69	0.2189	4.029	corn; ditch, stream, culvert, pond, creek, marsh

ND = not detected

[1] The number of samples collected and the number of detections was not reported for all studies. Thus, the totals reported in this table are an approximation, calculated based on available information.

Risk assessment for surface water exposure route using monitoring data

The potential risks resulting from exposure to contaminated water sources were assessed using the same approach as for pollen and nectar. For the Tier I risk assessment, the exposure estimate was calculated using the water consumption rates of 11.4 µL/ng water contaminated at the maximum (acute) or maximum mean (chronic) detected/bee/day for adults and 111 µL/larvae/5-days development for larvae (the total water consumption for larvae over 5 days of larvae development period). The exposure estimates were compared with the same toxicity endpoints that were used for pollen and nectar to calculate a risk quotient (RQ). These toxicity endpoints were adjusted for larvae to consider the total exposure over the entire larval development period for better comparison with the exposure estimates. The RQs were considered to identify a potential for risk via water exposure routes when calculated RQ values were greater than the Level of Concern (LOC), which is 0.4 for acute, and 1 for chronic risk.

The Tier I risk assessment for honey bees exposed to water containing clothianidin, thiamethoxam, or imidacloprid is summarized in Table 2 for acute risks and Table 3 for chronic risks. The range of maximum (acute) and maximum mean (chronic) exposure levels in potential water sources in Canada were considered in the risk assessment. Measured levels of imidacloprid were lower than those of thiamethoxam and clothianidin, most likely because sampling occurred primarily in corn growing areas where clothianidin and thiamethoxam are the primary neonicotinoids used. Therefore, the maximum and mean maximum cumulative totals of neonicotinoids in water were considered for the imidacloprid assessment, in order to consider potentially higher levels of imidacloprid residues that might be expected in agricultural areas where imidacloprid is used more extensively.

No potential for acute risks was identified for adults or larvae for any of the neonicotinoids. It is noted that the RQ for acute risks to larvae for clothianidin (< 1.14) is based on a toxicity value for which no effects were observed, and therefore risk is unlikely on an acute basis. No potential for chronic risks was identified for adults or larvae for any of the neonicotinoids.

Overall, based on available monitoring exposure data from potential bee surface water sources near agricultural areas, there is expected to be negligible acute or chronic risks to adult or larval bees from neonicotinoids (imidacloprid, thiamethoxam, clothianidin).

There are a number of challenges in this risk estimate including: true maximums and ranges of residues in potential bee water sources are unknown as sampling was limited and focussed primarily on corn growing agricultural areas; there is minimal information regarding how long residues may remain at maximum levels considering degradation in water and in the presence of light may occur; there is some question as to whether estimated water consumption values represent realistic exposures; the risk assessment is a Tier I risk assessment based on laboratory toxicity studies on individual bees and larvae, and overall impact on honey bee hive is unknown.

It is also noted that, as discussed earlier, honey bees, which require a high level water turnover, are expected to be a conservative surrogate for non-*Apis* bees as bumble bees are unlikely to drink water for their own water needs, and it is unclear whether solitary bees drink water. Overall, estimates of honey bee water consumption and use, and therefore potential for risk, is expected to be greater than that of non-*Apis* bees. Therefore, it is expected that negligible risk would also be expected for non-*Apis* bees through the surface water exposure route.

Table 2 Tier 1 acute risk estimates for water exposure route for adult and larval honey bees using monitoring information.

Chemical	Potential drinking water source	Maximum Residues measured in water (µg/L)	Estimated Exposure WCR = water consumption rate; value used to calculate estimated exposure		Acute oral toxicity		Acute RQ RQ = Exposure/Toxicity (LOC = 0.4)	
			Adults µg/bee/day [WCR: 11.4 µL/bee/day]	Larvae µg/larvae/5 days [WCR: 111 µL/larvae/5-days development]	Adults LD_{50} (µg/bee)	Larvae LD_{50} at 7 days (µg/larvae/day) [µg/larvae/over development period]	Adults	Larvae
Clothianidin	Puddles	55.7	0.000635	0.006183	0.00368	> 0.0018 (3-days feeding) [> 0.0054]	0.17	< 1.14
	Other	16.2	0.000185	0.001789	0.00368	> 0.0018 (3-days feeding) [> 0.0054]	0.050	< 0.33
Thiamethoxam	Puddles	63.4	0.000723	0.00704	0.0044	0.78 (4-days feeding) [3.12]	0.16	0.0022
	Other	7.5	8.55E-05	0.000833	0.0044	0.78 (4-days feeding) [3.12]	0.019	0.00027
Imidacloprid	Puddles	0.19	2.17E-06	2.11E-05	0.0038	4.17 (1-day feeding) [4.17]	0.00057	0.000005
	Other	0.066	7.5E-07	7.3E-06	0.0038	4.17 (1-day feeding) [4.17]	0.0002	0.000002
	Puddles	44.4 (cumulative neonic max)	0.000506	0.0049	0.0038	4.17 (1-day feeding) [4.17]	0.13	0.001

Table 3 Tier 1 chronic risk estimates for water exposure route for adult and larval honey bees using monitoring information.

Chemical	Potential drinking water source	Maximum Mean Residues measured in water	Estimated Exposure WCR = water consumption rate; value used to calculate estimated exposure		Acute oral toxicity		Chronic RQ RQ = Exposure/Toxicity (LOC = 1.0)	
		µg/L	**Adults** µg/bee/day **[WCR:** 11.4 µL/bee/day]	**Larvae** µg/larvae/5 days **[WCR:** 111 µL/larvae/5-days development]	**Adults Chronic 10-day NOED** (µg/bee/day)	**Larvae Chronic NOED at 22** days (µg/larvae/day) [µg/larvae/over development period]	**Adults**	**Larvae**
Clothianidin	Puddles	7.92	9.03E-05	0.000879	0.00036	0.0009 (3-days feeding) [0.0027]	0.25	0.325
	Other	1.87	2.13E-05	0.000208	0.00036	0.0009 (3-days feeding) [0.0027]	0.059	0.077
Thiamethoxam	Puddles	7.7	8.78E-05	0.000855	0.00245	0.0157 (4-days feeding) [0.0628]	0.036	0.014
	Other	1.06	1.2E-05	0.000118	0.00245	0.0157 (4-days feeding) [0.0628]	0.005	0.002
Imidacloprid	Puddles	0.008	9.12E-08	8.88E-07	0.00016	0.0018 (3-days feeding) [0.0054]	0.00057	0.00016
	Other	0.0018	2.05E-08	2E-07	0.00016	0.0018 (3-days feeding) [0.0054]	0.00012	0.000037
	Puddles	8.81 (cumulative neonic max mean)	0.0001	0.000978	0.00016	0.0018 (3-days feeding) [0.0054]	0.62	0.18

Table 4 Monitoring data summary for neonicotinoids in water sources near bee hives in Canada and the United States. Bolded values were used in the risk assessment.

Reference (PMRA#)	Sampling year	Location	Water type	Land use (crop; timing)	Chemical	LOD (µg/L)	Mean concentration (µg/L)	Max concentration (µg/L)	N detects	N samples	% detection
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Puddles in corn field	Agricultural (corn; pre-plant)	Clothianidin	0.02	1.12	4.75	18	18	100
Samson-Robert *et al*., 2014 (2526146)	2012-2013	Quebec	Puddles in corn field	Agricultural (corn; during planting)	Clothianidin	0.1	4.6	**55.7**	23	25	92
Samson-Robert *et al*., 2014 (2526146)	2012-2013	Quebec	Puddles in corn field	Agricultural (corn; post-seeding)	Clothianidin	0.001	0.523	2.3	34	34	100
2548877	2013	Ontario	Puddles	Agricultural	Clothianidin	NR	NC	2.662	2	9	22
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Puddles in corn field	Agricultural (corn; post-plant 1-5 weeks)	Clothianidin	0.02	**7.92**	43.6	17	17	100
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Puddles in corn field	Agricultural (corn; post-plant 6-7 weeks)	Clothianidin	0.02	2.04	6.95	8	8	100
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Puddles outside corn field	Agricultural (corn; pre-plant)	Clothianidin	0.02	0.69	1.98	12	12	100
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Puddles outside corn field	Agricultural (corn; post-plant 1-5 weeks)	Clothianidin	0.02	1.02	3.25	28	28	100
Schaafsma *et al*., 2015 2526184)	2013	Ontario	Puddles outside corn field	Agricultural (corn; post-plant 6-7 weeks)	Clothianidin	0.02	0.96	1.39	7	7	100
2548876	2014	British Columbia, Manitoba, Ontario, Quebec, Nova Scotia	Puddles	Agricultural	Clothianidin	0.0022	0.1281	0.652	6	10	60
2548877	2014	Ontario	Puddles	Agricultural	Clothianidin	0.0022	0.0628	0.235	2	4	50
2548876	2014	British Columbia, Manitoba, Ontario, Quebec, Nova Scotia	Ditch, stream, culvert	Agricultural	Clothianidin	0.0022	0.055046	0.424	8	13	62

Reference (PMRA#)	Sampling year	Location	Water type	Land use (crop; timing)	Chemical	LOD (µg/L)	Mean concentration (µg/L)	Max concentration (µg/L)	N detects	N samples	% detection
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Drains, ditches	Agricultural (corn; pre-plant and post-plant 1-7 weeks)	Clothianidin	0.02	**1.87**	**16.2**	30	30	100
2548877	2013	Quebec, Ontario, Manitoba	Pond, creek, stream, culvert	Agricultural	Clothianidin	NR	NC	3.324	7	68	10
2548877	2014	Ontario, Manitoba	Pond, creek, marsh, water from a bucket	Agricultural	Clothianidin	0.0022	0.1882	3.91	14	23	61
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Puddles in corn field	Agricultural (corn; pre-plant)	Thiamethoxam	0.01	0.57	2.23	18	18	100
Samson-Robert *et al*., 2014 (2526146)	2012-2013	Quebec	Puddles in corn field	Agricultural (corn; during planting)	Thiamethoxam	0.1	**7.7**	**63.4**	18	25	72
Samson-Robert *et al*., 2014 (2526146)	2012-2013	Quebec	Puddles in corn field	Agricultural (corn; post-seeding)	Thiamethoxam	0.0001	0.585	2.8	34	34	100
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Puddles in corn field	Agricultural (corn; post-plant 1-5 weeks)	Thiamethoxam	0.01	0.9	2.57	17	17	100
Schaafsma *et al*., 2015 (PMRA# 2526184)	2013	Ontario	Puddles in corn field	Agricultural (corn; post-plant 6-7 weeks)	Thiamethoxam	0.01	1.14	3.43	8	8	100
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Puddles outside corn field	Agricultural (corn; pre-plant)	Thiamethoxam	0.01	1.89	16.5	12	12	100
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Puddles outside corn field	Agricultural (corn; post-plant 1-5 weeks)	Thiamethoxam	0.01	0.81	8.3	27	28	96
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Puddles outside corn field	Agricultural (corn; post-plant 6-7 weeks)	Thiamethoxam	0.01	1.14	3.43	8	8	100
2548876	2014	British Columbia, Manitoba, Ontario, Quebec, Nova Scotia	Puddles	Agricultural	Thiamethoxam	0.0008	1.2953	6.87	5	10	50

Reference (PMRA#)	Sampling year	Location	Water type	Land use (crop; timing)	Chemical	LOD (µg/L)	Mean concentration (µg/L)	Max concentration (µg/L)	N detects	N samples	% detection
2548877	2014	Ontario	Puddles	Agricultural	Thiamethoxam	0.0008	0.0033	0.0069	3	4	75
2548877	2013	Ontario	Puddles	Agricultural	Thiamethoxam	NR	NC	0.202	2	9	22
2548876	2014	British Columbia, Manitoba, Ontario, Quebec, Nova Scotia	Ditch, stream, culvert	Agricultural	Thiamethoxam	0.0008	0.05167	0.54	5	13	38
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Drains, ditches	Agricultural (corn; pre-plant and post-plant 1-7 weeks)	Thiamethoxam	0.01	**1.06**	**7.5**	29	30	97
2548877	2013	Quebec, Ontario, Manitoba	Pond, creek, stream, culvert	Agricultural	Thiamethoxam	NR	NC	0.17	10	68	15
2548877	2014	Ontario, Manitoba	Pond, creek, marsh, water from a bucket	Agricultural	Thiamethoxam	0.0008	0.0189	0.2	15	23	65
Samson-Robert *et al*., 2014 (2526146)	2012-2013	Quebec	Puddles in corn field	Agricultural (corn; post-seeding)	Imidacloprid	0.001	0.004	0.007	3	34	9
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Puddles (in and outside corn field)	Agricultural (corn)	Imidacloprid	0.01	NC	**0.19**	2	90	2
2548876	2014	British Columbia, Manitoba, Ontario, Quebec, Nova Scotia	Puddles	Agricultural	Imidacloprid	0.0011	0.0048	0.0057	3	10	30
2548877	2014	Ontario	Puddles	Agricultural	Imidacloprid	0.0011	**0.0080**	0.012	2	4	50
2548877	2013	Ontario	Puddles	Agricultural	Imidacloprid	NR	ND	ND	0	9	0
2548876	2014	British Columbia, Manitoba, Ontario, Quebec, Nova Scotia	Ditch, stream, culvert	Agricultural	Imidacloprid	0.0011	0.0059	0.0112	1	13	8
2548877	2013	Quebec, Ontario, Manitoba	Pond, creek, stream, culvert	Agricultural	Imidacloprid	NR	NC	**0.066**	1	68	1
2548877	2014	Ontario, Manitoba	Pond, creek, marsh, water from a bucket	Agricultural	Imidacloprid	0.0011	**0.0018**	0.018	7	23	30

Reference (PMRA#)	Sampling year	Location	Water type	Land use (crop; timing)	Chemical	LOD (µg/L)	Mean concentration (µg/L)	Max concentration (µg/L)	N detects	N samples	% detection
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Ditches, field drainage outlets within and outside of corn field	Agricultural (corn)	Imidacloprid	0.01	NC	0.06	3	30	10
Samson-Robert *et al*., 2014 (2526146)	2012-2013	Quebec	Puddles in corn field	Agricultural (corn; post-seeding)	Imidacloprid-urea	0.0009	0.005	0.005	3	34	9
Samson-Robert *et al*., 2014 (2526146)	2012-2013	Quebec	Puddles in corn field	Agricultural (corn; post-seeding)	Imidacloprid-guanidine	0.0008	ND	ND	0	34	0
Samson-Robert *et al*., 2014 (2526146)	2012-2013	Quebec	Puddles in corn field	Agricultural (corn; post-seeding)	Imidacloprid-olefin	0.0007	ND	ND	0	34	0
Monitoring data from US											
Johnson and Pettis, 2014 (2538821); Johnson, 2012 (2373072)	2010	Maryland, US	Puddles	Urban	Imidacloprid	ELISA: 0.07	16.04	131	5	10	50
						LC-MS: 1	1.06	9.2	3	10	30
Johnson and Pettis, 2014 (2538821); Johnson, 2012 (2373072)	2010	Maryland, US	Puddles	Suburban	Imidacloprid	ELISA: 0.07	2.4640	12	3	5	60
						LC-MS: 1	<LOQ	<LOQ	2	5	40
Johnson and Pettis, 2014 (2538821); Johnson, 2012 (2373072)	2010	Maryland, US	Rivulets, ponds, drainage ditches	Suburban	Imidacloprid	ELISA: 0.07	1.002	10	7	19	37
						LC-MS: 1	0.434	3.6	7	19	37
Johnson and Pettis, 2014 (2538821); Johnson, 2012 (2373072)	2010	Maryland, US	Rivulets, ponds, farm runoff, stream, wetlands, ditches	Rural	Imidacloprid	ELISA: 0.07	1.374	25	5	34	15
						LC-MS: 1	0.153	3.3	4	34	12
Johnson and Pettis, 2014 (2538821); Johnson, 2012 (2373072)	2010	Maryland, US	Fountains, bird baths, car wash, culvert, statue with standing water, drainpipe, fish pond, storm management pond, lowland, irrigation pipes, springs	Urban, suburban, rural	Imidacloprid	ELISA: 0.07	0.683	27	4	42	10
						LC-MS: 1	0.131	3.8	4	42	10

Reference (PMRA#)	Sampling year	Location	Water type	Land use (crop; timing)	Chemical	LOD (µg/L)	Mean concentration (µg/L)	Max concentration (µg/L)	N detects	N samples	% detection
Cumulative											
2548876	2014	British Columbia, Manitoba, Ontario, Quebec, Nova Scotia	Ditch, stream, culvert	Agricultural	Cumulative*	NC	0.1177	0.98	8	13	At least one: 62
2548877	2014	Ontario, Manitoba	Pond, creek, marsh, water from a bucket	Agricultural	Cumulative*	NC	0.2189	4.029	17	23	At least one: 74
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Puddles outside corn field	Agricultural (corn; post-plant 1-5 weeks)	Cumulative**	NC	1.81	9.38	28	28	At least one: 100
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Puddles outside corn field	Agricultural (corn; post-plant 6-7 weeks)	Cumulative**	NC	2.31	4.2	7	7	At least one: 100
2548876	2014	British Columbia, Manitoba, Ontario, Quebec, Nova Scotia	Puddles	Agricultural	Cumulative*	NC	1.438	6.947	6	10	At least one: 60
2548877	2014	Ontario	Puddles	Agricultural	Cumulative*	NC	0.085	0.264	3	4	At least one: 75
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Drains, ditches	Agricultural (corn; pre-plant and post-plant 1-7 weeks)	Cumulative**	NC	2.93	16.35	30	30	At least one: 100
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Puddles in corn field	Agricultural (corn; pre-plant)	Cumulative**	NC	1.69	5.48	18	18	At least one: 100
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Puddles in corn field	Agricultural (corn; post-plant 1-5 weeks)	Cumulative**	NC	**8.81**	**44.38**	17	17	At least one: 100
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Puddles in corn field	Agricultural (corn; post-plant 6-7 weeks)	Cumulative**	NC	3.18	10.38	8	8	At least one: 100
Schaafsma *et al*., 2015 (2526184)	2013	Ontario	Puddles outside corn field	Agricultural (corn; pre-plant)	Cumulative**	NC	2.57	17.83	12	12	At least one: 100

NC: not calculated; NR: not reported; LOD: limit of detection; LOQ: limit of quantification; ND: not detected

* Analyzed for clothianidin, thiamethoxam, imidacloprid, thiacloprid, acetamiprid; all considered in cumulative concentration, many were not detected.

** Analyzed for clothianidin, thiamethoxam, imidacloprid, thiacloprid, acetamiprid, dinotefuran, nitenpyram; all considered in cumulative concentration, many were not detected.

Guttation water exposure route

Guttation is a natural plant phenomenon whereby xylem fluid is excreted from leaf margins. It is a result of positive xylem pressure originating in the roots of plants that occurs during periods of reduced transpiration and high relative humidity. This phenomenon may occur at night and in the early morning especially during the crop seedling stages.

Residues in guttation liquid

The levels of neonicotinoids in guttation liquid from plants were assessed using available residue data from the open literature and registrant submitted studies. Studies included those examining residue levels in guttation liquid as well as semi-field and field studies where effects on honey bees were also analyzed. Studies focussed primarily on residues in guttation fluid following seed treatment applications in a variety of crops including winter wheat, winter barley, oilseed rape, corn and beets. Two studies investigated residues in guttation fluid following a foliar application or in-furrow application in potato. In addition, residues in rotational crops following soil and seed treatment applications the preceding year were available for imidacloprid.

Based on available data, clothianidin, thiamethoxam, imidacloprid and relevant metabolites were detected in guttation fluid at varying concentrations. The maximum, minimum and mean of the maximum concentrations in plant guttation liquid are summarised in Table 5 for each active ingredient. Further information on the residue measurements from each study are presented in Table 6. Residue levels of clothianidin, thiamethoxam and imidacloprid in guttation liquid were variable but overall considered to be high despite differences in crop type, application rate or application method. Highest concentrations up to 717 ppm for clothianidin, 200 ppm for imidacloprid and 100 ppm for thiamethoxam were detected in guttation fluid following seed treatment application in corn plants. Residue levels in rotational crops following soil and seed treatment application the preceding year were comparatively much lower. Residue concentrations of imidacloprid in guttation liquid of rotational crops (e.g. maize) ranged from 1.3 to 8 ppb.

Table 5 Neonicotinoid concentrations (µg/L parent) measured in guttation liquid of plants that were treated.

	Clothianidin	Thiamethoxam	Imidacloprid
Maximum	717000	100000	200000
Mean	64912	26553	30744
Minimum	64	12.94	10
n	16	8	7

Table 6 Neonicotinoid concentration in plant guttation liquid from available residue studies.

Test chemical	Treatment method	Test crop	Detected Maximum Residues (ppb)							Total CLO equivalent (for TMX studies**)	Reference study (PMRA#)
			CLO	TZNG	TZMU	IMI	5-OH	IMI-Olefine	TMX		
Clothianidin	ST	corn	717000	4000	9000	-	-	-	-	-	2355499, 2355481, 2377282
Clothianidin	ST	corn	285 000	4900	6700	-	-	-	-	-	
Clothianidin	ST	corn	39 000	-	-	-	-	-	-	-	2377280
Clothianidin	SO + ST	corn	126	23	5	-	-	-	-	-	2510484
Clothianidin	SO + ST	corn	547	92	13	-	-	-	-	-	
Clothianidin	SO + ST	corn	175	12	9	-	-	-	-	-	2510485
Clothianidin	SO + ST	corn	73	5	3	-	-	-	-	-	
Clothianidin	ST	corn	100000	-	-	-	-	-	-	-	Girolami et al, (2009)
Clothianidin	ST	winter oilseed rape	410	-	-	-	-	-	-	-	2355469
Clothianidin	ST	winter oilseed rape	132	-	-	-	-	-	-	-	Reetz *et al.* (2015)
Clothianidin	FO	potato	1317	53	32	-	-	-	-	-	2532796
Clothianidin Imidacloprid	ST	winter barley	8511	-	-	6650	-	-	-	-	2355472, 2510478, 2535877
Clothianidin Imidacloprid	ST	winter barley	2300	50	20	1500	640	50	-	-	2355498, 2510477, 2535882
Clothianidin Imidacloprid	ST	winter wheat	13000	490	320	6900	610	120	-	-	2355497, 2510486, 2535904
Clothianidin Imidacloprid	ST	sugar beets	327	57	53	61	16	4	-	-	2510479, 2535883
Clothianidin Imidacloprid	ST	sugar beets	64	12	11	10	4.2	1.3	-	-	2510480, 2535884

Test chemical	Treatment method	Test crop	Detected Maximum Residues (ppb)							Total CLO equivalent (for TMX studies**)	Reference study (PMRA#)
			CLO	TZNG	TZMU	IMI	5-OH	IMI-Olefine	TMX		
Imidacloprid	SO+ST	rotational crop Maize*	-	-	-	88	12	2	-	-	2513416
Imidacloprid	ST	rotational crop Maize*	-	-	-	1.3	< 1	< 1	-	-	2535892
Imidacloprid	ST	rotational crop Maize*	-	-	-	5.7	< 1	ND	-	-	2535894
Imidacloprid	ST	rotational crop Maize*	-	-	-	4.1	< 1	ND	-	-	2535895
Imidacloprid	ST	corn	-	-	-	200000	-	-	-	-	Girolami et al, (2009)
Imidacloprid	FO	bentgrass	-	-	-	88	-	-	-	-	Larson et. al. (2015)
Thiamethoxam	ST	oilseed rape next to seeded maize	1900	-	-	-	-	-	28000	25868	2365336
Thiamethoxam	ST	off field to maize	3500	-	-	-	-	-	28000	27468	2365365
Thiamethoxam	ST	off field to maize	2000	-	-	-	-	-	16000	15696	2365370
Thiamethoxam	ST	off field to maize	4000	-	-	-	-	-	29000	28824	2365373
Thiamethoxam	ST	corn	-	-	-	-	-	-	100000	85600	Girolami et al, (2009)
Thiamethoxam	ST	winter oilseed rape	6.47	-	-	-	-	-	12.94	17.55	Reetz et al (2015)
Thiamethoxam	ST	winter oilseed	408.65	-	-	-	-	-	11136.94	9941.9	2766425

Test chemical	Treatment method	Test crop	Detected Maximum Residues (ppb)							Total CLO equivalent (for TMX studies**)	Reference study (PMRA#)
			CLO	TZNG	TZMU	IMI	5-OH	IMI-Olefine	TMX		
		rape									
Thiamethoxam	ST	winter oilseed rape	14.64	-	-	-	-	-	273.6	248.84	2766426
Maximum*			717000	4900	9000	200000	640	120	100000	85600	
Mean*			64912	1298	2252	30744	318	44	26553	24208	
Minimum*			64	5	3	10	4.2	1.3	12.94	18	
n*			16	11	11	7	4	4	8	8	

Abbreviations: CLO-Clothianidin; IMI-imidacloprid; TMX: thiamethoxam, ST, seed treatment, FO: Foliar application, ND: Not determined

* Measurement for the rotational crop is not used in the mean, maximum and minimum calculation. Maximum, mean and minimum calculation for clothianidin based on parent only.

** Total CLO equivalent for TMX studies is the sum of measured CLO and clothianidin equivalent converted based on molecular weight (ratio of molecular weight of clothianidin to thiamethoxam is 0.8559).

Risk assessment for guttation water exposure route

Tier I risk assessment using measured data for guttation water exposure route

The potential risks to bees from exposure to contaminated plant guttation liquid were assessed using a similar approach described in the previous section for surface water. A potential for risk via guttation liquid was identified when calculated RQ values were greater than the Level of Concern (LOC), which is 0.4 for acute, and 1 for chronic risk. The maximum residue values were used for the acute risk assessment, and the mean of the maximum residue values was used for the chronic risk assessment. Risk assessments were conducted for clothianidin and imidacloprid but not their respective transformation products as residue levels of the parent were higher and it is expected that the transformation products are covered off by the risk assessment for the parent. In the case of thiamethoxam, the major transformation product is clothianidin. Both of these neonicotinoid active ingredients share a similar biological/toxicological mode of action and some toxicity information suggests similar effects. As residues of the transformation product clothianidin were detected in high amounts following applications of thiamethoxam, both thiamethoxam and clothianidin residues are considered in this risk assessment. Residues of thiamethoxam were converted to clothianidin equivalents based on molecular weight (molar ratio of clothianidin to thiamethoxam is 0.856) and summed with clothianidin residues. Total clothianidin equivalent residues for thiamethoxam were calculated to be 85600 ppb for the acute assessment (maximum value) and 24208 ppb for the chronic assessment (mean value). Individual bee toxicity was compared for thiamethoxam converted to clothianidin equivalents, and clothianidin. The more sensitive of these two toxicity endpoints was used in the risk assessment, and compared to exposure levels in terms of clothianidin equivalents.

The Tier I risk assessment for honey bees exposed to guttation fluid containing clothianidin, thiamethoxam or imidacloprid is summarized in Table 7 for acute and chronic risks. Based on the Tier I risk assessment, a potential for risk to adult bees and bee larvae was indicated from acute and chronic exposure to residues in plant guttation fluid following applications of clothianidin, thiamethoxam and imidacloprid to crops in the same season. With the exception of a marginal potential for chronic risk to adult bees, no risk was indicated for adult bees and bee larvae exposed to guttation liquid from rotational crops following treatment application to another crop in the preceding year. Overall the risk assessment approach is considered to be conservative as it assumes that the water used by bees is all from contaminated guttation fluid.

Table 7 Tier I acute and chronic risk assessment for honey bees using available residue information in plant guttation liquid.

Test chemicals	Type of risks	Residues (µg/L)	Adults			Larvae		
			Estimated exposure (µg/bee/day) [**WCR:** 11.4 µL/bee/day]	**Toxicity endpoint (LD_{50} µg/bee for acute, 10-d NOEC µg/bee/day for chronic)**	**RQ*** (Exposure/Toxicity (LOC = 0.4 for acute, 1 for chronic)**	**Estimated exposure µg/larvae/5 days** [**WCR:** 111 µL/larvae/5-days development]	**Toxicity endpoint (µg/larvae/day) [µg/larvae/over development period] LD_{50} at D7 for acute, NOEC at D22 for chronic**	**RQ*** (Exposure/Toxicity (LOC = 0.4 for acute, 1 for chronic)**
Clothianidin	Acute	717000	8.1738	0.00368	**2221**	79.587	> 0.0018 (3-days feeding) [> 0.0054]	**< 14738**
	Chronic	64912	0.7399968	0.00036	**2056**	7.205232	0.0009 (3-days feeding) [0.0027]	**2669**
Thiamethoxam*	Acute	85600	0.97584	0.00368	**265**	9.5016	> 0.0018 (3-days feeding) [> 0.0054]	**1760**
	Chronic	24208	0.2759712	0.00036	**767**	2.687088	0.0009 (3-days feeding) [0.0027]	**995**
Imidacloprid	Acute	200000	22.2	0.0038	**600**	22.2	4.17 (1-day feeding) [4.17]	**5**
	Chronic	30744	3.979794	0.00016	**2555**	3.979794	0.0018 (3-days feeding) [0.0054]	**737**
Guttation in rotational crops**	Acute	88	0.0010032	0.0038	0.3	0.009768	4.17 (1-day feeding) [4.17]	0.002
	Chronic	25	0.000285	0.00016	**1.781**	0.002775	0.0018 (3-days feeding) [0.0054]	0.514

* For thiamethoxam, exposure to residues in guttation water considered the sum of thiamethoxam and clothianidin residues. Residues for thiamethoxam were converted to clothianidin equivalents based on molecular weight (molar ratio of clothianidin to thiamethoxam is 0.856) and summed with clothianidin residues. Exposure in terms of clothianidin equivalents was compared with the clothianidin toxicity endpoints (which were more sensitive than the thiamethoxam toxicity endpoints in terms of clothianidin equivalents) for the RQ calculation.

** Only residue studies for imidacloprid were available for rotational crops after soil and seed treatment.

*** Bolded values indicate the RQ > LOC

Refinement of risks for guttation water exposure route with available higher tier studies

There were multiple higher tier semi-field and field studies from the open literature and registrant which investigated effects on honey bee colonies following exposure to plant guttation liquid. Studies focussed primarily on exposure scenarios following seed treatment applications in a variety of crops including winter wheat, winter barley, oilseed rape, corn and sugar beets. Other studies were available which tested other application methods (foliar, seed/soil) in potato, turf in the same season and in rotational crops where applications were made the preceding year. In the studies honey bee colonies were continuously exposed from 21 up to 83 days to treated crops when guttation fluid was potentially available and hives were observed for bee mortality, flight activity, brood development, hive strength, bee health and/or overwintering performance from 36–278 days. In addition to colony level effects information, the occurrence and duration of guttation, bees foraging activity on guttation liquid were also monitored.

The results show that in almost all cases, guttation was present at various levels in test crops and mainly in the morning during the early growth stage of the crop; however bees were either not observed consuming guttation liquid, or did but only at a very low level. A transitory increase in individual bee mortality was observed in some of the studies; however no treatment related long term colony level adverse effects were observed in any available studies for all the three neonicotinoids. Observations from available studies indicate that although residue levels measured in plant guttation can be high, bees were not observed consuming guttation liquid, or only a small portion of bees were observed collecting guttation liquid, especially when other water sources are available. It has been reported that thiamethoxam residues detected in the sac of returning water foraging bees were about 10 times less than the residues measured directly in plant guttation (Reetz et al., 2015), likely indicating that the majority of water comes from sources other than the guttation. As such there is likely limited exposure for bees from this source.

The effect of plant guttation droplets on honey bee adults were also tested in the laboratory (Girolami et al., 2009). In the study guttation liquid was collected from plants grown from corn seeds treated with clothianidin, imidacloprid or thiamethoxam. Honey bee adults were forced to feed on the guttation droplets either with or without honey added. It was reported that wing paralysis was observed 2–9 minutes after feeding. The study demonstrated that contaminated guttation liquid might intoxicate bees under laboratory conditions. However information on the potential exposure of guttation liquid to bees was not provided. Such information may include the frequency or likelihood of bee consuming guttation fluid, co-occurrence of the guttation liquid on plants and the foraging period of the bees. The study did report that test bees were not particularly attracted to guttation liquid without adding the incentive honey, suggesting that guttation liquid without the addition of honey was not particularly attractive to the study bees.

Overall, the available information indicates that clothianidin, imidacloprid and thiamethoxam applications may result in a transitory increase in mortality on individual adult bees following exposure to contaminated plant guttation liquid; however, in general bees were not typically observed using guttation liquid as a water source in the field and as such there is likely limited exposure from this route. Therefore, no adverse effects on colony and brood development are expected due to the limited exposure potential.

The risk assessment for guttation was conducted using honey bees as a surrogate for non-*Apis* bees including bumble bees and solitary bees due to their high water turnover. The approach is considered to be conservative and likely representing a worst-case exposure scenario for non-*Apis* bees; however, as described above, it is unclear whether and to what extent non-Apis bees use guttation liquid.

Overall risk conclusions for bees via water exposure

Overall risk potential is expected to be negligible for bees at the colony level, including *Apis* and non-*Apis* bees that are exposed to contaminated guttation water or surface water in areas treated with clothianidin, imidacloprid or thiamethoxam based on the information currently available.

Appendix XII Risk Conclusion Summary – Imidacloprid

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
From Crop Group 1: Root and Tuber Vegetables: Subgroups 1B: Root Vegetables (except sugarbeet) and 1D: Tuberous and corm vegetables (except potatoes) **(Excluding potato and sweet potato)** 1B: beet-garden; burdock-edible; carrot; celeriac; chervil-turnip rooted; chicory; ginsing; horseradish; parsley-turnip rooted; parsnip; radish; radish-oriental; rutabaga; salsify; salsify-black; salsify-Spanish; skirret; turnip. 1D: arracacha; arrowroot; artichoke-Chenese; artichoke-Jerusalem; canna-edible; cassava-bitter and sweet; chayote-root; chufa; dasheen; ginger; leren; sweet potato; tanier; turmeric;	FO	**No timing restrictions. Not when bees are visiting treatment area.** **Products:** 24094 **Current Label Statements:** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Insect pollination not required for crop production (unless grown for seed). Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada. **Exposure potential**: O: N^2 C: N^2 **Overall, there is minimal potential for exposure.** **Pollinator Exposure (pollen/nectar): Negligible.** There is minimal potential for exposure through pollen and nectar as harvested before bloom. Not grown for seed in Canada.	**Minimal potential for risk through pollen and nectar exposure route as harvested before bloom**	**None**	**Maintain use considering negligible pollinator exposure as harvested before bloom.** **No additional risk management.** **Label Update:** **Add under:** Environmental Precautions, after the other bee statements: *To further minimize exposure to pollinators, refer to the complete guidance "Protecting Pollinators during Pesticide Spraying- Best Management Practices" on the Health Canada website (www.healthcanada.gc.ca/pollinators). Follow crop specific directions for application timing.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
yam bean; yam-true						
From Crop Group 1: Root and Tuber Vegetables: Subgroups 1B: Root Vegetables (except sugarbeet) and 1D: Tuberous and corm vegetables (except potatoes) **(Excluding potato and sweet potato)** 1B: beet-garden; burdock-edible; carrot; celeriac; chervil-turnip rooted; chicory; ginsing; horseradish; parsley-turnip rooted; parsnip; radish; radish-oriental; rutabaga; salsify; salsify-black; salsify-Spanish; skirret; turnip. 1D: arracacha; arrowroot; artichoke-Chenese; artichoke-Jerusalem; canna-edible; cassava-bitter and sweet; chayote-root; chufa; dasheen; ginger; leren; sweet potato; tanier; turmeric;	SO	**Soil application at/near planting.** *Note: When CG1 soil drenches are not applied at planting, they are applied around field edges followed by irrigation* **Products:** 24094 28475 (ginseng only) 28726 (ginseng only) 29048 (ginseng only) **Current Label Statements:** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 28475: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Insect pollination not required for crop production (unless grown for seed). Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada. **Exposure potential**: O: N[2] C: N **Overall, there is minimal potential for exposure.** **Pollinator Exposure (pollen/nectar): Negligible.** There is minimal potential for exposure through pollen and nectar as harvested before bloom. Not grown for seed in Canada.	**Minimal potential for risk through pollen and nectar exposure route as harvested before bloom**	**None**	**Maintain use considering negligible pollinator exposure as harvested before bloom.** **No additional risk management.**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
yam bean; yam-true		*treatment area.* Additionally, statements related to planting of treated seed are included. 28726: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* 29048: Environmental Hazards: *This product is TOXIC to aquatic organisms, birds,bees and beneficial insects.DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees and beneficial insects in habitats close to the application site.*				
From Crop group 1 Root and Tuber Vegetables: Crop Subgroup 1B **(Excluding potato and sweet potato)** Carrot only	ST (carrot only)	**CG1 (carrot only): Planting treated seed.** **Products:** 30972 **Current Label Statements:** 30972:Environmental Precautions and Information: *Toxic to bees. Bees may be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment application.* *Do not expose treated seeds on the soil surface. Any spilled or exposed seeds should be*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Insect pollination not required for crop production (unless grown for seed). Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada. **Exposure potential**: O: N[2] C: N **Overall, there is minimal potential**	**Minimal potential for risk through pollen and nectar exposure route as harvested before bloom.** **Minimal potential for risk from dust generated during planting of treated seed.**	**None**	**Maintain use considering negligible pollinator exposure as harvested before bloom.** **No additional risk management.** **Label update:** May update label language to include the following: Environmental Precautions and Information: Add (after current bee statements): *When used according to label directions minimal exposure or risk*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		incorporated into the soil or otherwise cleaned up from the soil surface.	**for exposure.** **Pollinator Exposure (pollen/nectar): Negligible.** There is minimal potential for exposure through pollen and nectar as harvested before bloom. Not grown for seed in Canada. **Pollinator Exposure (dust): Minimal potential for exposure from dust generated during planting of treated seed.** Exposure through dust generated during planting of treated seed is not expected. CG1 seeds typically have low dust levels and may be pelletized for certain crops within the crop group (including carrot). Certain planting equipment can increase emission of pesticide containing dust, but is not typically used when planting seeds from this CG.			*is expected.* Example: Where states the following, the additional sentence may be added: *Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications.* ***When used according to label directions minimal exposure or risk is expected.***
From Crop Group 1: Root and Tuber Vegetables: Potato and Sweet potato	FO (potato and sweet potato)	**Sweet potato: no application during bloom. Potato: no timing restrictions. Not when bees are visiting treatment area.** **Products:** 24094 (potato and sweet potato) 28475 (potato only) 28726 (potato only) 29048 (potato only) 29611 (potato only, includes aerial) **Current Label Statements** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to*	**Attractive to**: Sweet potato: HB, BB, SB Potato: BB, SB **Agronomic considerations**: Insect pollination not required for crop production. Potato and sweet potato: Harvested after bloom. Bloom time 2 – 3 weeks. Some cultivars do not flower. Potato plants produce no nectar and very little pollen, which is not considered attractive to most bees. Sweet potato produces nectar and pollen. **Exposure potential**: O: Y C: Y **Potential for exposure through pre-bloom and during bloom foliar application.** **Annual crops; no exposure through**	Tiered Framework (potato and sweet potato): *Apis* and non-*Apis* bees: T1SL: Yes Residues: No potato or sweet potato residues. Considered residues from pre-bloom cotton, sugarmelon, soybean T1R: Yes T2 CFS: Pre-bloom: Potential risk for bumble bees and honey bees using cotton as surrogate; potential risk for bumble bees (not honey bees) using sugarmelon as surrogate. Minimal potential for risks for honey bees and bumble bees using soybean as surrogate. T2 Tunnel: NA	**Residues:** No potato or sweet potato specific residues. Cotton, sugarmelon, soybean were used as surrogate for pre-bloom applications. Rates for residue studies were higher than Canadian rates. Overall, residues are considered conservative for pre-bloom foliar application. **T2 Tunnel; T3 field; Incidents:** None **Bloom period compared to CFS:** Blooming period may be shorter than colony feeding study exposure durations. Potatoes provide only pollen source. **Effects endpoints**: Some uncertainty and differences among CFS endpoints.	**CG1 Potato and Sweet Potato:** **Remove during-bloom use based on potential for risk. Maintain pre-bloom use considering low pollinator exposure. Maintain post-bloom use considering negligible risk (annual crop).** **Add to directions for use for Potato:** *Do not apply during bloom or when bees are actively foraging.* **Directions for use for sweet potato already restrict application during bloom.** **Add to Environmental Precautions following the other bee statements:** Environmental Hazards/ Environmental Precautions: *To further minimize exposure to pollinators, refer to the complete guidance "Protecting Pollinators*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site. 28475; 28726: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* *29048; 29611: Environmental Hazards:* *[29048: This product is toxic to …bees.] [29611: This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds]. DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 24094: Use Directions: Sweet Potato- foliar: *DO NOT apply ADMIRE 240 Flowable Systemic Insecticide during flowering of the crop.* Note: no other labels include sweet potato foliar use.	**post-bloom application.** **Pollinator Exposure (pollen/nectar): Low to Moderate; considered Low**. Potato and Sweet potato crops do not require insect pollination. **Potato** is a minor source of pollen for some BB and SB. Potato plants produce no nectar and very little pollen; some cultivars produce many flowers while some do not produce any flowers. Not attractive to HB, but some BB and SB will forage on potato pollen. Potato is medium acreage (Canada 2017: 344,884 acres). Potato is produced in every province in Canada with high production (2014: potato 59% of total vegetable acreage) and fields can be large in some areas.]. **Sweet potato** is a minor source of pollen and nectar for HB, BB, SB. Sweet potato is low acreage.	T3: NA Incidents: None **Overall:** **Based on the risk assessment using surrogate crops:** **Pre-bloom: potential for risks for bees; risks vary depending on surrogate crops considered.** **Consider Pollinator Exposure: Low to Moderate; considered low.**	*Apis* and non-*Apis* endpoints considered.	*during Pesticide Spraying- Best Management Practices" on the Health Canada website (www.healthcanada.gc.ca/pollinators). Follow crop specific directions for application timing.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
From Crop Group 1: Root and Tuber Vegetables: Potato and Sweet potato	SO (potato and sweet potato)	**At planting-soil drench in furrow.** *Note: When CG1 soil drenches are not applied at planting, they are applied around field edges followed by irrigation.* **Products:** 24094 28475 28726 29048 **Current Label Statements** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 28475; 28726: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.*	**Attractive to**: Sweet potato: HB, BB, SB Potato: BB, SB **Agronomic considerations**: Insect pollination not required for crop production. Potato and sweet potato: Harvested after bloom. Bloom time 2 – 3 weeks. Some cultivars do not flower. Potato plants produce no nectar and very little pollen, which is not considered attractive to most bees. Sweet potato produces nectar and pollen. **Exposure potential**: O: Y C: N **Pollinator Exposure (pollen/nectar): Low to Moderate; considered Low**. Potato and Sweet potato crops do not require insect pollination. **Potato** is a minor source of pollen for some BB and SB. Potato plants produce no nectar and very little pollen; some cultivars produce many flowers while some do not produce any flowers. Not attractive to HB, but some BB and SB will forage on potato pollen. Potato is medium acreage (Canada 2017: 344,884 acres). Potato is produced in every province in Canada with high production (2014: potato 59% of total vegetable acreage) and fields can be large in some areas.]. **Sweet potato** is a minor source of pollen and nectar for HB, BB, SB. Sweet potato is low acreage.	Tiered Framework (potato and sweet potato): *Apis* and non-*Apis* bees: T1SL: Yes Residues: Potato (pollen only). Rates lower than Canadian rates. T1R: No (pollen; at lower rate) T2CFS: No risks were detected using residues in pollen collected by free-flying bumble bees with limitation that the test rate was low compared with the maximum Canadian label rate. Low residue level in bee collected pollen (Maximum of 1.4 ppb) indicates low potential for exposure and risks to bumble bees. T2 Tunnel: NA T3: Two T3 field studies detected no treatment-related effects at colony level for bumble bees for in-furrow soil application of potato conducted 68-77 days before its flowering. No risks are expected for honey bees for potato given that honey bees are not attracted to potato and likely less sensitive than bumble bees at colony level. Incidents: None **Overall:** **Minimal potential for risks for in-furrow soil application at planting up to application rate of 180 g**	**Residues:** Potato specific residues (pollen only; potato has only pollen). Residues in potato pollen were collected by free-flying bumble bees in T3 field effect studies. However, the test rates (180 g a.i./ha) were less the maximum Canadian label rate which is 480 g a.i./ha. **T2 Tunnel; T3 field; Incidents:** T3 field effect studies were available for bumble bee with potato in-furrow soil application (180 g a.i./ha), with application made 68-77 days before crop flowering. There was a large variation in observed effect parameters. Overall, no effects were detected in bumble bees. **Bloom period compared to CFS:** Blooming period may be shorter than colony feeding study exposure durations. Potatoes provide only pollen source. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	**Maintain use considering low pollinator exposure and low/negligible risk based on risk characterization.** **No additional risk management.**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		29048: Environmental Hazards: *[29048: This product is toxic to …bees.] DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 24094; 28475; 28726; 29048: Use Directions: Sweet Potato-specific use directions (SO): *Apply as a single soil drench application after transplanting and before crop foliage covers more than 25% of the planting bed to ensure adequate soil penetration. DO NOT apply [PRODUCT] during flowering of the crop.* NOTE: 28475; 28726; 29048 are for soil use on sweet potato in ON, QC only		**a.i./ha based on the risk assessment using representative crop potato (pollen only). Some uncertainty for higher rates**. **Consider Pollinator Exposure: Low to Moderate; considered low.**		
From Crop group 1 Root and Tuber Vegetables: Potato	ST (potato seed piece)	**CG1 (potato only): Planting treated seed pieces.** **Products:** Labels with multiple uses/crops: 24094 28475 28726 29048 Labels with only potato seed piece treatment: 27349 27702 28159	**Attractive to**: Potato: BB, SB **Agronomic considerations**: Insect pollination not required for crop production. Potato: Harvested after bloom. Bloom time 2 – 3 weeks. Some cultivars do not flower. Potato plants produce no nectar and very little pollen, which is not considered attractive to most bees. **Exposure potential**: O: Y C: N **Potential for exposure from potato (pollen) from seed piece treatment.** **Pollinator Exposure (pollen/nectar):**	Tiered Framework (potato): Apis and non-Apis bees: T1SL: Yes Residues: Potato residues available from soil application; used as a surrogate for potato seed piece treatment. T1R: No T2 CFS: No potential risks for honey bees or bumble bees. T2 Tunnel: NA T3: No field study available on potato for seed treatment. But two potato soil	**Residues:** No residues measured for potato seed treatment, residues from potato after a soil application were used as surrogate. The soil application rate was 180 g a.i./ha, slightly lower than the maximum but within the range of Canadian label rate for potato seed pieces treatment (70-280 g a.i./ha) **T2 Tunnel; T3 field; Incidents:** Field study was not available for bumble bees for potato seed treatment, but two field potato studies were available for soil application, and no effects	**Maintain use considering low pollinator exposure and negligible risk based on risk characterization.** **No additional risk management.** **Label updates:** **Add:** Environmental Precautions/ Environmental Hazards: *Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications. When used according to label directions minimal exposure*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		28160 **Current Label Statements:** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 28475; 28726: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* *29048: Environmental Hazards:* *[29048: This product is toxic to …bees.] DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 27349; 27702: Environmental Hazards: *Dispose of all excess*	**Low.** Crop does not require insect pollination. Potato is a minor source of pollen for some BB and SB. Potato plants produce no nectar and very little pollen; some cultivars produce many flowers while some do not produce any flowers. Not attractive to HB, but some BB and SB will forage on potato pollen. Potato is medium acreage (Canada 2017: 344,884 acres). Potato is produced in every province in Canada with high production (2014: potato 59% of total vegetable acreage) and fields can be large in some areas. **Pollinator Exposure (dust): Minimal potential for exposure from dust generated during planting of treated potato seed pieces.** Exposure through dust generated during planting of treated seed is not expected. Potato seed pieces typically have low dust levels. Certain planting equipment can increase emission of pesticide containing dust, but is not used when planting potato seed pieces.	application field studies were available, and no treatment effects were reported for bumble bees. Incidents : None **Overall:** **Minimal potential for risk from pollen from potato seed piece treatment (potato has only pollen).** **Consider Pollinator Exposure: Low** **Minimal potential for risk from dust generated during planting of treated potato seed pieces.** .	were detected for soil application for bumble bees. The label rates for potato seed treatment and soil application are similar. It is assumed that the residues in potato after seed treatment are not greater than what may result from soil application at the same rate. **Bloom period compared to CFS:** Bloom time is likely shorter than colony feeding study exposure duration. Potato not attractive to honey bees, but bumble bees may forage on potato. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	*or risk is expected.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		and any spilled treated seed pieces by covering or incorporating into the soil. Left over treated seed should be doublesown around the headland, or buried away from water sources such as lakes, streams, ponds or other aquatic systems. 28159; 28160: Environmental Hazards: *Dispose of all excess and any spilled treated seed pieces by covering or incorporating into the soil.*				
Crop Group 2: Leaves of Root and Tuber Vegetables Beet, garden; burdock, edible; carrot; cassava, bitter and sweet; celeriac; chervil, turnip-rooted; chicory; dasheen (taro); parsnip; radish; radish, oriental; rutabaga; salsify, black; sweet potato; tanier (cocoyam); turnip; and yam, true	FO	**No timing restrictions. Not when bees are visiting treatment area.** **Products:** 24094 **Current Label Statements:** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Insect pollination not required for crop production (unless grown for seed). Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada. **Exposure potential**: O: N^2 C: N^2 **Overall, there is minimal potential for exposure.** **Pollinator Exposure (pollen/nectar): Negligible.** There is minimal potential for exposure through pollen and nectar as harvested before bloom. Not grown for seed in Canada.	**Minimal potential for risk through pollen and nectar exposure route as harvested before bloom**	**None**	**Maintain use considering negligible pollinator exposure as harvested before bloom.** **No additional risk management.** **Label update**: **Add under:** Environmental Precautions, after the other bee statements: *To further minimize exposure to pollinators, refer to the complete guidance "Protecting Pollinators during Pesticide Spraying- Best Management Practices" on the Health Canada website (www.healthcanada.gc.ca/pollinators). Follow crop specific directions for application timing.*
Crop Group 2: Leaves of Root and Tuber	SO	**Soil application at/near planting**	**Attractive to**:	**Minimal potential for risk through pollen and nectar exposure route as harvested**	**None**	**Maintain use considering negligible pollinator exposure as**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
Vegetables Beet, garden; burdock, edible; carrot; cassava, bitter and sweet; celeriac; chervil, turnip-rooted; chicory; dasheen (taro); parsnip; radish; radish, oriental; rutabaga; salsify, black; sweet potato; tanier (cocoyam); turnip; and yam, true		**Products:** 24094 **Current Label Statements:** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* *Note: When CG2 soil drenches are not applied at planting, they are applied around field edges followed by irrigation.*	HB, BB, SB **Agronomic considerations**: Insect pollination not required for crop production (unless grown for seed). Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada. **Exposure potential**: O: N[2] C: N **Overall, there is minimal potential for exposure.** **Pollinator Exposure (pollen/nectar): Negligible.** There is minimal potential for exposure through pollen and nectar as harvested before bloom. Not grown for seed in Canada.	**before bloom**		**harvested before bloom.** **No additional risk management.**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
From Crop Group 3: Bulb vegetables onion (bulb and green) and leek	ST [onion (bulb, green) and leek only]	**CG3 Bulb vegetables (onion and leek only): Planting treated seed.** **Products:** 30972 **Current Label Statements:** 30972:Environmental Precautions and Information: *Toxic to bees. Bees may be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment application.* *Do not expose treated seeds on the soil surface. Any spilled or exposed seeds should be incorporated into the soil or otherwise cleaned up from the soil surface.*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Insect pollination not required for crop production (unless grown for seed). Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada. **Exposure potential**: O: N[2] C: N **Overall, there is minimal potential for exposure.** **Pollinator Exposure (pollen/nectar): Negligible.** There is minimal potential for exposure through pollen and nectar as harvested before bloom. Not grown for seed in Canada. **Pollinator Exposure (dust): Minimal potential for exposure from dust generated during planting of treated seed.** Exposure through dust generated during planting of treated seed is not expected. CG3 treated seeds typically have low dust levels and may be pelletized for certain crops within the crop group (including onion). Certain planting equipment can increase emission of pesticide containing dust, but is not typically used when planting seeds from CG3.	**Minimal potential for risk through pollen and nectar exposure route as harvested before bloom.** **Minimal potential for risk from dust generated during planting of treated seed.**	**None**	**Maintain use considering negligible pollinator exposure as harvested before bloom.** **No additional risk management.** **Label update:** May update label language to include the following: Environmental Precautions and Information: Add (after current bee statements): *When used according to label directions minimal exposure or risk is expected.* Example: Where states the following, the additional sentence may be added: *Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications.* ***When used according to label directions minimal exposure or risk is expected.***
From Crop Group 4: Leafy Vegetables (except brassica vegetables): Subgroup 4A:	FO	**No timing restrictions. Not when bees are visiting treatment area.** **Products:** 24094 [4A]	**Attractive to**: HB, BB, SB **Agronomic considerations**: Insect pollination not required for crop	**Minimal potential for risk through pollen and nectar exposure route as harvested before bloom.**	**None**	**Maintain use considering negligible exposure as harvested before bloom.** **No additional risk management.**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
Leafy Greens Amaranth; Arugula; Chervil; Chrysanthemum, edible-leaved and garland; Corn salad; Cress, garden and upland; Dandelion; Dock; Endive; Lettuce, head and leaf; Orach; Parsley; Purslane, garden and winter; Radicchio (red chicory); Spinach [including New Zealand and vine (Malabar spinach, Indian spinach)]; Watercress		28475 [lettuce] 28726 [lettuce] 29048 [lettuce] **Current Label Statements:** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 28475; 28726: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* *29048: Environmental Hazards:* *[29048: This product is toxic to …bees.] DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.*	production. Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada. **Exposure potential**: O: N[2] C: N[2] **Overall, there is minimal potential for exposure.** **Pollinator Exposure (pollen/nectar): Negligible.** There is minimal potential for exposure through pollen and nectar as harvested before bloom. Not grown for seed in Canada.			**Label update:** **Add to:** Environmental Hazards/ Environmental Precautions, after the other bee statements: *To further minimize exposure to pollinators, refer to the complete guidance "Protecting Pollinators during Pesticide Spraying- Best Management Practices" on the Health Canada website (www.healthcanada.gc.ca/pollinators). Follow crop specific directions for application timing.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
From Crop Group 4: Leafy Vegetables (except brassica vegetables): Subgroup 4A: Leafy Greens Amaranth; Arugula; Chervil; Chrysanthemum, edible-leaved and garland; Corn salad; Cress, garden and upland; Dandelion; Dock; Endive; Lettuce, head and leaf; Orach; Parsley; Purslane, garden and winter; Radicchio (red chicory); Spinach [including New Zealand and vine (Malabar spinach, Indian spinach)]; Watercress **And** **From Crop Group 4: Leafy Vegetables (except brassica vegetables): Subgroup 4B: Leaf Petioles** Cardoon, celery, chinese celery (fresh leaves and stalk only), celtuce, florence fennel (including sweet anise, sweet fennel, finocchio),	SO	**Soil application at/near planting.** **Products:** 25636 [Greenhouse lettuce; transplant] 27357 [Greenhouse lettuce; transplant] 24094 [4A; 4B] 28475 [lettuce] 28726 [lettuce] 29048 [lettuce] **Current Label Statements:** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 28475; 28726: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Insect pollination not required for crop production. Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada. **Exposure potential**: O: N[2] C: N **Overall, there is minimal potential for exposure.** **Pollinator Exposure (pollen/nectar): Negligible.** There is minimal potential for exposure through pollen and nectar as harvested before bloom. Not grown for seed in Canada.	**Minimal potential for risk through pollen and nectar exposure route as harvested before bloom.**	**None**	**Maintain use considering negligible pollinator exposure as harvested before bloom.** **No additional risk management.**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
rhubarb, swiss chard		*weeds if bees are visiting the treatment area.* *29048: Environmental Hazards:* *[29048: This product is toxic to …bees.] DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 25636; 27357: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* *Toxic to pollinators and certain beneficial insects. This product is systemic, and residues may be transported through plants into leaves, pollen and nectar. May harm pollinators and certain beneficial insects, including those used in greenhouse production.* 25636; 27357: Directions for Use: For APPLICATION IN NURSERIES; GREENHOUSES: *Repellency of bumble bee pollinators and negative effects on some beneficials (Orius sp.) can occur when [PRODUCT] is applied.*				

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
From Crop Group 4: Leafy Vegetables (except brassica vegetables): Subgroup 4A: Leafy Greens Lettuce (head, leaf)	ST [lettuce (head, leaf) only]	**CG4A Leafy Greens (lettuce only): Planting treated seed.** **Products:** 30972 **Current Label Statements:** 30972:Environmental Precautions and Information: *Toxic to bees. Bees may be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment application.* *Do not expose treated seeds on the soil surface. Any spilled or exposed seeds should be incorporated into the soil or otherwise cleaned up from the soil surface.*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Insect pollination not required for crop production. Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada. **Exposure potential**: O: N[2] C: N **Overall, there is minimal potential for exposure.** **Pollinator Exposure (pollen/nectar): Negligible.** There is minimal potential for exposure through pollen and nectar as harvested before bloom. Not grown for seed in Canada. **Pollinator Exposure (dust): Minimal potential for exposure from dust generated during planting of treated seed.** Exposure through dust generated during planting of treated seed is not expected. All seeds from CG4 typically have low dust levels and may be pelletized for certain crops within the crop group (including lettuce). Certain planting equipment can increase emission of pesticide containing dust, but is not typically used when planting seeds from CG4.	**Minimal potential for risk through pollen and nectar exposure route as harvested before bloom.** **Minimal potential for risk from dust generated during planting of treated seed.**	**None**	**Maintain use considering negligible pollinator exposure as harvested before bloom.** **No additional risk management.** **Label update:** May update label language to include the following: Environmental Precautions and Information: Add (after current bee statements): *When used according to label directions minimal exposure or risk is expected.* Example: Where states the following, the additional sentence may be added: *Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications.* ***When used according to label directions minimal exposure or risk is expected.***
5: Brassica (Cole) Leafy Vegetables Broccoli; broccoli raab (rapini); Brussels sprouts; cabbage;	FO	**No timing restrictions. Not when bees are visiting treatment area.** **Products:** 24094 28475	**Attractive to**: HB, BB, SB **Agronomic considerations**: Insect pollination not required for crop production (unless grown for seed).	**Minimal potential for risk through pollen and nectar exposure route as harvested before bloom.**	**None**	**Maintain use considering negligible pollinator exposure as harvested before bloom.** **No additional risk management.**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
cauliflower; cavolo broccoli; Chinese broccoli; Chinese cabbage (bok choy); Chinese cabbage (napa); Chinese mustard cabbage (gai choy); collards; kale; kohlrabi; mizuna; mustard greens; mustard spinach; rape greens; turnip greens **CG5A Head and Stem Brassica** Broccoli, Chinese broccoli, Brussels sprouts, Cabbage, Chinese cabbage (napa), Chinese mustard cabbage, Cauliflower, Cavalo broccolo, Kohlrabi		28726 29048 29611 [CG5A] **Current Label Statements:** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 28475; 28726: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* *29048: Environmental Hazards:* *[29048: This product is toxic to …bees.] DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.*	Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada. **Exposure potential**: O: N^2 C: N^2 **Overall, there is minimal potential for exposure.** **Pollinator Exposure (pollen/nectar): Negligible.** There is minimal potential for exposure through pollen and nectar as harvested before bloom. Not grown for seed in Canada.			**Label update:** **Add to:** Environmental Hazards/ Environmental Precautions, after the other bee statements: *To further minimize exposure to pollinators, refer to the complete guidance "Protecting Pollinators during Pesticide Spraying- Best Management Practices" on the Health Canada website (www.healthcanada.gc.ca/pollinators). Follow crop specific directions for application timing.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		29611: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.*				
5: Brassica (Cole) Leafy Vegetables Broccoli; broccoli raab (rapini); Brussels sprouts; cabbage; cauliflower; cavolo broccoli; Chinese broccoli; Chinese cabbage (bok choy); Chinese cabbage (napa); Chinese mustard cabbage (gai choy); collards; kale; kohlrabi; mizuna; mustard greens; mustard spinach; rape greens; turnip greens **CG5A Head and Stem Brassica** Broccoli, Chinese broccoli, Brussels sprouts, Cabbage, Chinese cabbage (napa), Chinese mustard cabbage,	SO	**Soil application at/near planting.** **Products:** 24094 28475 28726 29048 25636 [Greenhouse CG5A, transplant] 27357 [Greenhouse CG5A, transplant] **Current Label Statements:** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Insect pollination not required for crop production (unless grown for seed). Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada. **Exposure potential**: O: N[2] C: N **Overall, there is minimal potential for exposure.** **Pollinator Exposure (pollen/nectar): Negligible.** There is minimal potential for exposure through pollen and nectar as harvested before bloom. Not grown for seed in Canada.	**Minimal potential for risk through pollen and nectar exposure route as harvested before bloom.**	**None**	**Maintain use considering negligible pollinator exposure as harvested before bloom.** **No additional risk management.**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
Cauliflower, Cavalo broccolo, Kohlrabi		*spray drift to reduce harmful effects on bees in habitats close to the application site.* 28475; 28726: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* *29048: Environmental Hazards:* *[29048: This product is toxic to …bees.] DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 25636; 27357: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* *Toxic to pollinators and certain beneficial insects. This product is systemic, and residues may be transported through plants into leaves, pollen and nectar. May harm pollinators and certain beneficial insects, including those used in greenhouse production.*				

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		25636; 27357: Directions for Use: For APPLICATION IN NURSERIES; GREENHOUSES: *Repellency of bumble bee pollinators and negative effects on some beneficials (Orius sp.) can occur when [PRODUCT] is applied*.				
From Crop Group 5: Brassica (Cole) Leafy Vegetables Broccoli and Cabbage	ST (broccoli, cabbage only)	**CG5 Brassica (Cole) Leafy Vegetables (broccoli, cabbage only): Planting treated seed.** **Products:** 30972 **Current Label Statements:** 30972:Environmental Precautions and Information: *Toxic to bees. Bees may be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment application.* *Do not expose treated seeds on the soil surface. Any spilled or exposed seeds should be incorporated into the soil or otherwise cleaned up from the soil surface.*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Insect pollination not required for crop production (unless grown for seed). Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada. **Exposure potential**: O: N[2] C: N **Overall, there is minimal potential for exposure.** **Pollinator Exposure (pollen/nectar): Negligible.** There is minimal potential for exposure through pollen and nectar as harvested before bloom. Not grown for seed in Canada. **Pollinator Exposure (dust): Minimal potential for exposure from dust generated during planting of treated seed.** Exposure through dust generated during planting of treated seed is not expected. CG5 treated seeds typically have low dust levels and may be pelletized for certain crops within the crop group. Certain planting equipment can increase emission of pesticide containing dust, but is not	**Minimal potential for risk through pollen and nectar exposure route as harvested before bloom.** **Minimal potential for risk from dust generated during planting of treated seed.**	**None**	**Maintain use considering negligible pollinator exposure as harvested before bloom.** **No additional risk management.** **Label update:** May update label language to include the following: Environmental Precautions and Information: Add (after current bee statements): *When used according to label directions minimal exposure or risk is expected.* Example: Where states the following, the additional sentence may be added: *Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications.* ***When used according to label directions minimal exposure or risk is expected.***

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
			typically used when planting seeds from CG5.			
CG6: Legume Vegetables Soybean Crop Group 6: Legume vegetables (except dry soybean): Edible Podded, Succulent Shelled Pea and Bean and Dried Shelled Pea and Bean: Bean (Lupinus spp., includes grain lupin, sweet lupin, white lupin, and white sweet lupin); Bean (Phaseolus spp., includes field bean, kidney bean, lima bean, navy bean, pinto bean, runner bean, snap bean, tepary bean, wax bean); Bean (Vigna spp., includes adzuki bean, asparagus bean, blackeyed pea, catjang, Chinese longbean, cowpea, Crowder pea, moth bean, mung bean, rice bean, Southern pea, urd bean, yardlong bean); Pea (Pisum spp., includes dwarf	FO	**No timing restrictions. Not when bees are visiting treatment area.** **Products:** 24094 [CG6 except dry soybean] 29611 [soybean (ground and aerial application)] **Current Label Statements:** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 29611: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Not harvested prior to bloom. Crop blooming period typically 2-3 weeks. Most legumes are self-pollinated and do not require insect pollination. Some do require insect pollination. In some cases, insect pollination can enhance crop production. Legume vegetable attractiveness to pollinators varies; some can be a source of nectar and/or pollen for insect pollinators. **Exposure potential**: O: Y C: Y **There is potential for exposure.** **Pollinator Exposure (pollen/nectar): Varies with legume type- Low, Moderate, High.** Most legumes are self-pollinated and do not require insect pollination. However, some do require insect pollination. In some cases, insect pollination can enhance crop production. Legume vegetable attractiveness to pollinators varies; Most can be a minor source of nectar and/or pollen for HB, BB, SB. A few are a major source of pollen/nectar for HB and BB and minor source for SB. Soybean and *Phaseolus vulgaris* (includes e.g. navy beans, kidney bean, great northern, black, small red, pink, pinto, cranberry (Romano) beans) are typically less attractive to pollinators, and are expected to result in lower exposure to pollinators. *Vicia faba (*broad beans, including horse and faba bean) are typically attractive to	Tiered Framework (CG6 legume vegetables): *Apis* and non-*Apis* bees: T1SL: Yes Residues: soybean (pre-bloom); cotton (during bloom) T1R: Yes T2 CFS: During bloom: potential risks for both bumble bees and honey bees using surrogate crop. Pre-bloom application, no risk was found for honey bees or bumble bees using representative soybean residues measured 16 day after the last spray application. T2 Tunnel: NA T3: NA Incidents: None **Overall:** **Based on the risk assessment using representative and surrogate crops:** **During bloom: Potential risks based on the risk assessment using surrogate crops.** **Pre-bloom: Minimal potential for risks for pre-bloom application based on residues sampled 16 days after the last foliar**	**Residues:** **Pre-bloom Residues** from representative crop soybean for pre-bloom. Rate was higher than the Canadian rates. Residues were measured from honey bees or hives in soybean tunnels, collected 16 days after the last foliar application. Soybean may not be highly attractive to honey bees, reducing exposure. **During bloom residues**: Cotton is used as surrogate for during bloom foliar application. Rates were comparable to Canadian label rates. However, the residues may be underestimated for during-bloom application as the samples were collected days after treatment. **T2 Tunnel; T3 field; Incidents:** None **Bloom period compared to CFS:** Bloom time may be shorter than the exposure duration in colony feeding studies for some crops. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	**Remove during-bloom foliar uses for all CG6 due to potential risk** **Remove pre-bloom use for CG6 crops with high potential for exposure (broad beans/ fava beans/ Vicia faba only) due to potential risk.** **Maintain pre-bloom use for CG6 crops with moderate potential for exposure (all CG6 other than broad beans/ fava beans/ Vicia faba).** **Maintain post-bloom use for all CG6 due to negligible potential for exposure.** **Label mitigation:** **24094: Add to directions for use for CG6:** *For CG6 broad beans/fava beans/Vicia faba: Do not apply pre-bloom or during bloom or when bees are actively foraging. Apply post-bloom only.* *For all other CG6 excluding broad beans/ fava beans/ Vicia faba: Do not apply during bloom or when bees are actively foraging.* **29611: Add to directions for use for soybean:** *Do not apply during bloom or when bees are actively foraging.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
pea, edible-pod pea, English pea, field pea, garden pea, green pea, snow pea, sugar snap pea); Other Beans and Peas Broad bean (fava), Chickpea (garbanzo bean), Guar, Jackbean, Lablab bean (hyacinth bean), Lentil, Pigeon pea, Soybean (immature seed), Sword bean.			pollinators, and may result in higher exposure. Some varieties of *P. lunatus* (lima bean) and *P. coccineus* (scarlet and runner beans) and *P. vulgaris* can produce large quantities of pollinator attractive nectar. Crop acreage is variable. Most have low to moderate acreage, soybean has high acreage. **Pollinator Exposure (pollen/nectar) High:** Broad beans (*Vicia faba*). They require pollination for crop production, and are highly attractive to HB (pollen and nectar), BB, and have minor attractiveness to SB. Crop acreage is low to moderate. **Pollinator Exposure (pollen/nectar): Low to Moderate:** All legumes including Soybean; Phaseolus spp. (excluding Broad beans (*Vicia faba*)). Most do not require pollination. They may be attractive under certain conditions to HB, BB, SB. Soybean does not appear to be attractive to pollinators under most conditions. Crop acreage varies from low, moderate, high depending on crop. Soybean is considered high acreage.	**application using the representative crop soybean.** **Post-bloom: No risk as annual crops.** **Consider Pollinator Exposure (pollen/ nectar): Varies with legume type- Low/Moderate, High**		**Additional Label Updates:** **Add under:** Environmental Precautions, after the other bee statements: *To further minimize exposure to pollinators, refer to the complete guidance "Protecting Pollinators during Pesticide Spraying- Best Management Practices" on the Health Canada website (www.healthcanada.gc.ca/pollinators). Follow crop specific directions for application timing.*
CG6: Legume Vegetables (except dry soybeans) Edible Podded, Succulent Shelled Pea and Bean and Dried Shelled Pea and Bean: Bean (Lupinus spp., includes grain lupin, sweet lupin, white lupin, and white sweet lupin);	SO	**Soil application at/near planting.** **Products:** 24094 **Current Label Statements:** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Not harvested prior to bloom. Crop blooming period typically 2-3 weeks. Most legumes are self-pollinated and do not require insect pollination. Some do require insect pollination. In some cases, insect pollination can enhance crop production. Legume vegetable attractiveness to pollinators varies; some can be a source of nectar and/or pollen for insect pollinators. **Exposure potential**:	Tiered Framework (CG6 legume vegetables): *Apis* and non-*Apis* bees: T1SL: Yes Residues: No CG6 legume residues. Surrogate residues for tomato, melon, pumpkin, strawberry, cotton. Rates similar to Canadian rates T1R: Yes T2 CFS: Potential for risks for bumble bees with almost all residues, and risks for honey bee with some residues using surrogate crops. Greater risk in coarse soils,	**Residues:** No specific CG6 residue information. Based on residues for soil application to tomato, melon, pumpkin, strawberry, and cotton. Rates used in the residue studies were comparable to Canadian label rates. **T2 Tunnel; T3 field; Incidents:** None **Bloom period compared to CFS:** Bloom time may be shorter than colony feeding study exposure duration for some crops. **Effects endpoints**: Some	**Remove use based on potential for risk.**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
Bean (Phaseolus spp., includes field bean, kidney bean, lima bean, navy bean, pinto bean, runner bean, snap bean, tepary bean, wax bean); Bean (Vigna spp., includes adzuki bean, asparagus bean, blackeyed pea, catjang, Chinese longbean, cowpea, Crowder pea, moth bean, mung bean, rice bean, Southern pea, urd bean, yardlong bean); Pea (Pisum spp., includes dwarf pea, edible-pod pea, English pea, field pea, garden pea, green pea, snow pea, sugar snap pea); Other Beans and Peas Broad bean (fava), Chickpea (garbanzo bean), Guar, Jackbean, Lablab bean (hyacinth bean), Lentil, Pigeon pea, Soybean (immature seed), Sword bean		*exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.*	O: Y C: Y **There is potential for exposure.** **Pollinator Exposure (pollen/nectar): Varies with legume type- Low, Moderate, High.** Most legumes are self-pollinated and do not require insect pollination. However, some do require insect pollination. In some cases, insect pollination can enhance crop production. Legume vegetable attractiveness to pollinators varies; Most can be a minor source of nectar and/or pollen for HB, BB, SB. A few are a major source of pollen/nectar for HB and BB and minor source for SB. Soybean and *Phaseolus vulgaris* (includes e.g. navy beans, kidney bean, great northern, black, small red, pink, pinto, cranberry (Romano) beans) are typically less attractive to pollinators, and are expected to result in lower exposure to pollinators. *Vicia faba (*broad beans, including horse and faba bean) are typically attractive to pollinators, and may result in higher exposure. Some varieties of *P. lunatus* (lima bean) and *P. coccineus* (scarlet and runner beans) and *P. vulgaris* can produce large quantities of pollinator attractive nectar. Crop acreage is variable. Most have low to moderate acreage, soybean has high acreage. **Pollinator Exposure (pollen/nectar) High:** Broad beans (*Vicia faba*). They require pollination for crop production, and are highly attractive to HB (pollen and nectar), BB, and have minor attractiveness to SB. Crop acreage is low to moderate. **Pollinator Exposure (pollen/nectar): Low to Moderate:** All legumes including Soybean; Phaseolus spp. (excluding Broad beans (*Vicia faba*)). Most do not require pollination. They	higher application rates. T2 Tunnel: NA T3: NA Incidents: None **Overall:** **Potential risks for bumble bees and possible risks for honey bees based on the risk assessment using surrogate crops.** **Consider Pollinator Exposure (pollen/ nectar): Varies with legume type- Low, Moderate, High**	uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered. [Note: REV2016-05 Preliminary Risk Conclusions indicated minimal potential for risk. This was based on honey bee only, and did not consider non-Apis effects information.]	

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
			may be attractive under certain conditions to HB, BB, SB. Soybean does not appear to be attractive to pollinators under most conditions. Crop acreage varies from low, moderate, high depending on crop. Soybean is considered high acreage.			
From CG6: Legume Vegetables: Faba bean; Lentil; Chickpeas; Field pea, Soybeans, **CG6A Edible podded beans (except peas)** [Bean (Phaseolus spp.) (includes runner bean, snap bean, wax bean); Bean (Vigna spp.) (Includes asparagus bean, Chinese longbean, moth bean, yardlong bean); Jackbean] **CG6C Dry shelled pea and bean (except soybeans and dry shelled peas)** [Bean (Lupinus spp.) (includes grain lupin, sweet lupin, white lupin, white sweet lupin); Bean (Phaseolus spp.) (includes field bean (dry	ST	**CG6 Legumes: Planting treated seed.** **Products:** 26124 [CG6A and 6C] 28475 [Soybean] 29610 [Soybean] 31068 [Soybean] 30668 [Soybean; field peas; chickpeas; lentils; faba beans; CG6A and 6C] **Current Label Statements:** 28475: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* 29610: Environmental Precautions: *Left over treated seed should be double-sown around the headland, or buried away from water sources.* 28475;29610; 30668; 31068: Environmental Hazards: *Imidacloprid is toxic to bees.*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Not harvested prior to bloom. Crop blooming period typically 2-3 weeks. Most legumes are self-pollinated and do not require insect pollination. Some do require insect pollination. In some cases, insect pollination can enhance crop production. Legume vegetable attractiveness to pollinators varies; some can be a source of nectar and/or pollen for insect pollinators. **Exposure potential**: O: Y C: N **Potential for exposure through pollen and nectar.** **Pollinator Exposure (pollen/nectar) High:** Broad beans (*Vicia faba*). They require pollination for crop production, and are highly attractive to HB (pollen and nectar), BB, and have minor attractiveness to SB. Crop acreage is low to moderate. **Pollinator Exposure (pollen/nectar): Low to Moderate:** All legumes including Soybean; Phaseolus spp. (except for Broad beans (*Vicia faba*)) Most do not require pollination. They may be attractive under certain conditions to HB, BB, SB. Soybean does not appear to be attractive to pollinators under most conditions.	Tiered Framework (CG6 legume vegetables): *Apis* and non-*Apis* bees: T1SL: Yes Residues: Soybean T1R: No/Yes (some) T2 CFS: No potential risks for honey bees or bumble bees. T2 Tunnel: No effects (field beans) based on endpoints measured (bee mortality, flower visits, hive weight, brood development). T3: No effects (field beans) based on endpoints measured (flower visits). Incidents : Possible incident in 2017 that may be related to starting seed planter next to honey bee hives and emitting pesticide containing dust directly onto hives resulting in mortalities. Treated seed type was legume/bean seed other than soybean. **Overall:** **Minimal potential for risk through pollen and nectar exposure route based on risk characterization using representative crop soybean.**	**Residues:** Residues were measured from representative crop soybean. They were measured from hives and bees, but not from the plant. This may not represent the highest residue exposure levels possible through the plant pollen and nectar, since honey bees collected only low amounts of pollen from soybeans. The test rates in residue studies are relevant to Canadian use pattern. The residue study was conducted in Brazil where the climate conditions may be different from Canadian conditions. **T2 Tunnel; T3 field:** No effects in studies, based on endpoints measured. However, exposure and observation period was only 14 days during flowering, and limited effect variables were measured. **Incidents:** Possible incident in 2017 that may be related to starting seed planter next to honey bee hives and emitting pesticide containing dust directly onto hives resulting in mortalities.	**Maintain use based on risk characterization of low risk from pollen and nectar exposure route.** **Propose additional mitigation to reduce the potential for exposure to dust during planting of treated legume seeds.** **Additional label mitigation for legume seeds:** As some legume seeds may be dusty, propose addition of label statements to all containers of treated legume seeds instructing user to follow best management practices for planting of treated seed. Use restrictions: **Add:** Use restrictions (soybean): No additions; Label statements are acceptable for soybean. Use restrictions (all other CG6 legume seeds excluding soybean): *Additionally, all treated CG 6 legume seed (excluding soybean) for sale or use in Canada must be labeled with the following information:* *Imidacloprid is toxic to bees. Dust generated during planting of treated seed may be harmful to bees and other pollinators.* *To help minimize the dust generated during planting, refer to the*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
common and coloured) such as kidney, black cranberry pink and navy bean, lima bean, pinto bean, tepary bean); Bean (Vigna spp.) (includes adzuki bean, blackeyed pea, catjang, cowpea, Crowder pea, moth bean, mung bean, rice bean, southern pea, urd bean); Broad bean (fava bean)]		*Dust generated during planting of treated seed may be harmful to bees and other pollinators.* *• To help minimize the dust generated during planting, refer to the complete guidance "Pollinator Protection and Responsible Use of Treated Seed- Best Management Practices" on the Health Canada webpage on pollinator protection at www.healthcanada.gc.ca/pollinators* *• When using a seed flow lubricant with this treated seed, only the Fluency Agent by Bayer CropScience is permitted. Carefully follow use directions for this seed flow lubricant.* *• Do not load or clean planting equipment near bee colonies, and avoid places where bees may be foraging, such as flowering crops or weeds.* *• When turning on the planter, avoid engaging the system where emitted dust may contact honey bee colonies.* *• Spilled or exposed seeds and dust must be incorporated into the soil or cleaned up from the soil surface.* 28475;29610; 30668; 31068 (31068 is missing this language, but is should be on label): For Labelling of treated SOYBEAN seed: All neonicotinoid treated [corn and] soybean seed for sale or	Crop acreage varies from low, moderate, high depending on crop. Soybean is considered high acreage. **Pollinator Exposure (dust): Potential for exposure through dust generated during planting of treated seed.** Exposure through dust generated during planting of treated seed is possible. Some legume seeds may result in dust generation. Certain planting equipment can increase emission of pesticide containing dust. While planting equipment which can increase emission of pesticide containing dust may be used for soybean, it is not typically used for other legumes. Pollinator exposure to dust generated during planting was previously identified as a concern for neonicotinoid treated corn and soybean seed, and mitigation was implemented. While planting equipment which can increase emission of pesticide containing dust may be used for soybean, it is not typically used for other legumes.	**Potential for risk from dust generated during planting of treated seed when label requirements or best management practices for planting of treated seed are not followed.**	Treated seed type was legume/bean seed other than soybean. Incidents in 2012 – 2016 related to exposure to dust during planting of treated corn and soybean seed. Pollinator exposure to dust generated during planting was previously identified as a concern for neonicotinoid treated corn and soybean seed, and mitigation was implemented. While planting equipment which can increase emission of pesticide containing dust may be used for soybean, it is not typically used for other legumes. **Bloom period compared to CFS:** Bloom time is likely shorter than colony feeding study exposure duration. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	*"Pollinator Protection and Responsible Use of Treated Seed- Best Management Practices" on the Health Canada webpage on pollinator protection at www.healthcanada.gc.ca/pollinators* . *Do not load or clean planting equipment near bee colonies, and avoid places where bees may be foraging, such as flowering crops or weeds.* *When turning on the planter, avoid engaging the system where emitted dust may contact honey bee colonies.* *Spilled or exposed seeds and dust must be incorporated into the soil or cleaned up from the soil surface.* **Additional Label updates:** 26124; 29610; 31068; 30668: Environmental Precautions/ Environmental Hazards: **Add:** *Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications. When used according to label directions minimal exposure or risk is expected*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		use in Canada must be labelled or tagged with the following information: *Imidacloprid is toxic to bees. Dust generated during planting of treated seed may be harmful to bees and other pollinators.* *• To help minimize the dust generated during planting, refer to the complete guidance "Pollinator Protection and Responsible Use of Treated Seed- Best Management Practices" on the Health Canada webpage on pollinator protection at www.healthcanada.gc.ca/pollinators* *• When using a seed flow lubricant with this treated seed, only the Fluency Agent by Bayer CropScience is permitted. Carefully follow use directions for this seed flow lubricant.* *• Do not load or clean planting equipment near bee colonies, and avoid places where bees may be foraging, such as flowering crops or weeds.* *• When turning on the planter, avoid engaging the system where emitted dust may contact honey bee colonies.* *• Spilled or exposed seeds and dust must be incorporated into the soil or cleaned up from the soil surface.*				
8: Fruiting Vegetables Eggplant; Groundcherry; Okra; Pepino;	FO	**CG8: No timing restrictions. Not when bees are visiting treatment area**	**Attractive to**: BB, SB **Agronomic considerations**: Do not require insect pollination, but	Tiered Framework (CG8 fruiting vegetables): *Apis* and non-*Apis* bees: T1SL: Yes	**Residues:** **During bloom:** Residues available for CG 8 tomatoes for during-bloom application. May	**Remove during-bloom and pre-bloom use based on potential for risk.** **Maintain post-bloom use as negligible exposure.**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
Peppers (including all peppers i.e. bell, non-bell, hot, sweet, etc., and cultivars and/or hybrids of these); Tomatillo; Tomato (including cultivars and/or hybrids of this).		**Products:** 24094 [CG8] 28475 [eggplant, tomato] 28726 [eggplant, tomato] 29048 [eggplant, tomato] **Current Label Statements:** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 28475; 28726: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* 29048: Environmental Hazards: *This product is TOXIC to …,bees ..].DO NOT apply this product to flowering crops or*	production enhanced by pollination. Managed bumble bees are used, primarily in greenhouse production. Indeterminate blooming. **Exposure potential**: O: Y C: Y **There is potential for exposure.** **Pollinator Exposure (pollen/nectar): Moderate** Crop does not require insect pollination; Crop production is enhanced by pollination; Pollination services may be used (BB particularly in greenhouse crops). Crop is a major source of pollen and nectar for BB, minor source for SB, and not attractive to HB. Acreage is low to medium.	Residues: Tomato (during-bloom foliar after a soil application); Cotton, sugar melon, soybean (pre-bloom) T1R: Yes T2 CFS: During bloom: potential risks for both bumble bees and honey bees using representative crop tomato. Pre-bloom: potential for risks for bumble bees and honey bees using cotton as surrogate, and risks for bumble bees (not honey bees) using sugarmelon as surrogate. Minimal potential for risks for pre-bloom application using soybean as surrogate. T2 Tunnel: Adverse effect on the reduction of foraging activity of bumble bees was observed in a tomato tunnel study conducted at a low application rate. T3: NA Incidents: None **Overall:** **Based on the risk assessment:** **During bloom: Potential risks based on representative crop tomato, and T2 tunnel study.** **Pre-bloom, potential risks for bees; risks vary depending on surrogate**	overestimate the residues since the foliar application was applied after a soil application. Foliar application was at a Canadian comparable rate. Could also underestimate the maximum foliar residue levels as samples were collected several days after the foliar treatment (however, there is also a soil application that occurred prior to the foliar application). **Pre-bloom:** Cotton, sugarmelon, soybean were used as surrogate for pre-bloom applications. Rates were higher than Canadian rates. The cotton study was conducted with a combination of foliar applications after a seed treatment application. **T2 Tunnel:** Adverse effect of reduced foraging activity of bumble bees on tomato with low application rate. **T3 field; Incidents:** None **Bloom period compared to CFS:** CG8 fruiting vegetable bloom time (indeterminate blooming throughout the season) may be relevant for the exposure duration in the colony feeding studies. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	**Update mitigation:** **Add to directions for use:** CG8 Fruiting vegetables (FO): *Do not apply pre-bloom or during bloom or when bees are actively foraging. Apply post-bloom only.* Tomato (field grown) [ON, QC, Atlantic Canada only] (FO): *Do not apply pre-bloom or during bloom or when bees are actively foraging. Apply post-bloom only* Eggplant (FO): *Do not apply pre-bloom or during bloom or when bees are actively foraging. Apply post-bloom only* **Additional Label Updates:** **Add under:** Environmental Precautions, after the other bee statements: *To further minimize exposure to pollinators, refer to the complete guidance "Protecting Pollinators during Pesticide Spraying- Best Management Practices" on the Health Canada website (www.healthcanada.gc.ca/pollinators). Follow crop specific directions for application timing.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees and beneficial insects in habitats close to the application site.		**crops considered**. **Annual crops; no risk post-bloom.** **Consider Pollinator Exposure (pollen/nectar): Moderate**		
8: Fruiting Vegetables Eggplant; Groundcherry; Okra; Pepino; Peppers (including all peppers i.e. bell, non-bell, hot, sweet, etc., and cultivars and/or hybrids of these); Tomatillo; Tomato (including cultivars and/or hybrids of this).	SO	**Soil application at/near planting/transplanting.** **Products (outdoor uses):** 24094 [CG8] 28475 [eggplant, tomato] 28726 [eggplant, tomato] 29048 [eggplant, tomato] **Products (Greenhouse uses):** 25636 [Greenhouse production: tomato, eggplant, pepper; Greenhouse transplant tray plug drench- pepper] 27357 [Greenhouse production: tomato, eggplant, pepper; Greenhouse transplant tray plug drench- pepper] **Current Label Statements: Outdoor uses:** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting*	**Attractive to**: BB, SB **Agronomic considerations**: Do not require insect pollination, but production enhanced by pollination. Managed bumble bees are used, primarily in greenhouse production. Indeterminate blooming. **Exposure potential**: O: Y C: N **There is potential for exposure through pollen and nectar.** **Pollinator Exposure (pollen/nectar): Moderate** Crop does not require insect pollination; Crop production is enhanced by pollination; Pollination services may be used (BB particularly in greenhouse crops). Crop is a major source of pollen and nectar for BB, minor source for SB, and not attractive to HB. Acreage is low to medium.	Tiered Framework (CG8 fruiting vegetables): *Apis* and non-*Apis* bees: T1SL: Yes Residues: Tomato T1R: Yes T2 CFS: Yes. Potential risks for bumble bees and honey bee colonies. T2 Tunnel: NA T3: NA Incidents: None **Overall:** **Potential risks for bumble bees and honey bees based on the risk assessment using representative crop, tomato.** **Consider Pollinator Exposure (pollen/nectar): Moderate**	**Residues:** Residues from tomato. Only pollen available for tomato. Rates relevant for Canadian use pattern. **T2 Tunnel; T3 field; Incidents:** None **Bloom period compared to CFS:** CG8 fruiting vegetable bloom time (indeterminate blooming throughout the season) may be relevant for the exposure duration in the colony feeding studies. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	**Remove outdoor uses for fruiting vegetables based on potential for risk.** **Remove greenhouse transplant drench on fruiting vegetables to be planted outdoors (pepper only).** **Maintain greenhouse uses for fruiting vegetables when treated plants are grown within greenhouse (greenhouse production of tomato, eggplant, pepper)** **Label Updates:** **Add under:** 25636; 27357: Directions for use for greenhouse production of tomato, eggplant, pepper: *Toxic to pollinators and certain beneficial insects. This product is systemic, and residues may be transported through plants into leaves, pollen and nectar. May harm pollinators and certain beneficial insects, including those used in greenhouse production.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site. 28475; 28726: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* 29048: Environmental Hazards: *This product is TOXIC to …,bees ..].DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees and beneficial insects in habitats close to the application site.* **Current Label Statements: Greenhouse uses (greenhouse production and greenhouse transplant tray plug drench):** 25636; 27357: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* *Toxic to pollinators and certain beneficial insects. This product is systemic, and residues may be transported*				

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		through plants into leaves, pollen and nectar. May harm pollinators and certain beneficial insects, including those used in greenhouse production. Directions for Use: For APPLICATION IN NURSERIES; GREENHOUSES: *Repellency of bumble bee pollinators and negative effects on some beneficials (Orius sp.) can occur when [PRODUCT] is applied.*				
From Crop Group 8: Fruiting Vegetables Tomato and Pepper	ST (pepper and tomato only)	**CG8 Fruiting Vegetables: Planting treated seed.** **Products:** 30972 **Current Label Statements:** 30972:Environmental Precautions and Information: *Toxic to bees. Bees may be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment application.* *Do not expose treated seeds on the soil surface. Any spilled or exposed seeds should be incorporated into the soil or otherwise cleaned up from the soil surface.*	**Attractive to**: BB, SB **Agronomic considerations**: Do not require insect pollination, but production enhanced by pollination. Managed bumble bees are used, primarily in greenhouse production. Indeterminate blooming. **Exposure potential**: O: Y C: N **There is potential for exposure through pollen and nectar.** **Pollinator Exposure (pollen/nectar): Moderate** Crop does not require insect pollination; Crop production is enhanced by pollination; Pollination services may be used (BB particularly in greenhouse crops). Crop is a major source of pollen and nectar for BB, minor source for SB, and not attractive to HB. Acreage is low to medium. **Pollinator Exposure (dust): Minimal potential for exposure from dust generated during planting of treated**	Tiered Framework (CG8 fruiting vegetables): *Apis* and non-*Apis* bees: T1SL: Yes Residues: Sweet Pepper T1R: No T2 CFS: Potential risks were not detected for honey bees or bumble bees. T2 Tunnel: NA T3: NA Incidents: None **Overall:** **Minimal potential for risk from seed treatments through pollen and nectar exposure route based on the risk assessment using representative crops.** **Minimal potential for exposure or risk from dust generated during planting of treated seed.**	**Residues:** Residues were measured from representative crop, sweet pepper. They were measured from flowers not from pollen and nectar, which may represent conservative residue information for risk assessment. The test rates in residue studies are relevant to Canadian use rate. The study was conducted in Spain where the climate conditions may be different from Canadian conditions. **T2 Tunnel; T3 field; Incidents:** None **Bloom period compared to CFS:** CG8 fruiting vegetable bloom time (indeterminate blooming throughout the season) may be relevant for the exposure duration in the colony feeding studies. **Effects endpoints**: Some uncertainty and differences among CFS endpoints.	**Maintain use based on risk characterization of low risk** **No additional risk management.** **Label update:** May update label language to include the following: Environmental Precautions and Information: Add (after current bee statements): *When used according to label directions minimal exposure or risk is expected.* Example: Where states the following, the additional sentence may be added: *Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications.* ***When used according to label directions minimal exposure or risk is expected.***

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
			seed. Exposure through dust generated during planting of treated seed is not expected. CG8 seeds typically have low dust levels and may be pelletized for certain crops within the crop group. Certain planting equipment can increase emission of pesticide containing dust, but is not typically used when planting CG8 seeds.		*Apis* and non-*Apis* endpoints considered.	
9: Cucurbit Vegetables Chayote (fruit); Chinese waxgourd (Chinese preserving melon); Citron melon; Cucumber; Gherkin; Gourd (edible, includes hyotan, cucuzza, hechima, Chinese okra); Momordica spp. (includes balsam apple, balsam pear, bitter melon, Chinese cucumber); Muskmelon (hybrids and/or cultivars of Cucumis melo including true cantaloupe, cantaloupe, casaba, Crenshaw melon, golden pershaw melon, honeydew melon, honey balls, mango melon, Persian melon, pineapple melon, Santa Claus melon, snake	SO	**Soil application at/near planting/transplanting** **Products (outdoor uses):** 24094 28475 28726 29048 **Products (Greenhouse uses):** 25636 [Greenhouse production: cucumber] 27357 [Greenhouse production: cucumber] **Current Label Statements: Outdoor uses:** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Requires insect pollination for crop production. Squash bees, a type of solitary bee, specialize on cucurbit crops and are important in pollination of cucurbits. They live and reproduce using cucurbit crops. Indeterminate blooming. Flowers close in afternoon; bloom lasts only for one day. **Exposure potential**: O: Y C: N (applied at/near planting) (Some potential for squash bee exposure through soil) **There is potential for exposure through pollen and nectar.** **Pollinator Exposure (pollen/nectar): High** Crop requires insect pollination; crop is a major or minor source of pollen and nectar for BB, SB (including squash bees), and minor source for HB. Acreage is low to medium.	Tiered Framework (CG9 cucurbit vegetables): *Apis* and non-*Apis* bees: T1SL: Yes Residues: melon, sugarmelon, pumpkin, squash T1R: Yes T2 CFS: Bumble bee: Potential risks for bumble bees were identified using data from multiple residue studies with melon, sugarmelon, pumpkin, squash at relevant rates. No risk was identified when using mean residues data from the described T3 study, or a residue study where residues were collected by honey bees, or a residue study where the treatment rate was low at 30 g a.i./ha. Honey bee: Potential risks for honey bee colonies were detected using some residue studies (e.g., pumpkin treated with transplant water). T2 Tunnel: NA T3: In pumpkin fields soil treated at a Canadian relevant rates at the six true leaf stage of pumpkin, no effect to honey bee colonies was detected after being exposed	**Residues:** Pollen and nectar residues were measured from representative CG9 crops, collected from hives in the melon studies, and from plant flowers in the pumpkin studies. The test rates used in residue studies were relevant to Canadian rates, except one test scenario for soil application in which the test rate was much lower than the maximum Canadian label rate for CG9. Some pumpkin residues were conducted using transplant water application, which may result in high level of residues compared with other soil application methods. Transplant water application is registered. **T2 Tunnel; Incidents:** None **T3 Field**: Pumpkin field studies examining soil treatment determined no effects on honey bees, and no effect species richness or abundance of native non-Apis bees. Introduced bumble bee colonies could not be assessed as they	**Remove outdoor uses based on potential for risk.** **Maintain greenhouse uses when treated plants are grown within greenhouse (greenhouse production of cucurbits)** **Label Updates:** **Add under:** 25636; 27357: Directions for use for greenhouse production of cucurbits: *Toxic to pollinators and certain beneficial insects. This product is systemic, and residues may be transported through plants into leaves, pollen and nectar. May harm pollinators and certain beneficial insects, including those used in greenhouse production.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
melon); Pumpkin; Squash (includes summer squash types such as: crookneck squash, scallop squash, straightneck squash, vegetable marrow, zucchini, and winter squash types such as acorn squash, butternut squash, calabaza, Hubbard squash, spaghetti squash); Watermelon (includes hybrids and/or varieties of Citrullus lanatus).		*to the application site.* 28475; 28726: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* 29048: Environmental Hazards: *This product is TOXIC to …,bees ..].DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees and beneficial insects in habitats close to the application site.* **Current Label Statements: Greenhouse uses** 25636; 27357: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* *Toxic to pollinators and certain beneficial insects. This product is systemic, and residues may be transported through plants into leaves, pollen and nectar. May harm pollinators and certain beneficial insects, including those used in greenhouse*		to flowering pumpkins for 6 weeks starting 26 days after the treatment. However, whether or not there were effects to bumble bees could not be assessed from the study (as all bumble bee colonies failed in controls and treatments). No effect was detected on the species richness and abundance of native non-Apis bees in the fields. No risk was detected for honey bees and bumble bees by comparing measured mean residues in the field study and the endpoints from colony feeding studies. Field study residues were lower than other residue studies with pumpkin. Incidents: None **Overall:** **Minimal potential for risk for honey bees. For bumble bees and non-Apis bees, potential for risk identified using residue studies from relevant crops at Canadian relevant rates.** **Consider Pollinator Exposure (pollen/nectar): High**	were all in poor development in both the treatment and controls. No risk was detected using the measured mean residues from the field effect study in comparison with the endpoints from colony feeding studies for honey bees and bumble bees. Residues from the field study were lower than other residue studies with pumpkin. **Bloom period compared to CFS:** Bloom time (indeterminate blooming throughout season) is considered relevant for colony feeding study exposure duration (6 weeks or longer). **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered. [Note: REV2016-05 Preliminary Risk Conclusions indicated minimal potential for risk. This was based on honey bee only, and did not consider non-Apis effects information.]	

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		production. Directions for Use: For APPLICATION IN NURSERIES; GREENHOUSES: *Repellency of bumble bee pollinators and negative effects on some beneficials (Orius sp.) can occur when [PRODUCT] is applied.*				
9: Cucurbit Vegetables Squash, winter and summer; melon; cucumber	ST (Squash, winter and summer; melon; cucumber only)	**CG9 Cucurbit vegetables: Planting treated seed.** **Products:** 30972 **Current Label Statements:** 30972:Environmental Precautions and Information: *Toxic to bees. Bees may be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment application.* *Do not expose treated seeds on the soil surface. Any spilled or exposed seeds should be incorporated into the soil or otherwise cleaned up from the soil surface.*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Requires insect pollination for crop production. Squash bees, a type of solitary bee, specialize on cucurbit crops and are important in pollination of cucurbits. They live and reproduce using cucurbit crops. Indeterminate blooming. Flowers close in afternoon; bloom lasts only for one day. **Exposure potential**: O: Y C: N **There is potential for exposure through pollen and nectar.** **Pollinator Exposure (pollen/nectar): High** Crop requires insect pollination; crop is a major or minor source of pollen and nectar for BB, SB (including squash bees), and minor source for HB. Acreage is low to medium **Pollinator Exposure (dust): Minimal potential for exposure from dust generated during planting of treated seed.** Exposure through dust generated	Tiered Framework (CG9 cucurbit vegetables): *Apis* and non-*Apis* bees: T1SL: Yes Residues: melon (whole flower; in hive) T1R: Yes T2 CFS: Potential risks for bumble bees (via nectar exposure routes), but not honey bees, based on whole flower measurements. However, this risk from whole flower is likely overestimated compared to pollen and nectar residues. No risk based on hive measures. T2 Tunnel: NA T3: No field study available for seed treatment on CG9, but were available for soil application (pumpkin), in which no effects were detected for honey bees, but effects to bumble bees could not be assessed. No effect was detected on species richness and abundance of other non-Apis bees. Residue levels from soil treatment will be higher than residues	**Residues:** Residues are from CG9 crops, measured from melon whole flowers; conservative in comparison with pollen and nectar. The measured hive pollen and nectar was <LOQ (1ppb). Rates used in residue studies relevant to Canadian rates. **T2 Tunnel; T3 field; Incidents:** None. Field studies were not available for CG9 seed treatment. But were available for soil application to pumpkin, and no effects for honey bees were detected for soil application. **Bloom period compared to CFS:** Bloom time (indeterminate blooming throughout season) relevant for colony feeding study exposure duration (6 weeks or longer). **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	**Maintain use based on risk characterization of low risk** **No additional risk management.** **Label update:** May update label language to include the following: Environmental Precautions and Information: Add (after current bee statements): *When used according to label directions minimal exposure or risk is expected.* Example: Where states the following, the additional sentence may be added: *Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications.* ***When used according to label directions minimal exposure or risk is expected.***

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
			during planting of treated seed is not expected. CG9 seeds typically have low dust levels and may be pelletized for certain crops within the crop group. Certain planting equipment can increase emission of pesticide containing dust, but is not typically used when planting CG9 seeds.	from seed treatment. Incidents: None **Overall:** **Minimal potential for risk through pollen and nectar exposure route based on risk characterization.** **Minimal potential for exposure or risk from dust generated during planting of treated seed.**		
11: Pome Fruit Pome fruit: Apple; Crabapples (Chinese apple, Chinese crab apple, Chinese flowering apple, Crab apple, Cutleaf crab apple, Florentine crab apple, Hall crab apple, Iowa crab apple, Japanese crab apple, Kai do crab apple, Manchurian crab apple, Paradise apple, Sargent's crab apple, Siberian crab apple, Soulard crab apple, Southern crab apple, Sweet crab apple, Tea crab apple, Toringa crab apple, Western Crabapple, Yunnan crab apple, and	FO	**CG11: Post-bloom.** **Products:** 24094 [CG11] 28475 [apple, peach, nectarine, cherry] 28726 [apple, peach, nectarine, cherry] 29048 [apple, peach, nectarine, cherry] **Current Label Statements** **Environmental Precaustions/Hazards:** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Requires insect pollination for crop production. Orchards are perennial crops. Approximately 2 – 3 week bloom period. There may be flowering groundcover in orchards. **Exposure potential**: O: Y Application currently allowed pre- and post-bloom only. There is the potential for oral exposure from residues present in flowers (pollen and nectar) from pre-bloom applications the same year, or from post-bloom applications in the following year. C: N (not applied during bloom) (Y if foraging on flowering groundcover in treated area.) **There is potential for exposure through pollen and nectar.** **Pollinator Exposure (pollen/nectar): High** Crop requires insect pollination; crop is a major source of pollen and nectar for HB, BB, SB. Pome fruit are	Tiered Framework (CG11 Pome Fruit): *Apis* and non-*Apis* bees: T1SL: Yes Residues: Apple (post-bloom foliar after a soil application) Cherry (post-bloom foliar) T1R: Yes T2 CFS: Bumble bees: Potential risks for bumble bees using apple and cherry residues for post-bloom foliar application. Honey bees: Using cherry as surrogate, there is a potential for risks for honey bees for post-bloom post-fruit harvest but not for post-bloom pre-fruit harvest application. Using apple residue information after a combination of uses, risks were not identified for honey bees. T2 Tunnel: NA T3: NA Incidents: None	**Residues:** For post-bloom foliar application, residues from representative crop apple (CG11), the foliar application rate is comparable to Canadian rate but was conducted following a soil application. Also used surrogate crop cherry (CG 12) tested with post-bloom foliar only, but the test application rate was higher than Canadian rates (twice as high). **T2 Tunnel; T3 field; Incidents:** None **Bloom period compared to CFS:** Bloom time shorter than colony feeding study exposure duration. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	**Remove use based on potential for risk.**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
varieties and/or hybrids of these); Loquat; Mayhaw; Medlar; Pear; Oriental pear; Quince; Chinese quince; Tejocote, and all varieties and/or hybrids of these.		*spray drift to reduce harmful effects on bees in habitats close to the application site.* 28475; 28476: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* 29048: Environmental Hazards: *[29048: This product is TOXIC to …bees ..] DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees and beneficial insects in habitats close to the application site* **Use directions:** 24094: Use Directions: Crop Group 11- Pome Fruit ; *Apply post-bloom only. Do not apply post-harvest. Apply specified dosage as a foliar spray after pollination is complete and bees have been removed from the orchard.* 28475; 28726; 29048: Directions for Use: Apple- specific use directions (FO): *Post-bloom Applications. Apply specified dosage as a dilute or concentrate foliar spray as needed after pollination is complete and bees have been removed from the orchard.*	medium acreage. Orchards in some locations can cover large areas.	**Overall:** **Based on the risk assessment using representative/surrogate crops:** **Post-bloom:** **Bumble bees: Potential risks for bumble bees.** **Honey bees: Potential risks for honey bees for post-bloom foliar application conducted after fruit harvest. Risk not expected for earlier post-bloom application timing (pre-harvest) for honey bees**. **Consider Pollinator Exposure (pollen/nectar): High**		

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
12: Stone Fruit Stone fruit: Apricot, Cherry (sweet and tart), Nectarine, Peach, Plum (includes Chickasaw, Damson, and Japanese), Plumcot, Prune (fresh and dried).	FO	**CG12: Post-bloom.** **Products:** 24094 [CG12] 28475 [apple, peach, nectarine, cherry] 28726 [apple, peach, nectarine, cherry] 29048 [apple, peach, nectarine, cherry] **Current Label Statements** **Environmental Precaustions/Hazards:** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 28475; 28476: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Requires insect pollination for crop production. Orchards are perennial crops. Approximately 2–3 week bloom period. There may be flowering groundcover in orchards. **Exposure potential**: O: Y Application currently allowed pre- and post-bloom only. There is the potential for oral exposure from residues present in flowers (pollen and nectar) from pre-bloom applications the same year, or from post-bloom applications in the following year. C: N (not applied during bloom) (Y if foraging on flowering groundcover in treated area.) **There is potential for exposure through pollen and nectar.** **Pollinator Exposure: High** Crop requires insect pollination; crop is a major source of pollen and nectar for HB, SB, used by BB. Stone fruit are medium acreage. Orchards in some locations can cover large areas.	Tiered Framework (CG12 Stone Fruit): *Apis* and non-*Apis* bees: T1SL: Yes Residues: Cherry (post-bloom foliar only); Cherry, plum, apricot and peach (post-bloom foliar after a soil application) T1R: Yes T2 CFS: Potential risks for bumble bees using cherry residue information for post-bloom foliar application. Using cherry residues, there is potential risk for honey bees for post-fruit harvest but not for pre-fruit harvest application. Using multiple stone fruit residue information after a combination of uses, potential risks were identified for both bumble bees and honey bees. T2 Tunnel: NA T3: NA Incidents: None **Overall:** **Based on the risk assessment using representative crops:** **Post-bloom:** **Bumble bees: Potential risks for bumble bees.** **Honey bees: Potential risks for honey bees. Risk expected to be reduced with earlier post-bloom**	**Residues:** Residues from stone crops. Residues from a representative cherry crop after a post-bloom foliar application. Rate was higher than Canadian rate (twice as high). Residues from cherry, plum, apricot, peach at comparable foliar application rate but followed a soil application. **T2 Tunnel; T3 field; Incidents:** None **Bloom period compared to CFS:** Bloom time shorter than colony feeding study exposure duration. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	**Remove use based on potential for risk.**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		29048: Environmental Hazards: *[29048: This product is TOXIC to …bees ..] DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees and beneficial insects in habitats close to the application site* **Use directions:** 24094: Use Directions: Crop Group 12- Stone Fruit: *Apply post-bloom only. Do not apply post-harvest. Apply specified dosage as a foliar spray after pollination is complete and bees have been removed from the orchard.* 28475; 28726; 29048: Directions for Use: Peach and Nectarine- specific use directions (FO): *Post-bloom Applications. Apply specified dosage as a dilute or concentrate foliar spray as needed after pollination is complete and bees have been removed from the orchard.* 28475; 28726; 29048: Directions for Use: Cherries (BC, ON only)- specific use directions (FO): *Post-bloom Applications.*		**application timing (pre-harvest).** **Consider Pollinator Exposure (pollen/nectar): High**		
13: Small fruit and berries Subgroups A; B; F; G **Subgroup 13-**	FO	**FO application: Some timing restrictions:** **13A Caneberry:** do not apply pre-bloom or during bloom. Post-bloom only.	**Attractive to**: HB, BB, SB **Agronomic considerations**:	Tiered Framework (CG13 Small fruit and berries): *Apis* and non-*Apis* bees:	**Residues:** No CG13 berry residues available. Used surrogate crop residues.	**Remove pre-bloom and during bloom application. Maintain post-bloom application only with renovation after harvest (excluding grape and strawberry):**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
07A: Caneberry Berry and small fruit – caneberry: blackberry; raspberry, red, black and wild; loganberry; cultivars and/or hybrids of these **Subgroup 13-07B: Bushberry** Berry, aronia; Blueberry, highbush, and/or hybrids of these; Blueberry, lowbush; Currant, buffalo, black, and red; Elderberry; Gooseberry; Cranberry, highbush; Honeysuckle; Huckleberry; Jostaberry; and Juneberry (Service berry or Saskatoon berry) **Subgroup 13-07F: Vine Climbing including grape** Berry and small fruit – vine including grapes: Grape, American bunch, Muscadine, and Vinifera; Gooseberry; Kiwifruit, hardy; Maypop; Schisandra berry **Subgroup 13-**		**Blueberry:** apply post-bloom. **13G Low growing Berry**: Do not apply prior to bud opening or during bloom. **Products:** **24094** [13A-soil and foliar; 13B-soil and foliar; 13F-soil and foliar; 13G-soil and foliar; cranberry-soil] **28475** [13A-soil and foliar; 13B-soil and foliar; 13G-soil] **28726** [13B-soil and foliar; 13G-soil] **29048** [13B-soil and foliar; 13G-soil] **29611** [blueberry-highbush/ blueberry lowbush-foliar] **Current Label Statements** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to*	Most small fruit and berries require bee pollination. (Exceptions: grape, elderberry, mulberry, strawberry). Managed pollination services are used for some berry crops, and may be used to enhance crop production (including for strawberry). Perennial crops. Bloom period varies; typically 2 – 3 weeks. Some strawberries are indeterminate blooming. **Exposure potential**: O: Y C: Y **There is potential for exposure.** **Pollinator Exposure:** **CG13-07A Caneberry (considered Blackberry/ Raspberry): Pollinator Exposure (pollen/nectar): High:** Blackberry/ raspberry require bee pollination. Pollination services typically used for raspberry (not for blackberry). Crop is a minor source of pollen and nectar for HB, and a major source of pollen and nectar for BB, SB (raspberry a minor source for SB). Medium acreage. **CG13-07B Bushberry: (considered Blueberry): Pollinator Exposure (pollen/nectar): High:** Blueberry requires bee pollination. Pollination services typically used (HB). Crop is a minor source of pollen and nectar for HB, and a major source of pollen and nectar for BB, SB. Blueberry is medium acreage. **CG13-07F Vine including grape, Grape: Pollinator Exposure (pollen/nectar): Low** Grape does not require insect pollination; cultivated grape is primarily wind and self-	T1SL: Yes Residues: Surrogate residues. Pre-bloom: cotton, sugarmelon; During bloom: cotton; Post-bloom: cherry. T1R: Yes T2 CFS: Pre-bloom application: Potential for risks for bumble bees and honey bees using surrogate crop, cotton. Potential for risk to bumble bee using one of the surrogate sugarmelon residue studies. During bloom: Potential for risk to honey bee and bumble bee . Post-bloom application: Potential risks for bumble bees using surrogate crop, cherry; potential risk for honey bees for post-fruit harvest but not for pre-fruit harvest application.. T2 Tunnel: NA T3: NA Incidents: None **Overall:** **Pre-bloom application: Potential for risk to bumble bee and honey bee based on surrogate residues from cotton (honey bee and bumble bee) and sugarmelon (bumble bee).** **During bloom application: Potential for risk to honey bee and bumble bee.** **Post-bloom application: Potential for risk to bumble**	Pre-bloom: cotton, sugar melon. During bloom: cotton Post-bloom: cherry Application rates used in residue studies were comparable or higher than Canadian application rates. Pre-bloom rates on cotton and sugar melon were comparable to Canadian rates for 13A Caneberry and 12B Bushberry, but were higher than Canadian rates for 13F Vine and 13G Low growing berry. During bloom rates used on cotton were comparable to Canadian rates. Post-bloom cherry residues used rates higher than Canadian rates, with the exception of Canadian use on raspberry, which was comparable to the rate used in the cherry residue study. **T2 Tunnel; T3 field; Incidents:** None **Bloom period compared to CFS:** Bloom time shorter than colony feeding study exposure duration. Some strawberries have indeterminate blooming throughout the season. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	**CG13A Berry and small Fruit-Caneberry** (FO) **CG13B Berry and small Fruit-Bushberry** (FO) **CG13F Berry and small Fruit-vine excluding grapes** (FO) **CG13G Berry and small Fruit-low growing berries excluding strawberries** (FO) Blueberries (FO) Highbush Blueberries [BC only] (FO) *May maintain post-bloom FO with renovation after harvest. **Add to directions for use**: *Application allowed only post-bloom with renovation after harvest. Do not apply pre-bloom or during bloom (Do not apply until petal fall). Do not apply when bees are present. When applying after petal fall, renovation of woody plants (cutting back of old growth) must occur after harvest and before the next season's bloom.* **Grape: Remove during bloom application. Maintain pre-bloom and post-bloom application:** From CG13F Berry and small Fruit-vine climbing: grapes only (FO): **Add to directions for use**: *Do not apply during bloom or when bees are actively foraging.* **Strawberry: Remove pre-bloom and during bloom application. Maintain post-bloom application**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
07G: Low growing berry including strawberry Bearberry; Bilberry; Blueberry, lowbush; Cranberry; Cloudberry; Lingonberry; Muntries; Partridgeberry; Strawberry		*residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 28475; 28726: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* 29048; 29611: Environmental Hazards: *[29048: This product is TOXIC to …bees ..] [29611: This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds].DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees and beneficial insects in habitats close to the application site.* **Use Directions:** **13A Caneberry** 24094: Use Directions: CG13A Berry and small fruit-Caneberry- specific use directions (**SO, FO**): *Do not apply pre-bloom or during bloom or when bees are actively foraging.*	pollinated. Grape is a minor source of pollen for HB only. Not a nectar source. It is not attractive to BB, SB. Grape is medium acreage. Vineyards in some locations can cover large areas. **CG13-07F Vine including grape, berries other than grape: Pollinator Exposure (pollen/nectar): High**. Crop may be a source of pollen and nectar for HB, BB, SB. Low to moderate acreage. **CG13-07G Low Growing Berry (excluding strawberry): (considering Cranberry): Pollinator Exposure (pollen/nectar): High:** Cranberry requires insect pollination. Pollination services typically used (HB). Crop is a minor source of pollen and nectar for HB, and a major source of pollen and nectar for BB, SB. Cranberry is low - medium acreage. **CG13-07G Low Growing Berry, Strawberry: Pollinator Exposure (pollen/nectar): Low to Moderate** Most strawberry varieties do not require insect pollination, though some varieties do. Pollination services may be used to enhance crop production; may be used for honey production. Strawberry is a minor source of pollen and nectar for HB, BB, SB. Strawberry is low acreage.	**bee and honey bee (with later application timing) based on surrogate cherry residues.** **Consider Pollinator Exposure (pollen/nectar): High; Moderate for strawberry; Low for grape**		**only:** From CG13G Berry and small Fruit-low growing berries: strawberries only (FO): **Add to directions for use**: *Do not apply pre-bloom or during bloom or when bees are actively foraging. Apply post-bloom only.* **Additional Label Updates:** **Add under:** Environmental Precautions, after the other bee statements: *To further minimize exposure to pollinators, refer to the complete guidance "Protecting Pollinators during Pesticide Spraying- Best Management Practices" on the Health Canada website (www.healthcanada.gc.ca/pollinators). Follow crop specific directions for application timing.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		28475 Directions for Use: CG13A Caneberries- specific use directions (**FO**): *Do not apply pre-bloom or during bloom or when bees are actively foraging. Postbloom Applications* **13B Bushberry** 24094: Use Directions: CG13B Berry and small fruit-Bushberry-For Juneberry (Serviceberry or Saskatoon berry only) for suppression of Woolly elm aphid, woolly apple aphid- specific use directions (**SO**): *Do not apply pre-bloom or during bloom or when bees are actively foraging.* [Note: these use directions are not included for other CG13B SO and FO uses] 28475 Directions for Use: Saskatoon Berry-specific use directions (**SO**): *Do not apply pre-bloom or during bloom or when bees are actively foraging.* 28475; 28726; 29048: Directions for Use: Highbush Blueberries (ON,QC only)- specific use directions (**SO**): *DO NOT apply [PRODUCT] during flowering of blueberries.* 28475; 28726; 29048: Directions for Use: Highbush Blueberries (BC only)- specific use directions (**FO**): *Apply post-bloom after bees have been removed.*				

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		29611: Directions for Use: Blueberry-specific use directions (**FO**): *In low bush blueberries, apply post-bloom during fruit producing years and anytime during the vegetative year. In high bush blueberries, apply post-bloom.* **13G Low Growing Berry Including Strawberry** 24094: Use Directions: CG13G Berry and small fruit-Low Growing Berries including strawberries- specific use directions (**SO, FO**): *Do not apply immediately prior to bud opening or during bloom or when bees are actively foraging.* [Note: For soil application to reduce numbers of larvae of European chafer, this statement is not included, but does include: *For strawberries, apply to fields before mulch is laid down.*] 28475; 28726; 29048: Directions for Use: Strawberries-specific use directions (**SO**): *Do not apply immediately prior to bud opening or during bloom or when bees are actively foraging.*				
13: Small fruit and berries Subgroups A; B; F; G **Subgroup 13-07A: Caneberry** Berry and small fruit – caneberry: blackberry;	SO	**SO application: Some timing restrictions:** **Caneberry:** do not apply pre-bloom or during bloom. **Juneberry/Saskatoon berry/Service berry**: do not apply pre-bloom or during bloom	**Attractive to**: HB, BB, SB **Agronomic considerations**: Most small fruit and berries require bee pollination. (Exceptions: grape, elderberry, mulberry, strawberry). Managed pollination services are used	Tiered Framework (CG13 Small fruit and berries): *Apis* and non-*Apis* bees: T1SL: Yes Residues: strawberry (soil pre-bloom); blueberry (soil post-bloom, post-harvest)	**Residues:** Residues from CG13: **Strawberry**: Soil application pre-bloom. Strawberry mainly produces pollen; collected from plant.	**Remove use based on potential for risk:** CG13A Berry and small Fruit-Caneberry (SO) CG13B Berry and small Fruit-Bushberry (SO) CG13F Berry and small Fruit- vine **excluding grapes** (SO)

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
raspberry, red, black and wild; loganberry; cultivars and/or hybrids of these **Subgroup 13-07B: Bushberry** Berry, aronia; Blueberry, highbush, and/or hybrids of these; Blueberry, lowbush; Currant, buffalo, black, and red; Elderberry; Gooseberry; Cranberry, highbush; Honeysuckle; Huckleberry; Jostaberry; and Juneberry (Service berry or Saskatoon berry) **Subgroup 13-07F: Vine Climbing including grape** Berry and small fruit – vine including grapes: Grape, American bunch, Muscadine, and Vinifera; Gooseberry; Kiwifruit, hardy; Maypop; Schisandra berry **Subgroup 13-07G: Low growing berry including strawberry**		**Strawberry:** do not apply immediately prior to bud opening or during bloom**.** **Blueberry**: do not apply during bloom **Products:** **24094** [13A-soil and foliar; 13B-soil and foliar; 13F-soil and foliar; 13G-soil and foliar; cranberry-soil] **28475** [13A-soil and foliar; 13B-soil and foliar; 13G-soil] **28726** [13B-soil and foliar; 13G-soil] **29048** [13B-soil and foliar; 13G-soil] **29611** [blueberry-highbush/ blueberry lowbush-foliar] **Current Label Statements** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to*	for some berry crops, and may be used to enhance crop production (including for strawberry). Perennial crops. Bloom period varies; typically 2 – 3 weeks. Some strawberries are indeterminate blooming. **Exposure potential**: O: Y C: N **There is potential for exposure.** **Pollinator Exposure:** **CG13-07A Caneberry (considered Blackberry/ Raspberry): Pollinator Exposure (pollen/nectar): High:** Blackberry/ raspberry require bee pollination. Pollination services typically used for raspberry (not for blackberry). Crop is a minor source of pollen and nectar for HB, and a major source of pollen and nectar for BB, SB (raspberry a minor source for SB). Medium acreage. **CG13-07B Bushberry: (considered Blueberry): Pollinator Exposure (pollen/nectar): High:** Blueberry requires bee pollination. Pollination services typically used (HB). Crop is a minor source of pollen and nectar for HB, and a major source of pollen and nectar for BB, SB. Blueberry is medium acreage. **CG13-07F Vine including grape, Grape: Pollinator Exposure (pollen/nectar): Low** Grape does not require insect pollination; cultivated grape is primarily wind and self-pollinated. Grape is a minor source of pollen for HB only. Not a nectar source. It is not attractive to BB, SB. Grape is medium acreage. Vineyards in some locations can cover large	T1R: Yes T2 CFS: Using residues from strawberry (pre-bloom soil application, in either coarse or medium soil types), there is potential for risk to bumble bees, and for honey bees for strawberry grown in coarse soil but not in medium soil. Using residues from blueberry (post-bloom, post-harvest application), there is potential for risks for bumble bees but not honey bees. T2 Tunnel: NA T3: NA Incidents: None **Overall:** **For pre-bloom soil application, using strawberry residues as surrogate crop (13A, B, F) or representative crop (13G): Potential for risk to bumble bees. Potential for risk to honey bees based on strawberry residues grown in coarse soil but not in medium soil.** **For post-bloom soil application, using blueberry residues (post-bloom, post-harvest application): Potential for risk to bumble bees. No potential for risk for honey bees.** **Consider Pollinator Exposure (pollen/nectar): High; Moderate for strawberry; Low for grape**	Studies with coarse and medium soil types. **Blueberry**: Soil application post-bloom, post-harvest. Blueberry pollen collected from bees; nectar collected from hive. Application rates used in residue studies were higher than the maximum Canadian label rates for CG13A Caneberry and CG13B Bushberry (approximately twice as high) Application rates were comparable (slightly higher) to maximum Canadian label rates for CGF Vine fruit and CGG Low growing berries. **T2 Tunnel; T3 field; Incidents:** None **Bloom period compared to CFS:** Bloom time typically shorter than colony feeding study exposure duration. Some strawberries have indeterminate blooming throughout the season. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	CG13G Berry and small Fruit- low growing berries including strawberries (SO) Cranberry (SO) Strawberries (SO) Saskatoon Berry (SO) Highbush Blueberries [ON, QC only] (SO) **Grape: Maintain use based on low potential for risk:** CG13F Grape only (SO)

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
Bearberry; Bilberry; Blueberry, lowbush; Cranberry; Cloudberry; Lingonberry; Muntries; Partridgeberry; Strawberry		*residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 28475; 28726: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* 29048; 29611: Environmental Hazards: *[29048: This product is TOXIC to …bees ..] [29611: This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds].DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees and beneficial insects in habitats close to the application site.* **Use Directions:** **13A Caneberry** 24094: Use Directions: CG13A Berry and small fruit-Caneberry- specific use directions (**SO, FO**): *Do not apply pre-bloom or during bloom or when bees are actively foraging.*	areas. **CG13-07F Vine including grape, berries other than grape: Pollinator Exposure (pollen/nectar): High**. Crop may be a source of pollen and nectar for HB, BB, SB. Low to moderate acreage. **CG13-07G Low Growing Berry (excluding strawberry): (considering Cranberry): Pollinator Exposure (pollen/nectar): High:** Cranberry requires insect pollination. Pollination services typically used (HB). Crop is a minor source of pollen and nectar for HB, and a major source of pollen and nectar for BB, SB. Cranberry is low - medium acreage. **CG13-07G Low Growing Berry, Strawberry: Pollinator Exposure (pollen/nectar): Low to Moderate** Most strawberry varieties do not require insect pollination, though some varieties do. Pollination services may be used to enhance crop production; may be used for honey production. Strawberry is a minor source of pollen and nectar for HB, BB, SB. Strawberry is low acreage.			

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		28475 Directions for Use: CG13A Caneberries- specific use directions (**FO**): *Do not apply pre-bloom or during bloom or when bees are actively foraging. Postbloom Applications* **13B Bushberry** 24094: Use Directions: CG13B Berry and small fruit-Bushberry-For Juneberry (Serviceberry or Saskatoon berry only) for suppression of Woolly elm aphid, woolly apple aphid- specific use directions (**SO**): *Do not apply pre-bloom or during bloom or when bees are actively foraging.* [Note: these use directions are not included for other CG13B SO and FO uses] 28475 Directions for Use: Saskatoon Berry-specific use directions (**SO**): *Do not apply pre-bloom or during bloom or when bees are actively foraging.* 28475; 28726; 29048: Directions for Use: Highbush Blueberries (ON,QC only)- specific use directions (**SO**): *DO NOT apply [PRODUCT] during flowering of blueberries.* 28475; 28726; 29048: Directions for Use: Highbush Blueberries (BC only)- specific use directions (**FO**): *Apply post-bloom after bees have been removed.*				

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		29611: Directions for Use: Blueberry-specific use directions (**FO**): *In low bush blueberries, apply post-bloom during fruit producing years and anytime during the vegetative year. In high bush blueberries, apply post-bloom.* **13G Low Growing Berry Including Strawberry** 24094: Use Directions: CG13G Berry and small fruit-Low Growing Berries including strawberries- specific use directions (**SO, FO**): *Do not apply immediately prior to bud opening or during bloom or when bees are actively foraging.* [Note: For soil application to reduce numbers of larvae of European chafer, this statement is not included, but does include: *For strawberries, apply to fields before mulch is laid down.*] 28475; 28726; 29048: Directions for Use: Strawberries-specific use directions (**SO**): *Do not apply immediately prior to bud opening or during bloom or when bees are actively foraging.*				
Crop Group 14: Tree Nuts and pistachio Almond; beechnut; brazil nut; butternut; cashew; chestnut; chinquapin; filbert (hazelnut);	FO	**Tree Nuts and Pistachio: Do not apply immediately prior to bud opening or during bloom.** **Products:** 24094 **Current Label Statements**	**Attractive to**: Variable attractiveness to HB, BB, SB **Agronomic considerations**: Variability regarding whether tree nut requires insect pollination for crop production. Those that require insect pollination are attractive to pollinators.	Tiered Framework (CG14 Tree nuts and pistachio): *Apis* and non-*Apis* bees: T1SL: Yes Residues: Citrus and Cotton (pre-bloom foliar) Cherry (post-bloom foliar)	**Residues:** Residues from surrogate crops, citrus and cotton for pre-bloom and cherry for post-bloom. Compared to Canadian label rates, the foliar application rates used for residues were comparable in cotton, but high in citrus	**Remove use for high pollinator exposure tree nuts including: Almond, Chestnuts, Chinquapin nuts, Japanese horse-chestnuts.** **Remove pre-bloom use and Maintain post-bloom use on all other tree nuts based on lower pollinator exposure**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
hickory nut; macadamia nut; pecan; pistachio; walnut, black and English Note: Not all are grown commercially in Canada		24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 24094: Use Directions: Crop Group 14 Tree nuts and pistachio- specific use directions: *Do not apply immediately prior to bud opening or during bloom or when bees are actively foraging.*	Those that are wind pollinated and do not require insect pollination are typically not attractive or have lower attractiveness to pollinators. Tree nut orchards are perennial crops. Approximately 2 – 3 week bloom period. There may be flowering groundcover in orchards. **Exposure potential**: O: Y Application currently allowed pre- and post-bloom only. There is the potential for oral exposure from residues present in flowers (pollen and nectar) from pre-bloom applications the same year, or from post-bloom applications in the following year. C: N (not applied during bloom) (Y if foraging on flowering groundcover in treated area.) **There is potential for exposure through pollen and nectar.** **Pollinator Exposure (pollen/nectar): Variable- Low/Moderate to High. Minimal information available.** Some crops require insect pollination; some crops are a source of pollen and nectar for HB, BB, SB. Tree nuts are low acreage in Canada. Minimal information is available regarding tree nuts currently grown commercially in Canada. **Pollinator Exposure (pollen/nectar) for specific tree crops**: **High**: Almond, Chestnuts, Chinquapin nuts, Japanese horse-chestnuts. **Low/Moderate:** beech nuts; black walnut, bur oak nuts, butternuts, English walnuts, hazelnuts (filberts), heartnuts, pistachio nuts; yellowhorn nuts, hickory nuts. **Not likely attractive**: gingko nuts; pecan; pine nuts; monkey puzzle nuts.	T1R: Yes T2 CFS: For pre-bloom application using citrus and cotton as surrogates, there is a potential for risks for honey bees and bumble bees. For post-bloom application using cherry as surrogate, there is a potential for risks for bumble bees. There is a potential for risks for honey bees for post-fruit harvest but not for pre-fruit harvest application. T2 Tunnel: NA T3: NA Incidents: None **Overall:** **Based on the risk assessment using surrogate crops:** Pre-bloom: Potential risks for both honey bees and bumble bees Post-bloom: Potential risks for bumble bees. Potential risks for honey bees for application conducted after fruit harvest. Earlier post-bloom application is expected to reduce the risk. **Consider Pollinator Exposure (pollen/nectar): Variable: Not attractive to Low/Moderate to High. It is uncertain which tree nuts are grown commercially in Canada.**	and cherry studies. **T2 Tunnel; T3 field; Incidents:** None **Bloom period compared to CFS:** Bloom time shorter than colony feeding study exposure duration. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	**[Note: during bloom use is not allowed on current label; maintain this restriction]** **Additional label mitigation:** **Add under:** Use Directions- crop specific (Crop Group 14: Tree Nuts and pistachio): *Do not apply pre-bloom or during bloom or when bees are actively foraging. Apply only during post-bloom period. Do not apply to Almond, Chestnuts, Chinquapin nuts, Japanese horse-chestnuts.* **Additionally, Label Update:** **Add under:** Environmental Precautions, after the other bee statements: *To further minimize exposure to pollinators, refer to the complete guidance "Protecting Pollinators during Pesticide Spraying- Best Management Practices" on the Health Canada website (www.healthcanada.gc.ca/pollinators). Follow crop specific directions for application timing.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
From Crop Group 15: Cereal Grains Barley, oats, wheat, corn	ST [barley, oats, wheat, corn only]	**CG15 Cereals grains: Planting treated seed.** **Products:** 28475 [wheat, oat, barley,(soy)] 29609 [wheat, oat, barley] 29610 [wheat, oat, barley, (soy)] 30668 [wheat, oat, barley, (soy)] 30505 [wheat, oat, barley, corn] 26124 [corn] 27170 [corn] **Current Label Statements:** 29609: Environmental Precautions: *Cover or incorporate spilled treated seeds. Left over treated seed should be doublesown around the headland, or buried away from water sources.* 28475; 29610 ; 30668; 30505 ; 26124; 27170 [labels that also include corn/soy have more extensive labeling] : Environmental Precautions: *Imidacloprid is toxic to bees. To help minimize the dust generated during planting, refer to the complete guidance "Pollinator Protection and Responsible Use of Treated Seed- Best Management Practices" on the Health Canada webpage on pollinator protection at www.healthcanada.gc.ca/polli*	**Attractive to**: HB (corn pollen only) **Agronomic considerations**: Almost all cereal grain crops are wind pollinated and do not need insect pollination. Only buckwheat uses insect pollination. Most grains are not attractive to pollinators and do not provide a pollen or nectar source (wheat, barley, oat, rye, triticale, rice). Cereals with pollen and/or nectar sources: Buckwheat (attractive to pollinators, pollen and nectar), corn, sorghum, millet. Corn provides only a pollen source. **Exposure:** O: Y (buckwhet, corn pollen, sorghum, millet only) C: N **Potential for exposure through pollen and nectar.** **Pollinator Exposure (pollen/nectar): None (most cereals), Moderate (Corn); High (buckwheat)** Most do not require insect pollination (wind pollinated); exception is buckwheat. Most are not a source of pollen or nectar (wheat, barley, oat, rye, triticale, rice). Corn has only pollen, and is considered a minor source of pollen for HB, not attractive to BB, SB. Buckwheat is a source of pollen and nectar to HB, BB, SB. Acreage for corn and wheat is high. **Pollinator Exposure (dust): Potential for exposure through dust generated during planting of treated seed**. Exposure through dust generated during planting of treated seed is possible. Some cereal seeds result in dust generation. Certain planting	Tiered Framework (cereal grains): Apis and non-Apis bees: T1SL: Y Residues: corn (pollen) T1R: Y T2 CFS: Potential for risk is detected using residue from representative crop, corn, in 1 out of 3 test scenario for honey bee colonies, 2 out of 3 test scenarios for bumble bee colonies. No risk was found using the study tested at 1.0 mg/seed. The test application rates were 1.0-1.3 mg/seed, greater than the maximum Canadian rate, 0.63 mg/seed. The identified risk may be overestimated. T2 Tunnel: 14 seed treatment tunnel studies were available for honey bees and one for bumble bees. No overall treatment-related effects were detected, while some either slight or transitory differences between the control and treatment were reported for honey bees in two out of all tunnel studies (the number of dead individuals or empty frame cells). All the tunnel studies had short exposure duration and tested a number of different crops (summer rape, winter rape, canola, sunflower, field bean). There were 9 studies on canola/rape; 4 studies on sunflower; 1 study on field bean.	**Residues:** Crop specific residues from corn (corn has pollen only). No other registered cereals are attractive to pollinators. The seed treatment rates for corn were 1.0-1.3 mg/seed, all of which were greater than the maximum Canadian rate, 0.63 mg/seed. The identified potential risk is expected to be overestimated. **T2 Tunnel:** Most (12 out of 14) T2 Tunnel studies showed no effects; while only two showed transitory effects. However, all had short exposure durations. **T3 Field:** All T3 studies, except one, were not conducted in Canada. The Canada study was conducted with a short duration in small canola fields without an appropriate control. Various limitations were identified in these studies, and majority of them includes the lack of sufficient characterization of exposure level and contamination of other pesticides. Some of them had short exposure and observation periods. **Bloom period compared to CFS:** Bloom time shorter than colony feeding study exposure duration. **Incidents**: Incidents in 2012 – 2016 related to exposure to dust during	**Maintain use based on risk characterization of negligible/low risk from pollen exposure route.** **Propose additional mitigation to reduce the potential for exposure to dust during planting of treated cereal seeds.** **Additional label mitigation for cereal seeds:** As cereal seeds can be dusty, propose addition of label statements to all containers of treated cereal seeds instructing user to follow best management practices for planting of treated seed. **Add:** LABELLING TREATED SEED (corn): No additions; Label statements are already present and acceptable for corn. 28475; 29609; 29610 ; 30668; 30505 LABELLING TREATED SEED (wheat, oat, barley): *Additionally, all treated wheat, oat, barley cereal seed for sale or use in Canada must be labeled with the following information:* *Imidacloprid is toxic to bees. Dust generated during planting of treated seed may be harmful to bees and other pollinators.* *To help minimize the dust generated during planting, refer to the "Pollinator Protection and Responsible Use of Treated Seed-Best Management Practices" on the Health Canada webpage on pollinator protection at www.healthcanada.gc.ca/pollinators*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		nators . When using a seed flow lubricant with corn seed treated with [PRODUCT], only a dust-reducing fluency agent is permitted. Talc and graphite are not permitted to be used as a seed flow lubricant for corn seed treated with this insecticide. Carefully follow use directions for the seed flow lubricant. Do not load or clean planting equipment near bee colonies, and avoid places where bees may be foraging, such as flowering crops or weeds. When turning on the planter, avoid engaging the system where emitted dust may contact honey bee colonies. Spilled or exposed seeds and dust must be incorporated into the soil or cleaned up from the soil surface. LABELLING TREATED SEED: *Additionally, all treated [corn seed and/or soybean seed] for sale or use in Canada must be labeled with the following information: Imidacloprid is toxic to bees. Dust generated during planting of treated seed may be harmful to bees and other pollinators. To help minimize the dust generated during planting, refer to the complete guidance "Pollinator Protection and Responsible Use of Treated Seed- Best Management Practices" on the Health Canada webpage on pollinator protection at www.healthcanada.gc.ca/pollinators. When using a seed flow lubricant with this treated seed, only a dust-reducing fluency agent is permitted. Talc*	equipment can increase emission of pesticide containing dust. While planting equipment which can increase emission of pesticide containing dust may be used for corn, it is not typically used for wheat or other cereals Pollinator exposure to dust generated during planting was previously identified as a concern for neonicotinoid treated corn and soybean seed, and mitigation was implemented. While planting equipment which can increase emission of pesticide containing dust may be used for corn, it is not typically used for wheat or other cereals.	T3: 12 seed treatment field studies were available for honey bees (7 sunflower; 3 canola/rape; 1 corn; 1 field bean) and one for bumble bees (sunflower). No overall long-term effects were reported in any studies. However, out of the 12 studies, short-term effects were reported in a few studies: reduced hive weight gain in two studies; reduced number of brood cells and increased queen supersedures in one study. The transitory effects were reported in the studies with sunflower, not with any other crops. Sunflower is not registered for imidacloprid in Canada. Incidents : Incidents associated with corn dust. PMRA has already implemented dust exposure reduction strategies for planting treated corn seed. **Overall:** **Minimal potential for risk through pollen and nectar exposure route based on risk characterization.** **Potential for risk from dust generated during planting of treated seed when label requirements or best management practices for planting of treated seed are not followed.**	planting of treated corn and soybean seed. All were associated with thiamethoxam and clothianidin (and not imidacloprid), as those neonicotinoids are typically used on corn. Pollinator exposure to dust generated during planting was previously identified as a concern for neonicotinoid treated corn and soybean seed, and mitigation was implemented (including for imidacloprid). While planting equipment which can increase emission of pesticide containing dust may be used for corn, it is not typically used for other cereals. **Bloom time/pollen shed shorter than CFS exposure durations** Corn pollen shed shorter than CFS exposure duration. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	. *Do not load or clean planting equipment near bee colonies, and avoid places where bees may be foraging, such as flowering crops or weeds.* *When turning on the planter, avoid engaging the system where emitted dust may contact honey bee colonies.* *Spilled or exposed seeds and dust must be incorporated into the soil or cleaned up from the soil surface.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		and graphite are not permitted to be used as a seed flow lubricant for corn seed treated with this insecticide. Carefully follow use directions for the seed flow lubricant. Do not load or clean planting equipment near bee colonies, and avoid places where bees may be foraging, such as flowering crops or weeds. When turning on the planter, avoid engaging the system where emitted dust may contact honey bee colonies. Spilled or exposed seeds and dust must be incorporated into the soil or cleaned up from the soil surface.				
Crop Group 19A: Herbs Angelica, Balm (lemon balm), Basil (fresh and dried), Borage, Bumet, Camomile, Catnip, Chervil (dried), Chinese chive, Chive, Clary, Coriander (cilantro or Chinese parsley leaves), Costmary, Culantro (leaf), Curry (leaf), Dillweed, Horehound, Hyssop, Lavender, Lemongrass, Lovage (leaf), Marigold, Marjoram, Nasturtium, Parsley (dried),	FO	**Herbs: Do not apply immediately prior to bud opening or during bloom.** **Products:** 24094 **Current Label Statements** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 24094: Use Directions: Crop	**Attractive to**: HB, BB, SB **Agronomic considerations**: Herbs do not typically require insect pollination for crop production. (Some spices, CG19B, which are seeds, may require insect pollination). Herbs include both annuals and perennials. There are variable bloom periods. Some herbs are harvested prior to bloom period. **Exposure potential**: O: Y (N when harvested prior to bloom) Application currently allowed pre- and post-bloom only. When the herb is not harvested before bloom, there is potential for oral exposure. There is the potential for oral exposure from residues present in blooms from pre-bloom applications the same year. There is also potential for oral exposure from post-bloom applications in blooms of the	Tiered Framework (CG19A Herbs): *Apis* and non-*Apis* bees: T1SL: Yes Residues: Surrogate residues. Pre-bloom: cotton, sugarmelon, soybean; Post-bloom: cherry. T1R: Yes T2 CFS: Pre-bloom application: Potential risk for bumble bees and honey bees using surrogate crop, cotton. Potential for risk to bumble bee using one of the surrogate sugarmelon residue studies. Minimal risk for honey bee or bumble bee using soybean residues. Post-bloom application: Potential risks for bumble bees using surrogate crop, cherry; potential risk for	**Residues:** No specific residues for herbs. Cotton, sugarmelon, soybean were used as surrogate for pre-bloom applications. Soybean was from honey bee-collected nectar and pollen, which had very low attractiveness to honey bee. Cherry was used as surrogate for post-bloom application. Rates for residue studies were higher than Canadian rates. **T2 Tunnel; T3 field; Incidents:** None **Bloom period compared to CFS:** Blooming period may be shorter than colony feeding study exposure durations. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	**Remove pre-bloom use based on potential for risk. *** ***Exception: Maintain pre-bloom use only for herbs that will be harvested prior to bloom.** **Remove use for perennial herbs lavender and rosemary, based on potential for risk and high pollinator exposure.** **Maintain post-bloom use for perennial herbs sweet bay and wintergreen, based on lower pollinator exposure potential.** **Maintain post-bloom use on annual herbs, as negligible exposure.** **[Note: during bloom use is not allowed on current label; maintain this restriction]** **Additional label mitigation:** **Add under:** Use Directions- crop specific (Crop

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
Pennyroyal, Rosemary, Rue, Sage, Savory (summer and winter), Sweet bay (bay leaf), Tansy, Tarragon, Thyme, Wintergreen, Woodruff, Wormwood		Group 19A Herbs- specific use directions for foliar: *Do not apply immediately prior to bud opening or during bloom or when bees are actively foraging.*	following year, but only when herb is a perennial herb. Many herbs are annuals, and are harvested at the end of the season. When an herb is harvested prior to bloom, no exposure is expected. C: N **There is potential for exposure through pollen and nectar.** **Pollinator Exposure (pollen/nectar): Variable- Low/Moderate to High.** Some herb crops are harvested before bloom, which will result in negligible pollinator exposure. Other herbs that are not harvested before bloom have variable pollinator exposure (low/moderate to high). Herbs include both annuals (harvested at the end of the season) and perennials. Some crops are a major source of pollen and nectar for HB, BB, SB. Herbs are low acreage. **Pollinator Exposure (pollen/nectar) for specific herb crops**: **Harvested before bloom**: Basil (fresh and dried); Borage; Chervil (dried); Chinese chive; Chive; Coriander (cilantro or Chinese parsley leaves); Dillweed; Hyssop; Lemongrass; Marjoram; Parsley (dried); Pennyroyal; Sage; Savory (summer and winter); Tarragon; Wormwood **Not harvested before bloom:** Wintergreen; Lavender; Rosemary; Sweet bay (bay leaf) [all of these are perennial herbs; Rosemary and Lavender are high attractiveness to pollinators; Sweet bay and wintergreen are low/moderate attractiveness] **Sometimes harvested before bloom:** Angelica; Bumet ; Lovage (leaf); Woodruff **No information regarding harvest time:** Balm (lemon balm; Camomile; Catnip; Clary; Costmary; Culantro	honey bees for post-fruit harvest but not for pre-fruit harvest application. Relevance of cherry to perennial herbs is uncertain; no other information available. T2 Tunnel: NA T3: NA Incidents: None **Overall:** **Based on the risk assessment using surrogate crops:** **Pre-bloom: potential for risks for bumble bees and honey bee varied depending on surrogate crops.** **Post-bloom: Potential for risk to bumble bee and honey bee (with late application) only for perennial herbs. Cherry may not represent herbs well. No risks are expected for annual herbs harvested at the end of the season.** **Consider Pollinator Exposure (pollen/ nectar): Varies depending on herb. Some may be harvested before bloom; some annuals; some perennials. Low, Moderate, High**		Group 19A: Herbs): *Do not apply pre-bloom* or during bloom or when bees are actively foraging. Apply only during post-bloom period. Do not apply to rosemary or lavender.* **Exception: Pre-bloom application is allowed only when herbs will be harvested prior to bloom.* **Additionally, Label Update:** **Add under:** Environmental Precautions, after the other bee statements: *To further minimize exposure to pollinators, refer to the complete guidance "Protecting Pollinators during Pesticide Spraying- Best Management Practices" on the Health Canada website (www.healthcanada.gc.ca/pollinators). Follow crop specific directions for application timing.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
			(leaf); Curry (leaf) ; Horehound; Marigold; Nasturtium ; Rue; Tansy; Thyme			
Crop Group 19A: Herbs Angelica, Balm (lemon balm), Basil (fresh and dried), Borage, Bumet, Camomile, Catnip, Chervil (dried), Chinese chive, Chive, Clary, Coriander (cilantro or Chinese parsley leaves), Costmary, Culantro (leaf), Curry (leaf), Dillweed, Horehound, Hyssop, Lavender, Lemongrass, Lovage (leaf), Marigold, Marjoram, Nasturtium, Parsley (dried), Pennyroyal, Rosemary, Rue, Sage, Savory (summer and winter), Sweet bay (bay leaf), Tansy, Tarragon, Thyme, Wintergreen, Woodruff, Wormwood	SO	**Herbs: Soil application at planting.** **Products:** 24094 **Current Label Statements** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Herbs do not typically require insect pollination for crop production. (Some spices, CG19B, which are seeds, may require insect pollination). Herbs include both annuals and perennials. There are variable bloom periods. Some herbs are harvested prior to bloom period. **Exposure potential**: O: Y (N when harvested prior to bloom) Application currently allowed pre- and post-bloom only. When the herb is not harvested before bloom, there is potential for oral exposure. There is the potential for oral exposure from residues present in blooms from pre-bloom applications the same year. There is also potential for oral exposure from post-bloom applications in blooms of the following year, but only when herb is a perennial herb. Many herbs are annuals, and are harvested at the end of the season. When an herb is harvested prior to bloom, no exposure is expected. C: N **There is potential for exposure through pollen and nectar.** **Pollinator Exposure (pollen/nectar): Variable- Low/Moderate to High.** Some herb crops are harvested before bloom, which will result in negligible pollinator exposure. Other herbs that	Tiered Framework (CG19A Herbs): *Apis* and non-*Apis* bees: T1SL: Yes Residues: No CG19A Herb residues. Surrogate residues for tomato, melon, pumpkin, strawberry, cotton. Rates similar to Canadian rates T1R: Yes T2 CFS: Potential for risks for bumble bees with almost all residues, and risks for honey bee with some residues using surrogate crops. Greater risk in coarse soils, higher application rates. T2 Tunnel: NA T3: NA Incidents: None **Overall:** **Potential risks for bumble bees and possible risks for honey bees based on the risk assessment using surrogate crops.** **Consider Pollinator Exposure (pollen/ nectar): Varies depending on herb. Some may be harvested before bloom; some annuals; some perennials. Low, Moderate, High**	**Residues:** No specific residues for herbs. Based on surrogate residues from soil applications to tomato, melon, pumpkin, strawberry, and cotton. Rates used in the residue studies were comparable to Canadian label rates. **T2 Tunnel; T3 field; Incidents:** None **Bloom period compared to CFS:** Bloom time may be shorter than colony feeding study exposure duration for some crops. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered. [Note: REV2016-05 Preliminary Risk Conclusions indicated minimal potential for risk. This was based on honey bee only, and did not consider non-Apis effects information.]	**Remove use based on potential for risk.*** ***Exception: Maintain use only for herbs that will be harvested before bloom.** **Label mitigation:** **Add under:** Use Directions- crop specific (Crop Group 19A: Herbs): *Soil application is allowed only when herbs will be harvested prior to bloom.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
			are not harvested before bloom have variable pollinator exposure (low/moderate to high). Herbs include both annuals (harvested at the end of the season) and perennials. Some crops are a major source of pollen and nectar for HB, BB, SB. Herbs are low acreage. **Pollinator Exposure (pollen/nectar) for specific herb crops**: **Harvested before bloom**: Basil (fresh and dried); Borage; Chervil (dried); Chinese chive; Chive; Coriander (cilantro or Chinese parsley leaves); Dillweed; Hyssop; Lemongrass; Marjoram; Parsley (dried); Pennyroyal; Sage; Savory (summer and winter); Tarragon; Wormwood **Not harvested before bloom:** Wintergreen; Lavender; Rosemary; Sweet bay (bay leaf) [all of these are perennial herbs; Rosemary and Lavender are highly attractive to pollinators; Sweet bay and wintergreen are low/moderate attractiveness] **Sometimes harvested before bloom:** Angelica; Bumet ; Lovage (leaf); Woodruff **No information regarding harvest time:** Balm (lemon balm; Camomile; Catnip; Clary; Costmary; Culantro (leaf); Curry (leaf) ; Horehound; Marigold; Nasturtium ; Rue; Tansy; Thyme			
From Crop Group 20: Oilseeds Canola, rapeseed, mustard	ST	**CG20 Oilseeds (canola, rapeseed, mustard, only): Planting treated seed.** **Products:** 25556 26124 [corn also] 27170 [corn also] 27174	**Attractive to:** HB, BB, SB **Agronomic considerations:** Most oilseed varieties planted in Canada are self-compatible and will set seed in the absence of insects. Bloom period is typically 2 – 3 weeks. Pollination services of HB and SB are used extensively in canola seed production. Canola / rapeseed is	Tiered Framework (oilseed grains): Apis and non-Apis bees: T1SL: Y Residues: Canola T1R: Y T2 CFS: Potential risks for bumble bees (via pollen exposure routes only), but not	**Residues**: Crop specific residues (canola). Residues were measured from honey bee hives placed in a representative crop field (canola) in an effect field study conducted in Canada and USA. The test rates in residue studies were relevant to Canadian use pattern. The maximum residue was	**Maintain use based on risk characterization of low risk.** **No additional risk management.** **Label update:** Environmental Precautions/ Environmental Hazards: **Add:**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		30505[corn, soybean also] **Current Label Statements:** 25556; 27174: Environmental Precautions: *Cover or incorporate spilled treated seeds. Left over treated seed should be doublesown around the headland, or buried away from water sources.* 26124; 27170; 30505 [labels that also include corn/soy have more extensive labeling] : Environmental Precautions: *Imidacloprid is toxic to bees. To help minimize the dust generated during planting, refer to the complete guidance "Pollinator Protection and Responsible Use of Treated Seed- Best Management Practices" on the Health Canada webpage on pollinator protection at www.healthcanada.gc.ca/pollinators . When using a seed flow lubricant with corn seed treated with GAUCHO 600 FL Insecticide, only a dust-reducing fluency agent is permitted. Talc and graphite are not permitted to be used as a seed flow lubricant for corn seed treated with this insecticide. Carefully follow use directions for the seed flow lubricant. Do not load or clean planting equipment near bee colonies, and avoid places where bees may be foraging, such as flowering crops or weeds. When turning on the planter, avoid engaging the system where emitted dust may contact honey bee colonies. Spilled or exposed seeds and*	highly attractive to pollinators and a good source of nutrition. **Exposure:** O: Y C: N **Potential for exposure through pollen and nectar.** **Pollinator Exposure (pollen/nectar): High** Most oilseed varieties planted in Canada are self-compatible and will set seed in the absence of insect pollination. Crop production is enhanced by pollination. Additionally, pollination services (both HB, SB) are used extensively in canola seed production in Canada. Canola/rapeseed is a major source of pollen and nectar for HB, SB, and a minor source for BB. Canola/rapeseed is highly attractive and a good source of pollinator nutrition. Acreage for canola/rapeseed is high. **Pollinator Exposure (dust): Minimal potential for exposure from dust generated during planting of treated seed.** Exposure through dust generated during planting of treated seed is not expected. Oilseeds typically have low dust levels. Certain planting equipment can increase emission of pesticide containing dust, but is not typically used when planting oilseeds.	for honey bees based on the endpoints from feeding studies and using residues from representative crop canola. T2 Tunnel: 14 seed treatment tunnel studies were available for honey bees and one for bumble bees. No overall treatment-related effects were detected, while some either slight or transitory differences between the control and treatment were reported for honey bees in two out of all tunnel studies (the number of dead individuals or empty frame cells). All the tunnel studies had short exposure duration and tested a number of different crops (summer rape, winter rape, canola, sunflower, field bean). There were 9 studies on canola/rape; 4 studies on sunflower; 1 study on field bean. T3: 12 seed treatment field studies were available for honey bees (7 sunflower; 3 canola/rape; 1 corn; 1 field bean) and one for bumble bees (sunflower). No overall long-term effects were reported in any studies. However, out of the 12 studies, short-term effects were reported in a few studies: reduced hive weight gain in two studies; reduced number of brood cells and increased queen supersedures in one study. The transitory effects were reported in the studies with sunflower, not with any other crops.	used as mean for the chronic risk assessment as only one sample was measured per time period; the maximum residue concentration was reduced after one week. **T2 Tunnel:** Most (12 out of 14) T2 Tunnel studies showed no effects; while only two showed transitory effects. However, all had short exposure durations. **T3 Field:** All T3 studies, except one, were not conducted in Canada. The Canada study was conducted with a short duration in small canola fields without an appropriate control. Various limitations were identified in these studies, and majority of them includes the lack of sufficient characterization of exposure level and contamination of other pesticides. Some of them had short exposure and observation periods. **Bloom period compared to CFS:** Bloom time shorter than colony feeding study exposure duration. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	*Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications. When used according to label directions minimal exposure or risk is expected.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		dust must be incorporated into the soil or cleaned up from the soil surface. LABELLING TREATED SEED: *Additionally, all treated [corn seed and/or soybean seed] for sale or use in Canada must be labelled with the following information: Imidacloprid is toxic to bees. Dust generated during planting of treated seed may be harmful to bees and other pollinators. To help minimize the dust generated during planting, refer to the complete guidance "Pollinator Protection and Responsible Use of Treated Seed- Best Management Practices" on the Health Canada webpage on pollinator protection at www.healthcanada.gc.ca/pollinators. When using a seed flow lubricant with this treated seed, only a dust-reducing fluency agent is permitted. Talc and graphite are not permitted to be used as a seed flow lubricant for corn seed treated with this insecticide. Carefully follow use directions for the seed flow lubricant. Do not load or clean planting equipment near bee colonies, and avoid places where bees may be foraging, such as flowering crops or weeds. When turning on the planter, avoid engaging the system where emitted dust may contact honey bee colonies. Spilled or exposed seeds and dust must be incorporated into the soil or cleaned up from the soil surface.*		Sunflower is not registered for imidacloprid in Canada. Incidents: None **Overall:** **Minimal potential for risk through pollen and nectar exposure route based on risk characterization.** **Minimal potential for risk from dust generated during planting of treated seed.**		

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
No associated Crop Group Hops, peanut, tobacco	FO	**Hops, peanut, tobacco: No timing restrictions; indicates do not apply to flowering crops or weeds when bees are visiting treatment area**. **Products:** 24094 [hops- foliar; peanut and tobacco- soil and foliar] **Current Label Statements** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.*	**Attractive to:** HB, BB, SB **Agronomic considerations:** Hops are wind pollinated. Hops are a perennial deciduous plant that dies back to the ground each winter and grows again the following spring. Peanut are self-pollinated, but production may be enhanced with insect pollination. Peanut can be a perennial. Tobacco is insect pollinated; however, commercial tobacco growers typically remove flowers from tobacco plants to improve crop production. Tobacco is an annual plant. Bloom period is typically 2 – 3 weeks. **Exposure:** O: Y C: Y **Potential for exposure through pollen and nectar.** **Pollinator Exposure (pollen/nectar): Low/Moderate:** Hops, peanut, tobacco may be a source of pollen or nectar for HB, SB. Low pollinator attractiveness for hops. While tobacco is attractive to pollinators, the blooms are typically removed by commercial growers to improve crop yield. Tobacco is an annual crop. Peanut and Hops are perennials. Hops die back to the ground each winter. Acreage is low.	Tiered Framework (Hops, peanut, tobacco): *Apis* and non-*Apis* bees: T1SL: Yes Residues: Surrogate residues. Pre-bloom: cotton, sugarmelon, soybean; Post-bloom (for perennials only): cherry; During bloom: cotton. T1R: Yes T2 CFS: Pre-bloom application: Potential risk for bumble bees and honey bees using surrogate crop, cotton. Potential for risk to bumble bee using one of the surrogate sugarmelon residue studies. Minimal risk for honey bee or bumble bee using soybean residues. Post-bloom application: Potential risks for bumble bees using surrogate crop, cherry; potential risk for honey bees for post-fruit harvest but not for pre-fruit harvest application. Relevance of cherry to hops, peanut is very uncertain; no other information available. During bloom: Potential risk for honey bee and bumble bee. T2 Tunnel: NA T3: NA Incidents: None **Overall:** **Based on the risk**	**Residues:** **During bloom:** Residues from cotton were used as surrogate for during-bloom applications. The test rate was comparable to Canadian label rates. **Pre-bloom:** Cotton, sugarmelon, soybean were used as surrogate for pre-bloom applications. Rates were higher than Canadian rates. The cotton study was conducted with a combination of foliar applications after a seed treatment application. **Post-bloom (peanut and hops are perennials):** Residues from cherry was used as surrogate for post-bloom application. The rate was higher than Canadian label rates. Relevance to peanut and hops is very uncertain. **T2 Tunnel; T3 field; Incidents:** None **Bloom period compared to CFS:** Bloom time shorter than colony feeding study exposure duration. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	**Remove during-bloom use based on potential for risk.** **Maintain pre-bloom and post-bloom use based on low pollinator exposure.** Hops, Peanut, Tobacco (FO): **Add to directions for use:** *Do not apply during bloom or when bees are actively foraging.* **<u>Additional Label Updates</u>:** **Add under:** Environmental Precautions, after the other bee statements: *To further minimize exposure to pollinators, refer to the complete guidance "Protecting Pollinators during Pesticide Spraying- Best Management Practices" on the Health Canada website (www.healthcanada.gc.ca/pollinators). Follow crop specific directions for application timing*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
				assessment using surrogate crops: **During bloom: potential risk to honey bee and bumble bee.** **Pre-bloom: potential for risks for bumble bees and honey bee varied depending on surrogate crops.** **Post-bloom (perennial crops only): Potential for risk to bumble bee and honey bee (with late application) only for perennial crops hops and peanut. Hops die back each winter to ground, therefore residue levels are expected to be reduced. Cherry is not likely to represent hops and peanut well. No risks are expected for annual crops harvested at the end of the season (tobacco).** **Consider Pollinator Exposure (pollen/nectar): Low/Moderate:** Hops, peanut, tobacco may be a source of pollen or nectar for HB, SB. Low pollinator attractiveness for hops. While tobacco is attractive to pollinators, the blooms are typically removed by commercial growers to improve crop yield. Tobacco is an annual crop. Peanut and Hops are perennials. Hops die back to the ground each winter. Acreage is low.		
No associated Crop Group Peanut, tobacco	SO	**Peanut and Tobacco: Soil application at/near planting.** **Products:**	**Attractive to:** HB, BB, SB	Tiered Framework (peanut, tobacco): *Apis* and non-*Apis* bees:	**Residues:** No specific residues for peanut, tobacco. Based on surrogate residues from soil	**Maintain use considering low pollinator exposure.** **No additional risk mitigation**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		24094 [hops- foliar; peanut and tobacco- soil and foliar] **Current Label Statements** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.*	**Agronomic considerations:** Peanut are self-pollinated, but production may be enhanced with insect pollination. Peanut can be a perennial. Tobacco is insect pollinated; however, commercial tobacco growers typically remove flowers from tobacco plants to improve crop production. Tobacco is an annual plant. Bloom period is typically 2 – 3 weeks. **Exposure:** O: Y C: N **Potential for exposure through pollen and nectar.** **Pollinator Exposure (pollen/nectar): Low/Moderate:** Peanut, tobacco may be a source of pollen or nectar for HB, BB, SB. While tobacco is attractive to pollinators, the blooms are typically removed by commercial growers to improve crop yield. Tobacco is an annual crop. Peanut is a perennial. Acreage is low.	T1SL: Yes Residues: No peanut, tobacco residues. Surrogate residues for tomato, melon, pumpkin, strawberry, cotton. Rates similar to Canadian rates T1R: Yes T2 CFS: Potential for risks for bumble bees with almost all residues, and risks for honey bee with some residues using surrogate crops. Greater risk in coarse soils, higher application rates. T2 Tunnel: NA T3: NA Incidents: None **Overall:** **Potential risks for bumble bees and possible risks for honey bees based on the risk assessment using surrogate crops.** **Consider Pollinator Exposure (pollen/nectar): Low/Moderate:** Peanut, tobacco may be a source of pollen or nectar for HB, BB, SB. While tobacco is attractive to pollinators, the blooms are typically removed by commercial growers to improve crop yield. Tobacco is an annual crop. Peanut is a perennial. Acreage is low.	applications to tomato, melon, pumpkin, strawberry, and cotton. Rates used in the residue studies were comparable to Canadian label rates. **T2 Tunnel; T3 field; Incidents:** None **Bloom period compared to CFS:** Bloom time may be shorter than colony feeding study exposure duration for some crops. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	
No associated crop group **Ornamentals** **Greenhouse**	SO	**Ornamentals: No timing restrictions; indicates do not apply to flowering crops or weeds when bees are visiting treatment area**.	**Attractive to:** HB, BB, SB **Agronomic considerations:** Ornamentals include many plant	Tiered Framework (Ornamentals): *Apis* and non-*Apis* bees: T1SL: Yes	**Residues:** Monitoring residue data for pollen and nectar of retail plants purchased directly from retail stores, and those plants re-bloomed after	**Remove use based on potential for risk.** **Potential risk identified for both outdoor ornamentals and greenhouse ornamentals that will**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
Ornamentals (herbaceous species; woody perennials) and **Outdoor Ornamentals**-container grown and field grown nursery stock (trees; shrubs; herbaceous perennials; ornamental grasses)		**Greenhouse Ornamentals (container plants)** **and** **Outdoor Ornamentals (field grown and container grown)** **Products:** 25636 [Greenhouse and Outdoor ornamentals] 27357 [Greenhouse and Outdoor ornamentals] **Current Label Statements:** 25636; 27357: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* *Toxic to pollinators and certain beneficial insects. This product is systemic, and residues may be transported through plants into leaves, pollen and nectar. May harm pollinators and certain beneficial insects, including those used in greenhouse production.* 25636; 27357: Directions for Use: For APPLICATION IN NURSERIES; GREENHOUSES: *Repellency of bumble bee pollinators and negative effects on some beneficials (Orius sp.) can occur when [PRODUCT] is*	varieties that are not typically listed separately on product labels. They can have varying bloom periods ranging from a few weeks to all season. Many are attractive to pollinators; though some may be less attractive or not attractive. For greenhouse uses, there is potential for exposure to managed pollinators used in greenhouse production. There is also potential for exposure to pollinators when greenhouse ornamentals are planted outside. **Exposure:** O: Y C: N **There is potential for exposure to pollinators through both greenhouse ornamentals that will be planted outdoors and outdoor ornamentals (field and container grown) that are attractive to pollinators.** **Pollinator Exposure (pollen/nectar): May vary from Low to Moderate to High.** In general, Ornamentals are considered to have potential for high pollinator exposure. Many require pollination, and are highly attractive to HB (pollen and nectar), BB, SB. Some ornamentals are not considered to have potential for high pollinator exposure, and are identified where possible. **Greenhouse Use:** Exposure to pollinators may occur when greenhouse ornamentals are planted outdoors. Greenhouse grown cut flowers will not result in pollinator exposure, as they are not planted outdoors. Additionally, there is potential for exposure to managed pollinators used	Residues: Monitoring residue data for pollen and nectar from ornamental plants purchased directly from retail stores, and those plants re-bloomed after planting. T1R: Yes T2 CFS: Potential risk for honey bees using monitoring residue data in plants purchased directly from retail stores. Potential risks for bumble bees from plants purchased directly from retail stores and in re-bloomed plants after the plants were transplanted in the field. T2 Tunnel: Multiple T2 tunnel studies showed short-term adverse effects on both honey bee and bumble bee colonies. The adverse effects were positively related to the portion of flowers being treated in the foraging area. T3 Field In potted plants which were soil treated at a Canadian comparable rate, there was a slight but prevalent increase of bumble bee mortality. In outdoor ornamental shrubs which were soil treated at a rate greater than the Canadian rate, a high level of residues was found over a long period of time, and increased numbers of dead honey bee and bumble bee individuals were found in treatment groups. A high level of imidacloprid residues were found in dead bees (in both treatment and controls), suggesting effects may have been treatment related, and	planting. **T2 Tunnel; T3 field:** Three T2 tunnel studies and three T3 field studies were available. Most were relevant to Canadian use pattern. **Bloom period compared to CFS:** Bloom time may be shorter than colony feeding study exposure duration for some ornamentals, similar to or longer for other ornamentals. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	**be planted outdoors and are attractive to pollinators.** **Uses without pollinator exposure as identified below may be maintained.** **Coniferous evergreens** (pine, fir, juniper, spruce, arborvitae, hemlock, cypress, yew, live Christmas trees). (as they are not attractive to pollinators) **Ornamental Grasses**: (as they are not attractive to pollinators) **Greenhouse Grown Cut flowers** (as they are not planted outside)

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		applied. Note: The above use directions are also included in the specific use directions for: **All container grown nursery stock, including:** Trees, shrubs, herbaceous perennials and ornamental grasses **Field grown nursery ornamentals, including:** Trees, shrubs, herbaceous perennials and ornamental grasses	in greenhouse production. **Coniferous Evergreens**: **Pollinator Exposure (pollen/nectar): Negligible:** Coniferous evergreens (pine, fir, juniper, spruce, arborvitae, hemlock, cypress, yew, live Christmas trees); these coniferous evergreens are not attractive to pollinators. **Ornamental Grasses Pollinator Exposure (pollen/nectar): Negligible**: Ornamental grasses are not typically attractive to pollinators. **Additional Notes:** Outdoor ornamentals include many plant varieties that are not typically listed separately on product labels. Many are attractive to pollinators; though some may be less attractive or not attractive. Because of the large variety of ornamentals that are included in this category, it is difficult to consider pollinator attractiveness for specific varieties when determining potential for exposure. In general, ornamentals are considered to be attractive to pollinators unless other information is available. Groups of ornamentals known to have differing pollinator attractiveness are considered separately where possible.	that cross foraging may have occurred between treatments and controls. Colony level effects in honey bee and bumble bee were not examined in one study, and in the second study differences were not found at the colony level between controls and treatments. Incidents: None **Overall:** **Potential risks for bumble bees and possible risks for honey bees based on the risk assessment.** **Risk for both outdoor ornamentals and for greenhouse ornamentals that will be planted outdoors and are attractive to pollinators.** **Consider Pollinator Exposure (pollen/nectar): May vary from Low to Moderate to High**		
No associated crop group **Turfgrass** Turfgrass sites including golf courses; sod farms; professional lawn care on municipal, industrial, residential, recreational turfgrass	FO	**Turf: No timing restrictions for turf. Indicates do not apply to flowering crops or weeds when bees are visiting treatment area**. **Ground sprayer application (e.g. boom sprayer)** **Irrigation or rainfall required within 24 hours after application.** **Products:**	**Attractive to:** HB, BB, SB Pollinator attractive only if turf contains flowering plants that are bee attractive (e.g., clover, dandelions) **Agronomic considerations:** Turf grass may contain flowering weeds, such as clover or dandelions, which may be attractive to pollinators. Attractiveness may depend on the type and abundance of weeds present. Both golf courses and sod farms manage weeds and, therefore, there is minimal	Tiered Framework (turf; when flowering weeds are present): *Apis* and non-*Apis* bees: T1SL: Yes Residues: Clover in turf. T1R: Yes T2 CFS: Potential risks based on feeding studies endpoints compared to measured residues in clover grown in turf fields (both directly	**Residues:** Used relevant residues from foliar application to turf containing blooming clover. Residues from directly sprayed clover, and re-blooming clover. Rates higher than Canadian rates. **T2 Tunnel:** Tier II tunnel study available and relevant to Canadian use pattern. Compared effects with and without irrigation following foliar application. Rates higher	**Maintain use based on risk characterization of low risk when use directions are followed (including irrigation after application).** **No additional risk mitigation** **Label update:** **Add under:**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
(including home lawns, business and office complexes, shopping complexes, multi-family residential complexes, airports, cemetaries, parks, playgrounds, athletic fields)		25932 29130 **Current label Statements:** 25932; 29130: Environmental Hazards: *This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.* 25932; 29130: Directions for Use- turf*:* *…followed by sufficient irrigation or rainfall (5 – 10 mm) to move the active ingredient through the thatch…* *NOTE: For optimum control, irrigation or rainfall should occur within 24 hours after application to move the active ingredient through the thatch. On golf courses, irrigate treated areas following application.* *Avoid mowing turf or lawn area until after irrigation or rainfall has occurred so that uniformity of application will not be affected. Apply [Product] Insecticide only once per year as directed by this label.*	exposure potential. Other turfgrass lawns may contain weeds that are attractive to pollinators. **Exposure:** O: Y (when flowering weeds are in turfgrass) C: Y (when flowering weeds are in turfgrass) **Overall there is potential for exposure to pollen and/or nectar if turfgrass contains bee attractive plants.** **Pollinator Exposure: May vary from Low to Moderate to High. Varies depending on weeds/flowering plants present in turf.** Clover and dandelions may be major sources of nectar and/or pollen for HB, BB, SB. Turf may cover large areas.	sprayed clover and re-blooming clover). Rates higher than Canadian rates. T2 Tunnel: Available tunnel study indicates no effects for bumble bees for use followed with irrigation, but there were effects on bumble bee for spray application without follow-up irrigation. Rates higher than Canadian rates. T3: NA Incidents: None **Overall:** **Minimal potential for risks based on the risk assessment, considering T2 tunnel study results. When following the current label directions requiring irrigation following application, minimal risk is expected.**	than Canadian rates. However residue concentrations in clover were not measured in the study. **T3 field; Incidents:** None **Bloom period compared to CFS:** Bloom time may be shorter than colony feeding study exposure duration for some crops. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	Environmental Hazards/ Precautions (following the other bee statements): *To further minimize exposure to pollinators, refer to the complete guidance "Protecting Pollinators during Pesticide Spraying- Best Management Practices" on the Health Canada website (www.healthcanada.gc.ca/pollinators). Follow crop specific directions.*
No associated crop group	SO	**No timing restrictions.** **Granular spreader, drop and rotary type.**	**Attractive to:** HB, BB, SB	Tiered Framework (turf; when flowering weeds are present):	**Residues**: No specific residues information for soil applied to turf. As surrogate, used residues	**Maintain use based on risk characterization of low risk when use directions are followed (including irrigation after**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
Turfgrass Turfgrass sites including golf courses; sod farms; professional lawn care on municipal, industrial, residential, recreational turfgrass (including home lawns, business and office complexes, shopping complexes, multi-family residential complexes, airports, cemetaries, parks, playgrounds, athletic fields)		**Irrigation or rainfall required within 24 hours after application (within 12 hours is proposed in PRVD2016-20)** **Products:** 25933 29185 **Current label Statements:** 25933; 29185: Environmental Hazards: None related to bees 25933; 29185: Directions for Use- turf: *…followed by sufficient irrigation or rainfall (5 – 10 mm) to move the active ingredient through the thatch…* *NOTE: For optimum control, irrigation or rainfall should occur within 24 hours after application to move the active ingredient through the thatch. On golf courses, irrigate treated areas following application.* *Avoid mowing turf or lawn area until after irrigation or rainfall has occurred so that uniformity of application will not be affected. Apply [Product] Insecticide only once per year as directed by this label.* **Proposed in PRVD2016-20 Imidacloprid (directions for use)**: To further reduce the potential risk to birds from granular turf application, it is recommended	Pollinator attractive only if turf contains flowering plants that are bee attractive (e.g., clover, dandelions) **Agronomic considerations:** Turf grass may contain flowering weeds, such as clover or dandelions, which may be attractive to pollinators. Attractiveness may depend on the type and abundance of weeds present. Both golf courses and sod farms manage weeds and, therefore, there is minimal exposure potential. Other turfgrass lawns may contain weeds that are attractive to pollinators. **Exposure:** O: Y (when flowering weeds are in turfgrass) C: Y (when flowering weeds are in turfgrass) **Overall there is potential for exposure to pollen and/or nectar if turfgrass contains bee attractive plants.** **Pollinator Exposure: May vary from Low to Moderate to High. Varies depending on weeds/flowering plants present in turf.** Clover and dandelions may be major sources of nectar and/or pollen for HB, BB, SB. Turf may cover large areas.	*Apis* and non-*Apis* bees: T1SL: Yes Residues: Clover in turf-surrogate residues from foliar application. Rates higher than Canadian rates. T1R: Yes T2 CFS: Potential risks based on feeding studies endpoints compared to measured residues in clover grown in turf fields (both directly sprayed clover and re-blooming clover as surrogate for soil application). Rates higher than Canadian rates. T2 Tunnel: Available tunnel study indicates no effects for bumble bees for use followed with irrigation, but there were effects on bumble bee for granule soil application without follow-up irrigation. Rates higher than Canadian rates. T3: NA Incidents: None **Overall:** **Minimal potential for risks based on the risk assessment, considering T2 tunnel study results. When following the current label directions requiring irrigation following application, minimal risk is expected.**	from foliar application to turf containing blooming clover. Residues from directly sprayed clover, and re-blooming clover. Rates higher than Canadian rates. **T2 Tunnel:** Tier II tunnel study available and relevant to Canadian use pattern. Compared effects with and without irrigation following granular soil application. Rates higher than Canadian rates. However residue concentrations in clover were not measured in the study. **T3 field; Incidents:** None **Bloom period compared to CFS:** Bloom time may be shorter than colony feeding study exposure duration for some crops. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	**application).** **No additional risk mitigation** **Label update:** **Add under:** Environmental Hazards/Precautions: *Toxic to bees. Bees can be exposed to product residues in flowers, pollen and/or nectar resulting from granule application. When used according to label directions minimal exposure or risk is expected.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
		that the current label direction on commercial granular product labels requiring irrigation or rainfall within 24 hours after application of granules, be reduced to a watering period within 12 hours after application: ***The granules must be watered within 12 hours after application by sufficient irrigation (5-10 mm) to ensure the active moves through the thatch.***				
No associated crop group **Turfgrass** Domestic Use Turfgrass sites (e.g. residential lawns)	SO	**No timing restrictions.** **Granular Broadcast spreaders: DOMESTIC USE** **Irrigation required within 1 hour after application** **Products:** 29738 **Current label Statements:** 29738: Environmental Hazards: *Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from granule application.* 29738: Directions for Use-turf: *The granules must be watered immediately after application (within 1 hour) by sufficient irrigation (5-10 mm) to ensure the active moves through the thatch. Avoid overwatering (more than 20 mm). Avoid runoff or puddling of irrigation water following application.*	**Attractive to:** HB, BB, SB Pollinator attractive only if turf contains flowering plants that are bee attractive (e.g., clover, dandelions) **Agronomic considerations:** Turf grass may contain flowering weeds, such as clover or dandelions, which may be attractive to pollinators. Attractiveness may depend on the type and abundance of weeds present. Both golf courses and sod farms manage weeds and, therefore, there is minimal exposure potential. Other turfgrass lawns may contain weeds that are attractive to pollinators. **Exposure:** O: Y (when flowering weeds are in turfgrass) C: Y (when flowering weeds are in turfgrass) **Overall there is potential for exposure to pollen and/or nectar if turfgrass contains bee attractive plants.** **Pollinator Exposure: May vary from Low to Moderate to High.**	Tiered Framework (turf; when flowering weeds are present): *Apis* and non-*Apis* bees: T1SL: Yes Residues: Clover in turf-surrogate residues from foliar application. Rates higher than Canadian rates. T1R: Yes T2 CFS: Potential risks based on feeding studies endpoints compared to measured residues in clover grown in turf fields (both directly sprayed clover and re-blooming clover as surrogate for soil application). Rates higher than Canadian rates. T2 Tunnel: Available tunnel study indicates no effects for bumble bees for use followed with irrigation, but there were effects on bumble bee for granule soil application without follow-up irrigation. Rates higher than Canadian rates.	**Residues**: No specific residues information for soil applied to turf. As surrogate, used residues from foliar application to turf containing blooming clover. Residues from directly sprayed clover, and re-blooming clover. Rates higher than Canadian rates. **T2 Tunnel:** Tier II tunnel study available and relevant to Canadian use pattern. Compared effects with and without irrigation following granular soil application. Rates higher than Canadian rates. However residue concentrations in clover were not measured in the study. **T3 field; Incidents:** None **Bloom period compared to CFS:** Bloom time may be shorter than colony feeding study exposure duration for some crops. **Effects endpoints**: Some uncertainty and differences among CFS endpoints.	**Maintain use based on risk characterization of low risk when use directions are followed (including irrigation after application).** **No additional risk mitigation** **Label update:** May update label language to include the following: **Add under:** Environmental Hazards/Precautions: *When used according to label directions minimal exposure or risk is expected.* Example: Environmental Hazards: *Toxic to*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
			Varies depending on weeds/flowering plants present in turf. Clover and dandelions may be major sources of nectar and/or pollen for HB, BB, SB. Turf may cover large areas.	T3: NA Incidents: None **Overall:** **Minimal potential for risks based on the risk assessment, considering T2 tunnel study results. When following the current label directions requiring irrigation following application, minimal risk is expected.**	*Apis* and non-*Apis* endpoints considered.	*bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from granule application.* ***When used according to label directions minimal exposure or risk is expected***.
No associated crop group **Christmas trees**	FO	**Christmas trees: No timing restrictions; indicates do not apply to flowering crops or weeds when bees are visiting treatment area**. **Products:** 24094 **Current Label Statements:** 24094: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. To minimize exposure to bees from foliar application, DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.*	**Not attractive to pollinators** **Exposure:** O: N C: Y (spray drift) **There is potential for exposure to pollinators through spray drift. Statements to minimize spray drift and not to apply when bees are visiting weeds on treatment area are already on label.** **Coniferous Evergreens**: **Pollinator Exposure (pollen/nectar): Negligible:** Coniferous evergreens (pine, fir, juniper, spruce, arborvitae, hemlock, cypress, yew, live Christmas trees); these coniferous evergreens are not attractive to pollinators.	**Minimal potential for risks due to limited exposure.**	**None**	**Maintain use based on negligible exposure** **No additional risk management** **Label Update:** **Add under:** Environmental Precautions, after the other bee statements: *To further minimize exposure to pollinators, refer to the complete guidance "Protecting Pollinators during Pesticide Spraying- Best Management Practices" on the Health Canada website (www.healthcanada.gc.ca/pollinators). Follow crop specific directions for application timing.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
Rotational Crops	FO	Not Applicable	**Attractive to:** HB, BB, SB **Agronomic considerations:** Many rotational crops can be planted following a crop treated with the pesticide of concern. The focus is on rotational crops that may be attractive to pollinators (e.g., clover, alfalfa, canola, etc.). **Exposure:** O: Y C: N **There is potential for exposure to pollinators that are attractive to pollinators.** **Pollinator Exposure (pollen/nectar): Varies with rotational crop planted. Consideration is for those that are High**	Tiered Framework (rotational crops planted following an imidacloprid treated crop): *Apis* and non-*Apis* bees: T1SL: Yes Residues: Clover grown following cotton which had received multiple foliar applications the previous season. Foliar application rates representative of or higher than Canadian rates. T1R: Yes (in some cases) T2 CFS: No potential risks based on feeding studies endpoints compared to measured residues in clover grown following cotton. T2 Tunnel: NA T3: NA Incidents: None **Overall:** **Minimal potential for risks based on the risk assessment using representative crops, clover following cotton treated with multiple foliar applications.**	**Residues:** Used relevant residues from clover grown following cotton which had received multiple foliar applications the previous season. Foliar application rates the previous season were representative of or higher than Canadian rates. **T2 Tunnel; T3 field; Incidents:** None **Bloom period compared to CFS:** Bloom time may be shorter than colony feeding study exposure duration for some crops. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	**Negligible risk identified.** **No additional risk management**
Rotational Crops, and off-field wildflowers	SO	Not Applicable	**Attractive to:** HB, BB, SB **Agronomic considerations:** Many rotational crops can be planted following a crop treated with a pesticide. The focus is on rotational crops that may be attractive to pollinators (e.g., clover, alfalfa,	Tiered Framework (rotational crops planted following an imidacloprid treated crop; off-field wildflowers): *Apis* and non-*Apis* bees: T1SL: Yes Residues: Rotational crops:	**Residues:** **Rotational crops:** Used relevant residues from clover, Phacelia, mustard, and maize grown in fields that had soil applications the previous cropping season. **Off-field wildflowers**:	**Negligible risk identified.** **No additional risk management**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
			canola, etc). **Exposure:** O: Y C: N **There is potential for exposure to pollinators that are attractive to pollinators.** **Pollinator Exposure (pollen/nectar): Varies with rotational crop planted. Consideration is for those that are High**	Clover, Phacelia, mustard, maize grown in fields that had soil application the previous cropping season. Off-field wildflowers: Wildflowers off-field of an in-furrow treated field. Soil application rates were comparable to Canadian rates. T1R: Yes (in some cases) T2 CFS: No potential risks based on feeding studies endpoints compared to measured residues in clover, Phacelia, mustard, maize grown in fields with soil applications the previous growing season. No potential risks based on residues in off-field wildflowers growing next to a soil treated field. T2 Tunnel: NA T3: NA Incidents: None **Overall:** **Minimal potential for risks based on the risk assessment using representative crops, clover, Phacelia, mustard,maize grown in fields with soil applications the previous growing season, and wildflowers growing off-field of an in-furrow treated field.**	Used residues from wildflowers growing next to a potato field treated with an in-furrow soil application. All soil application rates were comparable to Canadian rates. **T2 Tunnel; T3 field; Incidents:** None **Bloom period compared to CFS:** Bloom time may be shorter than colony feeding study exposure duration for some crops. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	
Rotational Crops and off-field wildflowers	ST	Not Applicable	**Attractive to:** HB, BB, SB	Tiered Framework (rotational crops planted following an imidacloprid treated crop; off-field wildflowers):	**Residues:** **Rotational crops:** No rotational crop residues	**Negligible risk identified.** **No additional risk management**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations/Limitations[4]	Proposed Risk Mitigation
			Agronomic considerations: Many rotational crops can be planted following a crop treated with a pesticide. The focus is on rotational crops that may be attractive to pollinators (e.g., clover, alfalfa, canola, etc). **Exposure:** O: Y C: N **There is potential for exposure to pollinators that are attractive to pollinators.** **Pollinator Exposure (pollen/nectar): Varies with rotational crop planted. Consideration is for those that are High**	*Apis* and non-*Apis* bees: T1SL: Yes Residues: Used residues from soil applications as a surrogate. Rotational crops: Clover, Phacelia, mustard, maize grown in fields that had soil application the previous cropping season. Off-field wildflowers: Wildflowers off-field of an in-furrow treated field. T1R: Yes (in some cases) T2 CFS: No potential risks based on feeding studies endpoints compared to measured residues in clover, Phacelia, mustard, maize grown in fields with soil applications the previous growing season. No potential risks based on residues in off-field wildflowers growing next to a soil treated field. T2 Tunnel: NA T3: NA Incidents: None **Overall:** **Minimal potential for risks based on the risk assessment using representative crops, clover, Phacelia, mustard,maize grown in fields with soil applications the previous growing season, and wildflowers growing off-field of an in-furrow treated field.**	following seed treatments were available. Used surrogate residues from clover, Phacelia, mustard, and maize grown in fields that had soil applications the previous cropping season. Soil applications are expected to result in higher carryover of residues to the following season than seed treatments. **Off-field wildflowers**: No off-field wildflower residues following seed treatments were available. Used surrogate residues from wildflowers growing next to a potato field treated with an in-furrow soil application. Soil applications are typically expected to result in higher soil residues than seed treatments. **T2 Tunnel; T3 field; Incidents:** None **Bloom period compared to CFS:** Bloom time may be shorter than colony feeding study exposure duration for some crops. **Effects endpoints**: Some uncertainty and differences among CFS endpoints. *Apis* and non-*Apis* endpoints considered.	

Appendix XIII Comments on Re-evaluation of Imidacloprid – Preliminary Pollinator Assessment (REV2016-05) and Responses

From	Topic	Comment	PMRA Response
Monsanto Canada Inc.	Science-based approach	"Monsanto supports the distinction the PMRA has made in evaluating foliar applications, soil applications and seed treatments separately. In addition, the pollinator risk assessment is based on the tiered approach that provides a more realistic exposure scenario."	No response is needed
Canadian Honey Council	Science-based approach	"As everyone is aware, bee health is affected by varroa mites, pests and pathogens, environment, pesticides, management practices and weather among other things. We are very pleased that the Pest Management Regulatory Agency is conducting a re-evaluation of imidacloprid which will help identify the impact this particular pesticide has on honey bees. The interim report is important in that it supports the use of risk-based assessment in understanding the factors the impact bee health. This science-based approach, conducted by our highly regarded regulatory agency, will provide beekeepers with the proper information from which to base business decisions. The interim report also provides the scientific framework necessary to conduct the other re-evaluations that are in the queue. Again, the Canadian Honey Council commends the work that the PMRA is doing and looks forward to the publication of the final report later this year."	No response is needed
Bayer CropScience	Estimation of exposure	"Field trials typically produce many field measurements of residue levels in pollen and nectar for a given use pattern. However, the Agencies have not previously established a standard methodology for determining an appropriate EEC from the many available field measurements." "In practice, because residue measurements varied between field sites, "relevant residue trials" were the single field trial for each use pattern that produced the highest residue measurements. The acute EEC was derived from the highest measurement in that field trial, and the chronic EEC was the average of the measurements of that single field trail on the day when the highest measurements occurred." "For example, blueberry trials were conducted in three regions of North America with samples collected in two consecutive years in each region, producing the six distributions of residue levels in floral nectar... Residue measurements varied between sites and years, but did not decline appreciably over the bloom period. Therefore, for a given site and year, all samples could be pooled to create the probability distributions…Given the availability of adequate data to derive probability distributions, Bayer proposed to derive the acute EEC as the 90th percentile of the measurements of the trial with the highest residues, and the chronic EEC as the median measurement of the trial with the highest residue. Bayer selected the 90th percentile measurement to be consistent with established exposure assessment procedures used for other taxa (e.g., terrestrial vertebrates, fish, aquatic invertebrates). Bayer selected the median measurement to estimate the chronic EEC since this represents the average exposure level over space (replicate bee tunnels at a site) and time (12 days in the case of the blueberry trial) appropriate for a chronic assessment of bee risk. These values may considered to be appropriately conservative (i.e., high-end) because they are derived for the site producing the highest residue levels. Bayer's approach resulted in an acute EEC of 12 ppb, and a chronic EEC of 7 ppb. From the same data set, PMRA and EPA derived an acute EEC as 16 ppb, the maximum of the	Relevant residue information is considered as one line of evidence in the overall risk assessment. Other studies, such as semi-field effect studies and Tier III field studies are also considered in the overall risk characterization. Many factors are expected to impact the residue concentrations measured in a study. Use of the reported highest residue measurement in a study may not necessarily represent the most conservative scenario for the use pattern in the field due to many variables, such as soil conditions, agricultural practices, biological/metabolic differences between crop groups and within a crop, speed of imidacloprid translocation in plants, and sampling timing. Available studies were conducted under specific test conditions and had different application rates and sampling times. There was considerable spatial and temporal variability in the available residue data. All available residue information was considered. When studies included multiple sampling scenarios (e.g., sampling sites; sampling over time), this information was considered in the risk assessment in most cases. Due to the potential for a large variation in measured residues, the detected maximum and highest mean are

From	Topic	Comment	PMRA Response
		58 measurements in the data set, and a chronic EEC of 8.8 ppb, the highest average value for a given sampling day in the trial producing the highest residues. Although the acute and chronic EECs calculated from this particular data set by PMRA and Bayer do not differ greatly, the underlying methodology is different and has the potential to result in vastly different EEC estimates. For example, the approach used by PMRA resulted in estimates of chronic EECs for pollen that were more than 10-fold greater than the respective EECs derived by Bayer from field residue trials of imidacloprid use on strawberries and cotton. Simply picking out the highest field measurement or highest daily mean measurement punishes registrants who generate large data sets, and encourages registrants to take a minimalist approach to the generation of data. Regulatory agencies should encourage registrants to produce robust data sets so that regulatory decisions can be made with high confidence. Bayer encourages PMRA to develop a standard procedure for deriving EECs from field residue trials that uses probabilistic methods, when appropriate, and rewards, rather than punishes, registrants who develop and submit large data sets."	used in the risk assessment in order to identify any uses that potentially cause risks to bees at the lower tier risk assessment. While 90th percentile and median provide insight of the residue distribution in the available studies, the detected maximum and highest means were considered as a conservative exposure scenario for the risk assessment.
	Endpoint selection – Use of Boily et al. 2013	"Bayer believes the Agency should reconsider their decision to select the no-effect level reported by Boily et al. as a suitable endpoint for use in risk assessment. We believe the measurement endpoints cited…from this endpoint are likely invalid given that they are contradicted by results produced by four other research teams, and that the Agency should review all available relevant information, including two studies that apparently were not considered."	Selection of the chronic endpoint was based on consideration of the strengths and limitations of multiple relevant studies available to date, including Kling (2012), Boily et al., (2013) and other studies that are described in the comments with an exception for UK DEFRA (2007). The cited DEFRA report is a project report that does not provide detailed study methodology. It reports 10-d LC_{50} values but not the NOEL values, which are typical endpoints used when conducting a chronic risk assessment. Other than the studies listed in the comments, PMRA also considered more relevant studies, including Alaux et al. (2010), Suchail et al. (2001), and Moncharmont et al. (2002). These studies were considered informative but each study has its own strengths and limitations. The selected NOEC endpoint of 3.9 µg a.i./L diet is from Boily et al. (2013) based on consideration of all available studies. The selected endpoint is also supported by another study (Moncharmont et al., 2002), in which a similar endpoint (<4 µg a.i./L) was reported based on increased mortality to newly emerged adults when they were exposed to treatments at 4 or 8 µg a.i./L for a long period of time. The consideration for the endpoint includes the quality of study, availability of raw data, strengths and limitations associated with the study, whether the study was conducted according to any guidelines, as well as conservatism of the endpoint.

From	Topic	Comment	PMRA Response
			It is acknowledged that there are limitations associated with all available studies. For instance, a registrant study reported a NOEC of 100 µg a.i./L (PMRA 2474493). The study was conducted under GLP conditions but it did not have a positive control, and was conducted at a temperature (25°C) lower than what is proposed in the OECD draft guideline. In addition, the reported NOEC of 100 µg a.i./L is greater than the NOEC observed in a higher tier study (25 µg a.i./L, PMRA 2474495) at the colony level, indicating a potential uncertainty of its representativeness. The most sensitive reported endpoint was <0.1 µg a.i./L, reported by Suchail et al. (2001). With an intention to verify this endpoint, Schmuck (2004) repeated the study using the same test methodology and tested with two imidacloprid metabolites that were also examined by Suchail et al. (2001). Schmuck (2004) concluded that the endpoints for the metabolites were not repeatable. The different outcomes of the two studies raised additional uncertainties about the NOEC for imidacloprid that was reported by Suchail et al. (2001). However, the verification study (Schmuck 2004) used the metabolites, not imidacloprid parent directly, thus the endpoint reported by Suchail et al. (2001) for imidacloprid could not be discarded with confidence. Alaux et al. (2010) reported a significant increase of adult honey bee mortality after a 10-day exposure to imidacloprid at 0.7, 7 or 70 ppb. However, the 10-d cumulative mortality was low in all the treatments, ranging from 10 to 17%. Boily et al. (2013) was conducted using a method similar to the OECD draft guideline. During the review of the study, PMRA contacted the study author and received the raw data. The discrepancy of the results reported in the publication was clarified with the study author, and the raw data were used in the study review. There were also limitations associated with the Boily study as it was not conducted under GLP conditions; chemical residue and food consumption were not directly measured, and the test temperature was relatively low. The selected endpoint of 3.9 µg a.i./L diet used in preliminary risk assessment was greater than the

From	Topic	Comment	PMRA Response
			twentieth percentile of all available NOEC values (2.06 ug a.i./L), but less than the average (40.1 µg a.i./L) of all available studies, which indicates a certain level of conservatism. Due to the limitations of all available studies and large variation of the endpoints, the selected chronic endpoint used in the preliminary risk assessment may be further considered when more reliable information becomes available.
	Endpoint selection – Use of Kling 2012	"Bayer believes the Agency should revisit the decision to not use the study by Kling (2012). Unlike the Boily study, this study was run under rigorous GLP requirements, with analytical verification of test concentrations and measurement of daily food consumption by every test group. Kling (2012) identified a no-effect level for the endpoint (lethality) found to be most sensitive by Boily. The slight decrease in food consumption by bees at the low test level reported by Kling should not be considered an adverse finding, since in a real field scenario, honey bees will always have access to food outside of a treated crop field, and any tendency for bees to prefer to reduce their foraging on site will reduce their exposure and not be adverse to their health. Adding to the credibility of the Kling (2012) study is the fact that its results are in broad agreement with those of other laboratory teams, including the French (Decourtye et al.) and UK (DEFRA) government labs that were pioneers in the development of the 10-day adult honey bee chronic study. Bayer recommends that the Kling (2012) study be used to identify the no effect level for lethal effects, which is an appropriate chronic toxicity endpoint for use in Tier 1 pollinator assessments. In higher tier assessments, the no-effect level from the Tier 2 honey bee colony-feeding study, which included both lethal and sublethal measures of effect, should then be the preferred effects endpoint."	See response above
	Boily et al. 2013 - deficiencies	"The Boily et al. 2013 study has several significant deficiencies that call into question its reliability. First, Boily et al. did not analytically confirm their test concentrations. It is therefore impossible for the Agency to verify that the test subjects were exposed to the test concentrations claimed by the authors. Analytical verification of test concentrations is especially important for studies that claim effects at levels far below those of other studies, and this is the case with the Boily study. Second, Boily et al. did not measure food consumption by the test groups exposed to imidacloprid. It is therefore impossible to verify that each group ingested the dose level claimed by the authors. The authors state they measured food consumption during the pre-exposure acclimation period when the test subjects were provided uncontaminated diet. They then assumed there was no difference in daily food consumption during the exposure period. However, numerous other studies have shown that consumption of treated diets of imidacloprid by bees can be very different for test levels that elicit toxic effects. Thus, the assumption of Boily et al. is likely invalid as are their estimates of dose levels. Third, the information on test concentrations provided to the agency by the senior author of the Boily study is inconsistent with information included in the published article. For example, in the publication in Environ Sci Pollut Res (2013) 20:5603–5614, the first sentence of the third paragraph on page 5612 states that the lowest dietary level tested by Boily was "0.08 ng/bee or 1.1 µg/L" in 50% sucrose solution. However, the information communicated to the Agency reviewers by the senior author of Boily was that the lowest test concentration	See response above In addition, with regard to the consideration of the dose-response slope, it is considered that the slope may be helpful to characterize toxicity profile of a chemical. However, its relationship with a NOEC is unclear, especially for bees in a long-term exposure study, which was 10 days in this case. Therefore, the slope of a dose-response chronic study may not be used as a factor to invalidate a study. As stated in the response above, during the selection of the endpoint, Boily's study was considered together with all other available studies and each of them has limitations and strengths.

<table>
<tr><th>From</th><th>Topic</th><th>Comment</th><th>PMRA Response</th></tr>
<tr><td></td><td></td><td>
was 1.95 µg/L, a difference of 77% from what was stated in the publication.
Also casting doubt on the validity of the Boily et al. study is the fact that its results are contradicted by data from four other research groups, including two studies not considered in the Agency's preliminary assessment. These four high quality research studies are Kling 2012 and the combined results of Cresswell et al. 2012 and 2013, plus Decourtye et al. (2003) and UK DEFRA (2007). The latter two studies apparently were not considered when the Agency prepared their assessment.
According to additional information provided to EPA by the senior author, Boily exposed test groups of honey bees to 0, 1.95, 3.9, 5.85 and 7.32 µg imidacloprid/ L of 50% sucrose solution. By day 10, Boily observed no significant increase in compound-related mortality at the lowest two test levels, 30% mortality in the test group exposed to 5.85 µg/L and 98% mortality in the group exposed to 7.32 µg/L. Agency reviewers estimated that the LD50 (median lethal daily dose) for 10 days of exposure was 0.191 ng/bee/day. Assuming daily consumption of 41 µL of 50% sucrose solution per day as estimated by Boily, the LC50 for 10 days of exposure would be 4.66 µg/L."
Kling 2012 and the combined results of Cresswell et al. 2012 and 2013, plus Decourtye et al. (2003) and UK DEFRA (2007) had different results.

Table 1. Comparison of results of Boily et al 2013 with those of four other laboratories. Note that results of Alaux et al. (2010) is not included because in this test the test subjects did not feed
exclusively on treated diets.
<table>
<tr><th>Study</th><th>No Observed Lethal Effect Concentration (µg/L) for 10[a] days of feeding</th><th>No Observed Lethal Effect Level (ng/bee/d) for 10[a] days of feeding</th><th>LDD_{50} (ng/bee/d) for 10[a] days of feeding</th></tr>
<tr><td>Boiley et al 2013</td><td>3.9</td><td>0.161</td><td>0.191</td></tr>
<tr><td>Decourtye et al 2003 Summer bees</td><td>58</td><td>1.9</td><td>38</td></tr>
<tr><td>Decourtye et al. 2003 Winter Bees</td><td>29</td><td>0.95</td><td>Not determined</td></tr>
<tr><td>DEFRA 2007</td><td>250</td><td>10.25</td><td>18.9</td></tr>
<tr><td>Kling 2012</td><td>100</td><td>2.82</td><td>>2.82</td></tr>
<tr><td>Cresswell et al. 2012, 2013</td><td>125</td><td>4.9</td><td>>4.9</td></tr>
</table>
[a]Exposure duration in the studies of Cresswell et al was 6 to 8 days

"In their publication, Boily et al. point out that their results are consistent with those reported by Suchail et al. 2001, but inexplicably do not mention that this study is considered unreliable based on a follow-up study(Schmuck 2004) that showed key
</td><td></td></tr>
</table>

From	Topic	Comment	PMRA Response
		findings of Suchail et al. could not be reproduced." "In addition to the points made above, the dose response relationship reported by Boily is highly unusual and difficult to believe on its own merits. Using Boily's data, the Agency's reviewer calculated a no observed affect level for lethality of 0.161 ng/bee/day and a median lethal daily dose (LD50) for 10 days of 0.191 ng/bee/day. The steepness of Boily's dose-response relationship stands in stark contrast to that reported by other labs (see Fig. 1). It is very difficult to believe that the median lethal level for any compound would be only 1.2 times greater than the no-effect level, and this is particularly true for imidacloprid and other neonicotinoid that have tended to produce shallow, not steep, dose-response slopes in ecotoxicology tests in general. The Boily et al. results appear to be anomalous. Unless they can be reproduced in other labs, they must be considered unsuitable for use in quantitative risk assessment."	
	Effect on beneficials	"Also, when earthworms are killed off in large numbers by this chemical soil quality will degrade. This undermines the ability of the land to support subsequent crops - an unsustainable (and uneconomical) strategy. We may save today's crop but subsequent crops will be diminished due to a degradation in soil quality, fewer pollinating insects, a growing number of resistant pests whose populations will be buoyed by the reduction in beneficial predator insects. This formula does not work and we can't keep putting chemical after chemical in the ground in place of sustainable agricultural practices."	The potential effects of imidacloprid on other organisms, including earthworms, beneficial arthropods, and levels of imidacloprid in the environment are assessed separately in another document (PMRA PRVD2016-20).
University of Guelph	Considering imidacloprid in isolation	"As a general comment it seems surprising that sources of information relating to effects of imidacloprid on insect pollinators are being considered entirely separately from studies on related neonicotinoids. For example, a recent field study of the potential impacts of exposure to clothianidin treated canola in Sweden showed that reduced reproduction in managed solitary bees, managed bumble bee colonies and reduced wild bee abundance were all associated with treated fields (Rundlöf et al. 2015). Similarly, a recent semi-field study reported impacts on the pollination services provided to apple trees by bumble bees exposed to thiamethoxam (Stanley et al. 2015). Given the limited number of semi-field and field studies (particularly for non-Apis bees) it would seem pertinent to consider the results from these studies as part of the assessment of potential risks of exposure associated with imidacloprid."	The current risk assessment approach is based on information available for imidacloprid, including chemical property, proposed uses, potential exposure and effect data. Assessments for other neonicotinoids are considered in a similar manner. The available information and resulting evaluations of all three neonicotinoids were considered together for consistency, however, the evaluations for each were conducted and published separately using the information specific for that neonicotinoid (e.g., PRVD2017-23, PRVD2017-24).
	References to include in assessment	"There are quite a number of relevant studies containing information on the potential impacts of imidacloprid on insect pollinators that are not included in the current draft version of the re-evaluation note. I have included a list of some of these information sources" 1) Alaux, C., J.- L. Brunet, C. Dussaubat, F. Mondet, S. Tchamitchan, M. Cousin, J. Brillard, A. Baldy, L. P. Belzunces and Y. Le Conte (2010). Interactions between Nosema microspores and a neonicotinoid weaken honey bees (Apis mellifera). Environmental Microbiology 12: 774-782. 2) Botías, C., D. Arthur, J. Horwood, A. Abdul---Sada, E. Nicholls, E. H. Hill and D. Goulson (2015). Neonicotinoid residues in wildflowers, a potential route of chronic exposure for bees. Environmental Science & Technology 49: 12731-12740. 3) Budge, G. E., D. Garthwaite, A. Crowe, N. D. Boatman, K. S. Delaplane, M. A. Brown, H. H. Thygesen and S. Pietravalle (2015). Evidence for pollinator cost and farming benefits of neonicotinoid seed coatings on oilseed rape. Scientific Reports 5: 12754.	Additional studies from the registrant and open literature sources that contain original data have been included in the update of the risk assessment, including, among others, the majority of the studies identified in this comment. In some cases, studies were not included where they did not contain original data, did not contain imidacloprid information, or contained information similar to other sources that were already considered in the risk assessment.

From	Topic	Comment	PMRA Response
		4) David, A., C. Botías, A. Abdul-Sada, E. Nicholls, E. L. Rotheray, E. M. Hill and D. Goulson (2016). Widespread contamination of wildflower and bee---collected pollen with complex mixtures of neonicotinoids and fungicides commonly applied to crops. Environment International 88: 169-178. 5) Fischer, J., T. Muller, A.- K. Spatz, U. Greggers, B. Grunewald and R. Menzel (2014). Neonicotinoids interfere with specific components of navigation in honey bees. PLoS One 9(3): e91364. 6) Godfray, H. C. J., T. Blacquiere, L. M. Field, R. S. Hails, G. Petrokofsky, S. G. Potts, N. E. Raine, A.J. Vanbergen and A. R. McLean (2014). A restatement of the natural science evidence base concerning neonicotinoid insecticides and insect pollinators. Proceedings of the Royal Society B-Biological Sciences 281: 20140558. 7) Godfray, H. C. J., T. Blacquiere, L. M. Field, R. S. Hails, S. G. Potts, N. E. Raine, A. J. Vanbergen and A. R. McLean (2015). A restatement of recent advances in the natural science evidence base concerning neonicotinoid insecticides and insect pollinators. Proceedings of the Royal Society B-Biological Sciences 282: 20151821. 8) Kessler, S. C., E. J. Tiedeken, K. L. Simcock, S. Derveau, J. Mitchell, S. S., J. C. Stout and G. A. Wright (2015). Bees prefer foods containing neonicotinoid pesticides. Nature 521: 74–76. 9) Krupke, C. H., G. J. Hunt, B. D. Eitzer, G. Andino and K. Given (2012). Multiple routes of pesticide exposure for honey bees living near agricultural fields. PLoS One 7: e29268. 10) Larson, J. L., C. T. Redmond and D. A. Potter (2015). Mowing mitigates bioactivity of neonicotinoid insecticides in nectar of flowering lawn weeds and turfgrass guttation. Environmental Toxicology and Chemistry 34: 127-132. 11) Moffat, C., J. G. Pacheco, S. Sharp, A. J. Samson, K. A. Bollan, J. Huang, S. T. Buckland and C. N. Connolly (2015). Chronic exposure to neonicotinoids increases neuronal vulnerability to mitochondrial dysfunction in the bumble bee (Bombus terrestris). The FASEB Journal 29(5): 2112-2119. 12) Palmer, M. J., C. Moffat, N. Saranzewa, J. Harvey, G. A. Wright and C. N. Connolly (2013). Cholinergic pesticides cause mushroom body neuronal inactivation in honey bees. Nature Communications 4: 1634. 13) Scholer, J. and V. Krischik (2014). Chronic exposure of imidacloprid and clothianidin reduce queen survival, foraging, and nectar storing in colonies of Bombus impatiens. PLoS One 9(3): e91573. 14) Stewart, S. D., G. M. Lorenz, A. L. Catchot, J. Gore, D. Cook, J. Skinner, T. C. Mueller, D. R. Johnson, J. Zawislak and J. Barber (2014). Potential exposure of pollinators to neonicotinoid insecticides from the use of insecticide seed treatments in the mid-southern United States. Environmental Science & Technology 48(16): 9762-9769. 15) Williamson, S. M., D. D. Baker and G. A. Wright (2013). Acute exposure to a sublethal dose of imidacloprid and coumaphos enhances olfactory learning and memory in the honey bee Apis mellifera. Invertebrate Neuroscience 13: 63–70. 16) Williamson, S. M., S. J. Willis and G. A. Wright (2014). Exposure to	

From	Topic	Comment	PMRA Response
		neonicotinoids influences the motor function of adult worker honey bees. Ecotoxicology 23: 1409-1418. 17) Williamson, S. M. and G. A. Wright (2013). Exposure to multiple cholinergic pesticides impairs olfactory learning and memory in honey bees. Journal of Experimental Biology 216: 1799-1807.	
	Exposure from non-crop plants	"Little mention is made in this document about the potential for exposure to imidacloprid (and other neonicotinoids) from non-crop plants – e.g. wild flowers around field margins. A number of recent studies have reported significant residues in the nectar and pollen of non-crop (wild) plants (e.g. Krupke et al. 2012; Stewart et al. 2014; Botías et al. 2015; David et al. 2016)." Krupke, C. H., G. J. Hunt, B. D. Eitzer, G. Andino and K. Given (2012). Multiple routes of pesticide exposure for honey bees living near agricultural fields. PLoS One 7: e29268. Stewart, S. D., G. M. Lorenz, A. L. Catchot, J. Gore, D. Cook, J. Skinner, T. C. Mueller, D. R. Johnson, J. Zawislak and J. Barber (2014). Potential exposure of pollinators to neonicotinoid insecticides from the use of insecticide seed treatments in the mid---southern United States. Environmental Science & Technology 48(16): 9762-9769 Botías, C., D. Arthur, J. Horwood, A. Abdul---Sada, E. Nicholls, E. H. Hill and D. Goulson (2015). Neonicotinoid residues in wildflowers, a potential route of chronic exposure for bees. Environmental Science & Technology 49: 12731-12740. David, A., C. Botías, A. Abdul---Sada, E. Nicholls, E. L. Rotheray, E. M. Hill and D. Goulson (2016). Widespread contamination of wildflower and bee---collected pollen with complex mixtures of neonicotinoids and fungicides commonly applied to crops. Environment International 88: 169---178.	Additional information on the exposure to non-crop flowers, including some of the studies listed in the comment, were considered in the update of the risk assessment for imidacloprid. Certain studies were not included in cases where imidacloprid was not studied.
	Cucurbits and blueberry	From page 5 of the report: ""No potential risk was identified for crops such as melon, pumpkin, and blueberry. Minimal risk is expected for bee-attractive crops in other registered crop groups (such as legumes and herbs)." This statement is surprising based on the information provided in the tables in this report as risk statements for theses crops varied depending on the tier assessment under consideration. In addition, PMRA initiated a special review "Potential environmental risk related to *Peponapis pruinosa* exposure to Clothianidin, Imidacloprid and Thiamethoxam used on cucurbits" in December 2014. PMRA initiated this review "Based on a preliminary analysis of the information received under subsection 17(4) of the *Pest Control Products Act*, PMRA has determined that a special review is warranted. The aspect of concern for these special reviews is a potential environmental risk related to squash bees, *Peponapis pruinosa*, from exposure to clothianidin, imidacloprid or thiamethoxam when used on cucurbits.""	The assessment has been updated with additional available information. The preliminary assessment focussed primarily on honey bees. Additional information on non-*Apis* bees has been considered in the updated assessment.
	Exposure from corn and soybean seed dust	From page 5 of the report: ""The exposure route of dust generated during planting of treated seed was also considered. Dust generated from planting of neonicotinoid treated corn and soybean seed was previously identified as a concern in Canada, and risk reduction measures were put in place in 2014 to reduce exposure to dust during planting of treated corn and soybean seed. Dust generation is related to multiple factors including the planting equipment and seed types, and at this time planting of other seed types in Canada is not associated with dust- generation or harm to pollinators." The document should report any information that is available on what impact these mitigations have made on the levels of neonicotinoid present in the dust and exposure for insect pollinators."	As stated in the *Update on Canadian Bee Incident Reports 2012-2016*, the number of incidents reported during corn and soybean planting has decreased by 70 – 90% following the 2014 implementation of mandatory dust reducing measures, including use of a dust-reducing fluency agent. Imidacloprid is not typically associated with incidents during corn and soy planting. Rather, the neonicotinoids thiamethoxam and clothianidin are used as seed

From	Topic	Comment	PMRA Response
			treatments on corn and soy, and have been associated with bee incidents during planting of treated seed. There is research available or being generated on the effect of various dust-reducing risk reduction measures (deflectors, dust-reducing fluency agents) on the amount of neonicotinoids released in dust during planting, which can affect the exposure of insect pollinators. This information was not discussed in detail in this re-evaluation document as there is a separate evaluation underway examining the dust-related bee mortality incidents. The further evaluation of incidents reported to result from planting of neonicotinoid treated corn and soybean seed will be made available when completed.
	Concentration in soil	From page 2 of the report: ""When imidacloprid is used for multiple years in succession, concentrations in soil initially increase and then stabilize after approximately three years." The degree to which concentrations in soil "stabilize after approximately three years" is widely debated and likely depends on factors such as application rate, soil type, local weather conditions and climatic factors. Data presented in Goulson's (2013: Figure 22) review paper indicate concentrations in soil can level off after 3-4 years or continue to increase year-on-year (over the 6 years of data presented)" Goulson, D. (2013). An overview of the environmental risks posed by neonicotinoid insecticides. Journal of Applied Ecology 50: 977-987	The comment has been considered in the update of the risk assessment. It is noted that when imidacloprid is used for multiple years in succession, concentrations in soil initially increase and then may stabilize after approximately three to four years.
	Number of non-*Apis* bees	From page 5 and 14 of the report: "Page 5:"There are approximately 1000 non-*Apis* bee species in Canada which have varying biological and ecological traits" and see also page 14 "There are approximately 1000 non-*Apis* bee species in Canada in addition to *Apis* bees, the genus including the honey bees (Packer et al. 2007)." This paper by Packer et al. (2007) actually puts the confirmed number of bee species in Canada at the time it was published at 730, followed by the statement "It seems likely that additional surveys and the application of genetic methods to reveal cryptic species (Packer and Taylor, 1997) will increase the number of species in Canada substantially." The most recent information on bee species numbers for Canada suggest there to be around 855 species (Dr. Cory Sheffield, personal communication: Curator of Invertebrate Zoology at the Royal Saskatchewan Museum)." Packer, L., Genaro, J. A. and C. S. Sheffield (2007) The bee genera of Eastern Canada. Canadian Journal of Arthropod Identification 3, doi:10.3752/cjai.2007.03 Packer, L. and J. Taylor. 1997. How many hidden species are there? An application of the phylogenetic species concept to genetic data for some comparatively well known bee species. Canadian Entomologist 129: 587---594.	The description has been updated in the risk assessment to include more precise numbers based on the same literature information.
	Using the honey bee as a surrogate	From page 3 of the report: "The honey bee is used in the risk assessment to represent all types of bees and other insect pollinators." Whilst it is true that honey bees are used in pesticide risk assessments as a representative species of bees and other insect pollinators, I think a number of lines of evidence indicate we should call into question the veracity of this premise. Recent publications suggest that comparable exposure to imidacloprid had stronger impacts on bumble bees (*Bombus terrestris*) than honey bees (Cresswell et al.	The risk assessment is conducted based on all available information on honey bees and other non-*Apis* bees. In updating the risk assessment, additional studies have been incorporated and considered , including the studies cited in the comments.

From	Topic	Comment	PMRA Response
		2014), and that there was high variability in sensitivity to a range of pesticides among bee species considered (Arena & Sgolastra 2014). *A priori*, we might consider differences in colony size, life-history and ecology would affect sensitivity to pesticides among bee species. Honey bees live in large colonies (up to perhaps 50,000 workers), overwinter as colonies – this is atypical for the majority of bee species (either in Canada or elsewhere). More than 95% of all bee species are solitary (rather than social) suggesting that we need to carefully consider the impacts of any pesticides to be evaluated on more than a single, somewhat atypical species which survives in Canada only in association with human management (beekeeping)." Cresswell, J. E., F. -X. L. Robert, H. Florance and N. Smirnoff (2014). Clearance of ingested neonicotinoid pesticide (imidacloprid) in honey bees (*Apis mellifera*) and bumble bees (*Bombus terrestris*). Pest Management Science 70: 332-337. Arena, M. and F. Sgolastra (2014). A meta-analysis comparing the sensitivity of bees to pesticides. Ecotoxicology 23(3): 324-334.	Risk assessment for non-*Apis* bees has been identified globally as an area that requires further investigation. PMRA is continuously working with other international regulatory agencies and scientists on this matter, including working groups of international experts on non-*Apis* bees.
	Sensitivity of the bumble bee and contradictions in the report	Section 5.1.2: "The conclusions of this section are somewhat divergent from those drawn by Arena & Sgolastra (2014) in their meta-analysis comparing the sensitivity of non-*Apis* and honey bees for a range of pesticide classes, including neonicotinoids: "The meta-analysis showed a high variability of sensitivity among bee species (R from 0.001 to 2085.7), however, in approximately 95% of the cases the sensitivity ratio was below 10. The effect of pesticides in domestic and wild bees is dependent on the intrinsic sensitivity of single bee species as well as their specific life cycle, nesting activity and foraging behaviour. Current data indicates a need for more comparative information between honey bees and non-*Apis* bees as well as separate pesticide risk assessment procedures for non-*Apis* bees." Section 5.2.2.2. Non-Apis bees (p22): "Based on the feeding study information, bumble bees appear to be more sensitive to effects from imidacloprid in pollen and/or nectar feeding solutions than honey bees." This statement, about Tier II impacts on non-*Apis* bees appears to be inconsistent with multiple statements earlier in the document such as "Available individual bee effect information suggested that toxicity of imidacloprid to non-*Apis* bees is similar to that of honey bees." (page 6)." Arena, M. and F. Sgolastra (2014). A meta-analysis comparing the sensitivity of bees to pesticides. Ecotoxicology 23(3): 324-334.	Additional information has been included in the update of the risk assessment, including effect information on individual bees and colonies for bumble bees. The response of bees, including bumble bees, to imidacloprid may be different at the individual level and at the colony level. At the individual level, a similar range of imidacloprid toxicity was reported between honey bees and bumble bees based on a limited amount of available information, especially on the acute oral exposure basis. However, at the colony level, the available feeding studies indicated that bumble bee colonies were more sensitive to imidacloprid than honey bee colonies.
	Exposure to multiple pesticides	"Section 5.2.2.2. Non-*Apis* bees (p22): I think it would be pertinent to this document to acknowledge data on combined impacts of different insecticide classes on non-*Apis* bees. Gill et al. (2012) reported a significantly higher rate of bumble bee (*Bombus terrestris*) colony failure when exposed to imidacloprid and the pyrethroid (lambda cyhalothrin) than when exposed to either of these insecticidal treatments alone. These authors also reported additive impacts of combined exposure to these insecticides in increasing worker losses (see Gill et al. 2012, Figure 3) compared to exposure to either active ingredient alone." Gill, R. J., O. Ramos-Rodriguez and N. E. Raine (2012). Combined pesticide exposure severely affects individual- and colony---level traits in bees. Nature 491: 105---108.	PMRA has considered studies reporting combination effects of imidacloprid with other pesticides, as well as the co-presence of imidacloprid with other pesticides in various matrices to which bees may be exposed. However, there is a lack of sufficient information for generalising the level of exposure for multiple pesticides in the environment, as there is much variability in the amounts and combinations of pesticides to which bees could be exposed. For example, there may be variability in the composition of pesticides, the seasonal dynamics of pesticide composition and the concentrations of each pesticide in various matrices. As well, the toxicity

From	Topic	Comment	PMRA Response
			information for various combinations of imidacloprid and other pesticides is limited. Therefore, in most cases, it is not possible to conduct a realistic risk assessment considering multiple active ingredients because it is not known which actives, how much, when and where multiple exposures would occur. Further investigation is needed in order to conduct appropriate environmental risk assessments with respect to the combination effects.
	Power of detection	"Section 5.3.1. Honey bees: an important consideration when assessing the results of studies in which no robust differences are found among treatment groups is whether the experimental design/level of replication is sufficient to provide robust statistical support for the absence of an effect. Absence of evidence is not the same as evidence of absence. Cresswell (2011) conducted a meta-analysis of the studies investigating the impacts of imidacloprid on honey bees and concluded that his "Statistical power analysis showed that published field trials that have reported no effects on honey bees from neonicotinoids were incapable of detecting these predicted sublethal effects with conventionally accepted levels of certainty." The limitation of field scale trials to detect effects is highlighted by power analysis in Rundlöf et al. (2015). Those authors stated that their "power analysis indicated that, given our design, replication and data analysis method, we would be able to detect an effect size of just below 20% with a power of 0.8 (Extended Data Fig. 2b)." This study used a paired design with 8 fields planted with neonicotinoid (Clothianidin) treated seed and 8 control fields (no neonicotinoid seed treatment used). This study is the largest field scale experiment yet published and still would only be able to detect a minimum effect size of about 19% for honey bees." Cresswell, J. E. (2011). A meta-analysis of experiments testing the effects of a neonicotinoid insecticide (imidacloprid) on honey bees. Ecotoxicology 20: 149---157. Rundlöf, M., G. K. S. Andersson, R. Bommarco, I. Fries, V. Hederström, L. Herbertsson, O. Jonsson, B. K. Klatt, T. R. Pedersen, J. Yourstone and H. G. Smith (2015). Seed coating with a neonicotinoid insecticide negatively affects wild bees. Nature 521: 77–80.	The issue of low detection power has been identified by numerous researchers in higher tier studies conducted with many organisms, including bees. The detection power is largely limited by the feasibly of using a high number of replicates, particularly in field studies.Higher tier studies are expected to represent conditions that are more realisticand are considered in a weight-of-evidence approach taking into account limitations, such as low detection power.
Capital Region Beekeepers' Association, British Columbia	Labelling of treated plants	"In urban areas, which are often cited as a relatively pesticide-free refuge for beneficial insects of all kinds, we are concerned about the cosmetic use of imidacloprid. Many bedding plants have been drenched in the plug stage with imidacloprid or other neonicotinoids but are not marked as such. We would like to see labelling of this use of systemic pesticides in at the point of sale. Most urban gardeners would prefer to grow "bee friendly" flowers that are not treated with any insecticides but they are not given a choice."	Ornamentals are included in the update of the risk assessment for pollinators.
	Turf use	"The other urban use which is most disturbing is in turf. The re-evaluation document says: "The Domestic Class imidacloprid products are applied by the general public using granular spreaders on turf." As beekeepers, we do not agree with allowing the general public to apply granular imidacloprid to turf because most lawns contain at least some weeds, such as dandelions and clover, which are highly attractive to bees. The application by non-professionals could cause over-application, leading to much higher doses of pesticide than expected by strict use according to the label. It is difficult to justify the cosmetic use of these powerful pesticides on residential lawns."	The risk assessment for turf use is based on the available studies, including semi-field tunnel studies. The available higher tier studies did not provide evidence of risk to bees when the use instructions on the label requiring irrigation after application are followed. The proposed regulatory decision regarding turf is outlined in this document.

From	Topic	Comment	PMRA Response
	Exposure period	"The studies that were used so far in this re-evaluation are of concern because of the short timelines for chronic exposure. 3-24 days is not enough time to determine chronic, subtle behavioural effects that are difficult to measure but that can lead to colony collapse in the long run. Also, when the toxic effects on castes are laid out in the tables, there is no mention of the queen, who is much longer-lived than workers and therefore could have more time to accumulate pesticides from being fed by the workers over at least a year or more. For chronic effects, is there more long-term research planned?"	Several feeding studies reviewed by the PMRA include an exposure period for 6 weeks or more, and an observation period into the following year, including overwintering. Parameters on queens were also considered during the study.
	Cumulative effects	"Cumulative effects of multiple pesticides in both urban and rural areas are not addressed in this document, although studies clearly show how the buildup or the combination of multiple chemicals affects bees. We should not only consider imidacloprid in isolation. Perhaps labelling could proscribe the use of imidacloprid if certain other chemicals have been used on the same crop."	See above comment on multiple pesticide exposure. In addition, the current label for imidacloprid restricts uses of other neonictinods after imidacloprid application. For example: *Do not apply any subsequent application of a Group 4 Insecticide (for example, in-furrow, soil or foliar application) following treatment with ADMIRE 240 Flowable Systemic Insecticide soil application.*
	Comparing PMRA results to EPA	"I read this today: "The EPA's long-awaited assessment focused on how one of the most prominent neonics—Bayer's imidacloprid—affects bees. The report card was so dire that the EPA"could potentially take action" to "restrict or limit the use" of the chemical by the end of this year, an agency spokesperson wrote in an emailed statement."And the PMRA says it poses little risk? I find that very hard to believe. This sounds like another case where there is an agenda at play which doesn't have the health of bees - or humans - above the interests of agribusiness. Please respond and explain why your results are so widely divergent from the EPA's!"	The PMRA and USEPA conducted the risk assessment for imidacloprid in a scientific manner using the same risk assessment framework that was co-developed by the California Department of Pesticide Regulation, USEPA, and PMRA. PMRA's risk assessment was conducted based on specific uses of imidacloprid that were registered in Canada. These may differ from uses registered in the United States; for example cotton and citrus are not grown in Canada, therefore, there are no registered uses for these crops in Canada. The risk assessments of EPA (Preliminary Pollinator Assessment to Support the Registration Review of Imidacloprid, EPA-HQ-OPP-2008-0844-0140) and PMRA (Re-evaluation of Imidacloprid - Preliminary Pollinator Assessment, REV2016-06) come to very similar conclusions regarding the potential risks to bees.
Turtle Mountain Municipality, Manitoba	Decline of beneficials	"I am alarmed by the disappearance of the native pollinators, honey bees, and butterflies (Monarch for one), in southwestern Manitoba. I have lived in the farming communityhere, in the summers for over 65 years, and have never witnessed such a depressing decline. The absence of these insects has been significantly apparent in the last few years, especially. I believe that the use of one or all of these neonicotinoids are in part responsible for their disappearance. Of course we can't discount the negative effects of Glyphosate and its adjunctives,either. It appears to me that the beneficial (all) insects are being affected by the use of these insecticides on treated corn, soybeans as well as other crops.It is getting into the sloughs and waterways affecting the aquatic life systemically, as well. Studies have proven this, as you know.	PMRA conducted a science-based risk assessment and considered all available evidence. Risks of imidacloprid to both *Apis* (honey bee) and non-*Apis* bees (e.g., bumble bees and solitary bees) are included in the update of the risk assessment. Risks of imidacloprid to organisms other than the pollinators, such as other beneficial insects (PRVD2016-20), as well as risks of other pesticides are assessed separately.

From	Topic	Comment	PMRA Response
		From my observation, it appears to be affecting them at even lower levels of use than you have determined as your bench mark for allowable safe levels of use. Our insect populations have basically disappeared from a once very desirable landscape for them to do their work."	
Received under the value document (REV2016-03)	Bee health	"How do we propose that plant health can be improved in a pesticide-laden environment in which pollinators cannot thrive, or even survive? It is important that we have both wild and commercial bees in order to sustain our natural ecosystems; the health and safety of our families and the general public depend on the health of the world in which we live."	No response is needed
	Neonic toxicity to bees	"There are countless studies demonstrating how toxic neonics are to honey bees. Les Eccles from the OBA Tech Transfer Team and Dr. Ernesto Guzman, University of Guelph submitted a report to OMAFRA in 2015 entitled "Effect of Sublethal doses of Neonicotinoids on Honey Bees in Ontario". It presents data that match our experiences and findings in the bee yard. To begin, it lays out the LD50s (lethal doses) at 24h for three neonicotinoids: Insecticide Oral LD50 Topical LD50 Imidacloprid 15 ng/bee 85 ng/bee Clothianidin 4 ng/bee 34 ng/bee Thiamethoxam 30 ng/bee 150 ng/bee Considering that insecticides with LD50s < 2000 ng/bee are deemed highly toxic to bees, these values are extremely low. Further, the report presents findings that imidacloprid, clothianidin, and thiamethoxam "reduce the length of life of Ontario honey bees at doses as low as 100 times lower than acute exposure… much lower than levels bees would encounter in field conditions". In other words, bees that are encountering field levels of neonicotinoids have significantly shortened lifespans. This means that the hive will have a reduced and weakened population throughout the season. A large, robust population is essential for hive health, as well as honey production and winter survival. Dr. Henk Tennekes detailed similar findings in a talk he did in February 2015 called "New Approaches to Pesticide Risk Assessment" during the Workshop on CCD and Neonicotinoid Insecticides in Cambridge. (Tennekes H.A., Sánchez-Bayo, F., 2013. Toxicology 309, 39– 51). He showed that by feeding bees nectar containing just 1ug/L of imidacloprid, only 26% of bees lived to the average life expectancy. If bees are fed pollen containing 10ug/L of imidacloprid, only 18% lived to the average life expectancy. A hive simply cannot function with these survival rates."	In the imidacloprid pollinator risk assessment, multiple effect and residue studies are considered as lines of evidence. Theses studies were conducted either in the laboratory or in the field under semi-field or field conditions. The risk is assessed by comparing the toxicity information to levels of exposure expected in the environment, as well as considering the outcomes from available semi-field and field studies. The two cited references (OMAFRA (2015), and the talk by Dr. Tennekes (2015)) are a project report and a meeting presentation that do not contain detailed study methodology that are not formally published in any peer-reviewed scientific journals and, therefore, the studies were not used in the risk assessment. Multiple other similar studies were considered in the risk assessment. "Tennekes H.A., Sánchez-Bayo, F., 2013. Toxicology 309, 39– 51)" cited in the comment is a review. It does not include original data. The life expectancy described in the comments appeared to be estimated using a model that was established based on a single 10-d adult study for honey bees. In the risk assessment, instead of being speculative, the potential long-term effects for bees are assessed using multiple chronic studies tested directly on honey bee adult and larva individuals, and multiple long-term colony feeding studies on colonies.
	Imidacloprid toxicity to bees	Rondeau et al (Scientific reports, 2014, Vol.4, pp.5566) used existing data to extrapolate the survivability of honey bees exposed to low doses of imidacloprid over time. They found that "daily ingestion of about 0.005 ng/day of imidacloprid would produce LT50 in 150 days. For bees consuming 0.02 g honey per day, this implies a concentration of 0.25 ppb in honey as the lowest concentration capable of causing long-term mortality. […] Hence, even with healthy bees, exposure to modest field-realistic residues of imidacloprid in pollen (range 0.5–30 ppb) and honey (range 0.7–13 ppb) could easily cause problems for summer bees and especially for longer-lived bees going through the winter." They close by recommending that "compounds with delayed toxicity should be avoided as pesticides because of the intrinsic difficulty they pose as environmental contaminants."	The cited publication was considered during the risk assessment, however, the model-estimated effect concentration is not considered to be definitive due to the multiple uncertainties associated with the study. Therefore, it was not used in the risk assessment.

From	Topic	Comment	PMRA Response
	Queen health	"In the OBA's Tech Transfer report to OMAFRA (2015), they discuss another one of their projects where queens were raised in Huntsville, ON; a location that is remote enough to be free of environmental neonicotinoids. Both Dr. Ernesto Guzman from the University of Guelph and Les Eccles of OBA Tech Transfer worked on this research. Prior to mating, queens were fed **one** 10 micro-liter dose of sugar syrup, containing 2.0 ng/bee of clothianidin, or 1.0 ng/bee of thiamethoxam, or a control containing only sugar syrup. These are both field-realistic, sublethal doses that bees are exposed to in certain areas of Ontario (including much of Southern Ontario). Though the control and treatment groups of queens had similar sperm counts, the queens that were fed **one, field-realistic, sublethal dose** of clothianidin had significantly fewer living sperm and significantly fewer viable sperm stored in their spermatheca compared to the control queens. After just one dose! Due to the requirements of egg laying, queens have high metabolisms and consume much more food than workers, and thus are likely to suffer an exposure. To quote the report, "this is particularly significant as clothianidin is more common of the two pesticides and is more prevalent in the environment. […] thiamethoxam breaks down into clothianidin, which is much more stable and has been shown to persist in soil and water for years". Consider as well that **queens mate only once in their life**. This means that *if* the queen is able to survive the average productive life expectancy of two to three years, the hive will be burdened with a queen that has significantly fewer viable sperm for the duration of her lifetime. This may have lasting detrimental effects on the hive for the following 2-3 years. That is, *if* the queen is able to survive and perform that long. As the report discusses, a poorly mated queen will begin to fail and be superseded more quickly than a healthy, well-mated queen. Adding to the problem, a hive is not always able to successfully supersede a failing queen. This results in queenless, unproductive hives. Finally, we as beekeepers often select queens for specific traits. A superseded queen means that we have lost that time and effort into establishing strong, healthy queen stock. For beekeepers raising their own queens, this represents a loss of years of investment in a selective breeding program."	PMRA contacted the commentor for the cited reference and determined that the citation was not published. An interim report of the research project was received from other sources, and while it reported an effect on queens from thiamethoxam and clothianidin, no effect on queens was reported for imidacloprid. The commentor provided a different publication after contact (listed below), however, the study was conducted with thiamethoxam and clothianidin, not imidacloprid. This publication has been considered by the PMRA in the evaluation of the other relevant chemicals (thiamethoxam and clothianidin). The potential effect of imidacloprid on queens is considered in the update of the final risk assessment using other relevant studies that are available. Straub L., L. Villamar-Bouza, S. Bruckner, P. Chantawannakul, L. Gauthier, K. Khongphinitbunjong, G. Retschnig, A. Troxler, B. Vidondo, P. Neumann and G.R. Williams. 2016. Neonicotinoid insecticides can serve as inadvertent insect contraceptives. Proc. R. Soc. B 283: 20160506. http://dx.doi.org/10.1098/rspb.2016.0506
	Drone exposure	"Another point to consider is drone exposure and sperm viability. A queen stores sperm from her mating flight and they must remain viable for years to ensure a productive, fertile queen. PMRA's research does not contemplate the "drone" part of the bee equation for ensuring healthy bees."	The effect of imidacloprid on the sperm in queens and motility drones is included in the update of the risk assessment.
	Assessing hive health	"How do we as beekeepers begin to quantify these damages to our hives? A simple "dead or alive" verdict for a hive does not nearly begin to encompass the impact that these small, sublethal doses are having on our livestock. Our hives are left weakened, damaged, with queens that simply don't perform. We often enter bee yards in Southern Ontario that require half of the hives to be reworked and requeened. Some hives require requeening multiple times a year – something virtually unheard of before neonicotinoids became prevalent. Furthermore, when you requeen a hive, you must resupply that hive with brood and bees. This draws resources from other hives, further weakening the populations and therefore the general health and production of those hives. Thus, when a bee yard is impacted by neonics, it is exceedingly detrimental."	Mutiple factors may impact the hive health. In this document PMRA assesses the potential risks of imidacloprid on bees, including potential long-term effects. Multiple parameters of colony health were measured and considered in the assessment of imidacloprid effects on hives.
	Sublethal effects	"Goulsen (Journal of Applied Ecology, 2013, 50, 977–987) discusses multiple papers that show field-realistic doses of neonicotinoids cause very damaging sublethal effects in honey bees. These effects include reduced learning, foraging ability, and homing ability.	Overall colony performance is expected to be influenced by many factors, including sub-lethal effects, such as learning, foraging ability, and homing ability. Most of

From	Topic	Comment	PMRA Response
		These abilities are essential for both individual honey bees as well as overall colony health. If a hive has a weakened workforce that is unable to function optimally, how does the beekeeper measure this loss? How can a beekeeper begin to document and recoup losses that are a result of sublethal toxicity? It is simply not possible. Keep in mind that honey bees are not only exposed to neonicotinoids as foraging adults. Consider that nectar and pollen are stored in the hive by honey bees to be consumed at a later date. If that pollen/nectar is contaminated (which it often is, as found by PMRA and OMAFRA), the bees are continually exposed as they feed on those stores. Additionally, when honey bees are developing larvae, worker 'nurse' bees feed them. Goulsen states that it is "highly likely" that bee larvae are routinely exposed to sublethal levels of neonicotinoids. The effect on development and function of that bee, and therefore on the colony, have yet to be studied in detail. One study that was published by Yang et al (2012, PLoS One, Vol.7(11)) demonstrated that larvae could be negatively affected by being fed a dose of imidacloprid as low as 0.04ng/larva. Once these larvae develop into adults, they have lasting learning and memory impairments. The authors explain that, "it is highly likely that they cannot learn and memorize food locations and homing routes and that therefore they fail to return to their hives, causing a reduction of bee products and getting even worse to induce CCD"."	the higher tier colony feeding studies used in the risk assessment were conducted using sublethal doses, and observation over a long period of time. In these studies, overall colony strength, as well as some specific sub-lethal parameters, such as foraging activity, were examined. The outcomes of these studies are expected to reflect overall effects of imidacloprid to the colonies, including sublethal effects. Effects on other stages of bees, such as larvae and nursing bees, were assessed in the Tier I assessment, as well as in the higher tiers using colony studies where effects on brood (eggs, larvae, pupae) were assessed over long periods of time.
	aquatic risk	"Neonicotinoids are also damaging to aquatic environments. Due to their high solubility and their ability to move through the environment, they inevitably end up in our aquatic ecosystems. Goulsen (2013) discusses environmental risks posed by neonicotinoids. In part of this review, he discusses how various studies have found that neonicotinoids are highly toxic to aquatic invertebrates. The LC50 is the concentration (in water) at which 50% of individuals die. The LC50 for aquatic invertebrates have been found to be low: only 0.65 ppb to 45ppb (parts per billion). Furthermore, the concentration required to kill an individual decreases as the length of time of exposure increases. One study found that a mayfly had an acute LC50 of 2.1ppb, but that value fell to 0.65ppb over an exposure time of just four days. Goulsen also states that "important sublethal effects (such as reduced feeding, movement, and reproduction) can be elicited at much lower doses [than the LC50]"."	Potential effects of imidacloprid on other organisms, including aquatic organisms, are assessed separately in another document (PMRA PRVD2016-20).
	Bird risk	"Invertebrates are incredibly important for broader ecosystems. Hallman et al published a paper (Nature, 2014, 511.7509, p341) demonstrating a link between the use of neonicotinoids and the decline of insectivorous bird populations in the Netherlands. Their closing statement is, "Our results on the declines in bird populations suggest that neonicotinoids pose an even greater risk than has been anticipated. Cascading trophic effects deserve more attention in research on the ecosystem effects of this class of insecticides and must be taken into account in future legislation.""	Potential effects of imidacloprid on other organisms, including aquatic organisms, are assessed separately in another document (PMRA PRVD2016-20).
	Water monitoring	"When we consider water residues within Canada over the past few years the results are somewhat grim. Quebec (MAPAQ) has collected data on neonicotinoid residue in 16 rivers, finding their presence continually throughout the summers of 2012 and 2013. Also, research conducted on field puddles during and following corn planting (Samson-Robert et al, PLOS One, Dec. 2014) found near-lethal neonic levels for honey bees. Considering that these pesticides cause permanent nervous system damage to insects we must conclude that although a single exposure may not be lethal, it may render a honey	Potential effects of imidacloprid on other organisms, including aquatic organisms, are assessed separately in another document (PMRA PRVD2016-20). Potential effects of imidacloprid on bees though water exposure routes are assessed in the update of the pollinator risk assessment.

From	Topic	Comment	PMRA Response
		bee incapable of performing normal functions. Additionally, when these residues are found frequently in the environment, it is highly likely that bees experience multiple exposures thus bringing them closer to a lethal outcome.”	

Appendix XIV Comments on Value Assessment of Corn and Soybean Seed Treatment Use of Clothianidin, Imidacloprid and thiamethoxam (REV2016-03) and Responses

From	Topic	Comment	PMRA Response
	Comments on the pest management value assessment for neonicotinoid seed treatments on corn and soybean from grower groups, honey producers, provincial governments, registrants, seed companies and seed trade organizations	There is little value for the neonicotinoid seed treatments when used for the control of soil insect pests on corn. European corn borer and corn rootworm are identified by Aginfomatics as the main pests of concern to corn growers. There was no value discussion for European corn borer and there are few challenges to implementing IPM for corn root worm which can be controlled using pest management strategies other than neonicotinoid seed treatments.	European corn borer was not discussed in the value assessment document since it is not listed on the neonicotinoid seed treatment product labels as a pest that is controlled using these seed treatments. Corn rootworm can effectively be controlled using pest management options other than seed treatments. However, there are limited or no alternative pest management options other than neonicotinoid seed treatments to control other co-occurring soil insect pests of corn seed. As a result neonicotinoid seed treatments have been identified as being of value for pest management of soil insect pests which damage corn seed.
Grower groups, provincial governments, registrants and seed trade organizations		Grower groups, provincial governments, registrants and seed trade organizations commented that neonicotinoid seed treatments offer protection against insect pests including those that carry bacterial and viral diseases. Neonicotinoid seed treatments provide growers with the tools required to reduce threats to crop establishment that would otherwise result in the waste of huge amounts of natural resources (fuel) as well as time, money and labour. Without access to neonicotinoid seed treatments, production would drop and costs would rise sharply for both farmers and consumers. Seed treatments allow for early planting of crops and complement modern production practices which have beneficial effects for the environment such as no-till.	In REV2016-03 the PMRA concluded that clothianidin and thiamethoxam seed treatments contribute to insect pest management in agriculture in Canada when pest thresholds are met and that neonicotinoid seed treatments also complement current crop production practices.
Grower groups and registrants		Grower groups and registrants indicated that growers want to retain the use of neonicotinoid seed treatments when insect pest pressures warrant the need. However, there are significant challenges for identifying when pest pressures warrant the use of an insecticide seed treatment. The spatial variation of soil insect pest populations in conjunction with variability of pest activity as a result of soil conditions makes	Pest monitoring practices are an important component of integrated pest management; however, the PMRA acknowledges that there are challenges for Canadian growers to implement these practices. The PMRA also acknowledges that the wireworm species and pest pressure in Québec from soil insect pests may not be equivalent to those in Ontario, and

From	Topic	Comment	PMRA Response
		implementation of pest monitoring practises impractical for commercial scale production of corn and soybean. Some pests are only active after the crop is planted. Soil insect pest thresholds have been established for Ontario, however these may not be applicable to Québec. Scouting methods and action thresholds are still in the process of being established and current research is primarily being conducted on wireworm. In addition, the knowledge transfer to growers and crop consultants needs to take place for effective adoption of these soil insect pest population survey methods.	that further research is required before economic action thresholds can be adopted by the Québec corn and soybean industries.
Registrants and honey producers	Comments on the economic assessment of the value of neonicotinoid seed treatments to corn and soybean	Registrants commented that the economic value of neonicotinoid seed treatments was over emphasized in the value assessment compared to the pest management value aspects. While the broader social and economic components of value are harder to quantify, they believe that they are as important as the economic impacts to the corn and soybean industries and should be afforded equal weight in an assessment. Honey producers commented that the economic value of the environment was not considered in the economic analysis	Value assessments use a comprehensive weight of evidence approach, of which one aspect may include estimates of the economic benefits realized from using a registered pest control product. Estimating the economic benefits was conducted as a supplementary component of the value assessment for neonicotinoid seed treatments on corn and soybean seed. This component of the value assessment is not intended to be an exhaustive analysis. It is limited to the economic benefits to the industry directly linked to the use of neonicotinoid seed treatments for insect pest management. As a result, this assessment is not intended to analyse the impact of neonicotinoid seed treatments to industries that are upstream (e.g., economic benefits of neonicotinoid seed treatments to seed companies) or downstream of the corn and soybean industries (e.g., ethanol, or feed/food industries). Nor was this component intended to estimate the impact to the provincial economies. Health Canada’s Pest Management Regulatory Agency (PMRA) acknowledges that a variety of models exist to estimate the economic value of neonicotinoid seed treatment use on corn and soybeans and that various assumptions are used

From	Topic	Comment	PMRA Response
			by each model which may lead to a wide range of conclusions. The PMRA also acknowledges that the current estimates of pest incidence and pressure may be attributable to the current widespread use of insecticide seed treatments and that the estimates for the economic value for the 2013 crop season also do not account for potential changes to soil insect pest populations as a result of a possible decrease in use of neonicotinoid seed treatments.
Grower groups		Grower groups indicated that it is more relevant for the grower to calculate the cost-benefits of using a neonicotinoid seed treatment for their own business and apply that information to their pest management plan. REV2016-03 concluded that there was no economic benefit to the corn and soybean industries in Québec. However there are some situations where there is a benefit to growers from using a neonicotinoid seed treatment.	While the analysis was done at the industry level, quantifying the economic impact at the farm level was not performed. The potential economic loss at the farm level is determined by many factors such as geographic location, soil type, tillage practices and crop rotation as just a few examples. Often these factors are unique to the individual crop, location or business. The PMRA recognizes that there are situations where the use of a neonicotinoid seed treatment would be critical to producing a viable crop. The PMRA also recognizes that pest management decisions required at the farm level may not be reflective of potential benefits at the industry level and that extrapolation of conclusions from the industry level to the farm level (and vice versa) is not always appropriate.
Honey producers		Honey producers commented that their industry has experienced a significant economic impact as a result of the use of neonicotinoid seed treatments. In addition, they believe this loss is greater than the financial burden corn producers would incur as a result of adapting to alternative products, such as tefluthrin.	The value assessment included an analysis of the contribution of neonicotinoid seed treatments to insect pest management under current crop production practices and estimated the direct economic benefits to the corn and soybean industries in Canada. The assessment did not attempt to quantify the economic impacts to other industries.
Grower groups		Grower groups indicated that there is a need for transparency around the actual cost of neonicotinoid seed treatments applied to corn and soybean seeds.	The estimated average cost for a neonicotinoid seed treatment for corn was approximately $12.36 per hectare while the average cost for soybean was estimated at approximately $24.71 per hectare. These average seed treatment cost

From	Topic	Comment	PMRA Response
			estimates were based upon available information at the time of the assessment. Health Canada gathers sales data along with pesticide usage information from proprietary data providers and confirmed that the estimates provided by the provinces were realistic.
Grower groups, provincial governments, registrants and seed trade organizations		Grower groups, provincial governments, registrants and seed trade organizations commented that the value assessment for Québec should be revised using more recent and complete information. It is unlikely that there would be an economic benefit to the corn and soybean industries in other provinces while there would be no benefit for the corn and soybean industries in Québec. There are certain cases where neonicotinoid seed treatments will provide an economic benefit, particularly for corn. Recent data for the economic benefit of using neonicotinoid seed treatment to the corn and soybean industries in Québec are available to support this. The economic value of neonicotinoid seed treatments to producers in Quebec has been underestimated, based on the yield benefits seen from using neonicotinoid seed treatments and the price values for the crops that were used in the PMRA assessment (2013) versus the average commodity prices seen in Quebec over the last six months (2015). Side by side seed treatment trials in 2014 and 2015 using neonicotinoid insecticide treated seeds and untreated controls indicate an average yield benefit of 307 kg/ha for corn. The monetary value for this yield increase would cover multiple times the cost of the seed treatment.	The estimates for the economic benefits to the corn and soybean industries for the 2013 crop season were based upon information available to Health Canada at the time of the assessment. Based upon additional data provided during the consultation period for REV2016-03 the economic benefits to the Québec corn and soybean industries were estimated for the 2014 and 2015 crop seasons. As demonstrated in the trial data submitted, there can be a yield benefit to corn when applying a neonicotinoid insecticide seed treatment. However, the benefits are highly variable from field to field. The presence and abundance of insect pests could not be correlated to the final yield. Field scouting for wireworm was not reliable due to spatial and temporal pest variability within a field. There are multiple challenges associated with scouting, establishing thresholds and the feasibility at the commercial level. The submitted data did not clearly demonstrate the link between pest pressure and economic benefit to the corn and soybean industries in Québec.

References

A. Registrant Submitted Studies/Information

A.1 Environmental Assessment

A.1.1 Environmental Fate and Effects Assessment

PMRA Document Number	Reference
1086407	Sorption of Imidacloprid and its Metabolites in Tropical Soils, DACO: 8.2.4.2
1155825	Soil/Sediment Adsorption-Desorption Of 14c- Imidacloprid (103817;N3182102)(Admire), DACO: 8.2.4.1
1155827	1988, Adsorption/Desorption Of Ntn 33893 On Soils, (99199;M 1310231/1)(Admire/Imidacloprid), DACO: 8.2.4.1
1155829	Photodegradation Of Ntn 33893 On Soil (100249;No. 88012/Esr)(Imidacloprid/Admire), DACO: 8.2.1
1155830	Metabolism Of [Pyridinyl- 14-C-Methylene] Ntn 33893 In Loamy Sand Soil Bba 2.2 Under Aerobic Conditions (100140;M 1250187-4)(Imidacloprid/Admire), DACO: 8.2.3.1
1155832	Degradation Of [Pyridinyl-14-C - Methylene] Ntn 33893 In Silt Soil Hoefchen Under Aerobic Conditions (100141;M 1250187-4)(Imidacloprid/Admire), DACO: 8.2.3.1
1155834	Photodegradation Of Ntn 33893 In Water (88010;101956)(Imidacloprid/Admire), DACO: 8.2.1
1155835	Terrestrial Field Dissipation For Ntn 33893 In Minnesota Soil (101988;392723;N3022103)(Imidacloprid/Admire), DACO: 8.3.2.3
1155836	1992, Terrestrial Field Dissipation In Turf For Ntn 33893 In Georgia (102603;393553)(Imidacloprid/Admire), DACO: 8.3.2.3
1155837	Terrestrial Field Dissipation For Ntn 33893 In California Soil (101989;392733;N3022102)(Imidacloprid/Admire), DACO: 8.3.2.3
1155838	Metabolism Of [Pyridinyl-14-C-Methylene] Ntn 33893 In Sandy Loam Under Anaerobic Conditions (101241;M 1250187-4)(Imidacloprid/Admire), DACO: 8.2.3.1
1155840	Hydrolysis Of Ntn 33893 (99708;88011/Esr)(Imidacloprid/Admire), DACO: 8.2.1
1155853	Leaching Behaviour Of Ntn 33893 Aged In Soil (99635;M 1210225/3)(Imidacloprid/Admire), DACO: 8.2.4.1
1155864	Degradation Of [Pyridinyl-14-C- Methylene] Ntn 33893 In Sandy Loam Monheim 1 Under Aerobic Conditions (101955;M 1250187-4)(Imidacloprid/Admire), DACO: 8.2.3.1
1155865	Degradation Of Pesticides Under Anaerobic Conditions In The System Water/Sediment: Imidacloprid, Ntn 33893 (Admire)(101346;1520205-5), DACO: 8.2.3.1
1155868	Dissipation Of Imidacloprid In Soil Under Field Conditions (103948;Ra-2082/91)(Admire), DACO: 8.3.2.3
1155869	1992, Terrestrial Field Dissipation In Turf For Ntn 33893 In Minnesota (102604;393543)(Admire/Imidacloprid), DACO: 8.3.2.3
1155870	Terrestrial Field Dissipation For Ntn 33893 In Georgia Soil (101987;392743;N3022101)(Admire/Imidacloprid), DACO: 8.3.2.3
1160858	1994, Degradation And Translocation Of Imidacloprid (Ntn33893) Under Field Conditions On A Lysimeter.(M1330351-6;106426;106426-1) + Amendment To The Original Report (Admire 240f), DACO: 8.2.4.1
1174607	1998, Terrestrial Field Dissipation Of Imidacloprid On Turf In Ontario, Canada,1994. (Admire 240fs), DACO: 8.3.2.1

1174608	1998, Terrestrial Field Dissipation Of Imidacloprid On Bare Sandy Loam In Prince Edward Island, Canada,1994. (Admire 240fs), DACO: 8.3.2.1
1174609	1998, Terrestrial Field Dissipation Of Imidacloprid On Bare Loam In Ontario, Canada,1994. (Admire 240fs), DACO: 8.3.2.1
1174610	1998, Terrestrial Field Dissipation Of Imidacloprid On Potatoes In Prince Edward Island, Canada, 1994. (107820;N3022120).(Admire 240fs), DACO: 8.3.2.1
1174611	1998, Terrestrial Field Dissipation Of Imidacloprid On Turf In British Columbia, Canada,1995. (Admire 240fs), DACO: 8.3.2.1
1182373	1996, Aerobic Aquatic (Water Only) Biotransformation Of [Pyridinyl-14c-Methyl] Imidacloprid At 22c, J. Stevens Et Al, Completed December 4, 1996 (107547;42622) [Bay Ntn 33893;Regn.#24468], DACO: 8.2.3.5.2
1774484	2008, United States Department of Agriculture (USDA), Pesticide Data Program Annual Summary, Calendar Year 2007. Science and Technology Programs., www.ams.usda.gov/pdp, DACO: 8.6
1812582	2009, Analysis of Various Imidacloprid Samples, DACO: 8.2.4.6
1856875	2010, Determination of Residues of Clothianidin and Imidacloprid and their Metabolites in Sweet Pepper following an Application of Clothianidin & Imidacloprid WS 56.25 + 18.75 as Seed Treatment, DACO: 8.5
1856879	2010, Determination of Residues of Clothianidin and Imidacloprid and their Metabolites in Melon following an Application of Clothianidin & Imidacloprid WS 56.25 + 18.75 as Seed Treatment, DACO: 8.5
2142714	2009, An isotopic exchange method for the characterization of the irreversibility of pesticide sorption-desorption in soil, DACO: 8.2.4.2
2142715	2009, Sorption-desorption of Imidacloprid and its metabolites in soils, DACO: 8.2.4.2
2142716	2009, Time-dependent sorption of imidacloprid in two different soils, DACO: 8.2.4.2
2142719	2009, Changes in sorption/bioavailability of imidacloprid metabolites in soil with incubation time, DACO: 8.2.4.2
2142724	2009, Sorption of imidacloprid on soil clay mineral and organic components, DACO: 8.2.4.2
2142729	2009, Biological effects and fate of imidacloprid SL 200 in outdoor microcosm ponds, DACO: 8.6
2142816	2011, Aerobic metabolism of imidacloprid, 14C-NTN 33893, in an aquatic model ecosystem, DACO: 8.2.3.5.4
2142817	2011, Aerobic aquatic metabolism of NTN 33893, DACO: 8.2.3.5.4
2373072	2012, The role of pesticides on honey bee health and hive maintenance with an emphasis on the neonicotinoid, imidacloprid, DACO: 8.6,9.9
2464657	1998, Long-term soil dissipation study with Confidor 70 WG in apple orchards in Germany following spray application, DACO: 8.3.2.3,8.3.4
1086415	1999, Residue Levels of Imidacloprid and Imidacloprid Metabolites in Nectar, Blossoms, Pollen and Honey Bees Sampled from a Summer Rape Field in Sweden and Effects of These Residues on Foraging Honey bees., DACO: 9.2.9
1086416	1999, Effects of Imidacloprid Residues in Sunflower Honey on the Development of Small Bee Colonies Under Field Exposure Conditions., DACO: 9.2.9
1086417	1999, Effects of Imidacloprid Residues in Maize Pollen on the Development of Small Bee Colonies Under Field Exposure Conditions., DACO: 9.2.9
1086418	1999, Residue Levels of Imidacloprid and Imidacloprid Metabolites in Nectar, Blossoms, Pollen of Sunflowers Cultivated on Soils with Different Imidacloprid Residue Levels and Effects of These Residues on Foraging Honey bees., DACO: 9.2.9

1086419	1999, Residue of Imidacloprid and Imidacloprid Metabolites in Nectar, Blossoms, Pollen and Honey Bees Sampled from a French Summer Rape Field and Effects of These Residues on Foraging Honey bees., DACO: 9.2.9
1086420	1999, Honey Bee (Apis mellifera L.) Contact Toxicity Study in the Laboratory with Imidacoprid Technical., DACO: 9.2.4.1
1086421	1999, Bumble bee (Bombus terrestris L.) Oral Toxicity Study in the Laboratory with Imidacloprid Technical., DACO: 9.2.4.2
1086422	1999, Bumble bee (Bombus terrestris L.) Contact Toxicity Study in the Laboratory with Imidacloprid Technical., DACO: 9.2.4.1
1086423	1999, Residue Levels of Imidacloprid and Imidacloprid Metabolites in Nectar, Blossoms and Pollen of Summer Rape Cultivated on Soils with Different Imidacloprid Residue Levels and Effects of these Residues on Foraging Honey bees., DACO: 9.2.9
1086424	1999, Residue Levels of Imidacloprid and Imidacloprid Metabolites in Pollen of Maize Plants Cultivated on Soils with Different Imidacloprid Residue Levels., DACO: 9.2.9
1086425	1999, Residue Levels of Imidacloprid and Imidacloprid Metabolites in Honey bees Orally Dosed with Imidacloprid in Standard Toxicity Tests (EPPO 170), DACO: 9.2.4.2
1086426	1998, Residue Levels of Imidacloprid and Imidacloprid Metabolites in Sunflower Blossoms Sampled in Argentina, DACO: 9.2.9
1086427	1998, The Impact of GAUCHO and TI-435 Seed Treated Canola on Honey Bees, Apis mellifera L., DACO: 9.2.9
1086428	1999, Residues Levels of 14C-NTN 33893 (Imidacloprid) in Blossoms of Sunflower (Helianthus annuus) After Seed Dressing, DACO: 9.2.9
1086429	2000, The Effect of Sublethal Doses of Imidacloprid, Hydroxy-Imidacloprid and Olefine-Imidacloprid on the Behaviour of Honey bees., DACO: 9.2.9
1086430	1999, Laboratory Testing for Toxicity (Acute Oral LD50) of WAK3745 on Honey Bees (Apis mellifera L.) (Hymenoptera, Apidae) - Limit Test -., DACO: 9.2.4.2
1086431	1999, Laboratory Testing for Toxicity (Acute Oral LD50) of WAK4103 on Honey Bees (Apis mellifera L.) (Hymenoptera, Apidae) - Limit Test -., DACO: 9.2.4.2
1086432	1999, Laboratory Testing for Toxicity (Acute Oral LD50) of WAK33893 on Honey Bees (Apis mellifera L.) (Hymenoptera, Apidae) - Limit Test -., DACO: 9.2.4.2
1086433	1999, Honey bee (Apis mellifera L.) Oral Toxicity Study in the Laboratory with Imidacoprid Technical., DACO: 9.2.4.2
1086434	1999, Residue Levels of Imidacloprid and Imidacloprid Metabolites in Nectar, Blossoms, Pollen of Sunflowers Cultivated on Soils with Different Imidacloprid Residue Levels and Effects of These Residues on Foraging Honey bees., DACO: 9.2.9
1086435	1999, Residue Levels of Imidacloprid and Imidacloprid Metabolites in Nectar, Blossoms and Pollen of Summer Rape Cultivated on Soils with Different Imidacloprid Residue Levels and Effects of these Residues on Foraging Honey bees., DACO: 9.2.9
1086436	1999, Residue Levels of Imidacloprid and Imidacloprid Metabolites in Pollen of Maize Plants Cultivated on Soils with Different Imidacloprid Residue Levels., DACO: 9.2.9
1086437	2001, Evaluation of Effects on the Foraging Activity of Bee Populations in the Sunflower Fields of Western France. Is Gaucho Seed Dressing (Active Ingredient: Imidacloprid) Responsible for the Effects?, DACO: 9.2.4.3
1086438	Risk Posed to Honey bees (Apis mellifera L, Hymenoptera) by an Imidacloprid Seed Dressing of Sunflowers., DACO: 9.2.4.3
1803473	2008, Summary of an Apparent Bumble bee Poisoning Incident Resulting from Imidacloprid Application to Linden Trees ¿ detailed observations requested by EPA for incident # INRI-0021, DACO: 9.2.9

2142734	1999, Residues of imidacloprid and imidacloprid metabolites in nectar, blossoms, pollen and honey bees sampled from a summer rape field in Sweden and effects of these residues on foraging honey bees, DACO: 9.9
2142736	2002, Imidacloprid (Admire) residue levels following in-furrow application in potato fields in Prince Edward Island and New Brunswick, DACO: 9.9
2142738	2001, Hazards of imidacloprid seed coating to Bombus terrestris (Hymenoptera: Aphidae) when applied to sunflower, DACO: 9.9
2142739	1999, No causal relationship between Gaucho seed dressing in sunflowers and the french bee syndrome, DACO: 9.2.4.3,9.9
2142745	2003, Effects of sub-lethal imidacloprid doses on the homing rate and foraging activity of honey bees, DACO: 9.9
2142748	2003, Safety of imidacloprid seed dressings to honey bees: A comprehensive overview and compilation of the current state of knowledge, DACO: 9.2.4.3,9.9
2142754	2004, Effects of chronic dietary exposure of the honey bee Apis mellifera (Hymenoptera: Apidae) to imidacloprid, DACO: 9.9
2142758	2003, Effects of imidacloprid and common plant metabolites of imidacloprid in the honey bee: Toxicological and biochemical considerations, DACO: 9.9
2142760	2001, Risk posed to honey bees (Apis mellifera L., Hymenoptera) by an imidacloprid seed dressing of sunflowers, DACO: 9.2.4.3,9.9
2142762	2009, Effects of residues of imidacloprid in maize pollen from dressed seeds on honey bees (Apis mellifera), DACO: 9.9
2142763	2009, Evaluation of the effects of residues of imidacloprid FS 600 in maize pollen from dressed seeds on honey bees (Apis mellifera) in the semifield, DACO: 9.9
2142765	2009, Residue levels of imidacloprid and imidacloprid metabolites in honey bees orally dosed with imidacloprid in standardized toxicity tests (EPPO 170), DACO: 9.9
2142766	1999, Effects of imidacloprid residues in maize pollen on the development of small bee colonies under field exposure conditions, DACO: 9.9
2142769	2003, Imidacloprid used as a seed dressing (Gaucho) and disorders in bees - Translation of report imidacloprid utilise en enrobage de semences (Gaucho) et troubles des abeilles-rapport final, DACO: 9.9
2142774	2009, Colony losses monitoring project - Trial years 2004 - 2008 summary and provisional assessment of results (Translation of German report: Monitoring-Projekt Voelkerverluste Untersuchungsjahre 2004 - 2008 Zusammenfassung und vorlaeufige Beurteilung der Ergebnisse), DACO: 9.9
2142775	2009, The effects of sublethal doses of imidacloprid on the foraging behaviour and orientation ability of honey bees, DACO: 9.9
2142777	2009, Abnormal foraging behavior induced by sublethal dosage of imidacloprid in the honey bee (Hymenoptera: Apidae), DACO: 9.9
2142781	1999, Effects of imidacloprid residues in sunflower honey on the development of small bee colonies under field exposure conditions, DACO: 9.9
2142787	2009, Residue levels of imidacloprid and imidacloprid metabolites in nectar, blossoms and pollen of summer rape cultivated on soils with different imidacloprid residue levels and effects of these residues on foraging honey bees. Laacher Hof 1999, DACO: 9.9
2142798	Assessment of Sublethal Effects of Imidacloprid on Honey Bee and Colony Health, DACO: 9.9
2142802	2010, Assessment of Bayer laboratory dust-off studies conducted in support of multiple Bayer seed treatment formulation risk assessments, DACO: 9.9

2142804	2004, Effects of chronic dietary exposure of the honey bee Apis mellifera (Hymenoptera: Apidae) to imidacloprid, DACO: 9.9
2142805	2010, Monitoring of potential effects of the drilling of clothianidin treated maize seeds on honey bees, guttationmonitoring of maize seedlings under agronomic use conditions and assessment of the relevance of guttation for honey bees in aquataine (France), DACO: 9.9
2142806	2011, Monitoring of potential effects of the drilling of Clothianidin treated maize seeds on honey bees, guttation monitoring of maize seedlings under agronomic use conditions and assessment of the relevance of guttation for honey bees in Languedoc-Roussillon (France), DACO: 9.9
2142807	2011, Monitoring of potential effects of the drilling of Clothianidin treated maize seeds on honey bees, guttation monitoring of maize seedlings under agronomic use conditions and assessment of the relevance of guttation for honey bees in Champagne (France), DACO: 9.9
2142808	2011, Monitoring of potential effects of the drilling of Clothianidin treated maize seeds on honey bees, guttation monitoring of maize seedlings under agronomic use conditions and assessment of the relevance of guttation for honey bees in Alsace (France), DACO: 9.9
2142809	2009, Occurrence and cause of guttation, DACO: 9.9
2142810	2003, Imidacloprid, potatoes and honey bees in Atlantic Canada: Is there a connection?, DACO: 9.9
2142811	2009, Imidacloprid (Admire) residue levels following in-furrow application in potato fields in Prince Edward Island and New Brunswick, DACO: 9.9
2142812	2010, Laboratory dust-off study of imidacloprid seed treatment formulations, DACO: 9.9
2142818	2001, The impact of Gaucho and TI-435 seed-treated Canola on honey bees, Apis mellifera L, DACO: 9.2.4.3
2142819	2002, Validation and analysis of residues of T1-435, Imidacloprid, hydroxy Metabolite, and Olefin metabolite in Nectar and Pollen, DACO: 9.2.4.3
2182453	2011, Imidacloprid tech.: Effects of exposure to spiked diet on honey bee larvae (Apis mellifera carnica) in an in vitro laboratory testing design, DACO: 9.9
2270888	2012, Assessment of exposure of honey bees (Apis mellifera) to imidacloprid in controlled feeding study, interim report, DACO: 9.2.4.3(EPA)
2270889	2012, Summary of Bayer CropScience-sponsored honey bee semi-field and field studies for imidacloprid seed-treatments, DACO: 9.2.4.3(EPA),9.9(EPA)
2270894	2012, Interim report: Pilot study of honey bee brood and colony level effects following dietary intake of Imidacloprid intake in a field study in North Carolina, DACO: 9.2.4.3(EPA)
2287055	2013, Pilot Study: Honey bee brood and colony level effects following Imidacloprid intake via treated artificial diet in a field study in North Carolina, DACO: 9.2.4.3
2287070	2011, Determination of the residues of imidacloprid and its metabolites 5-hydroxy imidacloprid and imidacloprid olefin in bee relevant matrices collected from cotton, grown at locations treated with imidacloprid at least once per year during two successive years, DACO: 9.9
2287073	2011, Determination of the residues of imidacloprid and its metabolites 5-hydroxy imidacloprid and imidacloprid olefin in bee relevant matrices collected from tomato, a fruiting vegetable, grown at locations treated with imidacloprid at least once per year during two successive years, DACO: 9.9
2287076	2011, Determination of exposure levels of honey bees foraging on flowers of citrus trees previously treated with imidacloprid, DACO: 9.9
2287077	2012, Summary of key findings and conclusions of investigations to evaluate bee exposure levels at Southern California citrus groves previously treated with imidacloprid, DACO: 9.9
2287080	2012, Determination of the residues of imidacloprid and its metabolites 5-hydroxy imidacloprid and imidacloprid olefin in bee relevant matrices collected from melons grown at locations treated with imidacloprid at least once per year during two successive years, DACO: 9.9
2287084	2012, Determination of the residue of imidacloprid and its metabolites 5-hydroxy imidacloprid and imidacloprid olefin in bee relevant matrices collected from strawberries, grown at locations treated with imidacloprid at least once per year during two successive years, DACO: 9.9

2351140	1999, 1999 Evaluation of: Gaucho seed dressing applied to canola on the honey bee,(Apis mellifera Linnaeus) at indian head, Saskatchewan (indian head research station site), DACO: 9.2.4.3
2351141	1999, Effects of imidacloprid residues in maize pollen on the development of small bee colonies under field exposure conditions, DACO: 9.2.4.3
2351142	1999, Effects of imidacloprid residues in sunflower honey on the development of small bee colonies under field exposure conditions, DACO: 9.2.4.3
2351145	2002, Evaluation of the effects of residues of imidacloprid FS 600 in maize pollen from dressed seeds on honey bees (Apis mellifera) in the semifield, DACO: 9.2.4.3
2351147	1999, Field test of Gaucho 350 FS seeddressed sunflowers on honey bee colonies, DACO: 9.2.4.3
2351149	2002, Field test: Side effects of oil-seed rape grown from seeds dressed with imidacloprid and beta-cyfluthrin FS 500 on the honey bee (Apis mellifera L.), DACO: 9.2.4.3
2351151	2000, Long-term population assessment (T6) after overwintering, addenda to the final report: Field assessment in Argentina of possible side-effects on the honey-bee of the product Gaucho in sunflowers, DACO: 9.2.4.3
2351169	1999, Residues of imidacloprid and imidacloprid metabolites in nectar, blossoms, pollen and honey bees sampled from a british summer rape field and effects of these residues on foraging honey bees, DACO: 9.2.4.3
2351175	1999, Residues of imidacloprid and imidacloprid metabolites in nectar, blossoms, pollen and honey bees sampled from a summer rape field in Sweden and effects of these residues on foraging honey bees, DACO: 9.2.4.3
2351179	2000, Substance A - Acute contact toxicity to honey bees (Apis mellifera), DACO: 9.2.4.1
2351182	2000, Substance A - Acute effects on the honey bee Apis mellifera (Hymenoptera, Apidae), non-GLP, DACO: 9.2.4.1
2351184	1990, The acute oral and contact toxicity to honey bees of compound NTN 33893 technical, DACO: 9.2.4.2
2351185	1998, The impact of Gaucho 70 WS seed treated sunflower seeds on honey bees, DACO: 9.2.4.3
2355472	2012, Amendment no. 1 to report no: MR-12/038 - Field study to monitor potential effects on honey bees from exposure to guttation fluid of winter barley (W-BAR), seed-treated with the insecticidal seed-treatment product Clothianidin + Imidacloprid FS 100 + 175 G in Germany in 2011/2012, DACO: 9.2.4.3,9.9
2355497	2010, Field study to monitor the potential exposure of honey bees to guttation fluid of winter wheat (W-WHT) treated with Clothianidin & Beta-Cyfluthrin FS 375 + 80 or Triadimenol & Imidacloprid & Fuberidazol & Imazalil FS 60 + 70 + 7.2 + 8 on fields in southern and northern Germany in autumn 2009 and spring 2010, DACO: 9.9
2355498	2010, Field study to monitor the potential exposure of honey bees to guttation fluid of winter barley (W-BAR) treated with clothianidin & beta-cyfluthrin FS 375 + 80 or triadimenol & imidacloprid & fuberidazol & imazalil FS 60 + 70 + 7.2 + 8 on fields in southern and northern Germany in autumn 2009 and spring 2010, DACO: 9.9
2355499	2009, Guttation monitoring of maize seedlings under agronomic use conditions in Austria and assessment of the relevance of Guttation for honey bees, DACO: 9.9
2364413	1995, Bienen VI: Bluetenbesuch nach Beizung, DACO: 9.2.4.3
2364414	1995, Bienen VI: Bluetenbesuch nach Beizung, DACO: 9.2.4.3
2364416	1998, Bluetenbesuch von Gaucho-gebeizten Sonnenblumen, DACO: 9.2.4.3
2364423	1988, Bienenvertraeglichkeit von Beizmitteln (Bienen-Zelt I), DACO: 9.2.4.3
2364425	1990, Biene IV: Bodenanwendung von NTN 33893 zur Saat, DACO: 9.2.4.3

2364426	1990, Biene IV: Bodenanwendung von NTN 33893 zur Saat, DACO: 9.2.4.3
2364427	1997, Bienen I: Systemizitaet von insektiziden Beizen, DACO: 9.2.4.3
2364429	1999, Beobachtungen im Zeltversuch mit Bienen nach Beizung von Sommerraps, DACO: 9.2.4.3
2397645	2014, Interim Report: Honey bee brood and colony level effects following Imidacloprid intake via treated artificial diet in a field study in North Carolina, DACO: 9.2.4.3
2463188	2014, Honey bee colony feeding study, evaluating the effects of imidacloprid-fortified artificial nectar diet on long term colony health in a field study in North Carolina: Colony Condition Assessment Data & Statistics - Interim Report, DACO: 9.9
2474493	2012, Imidacloprid (tech.) - Assessment of Chronic Effects to the Honey Bee, Apis mellifera L., in a 10 Days Continuous Laboratory Feeding Test, DACO: 9.2.4.3
2474495	2014, Honey bee brood and colony level effects following Imidacloprid intake via treated artificial diet in a field study in North Carolina - Final Report, DACO: 9.2.4.3
2474497	2014, Determination of the Residues of Imidacloprid and its Metabolites 5-Hydroxy Imidacloprid and Imidacloprid Olefin in Bee Relevant Matrices Collected from Seed Treated Field Corn During Two Successive Years and in White Clover Planted after Seed Treated Field Corn, DACO: 9.9
2474499	2014, Determination of the Residues of Imidacloprid and its Metabolites 5-Hydroxy Imidacloprid and Imidacloprid Olefin in Bee Relevant Matrices Collected from Treated Cotton During Two Successive Years and in White Clover Planted after Treated Cotton, DACO: 9.9
2479562	2014, ADMIRE PRO - Magnitude of the Residues of Imidacloprid and its Metabolites 5-Hydroxy Imidacloprid and Imidacloprid Olefin in Bee Relevant Matrices Collected from Citrus Trees following Foliar Applications of Imidacloprid Over Two Successive Years - Final Report, DACO: 9.9
2486614	2014, Determination of the Residues of Imidacloprid and its Metabolites 5-Hydroxy Imidacloprid and Imidacloprid Olefin in Bee Relevant Matrices Collected from Cherry Trees following Foliar Application of Imidacloprid over Two Successive Years - Final Report, DACO: 9.9
2486615	2014, Determination of the Residues of Imidacloprid and its Metabolites 5-Hydroxy Imidacloprid and Imidacloprid Olefin in Bee Relevant Matrices Collected from Blueberries following Soil Application of Imidacloprid over Two Successive Years - Final Report, DACO: 9.9
2510477	2012, Field study to monitor potential effects on honey bees from exposure to guttation fluid of winter barley (W-BAR), seed-treated either with an imidacloprid or a clothianidin combi-product, DACO: 9.2.4.3,9.9
2510479	2014, A long-term field study to monitor potential effects on the honey bee (Apis mellifera L.) from exposure to guttation fluid of sugar beets, seed-treated with the insecticides clothianidin + imidacloprid + beta-cyfluthrin in Southern Germany in 2013 and 2014, DACO: 9.2.4.3,9.9
2510480	2014, A long-term field study to monitor potential effects on the honey bee (Apis mellifera L.) from exposure to guttation fluid of sugar beets, seed-treated with the insecticides clothianidin + imidacloprid + beta-cyfluthrin in Southern Germany in 2013 and 2014, DACO: 9.2.4.3,9.9
2510486	2014, Field study to monitor potential effects on honey bees from exposure to guttation fluid of winter wheat (W-WHT), seed-treated either with an imidacloprid or a clothianidin combi-product, DACO: 9.2.4.3,9.9
2513415	2014, Imidacloprid FS 350 (350 g/L)- Acute Contact Toxicity to the Bumble bee, Bombus terrestris L. under Laboratory Conditions, DACO: 9.2.4.1
2513416	2014, Determination of the residues of imidacloprid in bee relevant matrices collected from succeeding crops following application of IMIDACLOPRID FS 600E G via soil incorporation to plateau concentration and sowing of imidacloprid-treated winter barley seeds. Field phase conducted in Southern France., DACO: 9.9
2523521	2001, Acute toxicity of imidacloprid SL 200 to the honey bee Apis mellifera L. under laboratory conditions, DACO: 9.2.4.1,9.2.4.2
2523522	2000, Acute toxicity of substance A to the honey bee Apis mellifera L. under laboratory conditions, DACO: 9.2.4.1,9.2.4.2

2523525	2000, Acute oral toxicity of substance C to the honey bee Apis mellifera L. under laboratory conditions prolonged for 10 days, DACO: 9.2.4.2
2523526	2000, Acute oral toxicity of substance B to the honey bee Apis mellifera L. under laboratory conditions prolonged for 10 days, DACO: 9.2.4.2
2523527	2000, Substance A - Acute oral toxicity to honey bee Apis mellifera, DACO: 9.2.4.2
2523528	1998, Feeding test with bees in field conditions, DACO: 9.2.4.3
2523530	2000, Substance C: feeding study with honey bees (Apis mellifera), DACO: 9.2.4.3
2523531	2000, Substance B: feeding test on the honey bees (Apis mellifera), non-GLP, DACO: 9.2.4.3
2523532	2000, Substance B: feeding study with honey bees (Apis mellifera), DACO: 9.2.4.3
2523533	2000, Repeat Test: Substance C: feeding test on the honey bee Apis mellifera L. (Hymenoptera, Apidae), non-GLP, DACO: 9.2.4.3
2523534	2000, Substance B: Assessment of side effects in a ten days feeding test on the honey bee, Apis mellifera L. in the laboratory - hive bees (< 5 days), DACO: 9.2.4.3
2523535	2000, Substance C: Assessment of side effects in a ten days feeding test on the honey bee, Apis mellifera L. in the laborators - hive bees (< 5 days), DACO: 9.2.4.3
2523536	2000, Substance C: Assessment of side effects in a ten days feeding test on the honey bee, Apis mellifera L. in the laboratory - foraging bees (= 22-32 days), DACO: 9.2.4.3
2523541	2003, A multiple-rate cage test to study effects of Confidor SL 200 on honey bee (Apis mellifera L.) when applied to flowering Phacelia tanacetifolia 24, 48 and 96 hours before bee exposure, DACO: 9.9
2523558	2002, Evaluation of the effects of a soil treatment of ornamental plants with Imidacloprid WG 5 on nectar and pollen sampling bumble bees (Bombus terrestris) in the semifield (test plants: Erica and Lobelia), DACO: 9.2.4.3
2523559	2001, Evalution of the effects of a soil treatment of ornamental plants with imidacloprid WG 5 on nectar and pollen sampling bumble bees (Bombus terrestris) in the semifield, DACO: 9.2.4.3
2523560	2003, Assessment of the effects of a soil treatment of ornamentals with imidacloprid WG 5 on nectar and pollen collecting bumble bees (Bombus terrestris) in the field (test plant: Lobelia erinus), DACO: 9.2.4.3
2523561	2003, Evaluation of the effects of a soil treatment of ornamental plants with Imidacloprid WG 5 on nectar and pollen sampling honey bees (Apis mellifera) in the semifield (test plants: Erica and Lobelia), DACO: 9.2.4.3
2535869	2014, Clothianidin + imidacloprid FS 275 (100+175 g/L): Acute contact toxicity to the bumble bee, Bombus terrestris L. under laboratory conditions, DACO: 9.2.4.1
2535870	2014, Imidacloprid + pencycuron FS 370 (120+250 g/L) - Acute contact toxicity to the bumble bee, Bombus terrestris L. under laboratory conditions, DACO: 9.2.4.1
2535872	2014, Effects of clothianidin + imidacloprid FS 275 (100+175) G (acute contact and oral) on honey bees (Apis mellifera L.) in the laboratory, DACO: 9.2.4.1,9.2.4.2
2535873	2014, Effects of imidacloprid + pencycuron FS 370 (120+250) G (acute contact and oral) on honey bees (Apis mellifera L.) in the laboratory, DACO: 9.2.4.1,9.2.4.2
2535874	2014, Effects of imidacloprid FS 350A G (acute contact and oral) on honey bees (Apis mellifera L.) in the laboratory, DACO: 9.2.4.1,9.2.4.2

2535875	2014, Final report - A field study to evaluate effects of Monceren G on the bumble bee (Bombus terrestris L; Hymenoptera, Apidae) in potato in southern Germany in 2014, DACO: 9.2.4.3
2535876	2014, A field study to evaluate effects of Monceren G on the bumble bee (Bombus terrestris L; Hymenoptera, Apidae) in potato in southern Germany in 2014, DACO: 9.2.4.3
2535877	2014, Field study to monitor potential effects on honey bees from exposure to guttation fluid of winter barley (W-BAR), seed-treated with the insecticidal seed-treatment product clothianidin + imidacloprid FS 100 + 175 G in Germany in 2011/2012, DACO: 9.2.4.3
2535878	2014, A long-term field study to monitor potential effects on the honey bee (Apis mellifera L.) from exposure to guttation fluid of potato plants, grown from seed tubers treated with Monceren G in southern Germany in 2014 and 2015, DACO: 9.2.4.3
2535879	2014, A long-term field study to monitor potential effects on the honey bee (Apis mellifera L.) from exposure to guttation fluid of potato plants, grown from seed tubers treated with Monceren G in Southern Germany in 2014 and 2015, DACO: 9.2.4.3
2535880	2014, Final report - Assessment of potential impacts on honey bee colony development, their hibernation performance and concurrent monitoring of aerial dust drift during the sowing operation of Poncho Beta Plus - Treated sugar beet pills with typical commercial vacuum-pneumatic sowing technology, directly adjacent to full-flowering Phacelia tanacetifolia in Germany, DACO: 9.2.4.3
2535881	2014, Interim report - Assessment of potential impacts on honey bee colony development, their hibernation performance and concurrent monitoring of aerial dust drift during the sowing operation of imidacloprid FS 350A G - Treated winter barley with typical commercial vacuum-pneumatic sowing technology, directly adjacent to full-flowering Phacelia tanacetifolia in United Kingdom, DACO: 9.2.4.3
2535892	2014, Determination of the residues of imidacloprid and its metabolites imidacloprid-5-hydroxy and imidacloprid-olefin in bee relevant matrices collected in a succeeding crop scenario with natural aged residues of imidacloprid - Field phase conducted with winter oil seed rape, Phacelia and maize in northern France, DACO: 9.9
2535893	2014, Determination of the residues of imidacloprid and its metabolites imidacloprid-5-hydroxy and imidacloprid-olefin in bee relevant matrices collected in a succeeding crop scenario with natural aged residues of imidacloprid - Field phase conducted with winter oil seed rape in northern France, DACO: 9.9
2535894	2014, Determination of the residues of imidacloprid and its metabolites imidacloprid-5-hydroxy and imidacloprid-olefin in bee relevant matrices collected in a succeeding crop scenario with natural aged residues of imidacloprid - Field phase conducted with Phacelia and maize in northern France, DACO: 9.9
2535895	2014, Determination of the residues of imidacloprid and its metabolites imidacloprid-5-hydroxy and imidacloprid-olefin in bee relevant matrices collected in a succeeding crop scenario with natural aged residues of imidacloprid - Field phase conducted with Phacelia and maize in northern France, DACO: 9.9

2535897	2014, Residues of imidacloprid in nectar and pollen of flowering rotational crops in western Germany, DACO: 9.9
2535900	2010, Monitoring of dust drift deposits during and after sowing of winter barley (W-BAR) treated with Triadimenol & Imidacloprid & Fuberidazol & Imazalil FS 145.2 (60 + 70 + 7.2 + 8 g/L) or Clothianidin & Beta-Cyfluthrin FS 455 (375 + 80 g/L) on fields in Germany, DACO: 9.9
2535901	2010, Monitoring of dust drift deposits during and after sowing of winter wheat (W-WHT) treated with Triadimenol & Imidacloprid & Fuberidazol & Imazalil FS 145.2 (60 + 70 + 7.2 + 8 g/L) or Clothianidin & Beta-Cyfluthrin FS 455 (375 + 80 g/L) on fields in Germany, DACO: 9.9
2535902	2014, Second amendment to final report - Investigation of dust drift deposits of clothianidin & imidacloprid treated winter barley seeds with pneumatic sowing machinery on fields in Germany in autumn 2011, DACO: 9.9
2542276	2006, Assessment of effects of imidacloprid WG 70 on foraging activity and mortality of honey bees and bumble bees after drenching application under field conditions on shrubs of the species Rhododendron catawbiense grandiflorum surrounded by other ornamental plant species, DACO: 9.2.4.3,9.9
2542277	2006, Assessment of effects of a drench application of imidacloprid WG 70 to shrubs of Rhododendron sp and to Hibiscus syriacus on foraging activity and mortality of honey bees and bumble bees under field conditions, DACO: 9.2.4.3,9.9
2542278	2004, Residues of imidacloprid WG 5 in blossom samples of Rhododendron sp. (variety Nova Zembla) after soil treatment in the field - 2003,, DACO: 9.9
2542279	2005, Residues of imidacloprid WG 5 in blossom and leaf samples of Amelanchier sp. after soil treatment in the field - Application: 2003, sampling: 2004 and 2005, DACO: 9.9
2542280	2004, Residues of imidacloprid WG 5 in blossom samples of Rhododendron sp. (variety Nova Zembla) after soil treatment in the field - Application: Spring 2003, sampling: 2003 and 2004, DACO: 9.9
2542281	2005, Residues of imidacloprid WG 5 in blossom samples of Cornus mas after soil treatment in the field - Application: 2003, sampling: 2005, DACO: 9.9
2542282	2005, Residues of imidacloprid WG 5 in blossom samples of shrubs of different sizes of the species Rhododendron sp after drenching application in he field - Application: 2004, Sampling: 2005, DACO: 9.9
2542283	2004, Determination of the residue levels of imidacloprid and its metabolites hydroxy-imidacloprid and olefin-imidacloprid in leaves and blossoms of horse chestnut trees (Aesculus hippocastanum) after soil treatment - Application 2001 and sampling 2002, DACO: 9.9
2542285	2004, Residues of imidacloprid WG 5 in blossom samples of lime trees (Tilia europaea) after soil treatment in the field - Application: 2003, sampling: 2004, DACO: 9.9
2542286	2004, Residues of imidacloprid WG 5 in blossom and leaf samples of apple trees after soil treatment in the field - Application: 2003, Sampling: 2004, DACO: 9.9
2542287	2004, Residues of imidacloprid WG 5 in blossom samples of Rhododendron sp. after soil treatment in the field - Application: Autumn 2003, sampling: 2004, DACO: 9.9

2542288	2004, Determination of the residue levels of imidacloprid and its relevant metabolites in nectar, pollen and other plant material of chestnut trees (Aesculus hippocastanum) after soil treatment application and sampling 2001, DACO: 9.9
2548345	2015, Determination of the Residues of Imidacloprid, 5-Hydroxy Imidacloprid, and Imidacloprid Olefin in Bee Relevant Matrices Collected from Cotton During Two Successive Years - Final Report, DACO: 9.9
2557112	2014, Assessment of potential impacts on honey bee colony development, their hibernation performance and concurrent monitoring of aerial dust drift during the sowing operation of imidacloprid FS 350A G - Treated winter barley with typical commercial vacuum-pneumatic sowing technology, directly adjacent to full-flowering Phacelia tanacetifolia in United Kingdom, DACO: 9.2.4.3,9.9
2557113	1995, Laboratory testing for toxicity (acute contact and oral LD50) of Confidor SC 200 to honey bees (Apis mellifera L.) (Hymenoptera, Apidae), DACO: 9.2.8
2557114	1995, Laboratory testing for toxicity (acute contact and oral LD50) of Confidor WG 70 to honey bees (Apis mellifera L.) (Hymenoptera, Apidae), DACO: 9.2.8
2557115	2001, Effects of imidacloprid SL 200 (acute contact and oral LD50) on honey bees (Apis mellifera L.) in the laboratory, DACO: 9.2.8
2557116	1992, NTN 33893: Toxicity to honey bees on alfalfa treated foliage, DACO: 9.9
2592246	2015, Interim Report: Pollinator field study evaluating chronic effects of seed, in-furrow at planting and a pre-bloom foliar application of imidacloprid to cotton, Gossypium barbadense L., DACO: 9.9
2593970	2015, Interim Report: Pollinator field study evaluating chronic effects of a post seeding application of imidacloprid in pumpkins (Curcubita pepo pepo), DACO: 9.9
2603450	2016, Determination of the Residues of Imidacloprid, 5-Hydroxy Imidacloprid, and Imidacloprid Olefin in Bee Relevant Matrices Collected from Stone Fruit Trees following Application of Imidacloprid over Two Successive Years - Final Report, DACO: 9.9
2603451	2016, Determination of the Residues of Imidacloprid and its Metabolites 5-Hydroxy Imidacloprid and Imidacloprid Olefin in Bee Relevant Matrices Collected from Apple Trees following Soil and Foliar Applications of Imidacloprid over Two Successive Years - Final Report, DACO: 9.9
2618610	2016, Determination of the Residues of Imidacloprid and its Metabolites 5-Hydroxy Imidacloprid and Imidacloprid Olefin in Bee Relevant Matrices Collected from Apple Trees following Soil and Foliar Applications of Imidacloprid over Two Successive Years., DACO: 9.9
2636144	2001, Confidor SL 200: a multiple rate cage study to determine effects on honey bees, Apis mellifera L, when applied to flowering Phacelia tanacetifolia, DACO: 9.9
2637324	2016, Amended Report 1 to EBNTN011: Determination of the Residues of Imidacloprid, 5-Hydroxy Imidacloprid, and Imidacloprid Olefin in Bee Relevant Matrices Collected from Cotton During Two Successive Years - Final Report, DACO: 9.9

2637325	2016, Amended Report 1 to EBNTN012: Determination of the Residues of Imidacloprid, 5-Hydroxy Imidacloprid, and Imidacloprid Olefin in Bee Relevant Matrices Collected from Tomatoes Following Application of Imidacloprid Over Two Successive Years - Final Report, DACO: 9.9
2652476	2015, Determination of Residues of Imidacloprid in Flowers, Leaves, Soil, Nectar and Pollen of Melon, after Drip, Drench or Foliar Applications with Evidence(R) 700 WG, Warrant(R) 700 WG or Provado(R) 200 SC in a Semi-Field Study in Brazil, DACO: 9.9
2693159	2016, Report Amendment No. 1 to Study No. S13-05010: Determination of Residues of Imidacloprid and Clothianidin in Flowers, Leaves, Soil, Nectar and Pollen of Soybean after Seed Treatment with Gaucho(R) FS (Imidacloprid 600 FS) or Poncho(R) (Clothianidin 600 FS), or Foliar Application with Connect(R) (Imidacloprid & Beta-Cyfluthrin 112.5 SC) in a Semi-Field Study in Brazil, DACO: 9.9
2693160	2016, Report Amendment No. 1 to Study No. S13-05011: Determination of Residues of Imidacloprid and Clothianidin in Flowers, Leaves, Soil, Nectar and Pollen of Soybean after Seed Treatment with Gaucho(R) FS (Imidacloprid 600 FS) or Poncho(R) (Clothianidin 600 FS), or Foliar Application with Connect(R) (Imidacloprid & Beta-Cyfluthrin 112.5 SC) in a Semi-Field Study in Brazil, DACO: 9.9
2737113	2017, Pollinator field study evaluating chronic effects of seed, in-furrow at planting and a pre-bloom foliar application of imidacloprid to cotton, Gossypium barbadense L., DACO: 9.2.4.3,9.9
2754585	2017, Final Report: Survey of imidacloprid residues in nectar and pollen collected by honey bees in urban and suburban environments across different regions of the United States, DACO: 9.9
2757276	2017, Pollinator full field study evaluating the chronic effects of a post seeding application of imidacloprid in pumpkins (Curcubita pepo pepo), DACO: 9.2.4.3,9.9

B. Additional Information Considered

B.1 Published Information

B.1.0 Environmental Assessment

B.1.1 Environmental Fate and Effects Assessment

PMRA Document Number	Reference
-	Abbo PM, Kawasaki JK, Hamilton M, Cook SC, DeGrandi-Hoffman G, Li WF, Liu J, Chen YP. 2016. Effects of imidacloprid and Varroa destructor on survival and health of European honey bees, Apis mellifera. Insect Sci. doi:10.1111/1744-7917.12335. DACO: 9.2.4.9
-	Abbott VA, Nadeau JL, Higo HA, Winston ML. 2008. Lethal and sublethal effects of imidacloprid on Osmia lignaria and clothianidin on Megachile rotundata (Hymenoptera: Megachilidae). Journal of Economic Entomology, 101(3): 784-796. DACO: 9.2.4.3, 9.2.4.6

PMRA Document Number	Reference
-	Alarcón AL, Cánovas M, Senn R, Correia R. 2005. The safety of thiamethoxam to pollinating bumble bees (Bombus terrestris L.) when applied to tomato plants through drip irrigation. Commun Agric Appl Biol Sci 70(4):569-579. DACO: 9.2.4.6
-	Alaux C, Brunet JL, Dussaubat C, Mondet F, Tchamitchan S, Cousin M, Brillard J, Baldy A, Belzunces LP, Le Conte Y. 2010. Interactions between Nosema microspores and a neonicotinoid weaken honey bees (Apis mellifera). Environmental Microbiology 12(3): 774-782. DACO: 9.2.4.2
-	Alkassab AT, Kirchner WH. 2017. Sublethal exposure to neonicotinoids and related side effects on insect pollinators: honey bees, bumble bees, and solitary bees. J. Plant Dis. Prot. 124: 1-30. DOI 10.1007/s41348-016-0041-0. DACO: 9.2.4.7
-	Ambolet B, Crevat JF, Schmidt HW. 1997. Research on secondary effects of seed treatment with imidacloprid on the behaviour of honey bees on flowers of sunflower. Proceedings of the fourth international conference on pests in agriculture; 6-8 January 1997; Montpellier, France; Association Nationale pour la Protection des Plantes (ANPP). DACO: 9.2.4.6, 9.2.4.7
2332677	Anhalt J, Moorman TB and Koskinen WC. 2008. Degradation and sorption of imidacloprid in dissimilar surface and subsurface soils. Journal of Environmental Science and Health Part B. 43: 207-213. DACO: 8.2.3.4.2
-	Arena M, Sgolastra F. 2014. A meta-analysis comparing the sensitivity of bees to pesticides. Ecotoxicology 23:324–334; DOI 10.1007/s10646-014-1190-1. DACO: 9.2.4.1
-	Bailey JC, Scott-Dupree CD, Harris CR, Tolman J, Harris BJ. 2005. Contact and oral toxicity to honey bees (Apis mellifera L.) of agents registered for use for sweet corn insect control in Ontario, Canada, Apidologie 36: 623-633. DACO: 9.2.4.1, 9.2.4.2
-	Barbosa WF, De Meyer L, Guedes RN, Smagghe G. Lethal and Sublethal Effects of azadirachtin on the Bumble Bee Bombus terestris. Ecotoxicology. 2015 Jan; 24(1):130-42. doi: 10.1007/s10646-014-1365-9. DACO: 9.2.4.6
-	Baskaran S, Kookana RS and Naidu R. 1999. Degradation of bifenthrin, chlorpyrifos and imidacloprid in soil and bedding materials at termiticidal application rates. Pestic. Sci. 55:1222-1228. DACO: 8.5
-	Belien T, Kellers J, Heylen K, Keulemans W, Billen J, Arckens L, Huybrechts R, Gobin B. 2009. Effects of sublethal doses of crop protection agents on honey bee (Apis mellifera) global colony vitality and its potential link with aberrant foraging activity. Communications in Agricultural and Applied Biological Sciences. 74/1. 245-253. DACO: 9.2.4.6
-	Biddinger DJ, Robertson JL, Mullin C, Frazier J, Ashcraft SA, Rajotte EG, Joshi NK, Vaughn M. 2013. Comparative Toxicities and Synergism of Apple Orchard Pesticides to Apis mellifera (L.) and Osmia cornifrons (Radoszkowski). PLoS ONE 8(9): e72587. DACO: 9.2.4.1
-	Blanken LJ, van Langevelde F, van Dooremalen C. 2015. Interaction between Varroa destructor and imidacloprid reduces flight capacity of honey bees. Proc. R. Soc. B 282: 20151738. http://dx.doi.org/10.1098/rspb.2015.1738". DACO: 9.2.4.6

PMRA Document Number	Reference
-	Boily M, Sarrasin B, DeBlois C, Aras P, Chagnon M. 2013. Acetylcholinesterase in honey bees (Apis mellifera) exposed to neonicotinoids, atrazine and glyphosate: Laboratory and field experiments. Environ Sci Pollut Res 20(8):5603-5614. DACO: 9.2.4.2
2545407	Bonmatin JM, Giorio C, Girolami V, Goulson D, Kreutzweiser DP, Krupke C, et al. 2015. Environmental fate and exposure; neonicotinoids and fipronil. Environmental Science and Pollution Research International 22(1):35-67. DACO: 8.5
-	Bonmatin JM, Marchand PA, Charvet R, Moineau I, Bengsch ER and Colin ME. 2005. Quantification of imidacloprid uptake in maize crops. J Agric Food Chem 53(13):5336-5341. DACO: 9.2.4.8
-	Bortolotti L, Grazioso E, Porrini C, Sbrenna G. 1999. Effect of pesticides on the bumble bee Bombus terrestris L. in the laboratory. Hazards of pesticides to bees, Avignon (France), September 07-09, 1999, Ed. INRA, Paris. DACO: 9.2.4.1, 9.2.4.2
-	Bortolotti L, Montanari R, Marcelino J, Medryzycki P, Maini S, Porrini C. 2003. Effects of sub-lethal imidacloprid doses on the homing rate and foraging activity of honey bees. Bulletin of Insectology 56 (1): 63-67. DACO: 9.2.4.6
-	Botías , C., D. Arthur, J. Horwood, A. Abdul-¬-Sada, E. Nicholls, E. H. Hill and D. Goulson, 2015. Neonicotinoid residues in wildflowers, a potential route of chronic exposure for bees. Environmental Science & Technology 49: 12731-12740. DACO: 9.2.4.8
-	Botias et al., 2017. Quantifying exposure of wild bumble bees to mixtures of agrochemicals in agricultural and urban landscapes. Environmental Pollution http://dx.doi.org/10.1016/j.envpol.2017.01.001. DACO: 9.2.4.7
-	Broznic D, Milin C. 2012. Effects of temperature on sorption-desorption processes of imidacloprid in soils of Croatian coastal regions. Journal of Environmental Science & Health - Part B: Pesticides, Food Contaminants, & Agricultural Wastes, 47(8):779-794. DACO: 8.5
-	Broznic D, Marinic J, Tota M, Juresic GC, Petkovic O, Milin C. 2012. Hysteretic behaviour of imidacloprid sorption-desorption in soils of Croatian coastal regions. Soil & Sediment Contamination 21(7):850-871. DACO: 8.5
-	Bryden J, Gill RJ, Mitton RAA, Raine NE, Jansen VAA. 2013. Chronic sublethal stress causes bee colony failure. Ecology Letters, 16: 1463-1469. DACO: 9.2.4.6
-	Byrne FJ, Visscher PK, Leimkuehler B, Fischer D, Grafton-Cardwell EE, Morse JG. 2013. Determination of exposure levels of honey bees foraging on flowers of mature citrus trees previously treated with imidacloprid. Pest Management Science. 70: 470-482. DACO: 9.2.4.8
-	Calatayud-Vernich P, Calatayud F, Simó E, Suarez-Varela MM, Picó Y. 2015. Influence of pesticide use in fruit orchards during blooming on honey bee mortality in 4 experimental apiaries. Science of the Total Environment, 541: 33-41. http://dx.doi.org/10.1016/j.scitotenv.2015.08.131. DACO: 9.2.4.7
2332664	California Department of Pesticide Regulation. Environmental Fate of Imidacloprid. April 2006. DACO: 12.5.8

PMRA Document Number	Reference
-	Chaimanee V, Evans JD, Chen Y, Jackson C, Pettis JS. 2016. Sperm viability and gene expression in honey bee queens (Apis mellifera) following exposure to the neonicotinoid insecticide imidacloprid and the organophosphate acaricide coumaphos. J Insect Physiol. 2016 Jun; 89:1-8. doi: 10.1016/j.jinsphys.2016.03.004. DACO: 9.2.4.1
-	Chandramani P, Rani BU, Muthiah C, Kumar S. 2008. Evaluation of toxicity of certain insecticides to India honey bee, Apis cerana indica F. Pestology, 32(8):42-43. DACO: 9.2.4.2
-	Chauzat MP, Carpenter P, Martel AC, Bougeard S, Cougoule N, Porta P, Lachiaze J, Madec F, Aubert M, Faucon JP. 2009. Influence of pesticide residue on honey Bee Health in France. Environ. Entomol. 38(3): 514-523. DACO: 9.2.4.8
-	Chauzat MP, Faucon JP, Martel AC, Lachaize J, Cougoule N and Aubert M. 2006. Pesticides, pollen and honey bees. Phytoma (594):40-45. DACO: 9.2.4.8
-	Choudhary A, Sharma DC, 2008. Dynamics of pesticide residues in nectar and pollen of mustard (Brassica juncea (L.) Czern.) grown in Himachal Pradesh (India). Environmental Monitoring and Assessment, 144: 143-150. DACO: 9.2.4.8
-	Ciereszko, A., Wilde, J., Dietrich, G.J., M. Siuda, B Bąk, S.Judycka, H. Karol. 2017. Sperm parameters of honey bee drones exposed to imidacloprid. Apidologie, 48: 211. https://doi.org/10.1007/s13592-016-0466-2. DACO: 9.2.4.9
1918520	Cohen SZ, Creeger SM, Carsel RF, Enfield CG. 1984. Potential for pesticide contamination of groundwater resulting from agricultural uses. Pages 297-325 In R.F. Krugger and J.N. Seiber, eds., Treatment and Disposal of Pesticide Wastes. ACS Symposium Series No. 259. American Chemical Society, Washington, DC, pp. 297-325. DACO: 9.9
-	Colin ME, Le Conte Y, Vermendere JP. 1999. Managing nuclei in insect-proof tunnel as an observation tool for foraging bee: sublethal effects of deltamethrin and imidacloprid. Hazard of pesticides to bees. Ed. INRA, Paris, 2001. DACO: 9.2.4.6
2358287	Columbo V, Mohr S, Berghahn R, Pettigrove VJ. 2013. Structural changes in a macrozoobenthos assemblage after imidacloprid pulses in aquatic field-based microcosms. Archives of Environmental Contamination and Toxicology 65(4) DOI 10.1007/s00244-013-9940-2. DACO: 8.6, 9.9
-	Costa LM, Grella TC, Barbosa RA, Malaspina O, Nocelli RCF. 2015. Determination of acute lethal doses (LD50 and LC50) of imidacloprid for the native bee Melipona scutellaris Latreille, 1811 (Hymenoptera: Apidae). Sociobiology 62(4): 578-582. DACO: 9.2.4.1
2334719	Cox L, Hermosín MC and Cornejo J. 2004. Influence of organic amendments on sorption and dissipation of imidacloprid in soil. International Journal of Environmental Analytical Chemistry. 84(1-3):95-102. DACO: 8.2.3.3.1, 8.2.4.2
-	Cresswell JE, Page CJ, Uygun CB, Holmbergh M, Li Y, Wheeler JG, Laycock I, Pook CJ, de Ibarra NH, Smirnoff N, Tyler CR. 2012. Differential sensitivity of honey bees and bumble bees to a dietary insecticide (imidacloprid). Zoology 115: 365– 371. DACO: 9.2.4.2, 9.2.4.4

PMRA Document Number	Reference
-	Cresswell, JE, Robert FX, Florance H, Smirnoff N. 2013. Clearance of ingested neonicotinoid pesticide (imidacloprid) in honey bees (Apis mellifera) and bumble bees (Bombus terrestris). Pest Management Science, 70(2): 332-337. doi: 10. 1002/ps.3569. DACO: 9.2.4.2, 9.2.4.4
-	Cure G., H.W. Schmidt, R. Schmuck. 1999. Results of a comprehensive field research programme with the systemic insecticide imidacloprid (Gaucho). Hazards of pesticides to bee. Ed. INRA. Paris 2001. DACO: 9.2.4.6, 9.2.4.7
-	Dai P, Jack CJ, Mortensen AN, Ellis JD. 2017. Acute toxicity of five pesticides to Apis mellifera larvae reared in vitro. Pest Manag Sci. 2017 May 9. doi: 10.1002/ps.4608. DACO: 9.2.4.3
-	David, A., C. Botías, A. Abdul-¬-Sada, E. Nicholls, E. L. Rotheray, E. M. Hill and D. Goulson (2016). Widespread contamination of wildflower and bee-¬-collected pollen with complex mixtures of neonicotinoids and fungicides commonly applied to crops. Environment International 88: 169-¬-178. DACO: 9.2.4.8
-	De Smet L, Hatjina F, Ioannidis P, Hamamtzoglou A, Schoonvaere K, Francis F, et al. 2017. Stress indicator gene expression profiles, colony dynamics and tissue development of honey bees exposed to sub-lethal doses of imidacloprid in laboratory and field experiments. PLoS ONE 12(2): e0171529. doi:10.1371/journal.pone.0171529. DACO: 9.2.4.6
-	Decourtye A, Armengaud C, Renou M, Devillers J, S. Cluzeau, M. Gauthier, M.H. Pham-Delègue. 2004. Imidacloprid impairs memory and brain metabolism in the honey bee (Apis mellifera L.). Pesticide Biochemistry and Physiology. 78: 83-92. DACO: 9.2.4.2
-	Decourtye A, Lacassie E, Pham-Delegue MH. 2003. Learning performances of honey bees (Apis mellifera L) are differentially affected by imidacloprid according to the season. Pest Manag Sci 59: 269-278. DACO: 9.2.4.2
-	Decourtye, A.,J. Devillers, S. Cluzeau, M. Charreton, and M.H. Pham-delegue. 2004. Effects of imidacloprid and deltamethrin on associative learning in honey bees under semi-field and laboratory conditions. Ecotoxicology and Environmental Safety, 57, 410–419. DACO 9.2.4.9
-	Dively GP, Embrey M, Pettis J. 2009. Assessment of sublethal effects of imidacloprid on honey bee and colony health. Department of Entomology, University of Maryland. North American Pollinator Protection Campaign. DACO: 9.2.4.6
-	Dively GP, Embrey MS, Kamel A, Hawthorne DJ, Pettis JS. 2015. Assessment of chronic sublethal effects of imidacloprid on honey bee colony health. PLoS ONE 10(3): e011874. DACO: 9.2.4.6
-	Dively GP, Kamel A. 2012. Insecticide Residues in Pollen and Nectar of a Cucurbit Crop and Their Potential Exposure to Pollinators. Journal of Agricultural and Food Chemistry, 60 (18): 4449-4456. DACO: 9.2.4.8
-	Donnarumma L, Pulcini P, Pochi D, Rosati S, Lusco L, Conte E. 2011. Preliminary study on persistence in soil and residues in maize of imidacloprid, Journal of Environmental Science and Health, Part B: Pesticides, Food Contaminants, and Agricultural Wastes, 46:6, 469-472. DACO: 9.2.4.8

PMRA Document Number	Reference
-	du Rand EE, Smit S, Beukes M, Apostolides Z, Pirk CW, Nicolson SW. 2015. Detoxification mechanisms of honey bees (Apis mellifera) resulting in tolerance of dietary nicotine. 5:11779. DOI: 10.1038/srep11779. DACO: 9.2.4.2
-	Dussaubat C. et al. Combined neonicotinoid pesticide and parasite stress alter honey bee queens' physiology and survival. Sci. Rep. 6, 31430; doi: 10.1038/srep31430 (2016). DACO: 9.2.4.6
-	Eiri DM, Nieh JC. 2012. A nicotinic acetylcholine receptor agonist affects honey bee sucrose responsiveness and decreases waggle dancing. The Journal of Experimental Biology. 215(12): 2022-2029. DACO: 9.2.4.2, 9.2.4.6
-	European Food Safety Authority. 2013. Evaluation of the FERA study on bumble bees and consideration of its potential impact on the EFSA conclusions on neonicotinoids. EFSA Journal 11(6):3242. DACO: 9.2.4.7
2332663	European Food Safety Authority. Conclusion regarding the peer review of the pesticide risk assessment of the active substance imidacloprid. Finalised: 29 May 2008, EFSA Scientific Report (2008) 148, 1-120. DACO: 12.5.8
-	Faucon, J.P., C. Aurières, P. Drajnudel, L. Mathieu, M. Ribière, A.C. Martel, S. Zeggane, M.P. Chauzat, M. F.A. Aubert. 2005. Experimental study on the toxicity of imidacloprid given in syrup to honey bee (Apis mellifera) colonies. Pest Manag Sci 61: 111-125. DACO: 9.2.4.6
-	Felsot AS, Cone W, Yu J, Ruppert JR. 1998. Distribution of imidacloprid in soil following subsurface drip chemigation. Bull. Environ. Contam. Toxicol. 60(3):363-370. DACO: 8.6
-	Felsot AS, Ruppert JR. 2002. Imidacloprid residues in Willapa bay (Washington State) water and sediment following application for control burrowing shrimp. J Journal of Agricultural & Food Chemistry 50(15):4417-4423. DACO: 8.6
-	Feltham, H., K. Park and D. Goulson. 2014. Field realistic doses of pesticide imidacloprid reduce bumble bee pollen foraging efficiency. Ecotoxicology 23:317–323. DACO: 9.2.4.6
-	FERA. 2013. Effects of neonicotinoid seed treatments on bumble bee colonies under field conditions. Sand Hutton, York YO41 1LZ: Food & Environment Research Agency. Available at http://FERA.co.uk/ccss/documents/defraBumble beeReportPS2371V4a.pdf. DACO: 9.2.4.7
-	Fernandez-Perez M, Gonzalez-Pradas E, Urena-Amate MD, Wilkins RM, Lindup I. 1998. Controlled release of imidacloprid from a lignin matrix: Water release kinetics and soil mobility study. Journal of Agricultural and Food Chemistry 46(9):3828-3834. DACO: 8.5
-	Fischer J, Müller T, Spatz A.-K, Greggers U, Grünewald B, Menzel R. 2014. Neonicotinoids interfere with specific components of navigation in honey bees. PLoS ONE 9(3): e91364. DACO: 9.2.4.6
-	Frazier MT, Mullin CA, Frazier JL, Ashcraft SA, Leslie TW, Mussen EC, Drummond FA. 2015. Assessing Honey Bee (Hymenoptera: Apidae) Foraging Populations And The Potential Impact Of Pesticides On Eight U.S. Crops. J. Econ. Entomol. 108(5): 2141–2152 (2015); DOI: 10.1093/jee/tov195. DACO: 9.2.4.9

PMRA Document Number	Reference
-	Gels J, Held DW, Potter DA. 2002. Hazard of Insecticides to bumble bee Bombus impatiens (Hymenoptera Apidea) Foraging on flowering White Clover Turf. Journal of Economic Entomology. 95(4): 722-728. DACO: 9.2.4.6
-	Gill RJ, Raine NE. 2014. Chronic impairment of bumble bee natural foraging behaviour induced by sublethal pesticide exposure. Funct Ecol 28(6):1459-1471. DACO: 9.2.4.6
-	Gill RJ, Ramos-Rodriguez O, Raine NE. 2012. Combined pesticide exposure severely affects individual- and colony-level traits in bees. Nature. doi:10.1038/nature11585. DACO: 9.2.4.6
-	Girolami V, Mazzon L, Sqartini A, Mori N, Mazaro M, Di Bernardo A, Greatti M, Giorio C, Tapparo A. 2009. Translocation of neonicotinoid insecticides from coated seeds to seedling guttation drops: A novel way of intoxication for bees. Journal of Economic Entomology, 102(5): 1808-1815. DACO: 9.2.4.2
2037242	Goring CAI, Laskowski DA, Hamaker JW, Meikle RW. 1975. Principle of pesticide degradation in soil. In (Haque, R. and V.H. Freed, eds.) Environmental dynamics of pesticides. Plenum Press, New York, pp. 135 - 172. DACO 12.5
-	Goulson D. 2015. Neonicotinoids impact bumble bee colony fitness in the field; a reanalysis of the UK's Food & Environment Research Agency 2012 experiment. Peer J 3:e854. DACO: 9.2.4.7
-	Gradish AE, Scott-Dupree CD, Shipp L, Harris CR, Ferguson G. 2009. Effect of reduced risk pesticides for use in greenhouse vegetable production on Bombus impatiens (Hymenoptera: Apidae). Pest Management Science. 66: 142-146. DACO: 9.2.4.1, 9.2.4.4
2332668	Graebing P, Chib JS. 2004. Soil photolysis in a moisture- and temperature-controlled environment. 2. Insecticides. Journal of Agricultural & Food Chemistry 52(9):2606-2614. DACO: 8.2.3.3.1
-	Gregorc A, Ellis JD. 2011. Cell death localization in situ in laboratory reared honey bee (Apis mellifera L.) larvae treated with pesticides. Pesticide Biochemistry and Physiology 99: 200-207. DACO: 9.2.4.3
-	Gupta S, Gajbhiye VT, Kalpana and Agnihotri NP. 2002. Leaching behaviour of imidacloprid formulations in soil. Bulletin of Environmental Contamination & Toxicology 80(5):431-437. DACO: 8.5
1918524	Gustafson DI. 1989. Groundwater ubiquity score: a simple method for assessing pesticide leachability. Environmental Toxicology and Chemistry 8(4):339-357. DACO: 9.9
2332666	Guzsvány V, Csanádi J, Gaál F. 2006. NMR study of the influence of pH on the persistence of some neonicotinoids in water. Acta Chim. Slov. 53:52-57. DACO: 8.2.3.2
-	Hatjina F, Papaefthimiou C, Charistos L, Dogaroglu T, Bouga M, Emmanouil C, Arnold G. 2013. Sublethal doses of imidacloprid decreased size of hypopharyngeal glands and respiratory rhythm of honey bees in vivo. Apidologie (2013) 44: 467. doi:10.1007/s13592-013-0199-4. DACO: 9.2.4.9

PMRA Document Number	Reference
-	Henry M, Cerrutti N, Aupinel P, Decourtye A, Gayrard M, Odoux J-F, Pissard A, Rüger C, Bretagnolle V. 2015. Reconciling laboratory and field assessments of neonicotinoid toxicity to honey bees. Proceedings of The Royal Society B Biological Sciences, Published 18 November 2015.DOI: 10.1098/rspb.2015.2110. DACO: 9.2.4.7
-	Hladik ML, Vandever M, Smalling KL. 2016. Exposure of native bees foraging in an agricultural landscape to current-use pesticides. Science of the Total Environment 542 (2016) 469–477. DACO: 9.2.4.8
-	Horwood MA. 2007. Rapid degradation of termiticides under field conditions. Australian Journal of Entomology. 46(1):75-78. DACO: 8.5
-	Husain D, Qasim M, Saleem M, Akhter M, Khan KA. 2014. Bioassay of insecticides against three honey bee species in laboratory conditions. Cercetari Agronomice in Moldova 47(2):69,79. DACO: 9.2.4.1
-	Iwasa T, Motoyama N, Ambrose JT, Roe RM. 2004. Mechanism for the Differential Toxicity of Neonicotinoid Insecticides in the Honey Bee, Apis Mellifera. Crop Protection. 23: 371-378. DACO: 9.2.4.1
2334745	Jeong CY, Selim HM. 2010. Modeling adsorption-desorption kinetics of imidacloprid in soil. Soil Science. 175(5): 214-222. DACO: 8.2.4.2
-	Jeyalakshmi T, Shanmugasundaram R, Saravanan M, Geetha S, Mohan SS, Goparaju A, Balakrishna Murthy P. 2011. Comparative toxicity of certain insecticides against Apis cerana indica under semi field and laboratory conditions. Pestology 35(12):23-26. DACO: 9.2.4.1
-	Júnior RPS, Smelt JH, Boeston JJTI, Hendriks RFA and van der Zee SEATM. 2014. Preferential flow of bromide, bentazon, and imidacloprid in a Dutch clay soil. Journal of Environmental Quality. 33:1473-1486. DACO: 8.5
-	Karahan A, Cakmak I, Hranitz J, Karaca I, Wells H. 2015. Sublethal imidacloprid effects on honey bee flower choices when foraging. Ecotoxicology. November 2015, Volume 24(9): 2017-2025. DACO: 9.2.4.6
-	Kasiotis KM, Anagnostopoulos C, Anastasiadou P, Machera K. 2014.Pesticide residues in honey bees, honey and bee pollen by LC-MS/MS screening: reported death incidents in honey bees. Science of the Total Environment 485–486 (2014) 633–642. DACO: 9.2.4.8
-	Kessler SC, Tiedeken EJ, Simcock KL, Derveau S, Mitchell J, Softley S, Stout JC, Wright GA. 2015. Bees prefer foods containing neonicotinoid pesticides. Nature 521: 74–76 doi:10.1038/nature14414. DACO: 9.2.4.2
-	Khan R.B. and M.D. Dethe. 2004. Median lethal time of new pesticides to foragers of honey bees. Pestology 28(1):28-29. DACO: 9.2.4.1
-	Krischik V, Rogers M, Gupta G, Varshney A. 2015. Soil-applied imidacloprid translocates to ornamental flowers and reduces survival of adult Coleomegilla maculata, Harmonia axyridis, and Hippodamia convergens lady beetles, and larval Danaus plexippus and Vanessa cardui butterflies. PLoS ONE 10(3): e0119133. DACO: 9.2.4.8

PMRA Document Number	Reference
2334741	Kurwadkar S, Dewinne D, Wheat R, McGahan D, Mitchell FL. 2013. Time dependent sorption behavior of dinotefuran, imidacloprid and thiamethoxam. Journal of Environmental Science and Health, Part B 48: 237-242. DACO: 8.2.4.2
2535319	Larsbo M, Löfstrand E, van Alphen de Veer D, Ulén B. 2013. Pesticide leaching from two Swedish topsoils of contrasting texture amended with biochar. Journal of Contaminant Hydrology 147: 73-81. DACO: 8.2.4.2
-	Larson JL, Redmond CT, Potter DA. 2015. Mowing mitigates bioactivity of neonicotinoid insecticides in nectar of flowering lawn weeds and turfgrass guttation. Environ Toxicol Chem 34:127–132. DACO: 9.2.4.8
-	Laurino D, Manino A, Patetta A, Ansaldi M, Porporato M. 2010. Acute oral toxicity of neonicotinoids on different honey bee strains. Redia; 2010.93:99-102. DACO: 9.2.4.2
-	Laurino D, Manino A, Patteta A, Porporato M. 2013. Toxicity of neonicotinoid insecticides on different honey bee genotypes. Bulletin of Insectology. 66 (1) 119-126. DACO: 9.2.4.2
-	Laycock I, Lenthall KM, Barratt AT, Cresswell JE. 2012. Effects of imidacloprid, a neonicotinoid pesticide on reproduction in worker bumble bees (Bombus terrestris). Ecotoxicology, 21: 1937—1945. DACO: 9.2.4.6
-	Laycock I, Cresswell JE. 2013. Repression and Recuperation of Brood Production in Bombus terrestris Bumble Bees Exposed to a Pulse of the Neonicotinoid Pesticide Imidacloprid. PLoS One 8(11): e79872. doi: 10.1371/journal.pone.0079872. DACO: 9.2.4.4
-	Liu W, Zheng W, Gan J. 2002. Competitive sorption between imidacloprid and imidacloprid-urea on soil clay minerals and humic acids. Journal of Agricultural and Food Chemistry. 50(23):6823-6827. DACO: 8.5
2332667	Liu W, Zheng W, Ma Y, Liu KK. 2006. Sorption and degradation of imidacloprid in soil and water. Journal of Environmental Science and Health, Part B: Pesticides, Food Contaminants, and Agricultural Wastes, 41(5): 623 - 634. DACO: 8.2.3.2, 8.2.3.3.2, 8.2.4.2
2332676	Liu Z, Dai Y, Huang G, Gu Y, Ni J, Wei H, Yuan S. 2011. Soil microbial degradation of neonicotinoid insecticides imidacloprid, acetamiprid, thiacloprid and imidaclothiz and its effects on the persistence of bioefficacy against horsebean aphid Aphis craccivora Koch after soil application. Pest Manag. Sci. 67: 1245 - 1252. DACO: 8.2.3.4.2
-	Lu C, Warchol KM, Callahan RA. 2014. Sub-lethal exposure to neonicotinoids impaired honey bees winterization before proceeding to colony collapse disorder. Bulletin of Insectology 67 (1): 125-130. DACO: 9.2.4.6
-	Marletto, F., A. Patetta, A. Manino. 2003. Laboratory assessment of pesticide toxicity to bumble bees. Bulletin of Insectology 56 (1): 155-158. DACO: 9.2.4.1, 9.2.4.2
2024011	McCall PJ, Laskowski DA, Swann RL and Dishburger HJ. 1981. Measurements of sorption coefficients of organic chemicals and their use in environmental fate analysis. In Test Protocols for Environmental Fate and Movement of Toxicants. Proceedings of AOAC Symposium, AOAC, Washington D.C. DACO: 8.6

PMRA Document Number	Reference
-	McEwen FL and Stephenson GR. 1979. The use and significance of pesticides in the environment. John Wiley and Sons Inc. Toronto. 282 pp. DACO: 8.6
-	Medrzycki P, Montanari R, Bortolotti L. 2003. Effects of imidacloprid administered in sub-lethal doses on honey bee behavior. Laboratory test. Bulletin of Insectology. 56: 59-62. DACO: 9.2.4.2
-	Moffat C, Buckland ST, Samson AJ, McArthur R, Pino VC, Bollan KA, Huang JTJ, Connolly CN. 2016. Neonicotinoids target distinct nicotinic acetylcholine receptors and neurons, leading to differential risks to bumble bees. Scientific Reports. 6: 24764. DOI: 10.1038/srep24764. DACO: 9.2.4.6
-	Moffat C, Pacheco JG, Sharp S, Samson AJ, Bollan KA, Huang J, Buckland ST, Connolly CN. 2015. Chronic exposure to neonicotinoids increases neuronal vulnerability to mitochondrial dysfunction in the bumble bee (Bombus terrestris). FASEB J. 29: 2112–2119. (doi:10.1096/fj.14-267179). DACO: 9.2.4.2, 9.2.4.6
-	Mommaerts V, Reynders S, Boulet J, Besard L, Sterk G, Smagghe G. 2010. Risk assessment for side-effects of neonicotinoids against bumble bees with and without impairing foraging behavior. Ecotoxicology 19: 207-215. DACO: 9.2.4.6
-	Moncharmont F-X, Decourtye DA. 2002. Statistical Analysis of Honey bee survival after chronic exposure to insecticide. Environmental Toxicology and Chemistry. Vol.22: 3088-3094. DACO: 9.2.4.2
-	Morandin LA, Winston ML. 2003. Effects of Novel Pesticides on Bumble Bee (Hymenoptera: Apidae) Colony Health and Foraging Ability. Environmental Ecology; 32 (3), 555-563. DACO: 9.2.4.6
-	Moza PN, Hustert K, Feicht E and Kettrup A. 1998. Photolysis of imidacloprid in aqueous solution. Chemosphere 36(3):497-502. DACO: 8.5
2334736	Nemeth-Konda L, Fuleky G, Morovjan G and Csokan P. 2002. Sorption behaviour of acetochlor, atrazine, carbendazim, diazinon, imidacloprid and isoproturon on Hungarian agricultural soil. Chemosphere 48:545-552. DACO: 8.2.4.2
-	Nguyen BK, Saegerman C, Pirard C, Mignon J, Widart J, Thirionet B, Verheggen FJ, Berkvens D, De Pauw E, Haubruge E. 2009. Does imidacloprid seed-treated maize have an impact on honey bee mortality? J. Econ. Entomol. 102(2): 616-623. DACO: 9.2.4.7
-	Palmer MJ, Moffat C, Saranzewa N, Harvey J, Wright GA, Connolly CN. 2013. Cholinergic pesticides cause mushroom body neuronal inactivation in honey bees. Nat Commun 4:1634. DACO: 9.2.4.1
-	Pastagia JJ, Patel MB. 2007. Relative contact toxicity of some insecticides to worker bees of Apis cerana F. Journal of Plant Protection and Environment 4(2):89-92. DACO: 9.2.4.1
-	Peng,Y-C,Yang E-C. 2016. Sublethal Dosage of Imidacloprid Reduces the Microglomerular Density of Honey Bee Mushroom Bodies. Scientific Reports 6, Article number: 19298 (2016). DOI: 10.1038/srep19298. DACO: 9.2.4.3

PMRA Document Number	Reference
-	Pettis JS, Vanengelsdorp D, Johnson J, Dively G. 2012. Pesticide exposure in honey bees results in increased levels of the gut pathogen Nosema. Naturwissenschaften 99:153-158. DACO: 9.2.4.6
-	Pettis J, Lichtenberg E, Andres M, Stitzinger J, Rose R, van Engelsdorp D. 2013. Crop pollination exposes honey bees to pesticides which alters their susceptibility to the gut pathogen Nosema ceranae. Plos One, 8, pp 1-9. DACO: 9.2.4.7
-	Pohorecka K, Skubida P, Miszczak A, Semkiw P, Sikorski P, Zagibajlo K, Teper D, Koltowski Z, Skubida M, Zdanska D, Bober A. 2012. Residues of neonicotinoid insecticides in bee collected plant materials from oilseed rape crops and their effect on bee colonies. Journal of Apicultural Science. 56(2): 115-133. DACO: 9.2.4.7
-	Pohorecka K, Skubida P, Semkiw P, Miszczak A, Teper D, Sikorski P, Zagibajlo K, Skubida M, Zdanska D, Bober A. 2013. Effects of Exposure of Honey Bee Colonies to Neonicotinoid Seed-Treated Maize Crops. Journal of Apicultural Science. 57 (2) pgs. 199-208. doi: 10.2478/jas-2013-0029. DACO: 9.2.4.7
-	Poquet Y, Kairo G, Tchamitchian S, Brunet JL, Belzunces LP. 2015, Wings as a new route of exposure to pesticides in the honey bee. Environ Toxicol Chem. 2015 Sep;34(9):1983-8. doi: 10.1002/etc.3014. DACO: 9.2.4.9
-	Raine NE, Gill RJ. 2015. Tasteless pesticides affect bees in the field. Nature. 521: 38-40. doi:10.1038/nature14391. DACO: 9.2.4.9
-	Ramirez-Romero R, Chaufaux J, Pham-Delégue MH. 2005. Effects of Cry1Ab protoxin, deltamethrin and imidacloprid on the foraging activity and the learning performances of the honey bee Apis mellifera, a comparative approach. Apidologie (2005) 36: 601-611. DACO: 9.2.4.2
-	Reetz JE, Schulz W, Seitz W, Spiteller M, Zühlke S, Armbruster W, Wallner K. 2015. Uptake of Neonicotinoid Insecticides by Water-Foraging Honey Bees (Hymenoptera: Apidae) Through Guttation Fluid of Winter Oilseed Rape. J. Econ. Ent. DOI: http://dx.doi.org/10.1093/jee/tov287. DACO: 9.2.4.7
-	Rinkevich FD, Margotta JW, Pittman JM, Danka RG, Tarver MR, Ottea JA. 2015. Genetics, Synergists, and Age Affect Insecticide Sensitivity of the Honey Bee, Apis mellifera. PLoS ONE 10(10): e0139841. doi:10.1371/journal.pone.0139841. DACO: 9.2.4.2
2350950	Rouchaud J, Gustin F and Wauters A. 1994. Soil biodegradation and leaf transfer of insecticide imidacloprid applied in seed dressing in sugar beet crops. Bulletin of Environmental Contamination & Toxicology. 53(3):344-350. DACO: 8.6
2350951	Rouchaud J, Gustin F and Wauters A. 1996a. Imidacloprid insecticide soil metabolism in sugar beet field crops. Bulletin of Environmental Contamination & Toxicology. 56(1):29-36. DACO: 8.6
-	Rouchaud J, Thirion A, Wauters A, Van de Steene F, Benoit F, Ceustermans N. et al. 1996b. Effects of fertilizer on insecticides adsorption and biodegradation in crop soils. Archives of Environmental Contamination & Toxicology. 31(1):98-106. DACO: 8.6

PMRA Document Number	Reference
-	Sánchez-Bayo F, Belzunces L, Bonmatin JM. 2017 Lethal and sublethal effects, and incomplete clearance of ingested imidacloprid in honey bees (Apis mellifera). Ecotoxicology. 26(9):1199-1206. doi: 10.1007/s10646-017-1845-9. DACO: 9.2.4.9
-	Sarkar MA, Biswas PK, Roy S, Kole RK and Chowdhury A. 1999. Effect of pH and type of formulation on the persistence of imidacloprid in water. Bulletin of Environmental Contamination and Toxicology 63(5):604-609. DACO: 8.6
-	Schmuck R. 2004. Effects of a Chronic Dietary Exposure of the Honey bee Apis mellifera (Hymenoptera: Apidae) to Imidacloprid. Arch. Environ. Contam. Toxicol. 47: 471-478. DACO: 9.2.4.2
-	Schmuck R, Nauen R, Ebbinghaus-Kintscher U. 2003. Effects of imidacloprid and common plant metabolites of imidacloprid in honey bee: toxicological and biochemical considerations. Bulletin of Insectology, 56 (1): 27-34. DACO: 9.2.4.1, 9.2.4.2
-	Schmuck R, Schoning R, Strok A. 2001. Risk posed to honey bees (Apis mellifera L, Hymenoptera) by an imidacloprid seed dressing of sunflowers. Pest Management Science 57: 225-238. DACO: 9.2.4.1, 9.2.4.2, 9.2.4.6
-	Schneider CW, Tautz J, Grünewald B, Fuchs S. 2012. RFID Tracking of Sublethal Effects of Two Neonicotinoid Insecticides on the Foraging Behavior of Apis mellifera. PLoS ONE 7 (1): e30023. DACO: 9.2.4.6
-	Schnier HF, Wenig G, Laubert F, Simon V, Schmuck R. 2003. Honey bee safety of imidacloprid corn seed treatment. Bulletin of Insectology. 56 (1): 73-75. DACO: 9.2.4.6
-	Scholer J, Krischik V. 2014. Chronic Exposure of Imidacloprid and Clothianidin Reduce Queen Survival, Foraging, and Nectar Storing in Colonies of Bombus terrestris. Published: March 18, 2014 http://dx.doi.org/10.1371/journal.pone.0091573. DACO: 9.2.4.6
-	Scott-Dupree CD, Conroy L, Harris CR. 2009. Impact of Currently Used or Potentially Useful Insecticides for Canola Agroecosystems on Bombus impatiens (Hymenoptera: Apidae), Megachile rotundata (Hymenoptera: Megachilidae), and Osmia lignaria (Hymenoptera: Megachilidae). J. Econ. Entomol. 102(1): 177-182. DACO: 9.2.4.1
2358286	Selim HM, Jeong CY, Elbana TA. 2010. Transport of imidacloprid in soils: miscible displacement experiments. Soil Science 175: 375-381. DACO: 8.6
-	Singh N, Karnatak AK. 2005. Relative toxicity of some insecticides to the workers of Apis mellifera L. Shashpa 12(1):23-25. DACO: 9.2.4.1
-	Soares HM, Jacob CR, Carvalho SM, Nocelli SM, Ferreira SC, Malaspina O. 2015. Toxicity of Imidacloprid to the Stingless Bee Scaptotrigona postica Latreille, 1807 (Hymenoptera: Apidae). Bull Environ Contam Toxicol. 2015 Jun;94(6):675-80. doi: 10.1007/s00128-015-1488-6. Epub 2015 Feb 10. DACO: 9.2.4.1
-	Stadler T, Martinez-Ginés D, Buteler M. 2003. Long-term toxicity assessment of imidacloprid to evaluate side effects on honey bees exposed to treated sunflower in Argentina. Bulletin of Insectology 77-81. DACO: 9.2.4.7

PMRA Document Number	Reference
-	Stanley J, Sah K, Jain SK, Bhatt JC, Sushil SN. 2015. Evaluation of pesticide toxicity at their field recommended doses to honey bees, Apis cerana and A. mellifera through laboratory, semi-field and field studies. Chemosphere 119:668-674. DACO: 9.2.4.1
-	Stewart, S. D., G. M. Lorenz, A. L. Catchot, J. Gore, D. Cook, J. Skinner, T. C. Mueller, D. R. Johnson, J. Zawislak and J. Barber, 2014. Potential exposure of pollinators to neonicotinoid insecticides from the use of insecticide seed treatments in the mid-southern United States. Environmental Science & Technology 48(16): 9762-9769. DACO: 9.2.4.9
-	Stoner KA, Eitzer BD. 2012. Movement of soil-applied imidacloprid and thiamethoxam into nectar and pollen of squash (Cucurbita pepo). Plos One 7(6):e39114. DACO: 9.2.4.8
-	Suchail S. 2004. In vivo distribution and metabolism of 14 C imidacloprid in different compartments of Apis mellifera L. Pest Manag Sci 60:1056–1062 (online: 2004) DOI: 10.1002/ps.895. DACO: 9.2.4.9
-	Suchail S, Debrauwer L, Belzunces LP. 2003. Metabolism of imidacloprid in Apis mellifera.Pest Manag Sci 60:291–296 (online: 2003) DOI: 10.1002/ps.772. DACO: 9.2.4.9
-	Suchail S, Guez D, Belzunces LP. 2000. Characteristics of Imidacloprid Toxicity in Two Apis Mellifera Subspecies. Environmental Toxicology and Chemistry. 19 (7): 1901-1905. DACO: 9.2.4.1, 9.2.4.2
-	Suchail S, Guez D, Bezunces LP. 2001. Discrepancy between acute and chronic toxicity induced by imidacloprid and its metabolites in Apis mellifera. Environmental Toxicology and Chemistry, Vol. 20, No. 11, pp. 2482–2486. DACO: 9.2.4.2
-	Switzer CM, Combes SA. 2016. The neonicotinoid pesticide, imidacloprid, affects Bombus impatiens (bumble bee) sonication behavior when consumed at doses below the LD50. 25: 1150-1159. DOI 10.1007/s10646-016-1669-z. DACO: 9.2.4.6
-	Tan K, Chen W, Dong S, Liu X, Wang Y, Nieh JC. 2014. Imidacloprid alters foraging and decreases bee avoidance of predators. PLoS ONE 9(7):e102725. DACO: 9.2.4.6
-	Tan K, Chen W, Dong S, Liu X, Wang Y, Nieh JC. 2015. A neonicotinoid impairs olfactory learning in Asian honey bees (Apis cerana) exposed as larvae or as adults. Scientific Reports 5: 10989. DOI: 10.1038/srep10989. DACO: 9.2.4.2, 9.2.4.3
-	Tasei JN, Ripault G, Rivault E. 1999. Effects of Gaucho seed coating on bumble bees visiting sunflower. Hazards of pesticides to bees. Avignon (France), September 07 - 09, 1999. Ed. INRA, Paris, 2001 (Les Colloques. no 98). DACO: 9.2.4.6, 9.2.4.7
-	Tasei JN, Ripault G. 2000. Sub-lethal effects of imidacloprid on bumble bees. Bombus terrestis (Hymenoptera: Apidae) during laboratory feeding test.Pest Manag Sci 56:784±788. DACO: 9.2.4.9
-	Thompson HM, Wilkins S, Harkin S, Milner S, Walters KF. 2014. Neonicotinoids and bumble bees (Bombus terrestris): Effects on nectar consumption in individual workers. Pest Manage Sci, 71(7):946-950. DACO: 9.2.4.2

PMRA Document Number	Reference
-	Thompson HM, Fryday SL, Harkin S, Milner S. 2014. Potential impacts of synergism in honey bees (Apis mellifera) of exposure to neonicotinoids and sprayed fungicides in crops. Apidologie 45(5):545-553. DACO: 9.2.4.1, 9.2.4.2
-	Thuyet DQ, Jorgenson BC, Wissel-Tyson C, Watanabe H, Young TM. 2012. Wash off of imidacloprid and filpronil from turf and concrete surfaces using simulated rainfall. Science of the Total Environment. 414:515-524. DACO: 8.6
-	Tomé HV, Martins GF, Lima MA, Campos LA, Guedes RN. 2012. Imidacloprid-induced impairment of mushroom bodies and behavior of the native stingless bee Melipona quadrifasciata anthidioides . PLoS ONE 7(6): e38406. doi:10.1371/journal.pone.0038406. DACO: 9.2.4.3
-	Tomé HV, Barbosa WF, Martins GF, Guedes RN. 2015. Spinosad in the native stingless bee melipona quadrifasciata: Regrettable non-target toxicity of a bioinsecticide. Chemosphere 124:103-109. DACO: 9.2.4.2
-	Tomé HV, Barbosa WF, Corrêa AS, Gontijo LM, Martins GF, Guedes RNC. 2015. Reduced-risk insecticides in Neotropical stingless bee species: impact on survival and activity. Annals of Applied Biology 167, 186–196. doi:10.1111/aab.12217. DACO: 9.2.4.1
2334762	United States Department of Agriculture. Imidacloprid - Human Health and Ecological Risk Assessment - Final Report. December 28, 2005. DACO: 12.5.8
-	United States Environmental Protection Agency, Pest Management Regulatory Agency, California Department of Pesticide Regulation. 2014. Guidance for Assessing Pesticide Risks to Bees. DACO: 8.6
2332665	United States Environmental Protection Agency. EFED Problem Formulation for the Imidacloprid Environmental Fate and Ecological Risk Assessment. November 13, 2008. DACO: 12.5.8
-	Valdovinos-Nunez GR, Quezada-Euan JJ, Ancona-Xiu P, Moo-Valle H, Carmona A, Ruiz Sanchez E. 2009. Comparative toxicity of pesticides to stingless bees (Hymenoptera: Apidae: Meliponini). J Econ Entomol 102(5):1737-1742. DACO: 9.2.4.1
-	Vollner L, Klotz D. 1997. Leaching and degradation of pesticides in groundwater layers. In Proceedings of an International Symposium on the use of nuclear and related techniques for studying environmental behaviour of crop protection chemicals: Environmental Behaviour of Crop Protection Chemicals, Vienna, pp.187-202. DACO: 8.5
-	Wallner K. 2001. Tests regarding effects of imidacloprid on honey bees. Hazards of pesticides to bees. Avignon (France), September 07-09, 1999. DACO: 9.2.4.6
2332671	Wamhoff H, Schneider V. 1999. Photodegradation of imidacloprid. Journal of Agriculture and Food Chemistry 47:1730-1734. DACO: 8.2.3.3.2
-	Wegener et al., 2016. Secondary biomarkers of insecticide-induced stress of honey bee colonies and their relevance for overwintering strength. Ecotoxicology and Environmental Safety 132: 379-389. http://dx.doi.org/10.1016/j.ecoenv.2016.06.038. DACO: 9.2.4.6

PMRA Document Number	Reference
-	Whitehorn PR, O'Connor S, Wackers FL, Goulson D. 2012. Neonicotinoid Pesticide Reduces Bumble Bee Colony Growth and Queen Production. Science 336: 351-352. DACO: 9.2.4.6
-	Williamson SM, Willis SJ, Wright GA.2014. Exposure to Neonicotinoids Influences the Motor Function of Adult Worker Honey bees Ecotoxicology. 2014 Oct;23(8):1409-18. doi: 10.1007/s10646-014-1283-x. Epub 2014 Jul 11. DACO: 9.2.4.2
-	Woodcock BA, Bullock JM, Shore RF, Heard MS, Pereira MG, Redhead J, Ridding L, Dean H, Sleep D, Henrys P, Peyton J, Hulmes S, Humes L, Saraspataki M, Saure C, Edwards M, Genersch E, Knabe S, Pywell RF. 2017. Country-specific effects of neonicotinoid pesticides on honey bees and wild bees. Science 356, 1393-1395. DACO: 9.2.4.6, 9.2.4.7
-	Wright GA, Softley S, Earnshaw H. 2015. Low doses of neonicotinoid pesticides in food rewards impair short-term olfactory memory in foraging-age honey bees. Scientific Reports. 5:15322. DOI: 10.1038/srep15322. DACO: 9.2.4.2
-	Wu JY, Anelli CM, Sheppard WS. 2011. Sub-lethal Effects of Pesticide Residues in Brood Comb on Worker Honey Bee (Apis mellifera) Development and Longevity. PLoS ONE 6(2): e14720. DACO: 9.2.4.7
-	Wu-Smart J, Spivak M. Sub-lethal effects of dietary neonicotinoid insecticide exposure on honey bee queen fecundity and colony development. Sci. Rep. 6, 32108; doi: 10.1038/srep32108 (2016). DACO: 9.2.4.6
-	Yang E-C, Chang H-C, Wu W-Y, Chen Y-W. 2012. Impaired Olfactory Associative Behavior of Honey bee Workers Due to Contamination of imidacloprid in the Larval Stage. PLoS ONE 7(11): e49472. doi:10.1371/journal.pone.0049472. DACO: 9.2.4.3
-	Yang EC, Chuang YC, Chen YL, Chang LH. 2008. Abnormal foraging behavior induced by sub-lethal dosage of imidacloprid in the honey bee. Journal of Economic Entomology, 101(6): 1743-1748. DACO: 9.2.4.6
-	Zhang E, Nieh JC. 2015. J Exp Biol. 2015. The neonicotinoid imidacloprid impairs honey bee aversive learning of simulated predation. J. of Exp. Biology. 218: 3199-3205. Oct;218(Pt 20):3199-205. doi:10.1242/jeb.127472. DACO: 9.2.4.2
2535318	Zheng W, Liu W. 1998. Kinetics and mechanism of the hydrolysis of imidacloprid. Pesticide Science. 55:482- 485. DACO: 8.2.3.2
2332670	Zheng W, Liu WP, Wen YZ, Lee SJ. 2004. Photochemistry of insecticide imidacloprid: direct and sensitized photolysis in aqueous medium. Journal of Environmental Sciences 16(4):539 -542. DACO: 8.2.3.3.2
-	Zhu YC, Adamczyk J, Rinderer T, Yao J, Danka R, Luttrell R, Gore J. 2015. Spray Toxicity and Risk Potential of 42 Commonly Used Formulations of Row Crop Pesticides to Adult Honey Bees. J Econ Entomol. 2015 Dec;108(6):2640-7. doi: 10.1093/jee/tov269. DACO: 9.2.4.1
-	Zhu YC, Yao J, Adamczyk J, Luttrell R. 2017. Synergistic toxicity and physiological impact of imidacloprid alone and binary mixtures with seven representative pesticides on honey bee (Apis mellifera). PLoS ONE 12(5): e0176837. https://doi.org/10.1371/journal.pone.0176837. DACO: 9.2.4.9

B.1. 2 Water Monitoring Assessment

PMRA Document Number	Reference
2526146	Samson-Robert, O., G. Labrie, M. Chagnon, and V. Fournier, 2014, Neonicotinoid-contaminated puddles of water represent a risk of intoxication for honey bees. PLoS ONE 9(12): e108443, DACO: 8.6
2526184	Schaafsma, A., V. Limay-Rios, T. Beaute, J. Smith and Y. Xue, 2015, Neonicotinoid insecticide residue in surface water and soil associated with commercial maize (corn) fields in Southwestern Ontario. PLoS ONE 10(2): e0118139, DACO: 8.6
2538821	Johnson, J.D. and J.S. Pettis, 2014, A survey of imidacloprid levels in water sources potentially frequented by honey bees (Apis mellifera) in the Eastern USA. Water Air and Soil Pollution 225: 2127, DACO: 8.6

B.2 Unpublished Information

B.2.0 Environmental Assessment

B.2.1 Environmental Fate and Effects Assessment

B.2. 2 Water Monitoring Assessment

PMRA Document Number	Reference
2548876	Pest Management Regulatory Agency, Pesticides detected in water and soil samples collected as part of the Hive Monitoring Program in 2014, Health Canada. Unpublished, DACO: 8.6
2548877	Pest Management Regulatory Agency, Pesticides detected in water and soil samples collected during Bee Mortality Incidents in 2013 and 2014, Health Canada. Unpublished, DACO: 8.6