Proposed Re-evaluation Decision PRVD2017-24

Thiamethoxam and Its Associated End-use Products: Pollinator Re-evaluation

Consultation Document

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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 and ornamental uses for thiamethoxam and its associated end-use products, specifically to asses 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 additional data requirements. Extensive information obtained from published literature, as well as data received from registrants, was considered. 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 various use sectors was assessed.

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 thiamethoxam, including proposed risk mitigation measures to further protect pollinators, as well as the science evaluation on which the proposed decision was based. Most products containing thiamethoxam registered in Canada are subject to this proposed re-evaluation decision. 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.

Additional reviews related to re-evaluations and special reviews previously announced in respect of thiamethoxam will be published separately at a later date. Anticipated time frames for decisions related to these activities are outlined in: *Update on the Neonicotinoid Pesticides (December 2017)*.

Outcome of Science Evaluation

Thiamethoxam is an insecticide that is widely used in Canada on a variety of crops. This document summarizes the potential risks posed by thiamethoxam to insect pollinators such as honey bees and wild 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 thiamethoxam are sold as sprays to be applied to plants and to bare soil. Thiamethoxam 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 thiamethoxam 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. Because bees use nectar and pollen as their primary sources of food, bees may be exposed to thiamethoxam (and its breakdown products) when they visit certain flowers to collect pollen and nectar. Bees may also be accidentally sprayed or collect water containing thiamethoxam.

Health Canada examined hundreds of laboratory studies 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:

- bees contacting thiamethoxam while visiting flowers,
- bees consuming thiamethoxam in the pollen and nectar of flowers,
- bees exposed to thiamethoxam for a short period of time (acute exposure) and for a long period of time (chronic exposure),
- bees exposed to thiamethoxam in water,
- bees exposed to dust that may be generated while planting seeds that were coated with thiamethoxam,
- adult bees, developing bees and the whole colony exposed within bee hives,
- bees exposed to a breakdown product of thiamethoxam called clothianidin, which is also a neonicotinoid insecticide used in agriculture to kill insects that harm agricultural crops, 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 thiamethoxam are not expected to affect bees; however, there are some uses of thiamethoxam 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. Refer to the Proposed Registration Decision for Thiamethoxam for a list of proposed measures to protect pollinators. When thiamethoxam 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 best management practices.

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 thiamethoxam is applied, and determined that water sources do not pose risks of concern to bees.

Proposed Regulatory Decision for Thiamethoxam

Under the authority of the *Pest Control Products Act* and based on the evaluation of currently available scientific information related to pollinators, products containing thiamethoxam are being proposed for continued registration in Canada, while 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 the re-evaluation of thiamethoxam, further risk mitigation measures for product labels are being proposed.

Measures to Protect Pollinators

Certain crops are highly attractive to bees when their flowers are in bloom. Because large numbers of bees are attracted to these crops when they are in bloom, and based on an assessment of the risks to bees, the application of pesticides containing thiamethoxam 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 that the following uses of thiamethoxam be phased out**:

- Foliar and soil application to ornamental crops that will result in pollinator exposure,
- Soil application to berry crops, cucurbit crops and fruiting vegetables, and
- Foliar application to orchard trees.

Due to the attractiveness of some crops to bees and based on an assessment of the risks to bees, application of pesticides containing thiamethoxam before and during crop flowering 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 that the following crops cannot be sprayed before and/or during bloom**:

- Foliar application to legume and outdoor fruiting vegetables, and
- Foliar application to berry crops.

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

Thiamethoxam 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) is currently conducting a pollinator risk assessment of thiamethoxam.

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 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

Thiamethoxam is a second-generation neonicotinoid insecticide. Thiamethoxam 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).

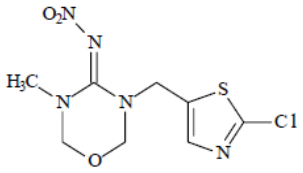
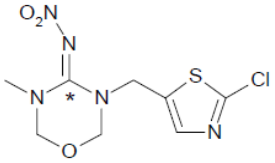
Following the re-evaluation announcement for thiamethoxam, the registrant of the technical grade active ingredient in Canada indicated their continued support for all registered uses of thiamethoxam in Canada.

Thiamethoxam is currently found in 18 end-use products to which pollinators may be exposed. Appendix I lists these products which are registered under the *Pest Control Products Act*. Uses of thiamethoxam considered in the pollinator risk assessment belong to the following use-site categories: greenhouse food crops, greenhouse non-food crops, terrestrial non-food and non-feed seed and fiber crops, seed and plant propagation materials food and feed, terrestrial feed crops, terrestrial food crops, and outdoor ornamentals. Appendix II provides a summary of the use pattern of thiamethoxam products considered in the pollinator risk assessment.

1.0 The Technical Grade Active Ingredient

1.1 Identity

Active Substance	Thiamethoxam
Function	Insecticide
Chemical name	
1. International Union of Pure and Applied Chemistry (IUPAC)	3-(2-chloro-1,3-thiazol-5-ylmethyl)-5-methyl -1,3,5-oxadiazinan-4-ylidene(nitro)amine
2. Chemical Abstract Services (CAS)	3-[(2-Chloro-5-thiazolyl)methyl]tetrahydro-5-methyl-*N*-nitro-4*H*-1,3,5-oxadiazin-4-imine
CAS Number	153719-23-4
Molecular Formula	$C_6H_{10}ClN_5O_3S$

Molecular Weight	291.7 g/mol
Structural Formula	
Position of Radiolabels in Environmental Studies	 [Guanidine-4-^{14}C] Thiamethoxam* * Also referred to as [Oxadiazine-4-^{14}C] Thiamethoxam

2.0 Pollinator Assessment

2.1 Fate and Behaviour in the Environment

A summary of available information pertaining to the fate and behaviour of thiamethoxam in the environment is provided in Appendix III. The environmental fate and behaviour of thiamethoxam are summarized as follows:

- Thiamethoxam is readily taken up by plants through treated leaves, treated seed, or roots growing in treated soil where it moves upward inside the plant through the xylem. Pollen and nectar contain thiamethoxam as a result of this upwards movement or when spray droplets or dust containing thiamethoxam (produced during the sowing of treated seeds) are deposited directly on open flowers.
- Once inside the plant, thiamethoxam transforms over time but remains a predominant residue. There are five major residues found in plants: CGA 322704 (clothianidin), CGA 265307, CGA 353042, NOA 407475 and NOA 421275. Of these, thiamethoxam and CGA 322704 (which is clothianidin, an insecticidal active ingredient) are considered to be the most relevant residues for the pollinator risk assessment.
- Thiamethoxam will come in contact with soil when it is applied directly on the ground, sprayed on foliage, or when thiamethoxam contained in the seed coating moves away from the seed into the surrounding soil. The length of time that thiamethoxam will persist in soil depends on various factors including soil type. In certain fields, thiamethoxam may persist long enough to carryover from one growing season to the next.
- Major products formed from the microbial degradation of thiamethoxam in soil are CGA 322704 (clothianidin) and CGA 355190. CGA 322704 has been found in rotational crops.
- Thiamethoxam can leach through the soil profile and has been detected in groundwater. CGA 322704 (clothianidin) has been found in both soil pore water and in groundwater. CGA 355190 has been found sporadically in soil pore water but was not detected in groundwater.

- Thiamethoxam may enter the aquatic environment through spray drift or run-off. Thiamethoxam in water is expected to dissipate relatively quickly if exposed to sunlight. In the absence of sunlight, thiamethoxam will degrade more slowly. Thiamethoxam is found in surface water, including puddles which are known sources of drinking water for pollinators.

2.2 Approach to Pollinator Risk Assessment

2.2.1 Background

The pollinator risk assessment followed a tiered framework developed jointly by the PMRA, USEPA (United States Environmental Protection Agency) and CDPR (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 3). Briefly the risk assessment considered the following:

- Potential acute and chronic risk to adults and brood for *Apis* (honey bees) and non-*Apis* bees (e.g., bumble bees) from foliar, soil and seed treatment applications.
- Potential 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) (see Appendix IV).

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 mitigation.

Pollinator exposure includes crop pollination requirements, crop attractiveness to *Apis* (honey bees) 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).

An extensive data set (>218 effects and residue studies) from open literature and the registrant were considered for the thiamethoxam pollinator risk assessment. 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). Because clothianidin is a transformation product of thiamethoxam, this assessment also considered potential exposure to clothianidin following application and transformation of thiamethoxam (see Appendix IV). The pollinator risk assessment for thiamethoxam is based on the information that was available to PMRA at the time of publication.

2.3 Endpoints considered in the pollinator risk assessment

2.3.1 Tier I risk assessment

The Tier I assessment considered acute and chronic laboratory endpoints for adults and brood. There were 93 Tier I studies available for consideration in the risk assessment from the registrant and open literature. Details on the strength and limitations of these studies can be found in Appendix V. In the case of thiamethoxam, the endpoints for clothianidin were also considered since thiamethoxam can convert to clothianidin, therefore, assessments were done for thiamethoxam and also for its conversion to clothianidin (referred to as clothianidin equivalents, c.e.) (see Appendix IV for further details). The following endpoints were considered most relevant in the Tier I risk assessment:

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

Exposure	Thiamethoxam risk assessment	Clothianidin equivalents risk assessment			Degree of toxicity[1]	Reference (PMRA#)
	Endpoint value	Clothianidin Endpoint value	Clothianidin equivalents Endpoint value	Notes		
Acute adult oral	96-h LD50: 0.0044 µg ai/bee	48-h LD50: 0.00368 µg ai/bee	96-h LD50: 0.00368 µg ai/bee	Lowest endpoint selected from clothianidin (LD50 of 0.00368 µg ai/bee/day). Lowest endpoint for thiamethoxam was 0.0044 µg ai/bee/day; molar adjusted value of 0.00377 µg c.e./bee/day)	Highly toxic	1194190
Acute adult contact	96-h LD50: 0.024 µg ai/bee	48-hLD50: 0.0275 µg ai/bee	48-hLD50: 0.021 µg c.e./bee	Lowest endpoint selected from molar adjusted thiamethoxam endpoint (LD50 of 0.024 µg ai/bee/day x 0.856 = 0.021 µg c.e./bee).	Highly toxic	1196699
Chronic adult	NOAED: 0.00245µg ai/bee/day	NOAED: 0.00036 µg ai/bee/day	NOAED: 0.00036 µg ai/bee/day	The most relevant endpoint for thiamethoxam (NOAED of 0.00245 µg ai/bee/day x 0.856 = 0.0021 µg c.e./bee/day for molar adjustment) Lowest endpoint selected from clothianidin (NOEC of 0.00036 µg ai/bee/day).	n/a	2355466
Larvae	LD50: 0.78 µg ai/larvae NOAED: 0.0157	LD50: >0.0018 µg ai/larvae NOAED:	LD50: >0.0018 µg ai/larvae NOAED: 0.0009	The most relevant and sensitive endpoint for	n/a	2355467

Exposure	Thiamethoxam risk assessment	Clothianidin equivalents risk assessment			Degree of toxicity[1]	Reference (PMRA#)
	Endpoint value	Clothianidin Endpoint value	Clothianidin equivalents Endpoint value	Notes		
	µg a.i./larva/day	0.0009 µg ai/larva/day	µg a.i./larva/day	thiamethoxam (acute LD50 of 0.78 µg ai/bee/day x 0.856 = 0.67 µg c.e./bee/day molar adjusted; chronic NOAED of 0.0157 µg ai/bee/day x 0.856 = 0.013 µg c.e./bee/day molar adjusted). Lowest endpoint selected from clothianidin (LD50 of 0.0018 µg ai/larvae and NOAEL of 0.0009 µg a.i./larva/day).		

[1] Atkins et al. 1981. n/a is owing to a lack of criteria for these types of studies.

In addition to mortality endpoints, sublethal effects were also considered in the risk assessment in a qualitative manner. In addition to topical or contact exposure and oral exposure studies, many open literature studies also looked at other endpoints and made comparisons among bee species and castes under various exposure regimes. Some of the open literature suggested that combination of thiamethoxam with fungicides increased toxicity. Toxicity of thiamethoxam also depended on the strain and age of bee and on the route of exposure, with higher toxicity resulting from direct contact exposure (the bee getting directly sprayed by the pesticide) compared to indirect contact (when a bee lands on or walks on leaves or other plant parts that were sprayed with thiamethoxam). In addition, bees demonstrated effects on learning and on probiscus extension from oral exposure to thiamethoxam. The overall applicability of sublethal endpoints in relation to whole colony effects and applicability under field conditions is unclear since some studies showed sublethal effects with no effects on mortality, while other studies showed that chronic exposure to thiamethoxam resulted in morphological and histochemical changes in addition to mortality.

2.3.2 Tier I refined assessment - Residues

There were 38 residue studies available for consideration in the risk assessment (most studies were from the registrant). See Appendix VI for foliar, Appendix VII for soil and Appendix VIII for seed treatment for the relevance of the crop in the assessment.

Table 2 Summary of Available Residue Studies for the Thiamethoxam Risk Assessment

Application type	Application timing	Residue studies
Foliar	Pre-bloom	apple, peach, tomato, strawberry, cranberry, soybean, cotton, cucumber, honeydew melon
	During bloom	pumpkin, phacelia
	Post-bloom	cherry, peach, plum
Soil	At planting	cucumber, pumpkin, summer squash, muskmelon, melon, pepper, tomato,

Application type	Application timing	Residue studies
		strawberry, orange
Seed treatment	At planting	canola, rapeseed, corn, pumpkin, sorghum, soybean, sunflower, cotton, carry over

2.3.3 Tier II refined assessment

The Tier II refined assessment considered effects from colony feeding studies compared to measured residues in pollen and/or nectar from labelled application to crops. There were 18 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 following endpoints were considered the most relevant in the Tier II refined risk assessment:

Table 3 Summary of Endpoints Selected from Colony Feeding Studies for the Tier II Refined Thiamethoxam Risk Assessment (reported as clothianidin equivalents)

Study type	Matrix which was dosed & length of exposure	Species and caste exposed to dose	Endpoint (clothianidin equivalents)[1]	Endpoints affected	Limitations	Reference (PMRA#)
Thiamethoxam colony feeding study (no overwintering results) Open	Sugar solution 5 weeks	Honey bee Whole colony	NOAEC: **25.3 µg c.e./kg sucrose** LOAEC: **34 µg c.e./kg sucrose**	Number of adults, pupae, total brood, total live bees and pollen storage	There was high overwintering mortality for control colonies. In CCAs (colony condition assessment) occurring post-exposure and pre-overwintering treatment, effects may have been masked when colonies declined in preparation for overwintering. There was a lack of dosing exposure from contaminated pollen/bee bread. Only nectar dosing was considered.	2586559
Thiamethoxam colony feeding study (overwintering results) Open	Sugar solution 5 weeks	Honey bee Whole colony	Preliminary NOAEC: 34.8 µg c.e./kg sucrose LOAEC: 69.6 c.e. µg/kg sucrose	Brood, larval and pupae coverage, pollen storage in pre-overwintering CCAs (colony condition assessments).	No study report available	*Preliminary information 2015/2016 study*
Clothianidin colony feeding study (no overwintering results) Open	Sugar solution 5 weeks	Honey bee Whole colony	NOAEC: **19 µg clothianidin/kg sucrose** LOAEC: **35.6 µg clothianidin/kg sucrose**	Number of adults, pupae, total brood, total live bees and pollen storage	There was high overwintering mortality for control colonies. There was a lack of dosing exposure from contaminated pollen/bee bread. Only nectar dosing was considered.	2610259
Clothianidin colony feeding study (overwintering	Sugar solution	Honey bee Whole	Preliminary NOAEC: 19 µg	Effects to pollen storage and brood were observed in	No study report available	*Preliminary information 2015/2016*

Study type	Matrix which was dosed & length of exposure	Species and caste exposed to dose	Endpoint (clothianidin equivalents)[1]	Endpoints affected	Limitations	Reference (PMRA#)
results) Open	5 weeks	colony	clothianidin/kg sucrose LOAEC: 29 µg clothianidin/kg sucrose	a number of pre-overwintering CCAs (colony condition assessments). With respect to colony survival, the LOAEC for this study is reported as 76 ppb and the NOAEC as 37 ppb.		*study*
Thiamethoxam and clothianidin colony feeding study Open	Pollen patties (40% sucrose and 55% pollen and 5% yeast) 6.5 weeks	Honey bee Colony	LOAEC: **6.6 µg c.e. /kg** (5.31 µg thiamethoxam /kg x 0.856 + 2.05 µg clothianidin/kg pollen patty)	Short-term effects (lower numbers of adult bees, brood and stored honey) Long-term effects (60% of queens in the treatment group were superseded within a year). No difference was observed in the fall observation, just prior to over wintering, indicating that the effects determined at CCA2 (second colony condition assessment) had recovered to the level of the control. However, after overwintering, 90% of control hives swarmed, whereas only 20% of treatment hives swarmed.	Only one concentration was tested. No details were provided about the forage surrounding the test apiary location. The bees were stated to have come from an area characterized by intense agriculture yet there was no screen of potential pesticide exposure before feeding began. Less pollen was collected by treated bees (as observed from the pollen traps), which may have led to some brood effects. It is noted that pollen traps were only in place during the exposure phase, and observations continued until after overwintering.	Sandrock et al. 2014
Thiamethoxam and clothianidin Open	Pollen paste (10% honey and 30% powder sugar and 60% pollen)	Honey bee queen and drone feeding study	LOAEC: **6.3 µg c.e./kg** (4.9 µg thiamethoxam /kg x 0.856 + 2.1 µg clothianidin/kg pollen patty	Declining drone survival/longevity for up to 14 days (the point of drone sexual maturity), an increase in median drone mortality, a decrease in sperm viability and the total amount of	The amount of the pollen paste "patties" consumed was not quantified. There appeared to be large variation in the control data for the sperm assessments. Effects could be attributed to both queen and drone pollen paste exposure through exposed workers who facilitated the queen and drone brood feeding.	Straub et al. 2016

Study type	Matrix which was dosed & length of exposure	Species and caste exposed to dose	Endpoint (clothianidin equivalents)[1]	Endpoints affected	Limitations	Reference (PMRA#)
	~7.1 weeks			living sperm	Only one concentration was tested. The study authors did not measure thiamethoxam and clothianidin residues in bee matrices relevant to the queen (i.e., royal jelly).	
Thiamethoxam and clothianidin colony feeding study Open	Pollen patties (3:1 pollen: honey) 5.1 weeks	Honey bee One day old larvae were transplanted into queenless nuclei that had contaminated pollen patties.	LOAEC: **4.5 µg c.e./kg** (4.16 µg thiamethoxam /kg x 0.856 + 0.96 µg clothianidin/kg)	By 4 weeks after queens emergence 25% fewer neonicotinoid-exposed queens were alive compared to controls. Surviving queens had fewer eggs (34% less compared to controls), stored less spermatozoa (20%) and had lower proportion of stored living sperm (9%). Neonicotinoid-exposed queens also had significantly larger ovaries than controls by 6.8%.	Only one concentration was tested. The amount of pollen patty consumed was not quantified and the authors noted that the bees never consumed the entire daily allotment. There was no mention if sucrose syrup was provided so the Agency review has assumed that nectar was provided via foraging. Pollen and honey used in the pollen patties were bee-collected from non-intensive agricultural areas in Switzerland. Dose verification was conducted on the pollen patties but residues from in-hive storage products (i.e., honey, bee bread) was not conducted. The study did not include long-term observations of the queen. It is unknown how these queen effects would relate to field colony observations.	Williams et al. 2015
Thiamethoxam Closed	Sucrose solution and pollen 28 days	Bumble bees Colony	LOAEC: **8.56 µg c.e./kg pollen** (dose of 10 µg thiamethoxam /kg sucrose)	Reduced nest building activity, increased uncoordinated movement, and extensive grooming, and fewer eggs and no larvae produced	The results for the 1 µg/kg treatment for the number of eggs and larvae was not significant but with a value of p=0.051. Worker weights were measured but not stated in article. The mean consumption values for the controls were not stated. Bees had a limited alternate food source, therefore, exposure only to contaminated food.	Elston et al. 2013
			LOAEC: **0.856 µg c.e./kg sucrose** (dose of 1 µg thiamethoxam/kg sucrose)	Decreased honey water consumption.		Elston et al. 2013
Thiamethoxam and clothianidin Closed	Sucrose solution and pollen patty 9 weeks	Bumble bees Colony (with parasite)	LOAEC: **4.9 µg c.e./kg** (4 ppb thiamethoxam + 1.5 ppb clothianidin)	Decreased worker production, shorter worker longevity, and decreased sucrose water and pollen collection (only during Weeks 6-9).	Dose verification was not conducted. Bees were maintained in a nest attached to a foraging box for 63 days, which may have caused stress on the bees since the space available for flight was severely limited. Bees had a	Fauser-Misslin et al. 2014

Study type	Matrix which was dosed & length of exposure	Species and caste exposed to dose	Endpoint (clothianidin equivalents)[1]	Endpoints affected	Limitations	Reference (PMRA#)
				Less gyne and male production, and queens had a decreased survival when also exposed to a parasite.	limited alternate food source, therefore, exposure only to contaminated food.	
Thiamethoxam Closed	Sucrose solution 27 days	Bumble bees Mature colony	NOAEC: **8.56 c.e. ppb** (10 ppb thiamethoxam) Study also dosed with 2.4 ppb thiamethoxam (equivalent to 2.05 ppb c.e.)	No effects on colony weight gain, number of males, workers or queens. Colonies exposed to 2.05 ppb c.e. produced larger males.	The tests were started with relative larger colonies that were at a late stage in the colony development cycle, which may affect the ability of the colony to withstand more stress. Colony conditions were examined once at 13 days after the end of the exposure period, and brood effects were not examined during the study. Bees had a limited alternate food source since this was a closed feeding study.	Stanley and Raine 2017
Thiamethoxam Closed	Sucrose solution 14 days	Bumble bees Queen (with parasitic infection and varying lengths of hibernation)	LOAEC: **2.05 ppb c.e.** (2.4 ppb thiamethoxam)	Lower colony initiation (26%) from treatment after hibernation. Hibernation duration alone also had an impact on egg laying, as did female weight. No effect on production of adult offspring.	The study was conducted under laboratory conditions, including mating, hibernation, and pesticide exposure, which are different from field conditions. There are challenges with extrapolating endpoints from the laboratory feeding study to the field using mathematical models, and some of the assumptions of the model. It is unclear if bees were provided with fresh food daily. There were effects on hibernation from queen weight. Tested hibernation period in the study may be different to what may be seen in Canada.	Baron et al. 2017
Thiamethoxam Closed	Sucrose solution (multiple doses) 17 days	Bumble bees Individual adults	NOAEC: **13.4 µg c.e./kg** (15.7 µg thiamethoxam /kg) LOAEC**: 39 µg c.e./kg** (33.4 µg thiamethoxam /kg)	Impaired feeding on syrup and pollen and brood production.	This study only considered the effects of dietary thiamethoxam in nectar and not in pollen. The exposure duration was only done for 17 days which may not be realistic as bumblebees forage on mass-flowering crops throughout their bloom and this could extend for more than a month. Bees had a limited alternate food source since this was a	Laycock et al. 2014

Study type	Matrix which was dosed & length of exposure	Species and caste exposed to dose	Endpoint (clothianidin equivalents)[1]	Endpoints affected	Limitations	Reference (PMRA#)
					closed feeding study.	
Thiamethoxam Closed	Sucrose solution (multiple doses) Exposed after nest constructio n and larval production 11 weeks	Bumble bees Colony	NOAEC: **85.6 ppb c.e.** (0.1 ppm thiamethoxam)	Decreased drone production.	It is not clear if bees were fed *ad libitum*, or a specific amount per week. Our review has presumed *ad libitum.* The results of the control fed mico-colonies were not discussed. There was a large amount of stress on these 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. The trial with foraging only tested one dose.	Mommaerts et al. 2010
Thiamethoxam Closed	Sucrose solution (multiple doses) 4 weeks	Bumble bees Colony	LOAEC: **2.05 c.e. ppb** (2.4 ppb thiamethoxam)	Workers were slower to learn and showed impaired 3-hour memory after 3–4 weeks of chronic exposure at a level of 2.4 ppb. Minimal effects observed on learning and memory from acute exposure.	The exposure scenario presented in this study is conservative since it only considered contaminated sugar exposure. Bumble bees were allowed to forage outside in an untreated apple orchard. Nothing was noted by the authors about the quality of the hives prior to the test.	Stanley et al. 2015
Thiamethoxam Open	Sucrose solution 9-10 days	Bumble bees Colony	LOAEC: **8.56 c.e. ppb** (10 ppb thiamethoxam)	Change in preference for flowers, increased pollen collection and faster foraging.	The exact calendar dates of when the exposure period occurred were not clearly stated in the article. The data were collected in an outdoor flight arena in which bees had to fly less than 50 cm to access their first flower, representing a relatively simple environment with little need to navigate, locate forage resources or avoid predators. It was presumed by the authors and the Agency reviewers that the control bees had not yet fully learned how to forage to the best of their ability, and so may not yet have been 'accurate' foragers during their initial foraging bout. Nothing was noted by the authors about the quality of the hives prior to the test.	Stanley et al. 2015; Stanley et al. 2016
Thiamethoxam closed/open	Sucrose solution 6 weeks	Bumble bees Colony	LOAEC: **2.05 c.e. ppb** (2.4 ppb	Change in foraging patterns (longer foraging	The volume of sugar solution was not reported. Large confidence intervals	Stanley et al. 2016

Study type	Matrix which was dosed & length of exposure	Species and caste exposed to dose	Endpoint (clothianidin equivalents)[1]	Endpoints affected	Limitations	Reference (PMRA#)
			thiamethoxam)	bouts and less pollen collection). Increased return to colonies. No effect on colony size.	may have led to lower statistical power. The distance between the control and treated colonies was not reported. In some instances in the summary of results the study author indicated effects to certain parameters despite of lack of statistical significance, which led to contradictory statements (i.e., the number of dead bees). These would be considered as 'trends' by the Agency reviewer. The study assessed potential effects from oral consumption of sucrose solution only, not pollen. Bees were excluded from analysis if they had no prior foraging experience, if they drifted between colonies and if they took an excessively long time to return home. This resulted in fewer bees in the pesticide colonies for the 2 km homing experiment.	
Thiamethoxam and clothiandin Closed	Sucrose solution 4 months	Red mason bee Colony	LOAEC: **2.9 c.e. ppb** (2.87 ppb thiamethoxam plus 0.45 ppb clothianidin)	Significant reductions in brood cell number, offspring development (approximately 50% less hatched), and sex ratio (biased towards males). No significant effects for female body weight, longevity or offspring body weight in the treatment group compared to controls.	Two populations of the *Osmia bicornis* were tested; the experiment was not repeated. Exposure from pollen was not tested. It was unclear if the outliers in the study were excluded from analysis – exclusion may have changed results. The study indicated that female weight affected offspring production (including gender of offspring). It is unclear if smaller males also impacts reproduction. The offspring sex ratio was significant; however, it is unclear if 47% compared to 55% females would result in a significant effect in the field.	Sandrock et al. 2014
Thiamethoxam Open	Sucrose solution 5 weeks	Bumble bees Colony	LOAEC: **2.14 c.e. ppb** (2.5 ppb thiamethoxam) It is noted that there was no reduction in endpoints from exposure to another	Reduced number of live bees present at the end of the 5-week exposure period by 38% compared to the control, and significantly	There were some Tier I laboratory test results presented in this paper but the materials and methods were not well documented. The amount of sugar syrup provided to the hives and rate of replenishment was not stated (for the purpose	Moffat et al. 2016

Study type	Matrix which was dosed & length of exposure	Species and caste exposed to dose	Endpoint (clothianidin equivalents)[1]	Endpoints affected	Limitations	Reference (PMRA#)
			experiment from dosing with clothianidin alone at 2.5 ppb.	reduced the number of brood cells at the end of the 5 week exposure period by 70% compared to the control. In addition, 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; and 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.	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. 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. There were limited assessments during the study (only at end of exposure period).	

1 Converted as dose thiamethoxam x 0.856 + clothianidin if applicable.

2.4 Incident reports

Since April 26, 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 thiamethoxam and clothianidin have been presented previously in the publiciation Update on Canadian Bee Incident Reports 2012-2016.

No incident reports related to foliar application of thiamethoxam have been reported for Canada; however, incident reports related to spray applications have been reported to the US EPA. The majority of these incidents were reports of dead bees that occurred in 2002 in Washington State when thiamethoxam was sprayed on orchard trees that were in bloom. For the remaining spray incidents, it is uncertain if the application occurred during the bloom period when bees could be actively foraging 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.

There were no incident reports associated with soil application of thiamethoxam in Canada or the United States.

The majority of the incident reports available from Canada and the United States are associated with seed treatments that use thiamethoxam. Incidents with seed treatments have primarily been associated with dust generated during planting of treated seeds. 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 this and subsequent planting periods of treated corn and soybean.

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 thiamethoxam and its major transformation product clothianidin 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 thiamethoxam and clothianidin and transformation products sampled from nectar and pollen in different matrices (i.e., hives, plants, bees) following applications with thiamethoxam were selected from available residue information to refine the Tier I screening level acute and chronic estimated environmental concentrations (EEC). There was also consideration of the range of residue values observed, and outliers were taken into account when choosing residue levels to estimate exposures. 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 thiamethoxam 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 (i.e., 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) x maximum nectar residue (µg/kg))/ 1.0 x 10^6] with the daily pollen dose [(pollen consumption rate (mg/day) x maximum pollen residue (µg/kg))/1.0 x 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, confinement can sometimes lead to stress.

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 to the effect outcome of the feeding study in which hives were fed with thiamethoxam and/or clothiandin 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 and challenges in interpretation of the assessment.

2.5.2 Risk Characterization

The overall pollinator risk characterization for thiamethoxam 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 and II risk assessment for each application method are presented in Appendix VI (foliar applications), Appendix VII (soil applications) and Appendix VIII (seed treatment applications). Appendix X further summarizes the overall risk characterization and conclusions for thiamethoxam.

2.5.2.1 Foliar applications

2.5.2.1.1 Tier I screening

In the Tier I screening assessment for foliar applications of thiamethoxam, the level of concern for oral and contact exposure was exceeded for adults and brood for acute and chronic exposure; 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 field residues from cherry, apple, plum, peach, strawberry, soybean, tomato, cucumber, pumpkin, melon, cranberry, cotton and phacelia. 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. Both thiamethoxam and clothianidin equivalents were considered. In general, the risk profile was similar between thiamethoxam and clothianidin equivalents. Below is a summary of potential risk (see Appendix VI for details).

Overall, considering relevant residue information, the Tier I refined risk assessment indicated that there are potential acute and chronic risks for orchard uses (stone fruit and pome fruit), low-growing berries, fruiting vegetables, and soybean from application of thiamethoxam before and during bloom. For orchard crops, residues in pollen sampled during the spring following the year of application indicate that there is a potential risk to pollinators from post-bloom application of thiamethoxam. Application of thiamethoxam post-bloom to annual crops such as fruiting vegetables and beans does not represent a risk to pollinators because there are no longer flowers available for foraging.

For both tomato and soybean, residues were much higher in plants compared to those collected by honey bees. Although this may indicate that tomato and soybean are not a preferred food source for honey bees, this may underestimate exposure to non-*Apis* bees.

For outdoor ornamentals, there is no residue data. Considering surrogate residue data from pre-bloom apple, and post-bloom cherry, peach and plum studies, there was potential acute and chronic risk for

outdoor woody ornamentals from pre-bloom applications. For non-woody outdoor ornamentals, there was potential acute and chronic risk identified considering the range of surrogate residue data from pre-bloom tomato (pollen only), cotton, cranberry, pumpkin, strawberry and honeydew melon.

There is no residue data for potato, so surrogate residue data from pre-bloom application to tomato and cotton, and pre-bloom and during bloom application to cucurbits was considered. Although this surrogate residue data indicated that there could be potential acute and chronic risks to pollinators, because potatoes are not very attractive crops to pollinators, the expected risk from foliar application to potatoes is minimal.

Considering residues from application to phacelia during bloom at very low rates, there was no risk.

2.5.2.1.3 Tier I non-*Apis*

Tier I effects information indicates that individual non-*Apis* bees, specifically bumble bees, have similar sensitivity to thiamethoxam exposure as honey bees. Therefore effect endpoints derived from the Tier I honey bee laboratory studies are considered suitable as a surrogate for non-*Apis* bees and 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

Apis

Considering **nectar residues and a range of *Apis* colony nectar feeding endpoints**, the Tier II refined assessment indicated a potential risk to *Apis* bees from pre-bloom foliar applications of thiamethoxam to apples, cucurbits (considered as surrogate data), soybean (flower), cranberry and strawberry.

Considering **pollen residues and calculated bee bread residues and a range of *Apis* colony feeding study endpoints whereby colonies were dosed with pollen patties** (mixture of nectar and pollen), the Tier II refined assessment indicated there was a potential risk to *Apis* bees from some post-bloom applications of thiamethoxam to orchard crops, but a higher risk to *Apis* bees from pre-bloom application to apples. Consistent with the nectar assessment, there was also risk to *Apis* bees from pre-bloom applications to most cucurbits, soybean (from flower residues), cranberry and strawberry. Because tomatoes do not produce nectar, a nectar assessment was not required for this crop. Based on pollen residues there was a potential risk to *Apis* bees when considering tomato plant residues.

Non-*Apis*

Considering **nectar residues and a range of non-*Apis* colony nectar feeding study endpoints**, the Tier II refined assessment indicated there was a larger range of risk to non-*Apis* bees than to *Apis* bees. This was owing to the large range in endpoints for non-*Apis* bees (2.05 to 89 c.e. ppb). The residues that exceeded the highest range of endpoints were from pre-bloom application of thiamethoxam to apple, cucumber, soybean (from flower residues), strawberry and cranberry, which is similar to the overall conclusion for *Apis* bees.

Considering **pollen residues and non-*Apis* colony feeding study endpoints,** whereby colonies were fed with a mixture of pollen and sucrose solution, all of the crop residues exceeded the endpoints. Effects in

non-*Apis* bees (for egg and larvae production, number of bees and queen effects) were similar to the effects observed in *Apis* bees and at similar endpoints (4.5 to 6.6 c.e. ppb.)

2.5.2.1.5 Tier II tunnel studies

Apis

In tunnel studies conducted with thiamethoxam, pre-bloom foliar applications to melon of 100 g a.i./ha (PMRA 2364950) made closer to the bloom period (5 days before bloom), resulted in more effects on mortality and colony size when compared to applications made well in advance of bloom (10 days before bloom). Brood effects were seen in colonies regardless of the timing of when thiamethoxam was applied pre-bloom; however, the brood recovered by the time the studies had been terminated, by up to 28 days. Exposure was also confirmed in the study through residue analysis. When foliar applications were made to *phacelia* **during bloom** and **during bee flight** at a rate of 5 – 80 g a.i./ha (PMRA 2364874, 2364881 and 2364974), increased mortality and a decrease in foraging and colony strength was seen for up to 27 days post treatment. When looked for, no effects on brood were noted in these studies. It is noted that the maximum foliar application rate of thiamethoxam in Canada is 150 g a.i./ha.

Non-*Apis*

Foliar applications of 100 g a.i./ha to indeterminate blooming tomato crops (PMRA 2364900) made **prior to introduction of bumble bee** hives resulted in mortality effects and reduced pollination of tomato plants.

2.5.2.1.6 Tier III field studies

Apis

In two field studies conducted with thiamethoxam, foliar applications of 25 g a.i./ha were made after bees were done foraging while honey bee hives were in blooming fields of *Phacelia tanacetifolia*. In a third field study, foliar applications of 52.7 g a.i./ha were made in evening or morning to blooming cucumber. The field studies resulted in limited long-term colony effects (PMRA 2364935, 2364932 and 2365392). **Pre-bloom foliar** applications of 62.5 g a.i./ha to a tree fruit crops made 6 days before bloom showed an increase in mortality when bloom started, for up to 5 days, that recovered to control levels. No other effects were seen on sustained mortality, brood development, behaviour, colony strength or foraging activity when colonies were exposed to foliar applications of 62.5 – 100 g a.i./ha made 7-15 days before tree fruit crop blooms (PMRA 2364910, 2364948 and 2364868). **Post-bloom foliar** sprays of 100 g a.i./ha applied either once or twice to tree fruit crops at fruit set, after the bloom period, did not result in mortality, brood development, foraging activity, hive weight or behavioural effects (PMRA 2364885 and 2364966). However, honey bee colonies were placed in the orchards before application and, in both trials, the wildflowers in the orchard had been mowed prior to application according to label directions. Therefore, exposure of the bees may have been limited to residues in surrounding plants.

Non-*Apis*

There were no foliar field studies reviewed for non-*Apis* bees.

Monitoring

Apis

A hive monitoring study was conducted in Spain in rural, cultivated areas where 70% of the area is represented by agriculture; the area was dominated by citrus orchards with some peach and plum orchards. An increase in honey bee mortality was seen in these areas that coincided with the flowering periods of peach and plum (January to mid-March) and at the end of the citrus bloom period that occurred in mid-May; however, there was limited thiamethoxam detected in the dead honey bees and a number of other chemicals were found (Caltayud-Vernich et al. 2015).

In a separate hive monitoring study, brood comb, from hives that were suspected as having been affected by a pesticide incident, were removed and placed into "clean" experimental colonies. The observed effects included the delayed development of the "affected" brood when compared with the "clean" brood and an increase in the total larval mortality in both the "clean" and "affected" sections of brood comb. Additionally, after repeated use of the same experimental frames, pesticide residues in the "affected" brood comb increased and moved beyond the sections of brood comb that were originally implanted into the uncontaminated/"clean" brood comb. The residue levels were on average 35, 38 and 45 ppb of clothianidin, thiamethoxam and imidacloprid, respectively. Other pesticides were also detected in high amounts (Wu et al. 2011).

Non-*Apis*

No foliar monitoring studies were available for non-*Apis* bees.

2.5.2.1.7 Summary of Incident Reports

No incident reports related to foliar application of thiamethoxam have been reported for Canada; however, incident reports related to spray applications have been reported to the US EPA. The majority of these incidents were reports of dead bees that occurred in 2002 in Washington State when thiamethoxam was sprayed on orchard trees that were in bloom. For the remaining spray incidents, it is uncertain if the application occurred during the bloom period when bees could be actively foraging 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

In the Tier I screening assessment for soil application of thiamethoxam, the level of concern was exceeded for exposure to adult bees and brood at the highest application rate (see Appendix VII). Therefore, a Tier I refined assessment was conducted.

2.5.2.2.2 Tier I refined

Risk estimates from soil application of thiamethoxam were based on field residues from pepper, cucumber, pumpkin, summer squash, muskmelon, melon, tomato, and strawberry, and orange tree studies following soil applications. 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. Both thiamethoxam and clothianidin equivalents were considered in this risk assessment. In general, the risk profile was similar between thiamethoxam and clothianidin equivalents. Below is a summary of potential risk (see Appendix VII for details).

Overall, considering relevant residue information from soil application at planting, there is potential acute and chronic risk to bees from soil applications for use on cucurbits (muskmelon, summer squash, pumpkin and cucumber), fruiting vegetables and low growing berries.

Currently there are no residue data for greenhouse ornamentals. Considering surrogate residue data from cucumber, pumpkin and melon, tomato, and pepper there was potential acute and chronic risk to bees from soil applications for use on ornamentals. Residue information from orange trees was used to assess potential risk to woody ornamentals. There is no risk to pollinators for plants which are not planted outside (such as cut flowers).

There are also no residue data for soil application of thiamethoxam for potato crops. Considering surrogate residue data from cucumber, pumpkin and melon, tomato, and pepper there was potential acute and chronic risk to bees from soil applications for use on potato; however, potatoes are not considered very attractive to pollinators, and thus the expected risk is minimal.

2.5.2.2.3 Tier I non-*Apis*

Tier I effects information indicates that individual non-*Apis* bees, specifically bumble bees, have similar sensitivity to thiamethoxam exposure as honey bees. Therefore effect endpoints derived from the Tier I honey bee laboratory studies are considered suitable as a surrogate for non-*Apis* bees and 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

Considering **nectar residues and a range of *Apis* colony nectar feeding endpoints**, there was a potential risk from soil application to strawberry, pepper, muskmelon and summer squash, however, most of the other residues were below the colony level endpoints. For the orange studies, residues in nectar did not exceed colony level endpoints at Canadian relevant rates, when considering extrapolation to other crops, such as ornamental tree species.

Considering **pollen residues and calculated bee bread residues and a range of *Apis* colony feeding study endpoints whereby colonies were dosed with pollen patties** (mixture of nectar and pollen), there was a potential risk from most strawberry, tomato and pepper residues, as well as orange residues. Based on the range of cucurbit residues, summer squash and muskmelon exceeded colony endpoints (which had a high contribution of clothianidin to the total residues). In almost all cases, some of the residues exceeded the range of pollen endpoints, and there did not appear to be a good correlation between soil type or the rate of application and residues measured in pollen.

Non-*Apis*

Considering **nectar residues and a range of non-*Apis* colony nectar feeding study endpoints**, there was a larger range of risk for non-*Apis* bees than for *Apis* bees. This was owing to the large range in endpoints for non-*Apis* bees (2.05 to 89 c.e. ppb). Considering the range of observed effects, most nectar residues exceeded these lower colony effect endpoints. Strawberry, pepper, muskmelon and summer squash residues resulted in higher risk compared to most other crops and this risk conclusion is similar to that of *Apis* bees. For the other cucurbit crops such as melon, pumpkin and cucumber, there was more risk for non-*Apis* bees compared to *Apis* bees.

Considering **pollen residues and non-*Apis* colony feeding study endpoints** in studies where colonies were fed with a mixture of pollen and sucrose solution, pollen residues from some cucurbit crops (muskmelon, pumpkin, and summer squash), strawberry, pepper and tomato applications resulted in potential risk to non-*Apis* bees. These effects were similar to those for *Apis* bees (4.5 to 6.6 c.e. ppb) based on effects on the queen, reduced eggs and sperm storage, drone survival rates, and reduced number of bees. Following soil application of thiamethoxam, residues of the metabolite clothianidin were high in both fruiting vegetable crops (tomato and pepper), resulting in higher risk to bees. Residues in the cucurbit crops did not appear to correlate with soil type. Although most bees may forage on a range of crops, the non-*Apis* squash bee relies solely on cucurbit crops for forage and breeding. As such, the exposure and potential risk to these species of bees may be higher than for other bees.

2.5.2.2.5 Tier II tunnel studies

Apis

No tunnel studies with soil applications of thiamethoxam were available for review.

Non-*Apis*

In tunnel studies conducted with soil application of thiamethoxam, the registrant submitted three studies which exposed small bumble bee hives to tomatoes treated by drip irrigation at rates ranging from 150 to 200 g a.i./ha (PMRA 2365420, 2364898 and 2364997). Overall, of the two studies conducted at 200 g a.i./ha, only one showed effects on mortality and pupae at 200 g a.i./ha when applications were made close to hive introductions. Effects on foraging were variable. In the open literature, there were two relevant soil studies. Alarcon et al. (2005) and Sechser et al. (2003) exposed *Bombus terrestris* to tomato plants at rates ranging from 150 to 166 g ai/ha. Alarcon et al. (2005) (2 applications x 100 g ai/ha) concluded that there were no significant effects on mortality and, based on fruit set of the tomato plants, pollination rates were not affected regardless of treatment applied. Sechser et al. (2003) concluded possible effects on mortality of adults and larvae and food storage when exposed to 1 application of 161 g a.i./ha or 1 application of 150 g a.i./ha. The maximum soil application rate of thiamethoxam in Canada is 150 g a.i./ha and, therefore, the study rates are within the range of registered rates.

2.5.2.2.6 Tier III field studies

Apis

In field studies conducted with soil application of thiamethoxam, there were two registrant-submitted open field studies conducted with soil applications of thiamethoxam, but there were no relevant studies in

the open literature. Overall, soil applications of 140-200 g a.i./ha made to bee attractive crops either at planting or during bloom did not result in effects on brood development or foraging activity, but soil applications did result in short-term effects on mortality when hives were placed in fields one day after application (PMRA 2364916 and 2365392); however, minimal pollen (<15%) was collected from plants, indicating a lack of exposure in the study.

Non-*Apis*

No field studies with soil applications of thiamethoxam were available for review.

Monitoring

Apis* and *Non-Apis

There were no monitoring studies of non-*Apis* bees using soil application of thiamethoxam for review.

2.5.2.2.7 Summary of Incident Reports

There were no incident reports associated with soil application of thiamethoxam in Canada or the United States.

2.5.2.3 Seed Treatment

2.5.2.3.1 Tier I screening

In the Tier I screening assessment for seed treatments of thiamethoxam, the level of concern is exceeded for acute and chronic exposure of thiamethoxam to adult bees and brood (see Appendix VIII). Therefore, a Tier 1 refined assessment was conducted.

2.5.2.3.2 Tier I refined

Risk estimates from seed treatment applications in the Tier I refined assessment were based on field residues from canola, rapeseed, corn, pumpkin, sorghum, soybean, sunflower, cotton and rotational 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 where both thiamethoxam and clothianidin equivalents were considered. In general, the risk profile was similar between thiamethoxam and clothianidin equivalents.

Overall, there is a low potential for acute and chronic risk to bees from all seed treatment applications (oilseed rape, oats, beans and peas, corn, cucurbit and legume vegetables, cereal grains, sunflower, sugar beets and potato). See Appendix VIII for details. There was also no potential acute and chronic risk from carry over from most uses (barley followed by sunflower, barley followed by corn, and sunflower followed by barley).

2.5.2.3.3 Tier I non-*Apis*

Tier I effects information indicates that individual non-*Apis* bees, specifically bumble bees, have similar

sensitivity to thiamethoxam exposure as honey bees. Therefore, effect endpoints derived from the Tier I honey bee laboratory studies are considered suitable as a surrogate for non-*Apis* bees, and 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

Considering **nectar residues and a range of *Apis* colony nectar feeding endpoints**, there was a low potential risk to bees from all seed treatment applications.

Considering **pollen residues, calculated bee bread residues, and a range of *Apis* colony feeding study endpoints whereby colonies were dosed with pollen patties** (a mixture of nectar and pollen), the majority of residues resulting from seed treatments were below the colony feeding study endpoints.

Non-*Apis*

Considering **nectar residues and a range of non-*Apis* colony feeding study endpoints** (2.14 to 89 c.e. ppb), most residues were below the lower range of colony level endpoints. Although the non-*Apis* endpoint range was more sensitive than *Apis* bees, there appears to be limited risk associated with these seed treatment uses.

Considering **pollen residues and non-*Apis* colony feeding study endpoints** whereby colonies were fed with a mixture of pollen and sucrose solution, most pollen residues were below colony level endpoints. These results for non-*Apis* bees were consistent with the conclusions from the risk assessment for *Apis* bees. These effects were similar to the *Apis* endpoint range (4.5 to 6.6 c.e. ppb) based on queen effects, reduced eggs and sperm storage, drone survival, and reduced number of bees.

Residues of pollen and nectar which exceeded *Apis* or non-*Apis* endpoints were found in crops grown in soil that contained residues of thiamethoxam prior to planting of the treated seeds. Low residues of thiamethoxam are expected in pollen and/or nectar from translocation alone within plants grown from seeds treated with thiamethoxam.

2.5.2.3.5 Tier II tunnel studies

A number of tunnel studies with honey bees were conducted which examined potential effects from dust exposure during seed treatment, as well as oral exposure from translocation of residues within the crops used in the studies.

Apis

In tunnel studies examining simulated dust exposure to thiamethoxam, (PMRA 2364974) applications at 1 and 5 g a.i./ha resulted in an increase in mortality and a decrease in colony strength after a 27-day exposure. Applications at the higher rate of 5 g a.i./ha caused a significantly lower level of flight intensity that was not an effect observed at the lower rate tested.

In tunnel studies examining oral exposure to thiamethoxam from carry-over residues in soil (PMRA 2365330, 2365332 and 2365321), effects such as a decrease in the average number of bees, eggs and larvae were observed; however, these effects could not be correlated with the residues recovered, which were less than 0.012 mg/kg (PMRA 2365330, 2365332 and 2365321).

In tunnel studies examining oral exposure to thiamethoxam from oilseed rape or sunflower grown from thiamethoxam treated seeds at rates of 0.02 – 0.64 mg a.i./seed, no long-term effects on mortality or brood were observed. One of four tunnel studies showed reduced foraging and one of four tunnel studies showed reduced pollen and honey stores by bees. These reductions were seen in studies that tested seed treatment rates greater than 0.19 mg a.i./seed, which is much higher than the maximum rate registered for use on canola/rapeseed in Canada (0.02 mg a.i./seed) (PMRA 2364919, 2364923, 2364887 and 2364914). Overall, depending on application rate, some studies indicated exposure to residues in pollen and/or nectar from crops grown from treated seeds, however, exposure to these residues appeared to be low in most studies. In Canada, the rates of thiamethoxam for use as a seed treatment are generally below the maximum rates in many of the studies that were reviewed; therefore, the results could be considered as conservative.

Non-*Apis*

No tunnel studies were available for review for seed treatment uses for non-*Apis* bees.

2.5.2.3.6 Tier III field studies

There were a large number of open field studies with seed treatment application for *Apis* and non-*Apis* bees. Twenty-two studies, some of which were longer-term studies, were submitted by the registrant; these assessed maize, oilseed rape, dust exposure from corn planting, sunflower, and canola. Nine relevant open literature studies were also assessed. These included studies with corn (at planting and also at pollen shed) and oilseed rape, occurrence of guttation, and one monitoring study.

Apis

Overall, seed treatment applications of 0.02 – 1.05 mg a.i./seed showed very little effect on mortality of bees. If mortality was observed, it was usually in conjunction with hives being placed in the field and being exposed during the planting of treated seeds (of mostly European studies); however, the bees recovered to control levels within a short period of time. Effects on foraging were seen in honey bee hives exposed to treated seed being planted without the use of deflectors and in hives located 1 km away from the treated field, but not when hives were placed closer to the field (0-0.5 km). No effects were observed on bee health, colony strength, hive weight, colony survival, brood development or bee behaviour when these endpoints were tested. In multiple studies with treated seeds of corn, maize, oilseed rape, canola, and sunflower, including studies conducted in Canada and one 4-year study, although residues were detected in guttation fluids, bees were not typically observed utilizing guttation droplets; as such, there is likely limited exposure of bees to thiamethoxam from guttation fluids (PMRA 2365336, 2365365, 2365373, 2364945, 2364957,2364931, 2487496, 2364905, 2364909, 2533585, 2364936, 2364922, 2364896, 2364985, Tremolada et al. 2010, Reetz et al. 2015, Thompson et al. 2016).

Non-Apis

Overall, seed treatment applications of 0.025 to 0.03 mg a.i./seed resulted in limited long-term effects to

adult mortality and brood (PMRA 2487497, Cutler and Scott-Dupree 2014, Thompson et al. 2015), although fewer workers were recovered from colonies in treated fields and there was a lag in queen production in one study. When red mason bee nests were exposed to blooming winter oilseed rape grown from seed treated with 0.02 mg a.i./seed and observed until after overwintering, there were no effects observed on the colony. There appeared to be low foraging on winter oilseed rape and low translocation of residues from treated seeds (PMRA 2694873 and 2694872).

Monitoring

Apis

Exposure to corn seed treated with 0.125 – 1.67 mg thiamethoxam/seed resulted in clothianidin and thiamethoxam detections in various matrices. In general, effects were observed in the form of an increase in pests and pathogens in the exposed hives and colonies dying in the fall before the overwintering period. A two-year long study conducted in Quebec on honey bee hives placed in corn fields grown from thiamethoxam treated seeds, showed an increase in Black Queen Cell Virus (BQCV) detects and Varroa mites. Furthermore, in this study, exposure to either 0.25 – 1.25 mg clothianidin/seed or 0.125 – 1.67 mg thiamethoxam/seed resulted in increased Varroa mites, but no effects on colony weight or brood production (Krupke et al. 2012, Alburaki et al. 2015, Alburaki et al. 2016).

In a study conducted in France in fields with treated **oilseed rape**, forager bees had collected nectar at detectable levels ranging from 0.1-0.8 ppb of thiamethoxam and 0.1-1.06 ppb of imidacloprid. The study noted that during flowering, the hive invested more in worker brood production at the expense of drone production and subsequently, drone production was delayed. After flowering, drone production increased in the exposed colonies when compared to the control (Henry et al. 2015).

Non-*Apis*

Regarding a study completed by FERA (2013) using treated **oilseed rape seeds**, the scientific community could not come to a consensus on any clear treatment-related effects. European Food Safety Authority (EFSA) (2013) completed an independent review of the study and Goulson (2015) re-analysed the statistical results. The study also tested clothianidin and imidacloprid seed treatments that were located within 1 km of oilseed rape grown from thiamethoxam treated seed. Exposure was confirmed by residue analysis of pollen and nectar in the control and one of two treatment fields. Because of the lack of consensus, this study was included in the weight-of-evidence approach, but it does little to inform the thiamethoxam pollinator risk assessment.

***Apis and* non-*Apis* (under agricultural settings)**

Woodcock et al. (2017) exposed hives of honey bees, bumble bees, and *Osmia bicornis* to flowering winter sown oilseed rape grown from seeds treated with either clothianidin, thiamethoxam or a control, in three different locations (Hungary, United Kingdom and Germany) and examined for colony effects and residues. The study was conducted in Europe following the 2-year ban on neonicotinoids from 2014-2015. Overall, negative and positive effects were apparent from exposure of the hives to pesticides; however, a number of factors (including number of workers, hive condition and queen production) contributed to colony health. The authors determined that pesticide exposure was not always related to seed treatment application which suggests that residues were present in the environment from use in previous years (i.e., carry-over), and that pollinators are likely exposed to a number of different pesticides in the environment.

2.5.2.3.7 Summary of Incident Reports

The majority of the incident reports available from Canada and the United States are associated with seed treatments that use thiamethoxam. Incidents with seed treatments have primarily been associated with dust generated during planting of treated seeds. 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 treated corn and soybean.

2.5.3 Water assessment

In addition to exposure through pollen and nectar, bees may be exposed to thiamethoxam and respective metabolites 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 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, the exposure route was explored.

A Tier I risk assessment approach simiar 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, no risks to bees exposed to surface water in the area treated with thiamethoxam are expected. A Tier I risk assessment was also conducted using measured residues in guttation fluid. The results show that at the Tier I level, both acute and chronic risks to adult bees and bee larvae are indicated for bees exposed to guttation fluid containing thiamethoxam residues from treated plants. No risks to bees were indicated for bees exposed to guttation liquid from rotational crops following soil and seed treatment applications. Higher tier effects studies on guttation were also considered. Despite the presence of thiamethoxam residues in guttation fluid in the higher tier studies, bees were not typically observed using guttation fluid as a water source which indicates there is likely limited exposure of bees to thiamethoxam from this route. No adverse effects on colony and brood development were observed following exposure to guttation fluid containing thiamethoxam residues in the available higher tier studies. Overall, based on the information available to date, negligible risk is expected for bees from surface water or plant guttation liquid in areas that are treated with thiamethoxam (Appendix IX).

3.0 Value

3.1 Value of Thiamethoxam

Thiamethoxam will control a broad spectrum of insect pests on a diverse range of agricultural crop and ornamentals. 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.

Thiamethoxam 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.

Thiamethoxam is registered as a single-active in several end-use products (solo-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 XI.

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. For example, neonicotinoid seed treatments control important pests and have replaced some older pesticides that were phased out due to health and environmental risk concerns. Neonicotinoid seed treatments also support current crop production practices, such as the use of reduced tillage or no-till and earlier planting for corn and soybean.

The economic benefit of neonicotinoid seed treatments to the Canadian corn and soybean industries depends in part on whether pest pressures are at a level that warrants the use of treated seeds and whether the economic return exceeds the cost associated with their use. However, identifying pest pressure in fields before planting poses considerable challenges for growers.

Using currently available quantitative and qualitative information collected from a variety of sources, neonicotinoid seed treatments are estimated to be of economic benefit to the Canadian corn industry with benefits varying by province. They are estimated to be of economic benefit to the Canadian crushing soybean industry in Manitoba and Ontario and to the Ontario Identity Preserved (IP) and food grade soybean industry in particular. It is apparent that at the farm level, the need for the use of an insecticide seed treatment on corn and soybean is highly dependent on local pest pressure and the value of these seed treatments could be substantial for affected growers.

4.0 Conclusion

4.1 Overall Risk Characterization

Based on the risk assessment for thiamethoxam and considering the pollinator exposure potential in each crop/crop group, the following risk conclusions are made for each registered use:

Foliar Applications:

Considering effects on individual honey bees and colonies, Canadian-relevant residue information, higher tier tunnel studies and field studies, non-*Apis* effects information, incident reports, crop attractiveness, and additional lines of evidence, the following risk characterization for foliar applications is provided.

(i) For the following crop groups (CG), there is negligible risk for post-bloom foliar application to these annual crops because they are no longer in flower and are harvested at the end of the season:

- **CG1 – Root and Tuber Vegetables: potato and sweet potato, and**
- **CG6 – Legume Vegetables.**

Similarly, there is negligible risk for post-bloom foliar application to these annual crops because the crops are harvested before bloom:

- **CG1 – Root and Tuber Vegetables excluding potato and sweet potato, and**
- **CG4 – Leafy Vegetables.**

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

- **Rotational crops following foliar application the preceding year:** Risk characterization was based on a full range of effects endpoints and residue levels in pollen and nectar from soil applications in a variety of crop rotation scenarios. Soil residue information was used as a surrogate for foliar and seed treatment.

(iii) For the following crop group, a potential for risk to bees is indicated based on Tier I screening, Tier I refined with surrogate residue information and Tier II with surrogate residue information; however, minimal risk to bees is expected considering the lower potential for pollinator exposure in this crop group:

- **CG1– Root and Tuber vegetables** (potato and sweet potato): Label currently allows pre-bloom, during, and post-bloom applications. The potential risk (from nectar and pollen exposure) was determined by comparing colony level effects to surrogate residue data. Minimal pollinator exposure is expected based on low crop attraction to bees and as these crops are mainly self-pollinated. There were no tunnel or field studies available for review.

(iv) For the following crop groups, a potential for risk to bees is indicated based on Tier I screening, Tier I refined and/or Tier II refined assessments with relevant residue information; however, minimal risk to bees is expected considering the lower potential for pollinator exposure:

- **CG6 – Legume vegetables** (*Phaseolus* spp., soybean, *Lupinus* spp, *Vigna* spp., lablab beans and chickpeas): Label currently allows pre-bloom, during and post-bloom applications. The potential risk (from pollen and nectar exposure) was determined by comparing colony level effects to relevant pre-bloom soybean residue data. Residues from honey bee collected nectar and pollen were lower than from the plant; however, this may not represent non-*Apis* collection of residues. There were no tunnel or field studies available for review.
- **CG 8 – Fruiting vegetables:** Label currently allows pre-bloom, during and post-bloom applications. The potential risk (from pollen exposure) was determined by comparing colony level effects to relevant pre-bloom tomato residue data. Residues from honey bee collected pollen were much lower than from the plant; however, this may not represent non-*Apis* collection of residues. The potential risk from nectar is from surrogate residue data. A tunnel study conducted with bumble bees resulted in some mortality and decreased pollination when thiamethoxam was applied during bloom. Pollinator attractiveness of this crop group is expected to be minimal for honey bees but may provide a source of pollen and nectar for bumble bees.
- **CG13G – Low-growing berry (strawberry):** Label currently allows pre-bloom, during and post-bloom applications. The potential risk (from pollen and nectar) was determined by comparing colony level effects to relevant residues in strawberry and cranberry which were high. Low to

moderate pollinator exposure is expected; however, since some cultivars of strawberry are indeterminate bloomers, exposure of bees may extend during the bloom season.

(v) For the following crops a potential for risk to bees is expected based on Tier I screening, Tier I refined and Tier II refined assessments with Canadian-relevant residue information and/or Tier II tunnel data and considering potential for high pollinator exposure:

- **During bloom applications for all crops:** Risk characterization was based on multiple lines of evidence including (a) incident reports from applications of thiamethoxam during bloom when bees were present, (b) a full range of effects endpoints and residue levels in pollen and nectar from multiple studies using a variety of crops, and (c) the potential for pollinator exposure in bee attractive crops.
- **CG11: – Pome fruit:** Label currently allows pre-bloom and post-bloom applications. Risk characterization was based on full range of effects endpoints and residue levels in pollen and nectar from orchard crop studies tested at Canadian-relevant rates and considering potential for high pollinator exposure. Higher tier studies indicated potential effects from pre-bloom applications.
- **CG12 – Stone fruit:** Label currently allows pre-bloom, during bloom and post-bloom applications. Risk characterization was based on full range of effects endpoints and residue levels in pollen from orchard crop studies and considering potential for high pollinator exposure. No tunnel or field studies available for review.
- **CG13A, B and G – Caneberry, Bushberry, low-growing berry** (except strawberry which has low/moderate exposure). Label currently allows pre-bloom, during bloom and post-bloom applications. Risk characterization was based on full range of effects endpoints and residue levels in pollen and nectar from berry and orchard crop studies and considering potential for high pollinator exposure. No tunnel or field studies available for review.
- **Outdoor and greenhouse ornamentals** (pollinator attractive plants outside) Label currently allows pre-bloom, during bloom and post-bloom applications. There is no pollinator concern for plants such as cut flowers which remain inside. Risk characterization was based on surrogate residue data and there are no higher tier tunnel or field studies.

Soil Applications:

Considering effects on individual honey bees and colonies, Canadian-relevant residue information, higher tier tunnel studies and field studies, non-*Apis* effects information, incident reports, crop attractiveness, and additional lines of evidence, the following risk characterization for soil applications of thiamethoxam is provided.

(i) For the following crops, minimal potential for risk to bees is indicated based on Tier I refined and Tier II refined assessments with Canadian-relevant residue information:

- **Rotational crops following soil application the preceding year:** Risk characterization was based on full range of effects endpoints and residue levels in pollen and nectar from soil applications in a variety of crop rotation scenarios. Soil residue information was used as a surrogate for foliar and seed treatment.

(ii) For the following crop group, a potential for risk to bees is indicated based on Tier I screening, Tier I refined and/or Tier II refined assessments with surrogate residue information; however, minimal risk to bees is expected considering the lower potential for pollinator exposure in these crops:

- **CG1 – Root and Tuber vegetables (potato):** Label currently allows soil application at planting. A potential for risk to bees is indicated based on Tier I screening, and Tier I refined with surrogate residue information; however, minimal risk to bees is expected considering the lower potential for pollinator exposure in this crop group. There were no tunnel or field studies available for review.

(iii) For the following crop groups, a potential for risk to bees is indicated based on Tier I screening, Tier I refined and/or Tier II refined assessments with relevant residue information, higher tier data and considering a low-moderate potential for pollinator exposure:

- **CG 8 – Fruiting vegetables:** Label currently allows soil application at planting. Risk characterization was based on a full range of effects endpoints and residue levels in pollen and nectar following applications to tomato and pepper and considering a low-moderate potential for pollinator exposure. Some higher tier studies indicated potential effects on mortality, brood and food storage.

i. **CG13G – Low-growing berry (strawberry only):** Label currently allows soil application at planting. Risk characterization was based on a full range of effects endpoints and residue levels in pollen and nectar following applications to strawberry, and considering a low-moderate potential for pollinator exposure. There were no tunnel or field studies available for review.

(iv) For the following crop groups, a potential for risk to bees is indicated based on Tier I screening, Tier I refined and/or Tier II refined assessments with relevant residue information and considering potential for high pollinator exposure:

- **CG9 – Cucurbit vegetables:** Label currently allows soil application at planting. Risk characterization was based on a full range of effects endpoints and residue levels in pollen and nectar following soil applications to a range of cucurbit plants, and the potential for high pollinator exposure. Some higher tier studies indicated a potential short- term effect on mortality.
- **CG 13G – Low-growing berry (except strawberry):** Label currently allows soil application at planting. Risk characterization was based on a full range of effects endpoints and residue levels in pollen and nectar from studies with soil application of thiamethoxam to strawberry. Only strawberry residues were available to use as a surrogate for more attractive berry crops. The potential for high pollinator exposure to low-growing berries, excluding strawberries (which have low-moderate pollinator exposure), was considered. There were no tunnel or field studies available for review.
- **Greenhouse ornamentals** (pollinator attractive plants intended for outdoor plantings): Label currently allows soil application at planting. There is no pollinator concern for plants such as cut flowers, as they remain indoors. Risk characterization was based on surrogate residue data. There were no tunnel or field studies available for review.

Seed Treatment

Considering honey bee effects on individual bees and colonies, residue information, and available higher tier tunnel studies, incident reports and additional lines of evidence, the following risk characterization for seed treatment application is provided.

(i) For the following crops grown from seed treatment (seed pieces), negligible risk to bees is expected because the crops are harvested before bloom:

- **CG1 – Root and Tuber vegetables (sugar beet).**

(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 data:

- **CG 6 – Legume vegetables:** Risk characterization was based on full range of effects endpoints and residue levels in pollen and nectar from relevant fruiting vegetable crop study tested at a Canadian-relevant rate. There were no tunnel or field studies available for review.
- **CG9 – Cucurbit vegetables**: Risk characterization was based on full range of effects endpoints and residue levels in pollen and nectar from relevant cucurbit vegetable crop study tested at a Canadian-relevant rate. There were no tunnel or field studies available for review.
- **CG15 – Cereals (corn, wheat)**: Risk characterization was based on full range of effects endpoints and residue levels in pollen in a number of corn studies using treated seed at Canadian-relevant rates and considered higher tier effect studies (tunnel, field) tested at Canadian-relevant rates that indicated no or negligible short- or long-term colony effects. No pollinator exposure is expected in wheat.
- **CG 20 – Oilseeds (mustard, carinata, canola, rapeseed)**: Risk characterization was based on full range of effects endpoints and residue levels in pollen and nectar from a number of oilseed crop studies using treated seed at Canadian-relevant rates and considering higher tier effect studies tested at Canadian-relevant rates indicating no or negligible short- or long-term colony effects.
- **Rotational crops following seed treatment application the preceding year:** Risk characterization was based on full range of effects endpoints and residue levels in pollen and nectar from soil applications in a variety of crop rotation scenarios. Soil residue information was used as a surrogate for foliar and seed treatment.

(iii) For the following crops, a potential for risk to bees is indicated from seed treatment based on Tier I screening, Tier I refined and/or Tier II refined assessments with relevant residue information; however, minimal risk to bees is expected under conditions of use considering the lower potential for pollinator exposure in these crops:

- **CG1 – Root and Tuber Vegetables (potato):** Risk characterization was based on a highly conservative screening level risk assessment as no relevant residue information was available, but low pollinator exposure is expected in this crop. There were no tunnel or field studies available for review.

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 clothianidin 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 4 based on the overall exposure potential (negligible, low, moderate, high) and the application method to the crop (foliar, soil, seed treatment). See Appendix X for further information.

Exposure to dust generated during planting of treated seed is possible for certain cereal in Crop Group 15 (CG15) and and legume crops 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.

Table 4 Summary of proposed risk mitigation for potential risk to pollinators from exposure to thiamethoxam in various labelled crops

Application Method	Negligible potential for risk No use restrictions required; Label improvements*	Potential for risk + Proposed mitigation	
		Low-Moderate pollinator exposure	High pollinator exposure
Foliar	<u>No exposure:</u> -CG1: Root and Tuber vegetables (pre-bloom) excluding potato and sweet potato -CG1: Root and Tuber vegetables (post-bloom) (all crops) -CG4: Leafy vegetables -CG6: Legume vegetables (post-bloom) <u>Based on risk assessment:</u> -Rotational crops	**Proposed removal of use:** -All during bloom applications for all foliar uses **Maintain use (pre-/post-bloom) considering lower pollinator exposure:** -CG1: Root and Tuber vegetables (sweet potato and potato) **Proposed removal of pre-bloom use:** -CG6: Legume vegetables (soybean; *Phaseolus* spp.; *Lupinus* spp., *Vigna* spp., lablab beans, chickpeas) -CG8: Fruiting vegetables -CG13G: Low-growing berry	**Proposed removal of use:** -CG11: Pome fruit -CG12: Stone fruit -CG13A, B, G: Caneberry, Bushberry, Low-growing berry (except strawberry which is low-moderate exposure))(pre-bloom and during bloom) -Outdoor and greenhouse ornamentals (not including cut flowers) **Maintain use post-bloom only:** -CG6: Legume vegetables (broad beans, fava beans/ Vicia faba) -CG13A, B, G: Caneberry, Bushberry, Low-growing berry (post-bloom with renovation after harvest)
Soil	<u>No exposure (harvested before bloom):</u> -CG4: Leafy vegetables -CG5: Brassica leafy vegetables <u>Based on risk assessment:</u> -Rotational crops	**Maintain use considering lower pollinator exposure:** -CG1: Root and Tuber vegetables (potato only) **Proposed removal of use:** -CG8: Outdoor Fruiting vegetables -CG13 G: Low-growing berry (strawberry only)	**Proposed removal of use:** -CG9: Cucurbit vegetables -CG13G: Low-growing berry (except strawberry) -Greenhouse (not including cut flowers)
Seed treatment	<u>No exposure (harvested before bloom):</u> -CG1: Root and Tuber vegetables (sugar beet only) <u>Based on risk assessment:</u> -CG6: Legume vegetables* -CG9: Cucurbit vegetables -CG15: Cereals*	**Maintain use considering lower pollinator exposure:** -CG1: Root and Tuber vegetables (potato only)	There are no seed treatments with high pollinator exposure with a potential for risk.

Application Method	Negligible potential for risk No use restrictions required; Label improvements*	Potential for risk + Proposed mitigation	
		Low-Moderate pollinator exposure	High pollinator exposure
	-CG 20: Oilseeds -Rotational crops		

* Addition of label statements, including best management practices, to treated seed tags to minimize exposure to dust during planting.

4.3 Value Considerations

Thiamethoxam will control a broad spectrum of insect pests on a diverse range of agricultural crops and ornamentals. 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. Thiamethoxam 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 cancellation of certain uses or modifications to the use pattern, have been proposed for some crops. These proposed changes may have an impact on pest management within those agricultural sectors. Use information, including whether the proposed changes will impact the application timing necessary to target pests; alternatives to manage pest outbreaks; and the importance of thiamethoxam for overall pest management of the crops may be submitted to Health Canada for further consideration.

List of Abbreviations

µg	microgram(s)
µl	microliter(s)
a.i.	technical active ingredient
Ads	adsorption
atm	atmosphere
BAF	Bioaccumulation Factor
BCF	Bioconcentration Factor
CAS	chemical abstracts service
CG	crop group
cm	centimeter
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
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 Product Act*
PCP	Pest Control Product number
pKa	dissociation constant
PMRA	Pest Management Regulatory Agency
ppb	parts per billion
ppm	parts per million
RQ	risk quotient
RT_{25}	residual time to 25% mortality
SSD	Species Sensitivity Distribution
$t_{1/2}$	half-life
TGAI	technical grade active ingredient
T_R	representative half-life
TSMP	Toxic Substances Management Policy
USEPA	United States Environmental Protection Agency
UV	ultraviolet
wt(s)	weight(s)
w/v	weight per volume
w/w	weight per weight

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

Registration Number	Marketing Class	Registrant	Product Name	Formulation Type	Guarantee
26665	Technical	Syngenta Canada Inc.	Thiamethoxam Technical	Dust or powder (solid)	99.1%
26637	Commercial		Helix Liquid Seed Treatment	Suspension	Thiamethoxam 10.3%; metalaxyl-M and S isomer 0.39%; fludioxonil 0.13%; difenoconazole 1.24%
26638			Helix Xtra Seed Treatment		Thiamethoxam 20.70%; metalaxyl-M and S isomer 0.39%; fludioxonil 0.13%; difenoconazole 1.25%
27045			Cruiser 5FS Seed Treatment		Thiamethoxam 47.6%
27986			Cruiser 350FS Seed Treatment Insecticide		Thiamethoxam 29.9%
28407			Actara 240SC Insecticide		Thiamethoxam 240 g/L
28408			Actara 25WG Insecticide	Wettable granules	Thiamethoxam 25.0%
28821			Cruiser Maxx Beans Seed Treatment	Suspension	Thiamethoxam 22.6%; metalaxyl-M and S isomer 1.70%; fludioxonil 1.12%
29127			Cruiser Maxx Cereals Commercial Seed Treatment	Suspension	Thiamethoxam 2.8%; metalaxyl-M and S isomer 0. 56%; difenoconazole 3.36%
29192			Cruiser Maxx Cereals Seed Treatment		Thiamethoxam 2.8%; metalaxyl-M and S isomer 0. 56%; difenoconazole 3.36%
30388			A18046A Seed Treatment		Thiamethoxam 261 g/L; metalaxyl-M and S isomer 19.7 g/L; fludioxonil 12.9 g/L; azoxystrobin 10.4g/L
30404			Endigo Insecticide		Thiamethoxam 141 g/L; lambda-cyhalothrin 106 g/L
30436			Cruiser Maxx Vibrance Cereals Seed Treatment		Thiamethoxam 30.7g/L; sedaxane 8.0 g/L; metalaxyl-M and S isomer 9.5 g/L; difenoconazole 36.9 g/L
30723			Flagship Insecticide	Wettable granules	Thiamethoxam 25%

Registration Number	Marketing Class	Registrant	Product Name	Formulation Type	Guarantee
30900			Minecto Duo 40WG		Thiamethoxam 20%; cyantraniliprole 20%
30901			Mainspring X Insecticide		Thiamethoxam 20%; cyantraniliprole 20%
31024			Cruiser Maxx Potato Extreme	Suspension	Thiamethoxam 250 g/L; fludioxonil 62.5 g/L; difenoconazole 123 g/L
31453			Cruiser Vibrance Quattro		Thiamethoxam 61.5 g/L Difenoconazole 36.9 g/L Metalaxyl-M and S-Isomer 9.2 g/L Sedaxane 15.4 g/L Fludioxonil 7.7 g/L
31454			Helix Vibrance		Thiamethoxam 269 g/L Difenoconazole 16 g/L Metalaxyl-M and S-Isomer 5 g/L Sedaxane 3.4 g/L Fludioxonil 1.7 g/L

Appendix II Registered Commercial Class Uses of Thiamethoxam in Canada Subject to This Re-evaluation as of October 2017

USC[1]	Site(s)[2]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Single Rate or rate range	Maximum Number Applications per year	Minimum Interval Between Application (Days)
5	Greenhouse Peppers	Pepper weevil	Wettable granules	Ground application: foliar spray handwand, backpack sprayers	3.5 g a.i./100L {70 g a.i./ha}	12/year - 3 applications per crop cycle	7
6	Greenhouse ornamentals	Aphids, dipteran leafminers, mealybugs, soft scales, thrips whiteflies	Wettable granules	Ground application: foliar spray handwand, backpack sprayers	7.5 - 15 g a.i./100L 75 - 150 g a.i./ha	8/year -2 application per crop cycle	14
6	Greenhouse ornamentals	Aphids, dipteran leafminers, mealybugs, soft scales, fungus gnats, root aphids, whiteflies, thrips	Wettable granules	Soil drench	10 - 15 g a.i./100L {200 - 300 g a.i./ha/crop cycle}	4/year -1 application per crop cycle	Not applicable
10	Barley, wheat	Wireworms, European chafer	Suspension	On farm and /or commercial seed treatment facility: seed treatment equipment	9.98 - 30 g a.i./100 kg seed	1	Not applicable
10	Oats	Wireworms	Suspension	On farm and /or commercial seed treatment facility: seed treatment equipment	9.98 - 19.98 g a.i./100 kg seed	1	Not applicable
10	Buckwheat, millet, sorghum, rye, triticale	Wireworm	Suspension	On farm and/ or commercial seed treatment facility: seed treatment equipment	10 - 30 g a.i./100 kg seed	1	Not applicable

USC[1]	Site(s)[2]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Single Rate or rate range	Maximum Number Applications per year	Minimum Interval Between Application (Days)
10	Bean (dry)	Potato leafhopper, seedcorn maggot	Suspension	Commercial seed treatment facility: seed treatment equipment	30 - 50 g a.i. /100 kg seed	1	Not applicable
10	Bean (dry)	wireworm	Suspension	Commercial seed treatment facility: seed treatment equipment	50 g a.i. /100 kg seed	1	Not applicable
10	Canola, rapeseed, mustard	Flea beetles	Suspension	Commercial seed treatment facility: seed treatment equipment	199.4 - 403.5 g a.i./100 kg seed	1	Not applicable
10	Chickpeas, faba bean, lentils, lupins, dry peas	Wireworm	Suspension	On farm and/ or commercial seed treatment facility: seed treatment equipment	10 - 30 g a.i./100 kg seed	1	Not applicable
10	Faba bean	Pea leaf weevil	Suspension	On farm and/ or commercial seed treatment facility: seed treatment equipment	30 g a.i./100 kg seed	1	Not applicable
10	Corn (Field, seed, sweet, popcorn)	European chafer, wireworm	Suspension	Commercial seed treatment facility: seed treatment equipment	50 g a.i./100 kg seed	1	Not applicable
10	Corn (Field, seed, sweet, popcorn)	Seedcorn maggot, corn flea beetle	Suspension	Commercial seed treatment facility: seed treatment equipment	50 - 100 g a.i./100 kg seed	1	Not applicable
10	Corn (Field, seed, sweet, popcorn	Corn rootworm	Suspension	Commercial seed treatment facility: seed treatment equipment	200 - 500 g a.i./100 kg seed	1	Not applicable

USC[1]	Site(s)[2]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Single Rate or rate range	Maximum Number Applications per year	Minimum Interval Between Application (Days)
10	Pea (dry)	Pea leaf weevil	Suspension	On farm and/ or commercial seed treatment facility: seed treatment equipment	30 - 50 g a.i./100 kg seed	1	Not applicable
10	Potato	Aphids, Colorado potato beetle, potato leafhopper	Suspension	Seed piece treatment equipment: slurry	1.9 - 5.86 g a.i./100 kg seed	1	Not applicable
10	Soybean	Seedcorn maggot	Suspension	Commercial seed treatment facility: seed treatment equipment	30 - 50.8 g a.i./100 kg seed	1	Not applicable
10	Soybean	Bean leaf beetle, European chafer, soybean aphid, wireworm	Suspension	Commercial seed treatment facility: seed treatment equipment	50.8 g a.i./100 kg seed	1	Not applicable
10	Succulent beans, succulent peas	Potato leafhopper, seedcorn maggot	Suspension	Commercial seed treatment facility: seed treatment equipment	30 - 50 g a.i./100 kg seed	1	Not applicable
10	Succulent beans, succulent peas	Wireworm, soybean aphid	Suspension	Commercial seed treatment facility: seed treatment equipment	50 g a.i./100 kg seed	1	Not applicable
10	Succulent peas	Pea leaf weevil	Suspension	Commercial seed treatment facility: seed treatment equipment	30 - 50 g a.i./100 kg seed	1	Not applicable
10	Sunflowers – importation of treated seeds	Wireworm	Suspension	Not applicable - treated prior to import	0.25 mg a.i./seed	1	Not applicable

USC[1]	Site(s)[2]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Single Rate or rate range	Maximum Number Applications per year	Minimum Interval Between Application (Days)
10	Sugar beet	Wireworm, sugar beet root maggot	Suspension	Commercial seed treatment facility: seed treatment equipment	30 - 60 g a.i./100,000 seeds	1	Not applicable
10	Crop Group 9 Cucurbit Vegetables	Cucumber beetle	Suspension	Not applicable – imported seeds only	0.25 - 0.75 mg a.i./seed	1	Not applicable
13,14	Apple, crab apple	Plum curculio, mullein bug	Water dispersible granule	Ground application: Foliar spray - airblast	78.75 g a.i./ha (pre-bloom) 78.75 - 96.25 g a.i./ha (post bloom)	2 (1 pre-bloom and 1 post bloom or 2 post bloom applications)	10
13,14	Apple, crab apple	Spotted tentiform leafminer	Water dispersible granule	Ground application: Foliar spray - airblast	78.55 g a.i./ha (pre and post bloom)	2 (1 pre-bloom and 1 post bloom or 2 post bloom applications)	10
13,14	Apple, crab apple	Rosy apple aphid	Water dispersible granule	Ground application: Foliar spray - airblast	40 g a.i./ha	2 (1 pre-bloom and 1 post bloom or 2 post bloom applications)	10
14	Pear, Oriental pear	Pear psylla, plum curculio	Water dispersible granule	Ground application: Foliar spray - airblast	78.75 - 96.25 g a.i./ha	2 (post bloom only)	10
13,14	Apple, crab apple, pear, Oriental pear	Brown marmorated stink bug	Water dispersible granule	Ground application: Foliar spray - airblast	96.25 g a.i./ha	2 (post bloom only)	10
14	Cherries (sweet and sour)	Aphids	Water dispersible granule	Ground application: Foliar spray - airblast	40 g a.i./ha	2	10

USC[1]	Site(s)[2]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Single Rate or rate range	Maximum Number Applications per year	Minimum Interval Between Application (Days)
14	Bean (dry) (*Phaseolus* spp., *Lupinus* spp., *Vigna* spp., dry fava beans, dry lablab beans and chickpeas, soybean)	Bean leaf beetle, Soybean aphid	Suspension	Aerial application: Foliar spray - rotary and fixed wing Ground application: Foliar spray conventional ground equipment	25.38 g a.i./ha	3	7
14	Pepper	Pepper weevil	Water dispersible granule	Foliar spray conventional ground equipment	70 g a.i./ha	2	7
14	Celeriac	Tarnished plant bug	Water dispersible granule	Foliar spray conventional ground equipment	52.5 - 70 g a.i./ha	2	Not stated
13,14	Potato	Aphids, Colorado potato beetle, potato leafhopper	Suspension	Ground application : In-furrow drench - ground equipment	0.82 - 1.06 g a.i./100m of row 37.9 - 140 g a.i./ha based upon row spacing of 215 cm to 75 cm	1	Not applicable
13,14	Potato	Aphids, Colorado potato beetle, potato leafhopper	Suspension	Foliar spray conventional ground equipment Aerial application: Foliar spray - rotary and fixed wing	26.2 g a.i./ha	2	7
13,14	Potato	Aphids, Colorado potato beetle, potato leafhopper	Water dispersible granule	Foliar spray conventional ground equipment Aerial application: Foliar spray - rotary and fixed wing	26.25 g a.i./ha	2	7

USC[1]	Site(s)[2]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Single Rate or rate range	Maximum Number Applications per year	Minimum Interval Between Application (Days)
13,14	Potato	Aphids, Colorado potato beetle, flea beetles, potato leafhopper	Wettable granule	Ground application: in-furrow drench – ground equipment or surface band drench + irrigation	88 - 140 g a.i./ha 0.66 - 3.2 g a.i./100m of row	1	Not applicable
14	Crop Group 1B and 1C Root vegetables	Aphids, Aster leafhopper	Water dispersible granule	Foliar spray conventional ground equipment	26.25 g a.i./ha	2	7
14	Crop Group 4 Leafy vegetables	Aphids	Water dispersible granule	Foliar spray conventional ground equipment	26.25 g a.i./ha	2	7
14	Crop Group 4 Leafy vegetables	Tarnished plant bug	Water dispersible granule	Foliar spray conventional ground equipment	52.5 g a.i./ha	1	Not applicable
14	Crop Group 4 Leafy vegetables	Aphids, dipteran leafminers, leafhoppers, cabbage looper, flea beetle, beet armyworm, corn earworm, fall armyworm	Wettable granule	Ground application: in-furrow drench – ground equipment or surface band drench + irrigation Drip trickle irrigation	150 g a.i./ha 0.23 - 4.5 g a.i./100m of row	1	Not applicable
14	Crop Group 5 Brassica vegetables	Aphids, dipteran leafminers, flea beetles, cabbage looper, diamondback moth, imported cabbageworm thrips, beet armyworm, corn earworm, fall armyworm, yellowstripped armyworm	Wettable granule	Ground application: in-furrow drench – ground equipment or surface band drench + irrigation Drip trickle irrigation	150 g a.i./ha 0.23 - 4.5 g a.i./100m of row	1	Not applicable

USC[1]	Site(s)[2]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Single Rate or rate range	Maximum Number Applications per year	Minimum Interval Between Application (Days)
14	Crop Group 8 Fruiting vegetables	Aphids, Colorado potato beetle, dipteran leafminers, leafhoppers, potato psyllid cabbage looper, flea beetles, thrips, beet armyworm, corn earworm, fall armyworm, tomato fruitworm, yellowstripped armyworm	Wettable granule	Ground application: in-furrow drench – ground equipment or surface band drench + irrigation	88 - 150 g a.i./ha 0.13 - 4.5 g a.i./100m of row	1	Not applicable
14	Crop Group 9 Cucurbit vegetables	Aphids, leafminers, leafhoppers, cucumber beetles, flea beetles,thrips	Wettable granule	Ground application: in-furrow drench – ground equipment or surface band drench + irrigation	150 g a.i./ha 0.23 - 4.5 g a.i./100m of row	1	Not applicable
14	Crop Group 4 Leafy vegetables	Aphids, leafhoppers, dipteran leafminers, flea beetle	Suspension	Ground application: in-furrow drench – ground equipment or surface band drench + irrigation	90 - 150 g a.i./ha	1	Not applicable
14	Crop Group 5 Brassica vegetables	Aphids, flea beetle	Suspension	Ground application: in-furrow drench – ground equipment or surface band drench + irrigation	90 - 150 g a.i./ha	1	Not applicable
14	Crop Group 8-09 Fruiting vegetables	Aphids, Colorado potato beetles, leafhoppers, dipteran leafminers, potato psyllids, flea beetle	Suspension	Ground application: in-furrow drench – ground equipment or surface band drench + irrigation	90 - 150 g a.i./ha	1	Not applicable
14	Crop Group 9 Cucurbit vegetables	Aphids, leafhoppers, dipteran leafminers, flea beetle	Suspension	Ground application: in-furrow drench – ground equipment or surface band drench + irrigation	90 - 150 g a.i./ha	1	Not applicable

USC[1]	Site(s)[2]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Single Rate or rate range	Maximum Number Applications per year	Minimum Interval Between Application (Days)
14	Crop Group 8 Fruiting vegetables	Aphids	Water dispersible granule	Ground application: foliar spray – ground equipment (over the row sprayer)	26.25 g a.i./ha	2	7
14	Crop Group 8 Fruiting vegetables	tarnished plant bug, stink bug	Water dispersible granule	Ground application: foliar spray – ground equipment (over the row sprayer)	26.25 - 52.5 g a.i./ha	2	7
14	Crop Group 8 Fruiting vegetables	brown marmorated stink bug	Water dispersible granule	Ground application: foliar spray – ground equipment (over the row sprayer)	52.5 g a.i./ha	2	7
14	Crop Group 8 Fruiting vegetables	Aphids, Tarnished plant bug, stink bugs	Water dispersible granule	Ground application: in-furrow drench-conventional ground equipment	0.85 - 1.1 g a.i./100m of row 48.5 - 146.8 g a.i./ha	1	Not applicable
14	Crop Group 8 Fruiting vegetables	Aphids, Tarnished plant bug, stink bugs	Water dispersible granule	Ground application: transplant water application	91.25 - 117 g a.i./ha at 30 000 plants/ha	1	Not applicable
14	Crop Group 13-07A Cane berries	Black vine weevil obscure root weevil	Water dispersible granule	Ground application: foliar spray – ground equipment (over the row sprayer)	52.5 - 70 g a.i./ha	2	7
14	Crop Group 13-07B Bush berries	Black vine weevil, obscure root weevil	Water dispersible granule	Ground application: foliar spray – ground equipment (over the row sprayer)	52.5 - 70 g a.i./ha	2	7

USC[1]	Site(s)[2]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Single Rate or rate range	Maximum Number Applications per year	Minimum Interval Between Application (Days)
14	Crop Group 13-07B Bush berries	Brown marmorated stink bug	Water dispersible granule	Ground application: foliar spray – ground equipment (over the row sprayer)	70 g a.i./ha	2	7
14	Crop Group 13-07G Low growing Berries	Adult black vine weevil, Cranberry weevil	Water dispersible granule	Ground application: foliar spray – ground equipment (boom sprayer)	52.5 - 70 g a.i./ha	2	7
14	Crop Group 13-07G Low growing Berries	Black vine weevil, strawberry root weevil	Water dispersible granule	Ground application: soil drench - post renovation	140 g a.i./ha	1	Not applicable
27	Outdoor ornamentals	aphids, black vine weevil, dipteran leafminers, lace bugs, leafhoppers, mealybugs, psyllids, soft scales, thrips	Wettable granules	Ground application equipment - Foliar application	7.5 - 15 g a.i./100L 75 - 150 g a.i./ha	1 at high rate or 2 at low rate	14
27	Viburnum	Viburnum leaf beetle	Water dispersible granule	Ground application: foliar spray – ground equipment	70 g a.i./ha	1	Not applicable
27	Outdoor ornamentals	Black vine weevil	Water dispersible granule	Ground application: foliar spray – ground equipment	2.63 - 3.5 g a.i./100L Maximum of 70 g a.i./ha in 2000 L/ha	(2)	7
27	Outdoor ornamentals	Aphids, leafhoppers	Water dispersible granule	Ground application: foliar spray – ground equipment	26.25 g a.i./ha	(2)	7
27	Outdoor ornamentals	Tarnished plant bug	Water dispersible granule	Ground application: foliar spray – ground equipment	52.5 - 70 g a.i./ha	(2)	7

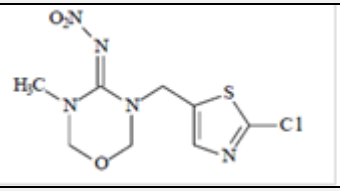
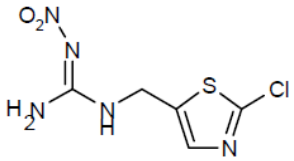
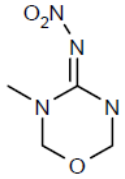
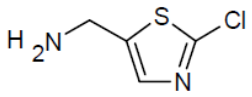
USC[1]	Site(s)[2]	Pest(s)	Formulation Type	Application Methods and Equipment	Application Single Rate or rate range	Maximum Number Applications per year	Minimum Interval Between Application (Days)
27	Outdoor nurseries and landscapes	Brown marmorated stink bug	Water dispersible granule	Ground application: foliar spray – ground equipment	70 g a.i./ha	(1)	Not applicable

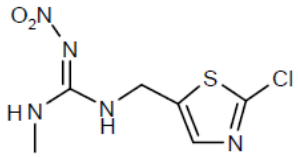
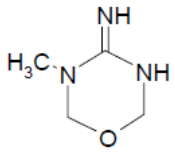
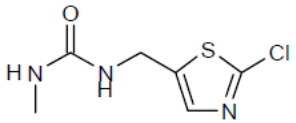
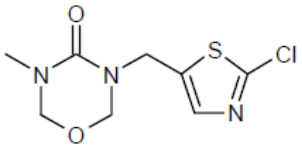
[1] Use Site Category (USC): 5 - Greenhouse Food crops, 6 - Greenhouse Non-food crops, 13 - Terrestrial Feed Crops, 14 - Terrestrial Food Crops, 27 - Ornamentals Outdoors.

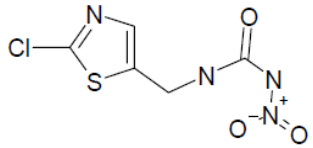
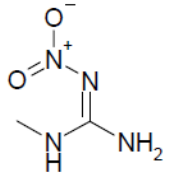
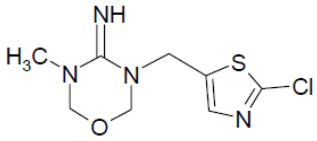
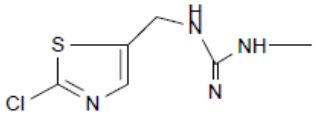
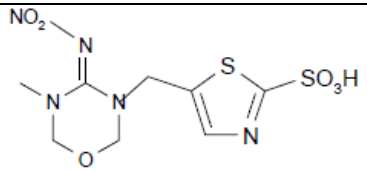
[2] Crop groups are identified as listed on the end use product labels and may not be identical to the crop groups listed on the Health Canada Residue Chemistry Crop Groups website: http://hc-sc.gc.ca/cps-spc/pest/part/protect-proteger/food-nourriture/rccg-gcpcr-eng.php

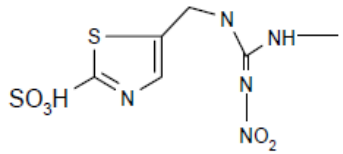
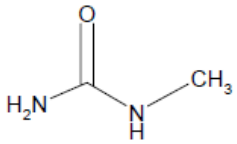
Appendix III Summary of Fate in Environment

Table 1 Thiamethoxam and its transformation products formed in the environment

Description	Structure	Matrix: Process (details)
Parent molecule		
Thiamethoxam		N/A
Transformation products (ordered alphanumerically by code name)		
CGA 265307 IUPAC Name: N-(2-chloro-thiazol-5-ylmethyl)-N'-nitro-guanidine CAS Name: N-[(2-chloro-5-thiazolyl)methyl]-N'-nitroguanidine CAS Number: 135018-15-4 Molecular formula: $C_5H_5ClN_5O_2S$ Molar mass: 235.65		Soil: Aerobic (minor) Field dissipation (minor) *Aerobic and anaerobic (minor, study with CGA 322704)* Water: N/A Plant: Metabolism (major)
CGA 282149 IUPAC Name: N-nitro-(3-methyl-[1,3,5]-oxadiazinan-4-ylidene)-amine CAS Name: 3,6-dihydro-3-methyl-N-nitro-2H-1,3,5-oxadiazin-4-amine CAS Number: 153719-38-1 Molecular formula: $C_4H_8N_4O_3$ Molar mass: 160.03		Soil: Phototransformation (minor) Aerobic (minor) Water: Anaerobic water-sediment at low temperature (minor in sediment and water) Plant: N/A
CGA 309335 IUPAC Name: 2-chlorothiazoly-5-lmethyl-amine CAS Name: 2-chloro-5 thiazolemethanamine CAS Number: 120740-08-1 Molecular formula: C_4H_5ClNS Molar mass: 148.61		Soil: Hydrolysis (major at pH 9) Aerobic (minor) Field dissipation (minor) Water: Hydrolysis (major at pH 9) Plant: N/A

Description	Structure	Matrix: Process (details)
CGA 322704 (Clothianidin) IUPAC Name: 1-(2-chloro-thiazol-5-ylmethyl)-3-methyl-N-nitroguanidine CAS NAME: (E)-N-[(2-chloro-5-thiazolyl)methyl]-N'-methyl-N"-nitroguanidine CAS Number: 205510-53-8 Molecular formula: C6H8ClN5O2S Molar mass: 249.68		Soil: Phototransformation (minor) Aerobic (major) Anaerobic water-soil (minor in soil and water) Field dissipation (major) Leaching (field lysimeter, PGW) Water: Phototransformation (minor) Plant: Metabolism (major)
CGA 353042 IUPAC Name: 3-methyl-1,3,5]oxadiazinan-4-ylideneamine CAS Name: 3,6-dihydro-3-methyl-2H-1,3,5-oxadiazin-4-amine CAS Number: not issued Molecular formula: $C_4H_8N_3O$ Molar mass: 115.14		Soil: Field dissipation (minor) Water: Phototransformation (major) Plant: Metabolism (major)
CGA 353968 IUPAC Name: 1-(2-chloro-thiazol-5-ylmethyl)-3-methyl-urea CAS Name: N-[(2-chloro-5-thiazolyl)methyl]-N'-methyl-urea CAS Number: not issued Molecular formula: $C_6H_8ClN_3OS$ Molar mass: 205.67		Soil: Phototransformation (minor) Aerobic (minor) Anaerobic water-soil (minor in soil) Field dissipation (minor) *Aerobic (major, study with CGA 355190)* *Anaerobic (minor, study with CGA 322704)* Water: Phototransformation (minor) Aerobic water (minor) *Phototransformation (minor, study with CGA 322704)* Plant: Metabolism (minor)
CGA 355190 IUPAC Name: 3-(2-chloro-thiazol-5-ylmethyl)-5-methyl[1,3,5]oxadiazinan-4-one CAS Name: 3-[(2-chloro-5-thiazolyl)methyl]tetrahydro-5-methyl-4H-1,3,5-oxadiazin-4-one CAS Number: not issued Molecular formula: $C_8H_{10}ClN_3O_2S$ Molar mass: 247.17		Soil: Hydrolysis (major at pH 9) Phototransformation (minor) Aerobic (major) Anaerobic water-soil (minor in soil and water) Field dissipation (major) Leaching (PGW) Water: Hydrolysis (major at pH 9) Phototransformation (minor) Aerobic water (major) Aerobic water-sediment (major) Anaerobic water-sediment (major in sediment and water) Plant: Metabolism (minor)

Description	Structure	Matrix: Process (details)
NOA 404617 IUPAC Name: 1-(2-chloro-thiazol-5-ylmethyl)-3-nitrourea CAS Name: N-[(2-chloro-5-thiazolyl)methyl]-N'-nitro-urea CAS Number: not issued Molecular formula: $C_5H_5ClN_4O_3S$ Molar mass: 236.63		Soil: Hydrolysis (major at pH 9) Anaerobic water-soil (minor in soil and water) Field dissipation (minor) Water: Hydrolysis (major at pH 9) Aerobic water (major) Aerobic water-sediment (minor) Anaerobic water-sediment (minor in sediment and water) *Phototransformation (minor, study with CGA 322704)* Plant: N/A
NOA 405217 IUPAC Name: N-nitro-N'-methyl-guanidine CAS Name: N-nitro-N'-methyl-guanidine CAS Number: not issued Molecular formula: $C_2H_6N_4O_2$ Molar mass: 118.10		Soil: N/A Water: N/A Plant: Metabolism (minor)
NOA 407475 IUPAC Name: 3-(2-chloro-thiazol-5-ylmethyl)-5-methyl[1,3,5]oxadiazinan-4-ylideneamine CAS Name: 3-[(2-chloro-5-thiazolyl)methyl] tetrahydro-5-methyl-N-nitro-4H-1,3,5-oxadiazin-4-imine CAS Number: not issued Molecular formula: $C_8H_{11}ClN_4OS$ Molar mass: 246.72		Soil: Anaerobic water-soil (major in soil, minor in water) Field dissipation (minor) Water: Phototransformation (minor) Aerobic water-sediment (major) Anaerobic water-sediment (major in sediment, minor in water) *Aerobic (major in sediment, study with CGA 322704)* Plant: Metabolism (major)
NOA 421275 IUPAC Name: N-(2-chloro-thiazol-5-ylmethyl)-N'-methyl-guanidine CAS Name: N-[(2-chloro-thiazol-5-ylmethyl)]-N'-methyl-guanidine CAS Number: not issued Molecular formula: $C_6H_9ClN_4S$ Molar mass: 204.68		Soil: *Aerobic (minor, study with NOA 407475)* *Anaerobic (major, study with CGA 322704)* Water: N/A Plant: Metabolism (major)
NOA 459602 IUPAC Name: 5-(5-methyl-4-nitroimino-[1,3,5]oxadiazinan-3-ylmethyl)thiazole-2-sulfonate CAS Name: 5-[(5-methyl-4-nitroimino-[1,3,5]oxadiazinan)-3-ylmethyl)]thiazole-2-sulfonate		Soil: Leaching (Field lysimeter, PGW) Water: N/A Plant: N/A

Description	Structure	Matrix: Process (details)
CAS Number: not issued Molecular formula: $C_8H_{11}N_5O_6S_2$ Molar mass: 337.32		
NOA 501406 / SYN 501406 [a] IUPAC Name: 5-(N'-Methyl-N''-nitro-guanidinomethyl)-thiazole-2-sulfonate CAS Name: 5-(N'-Methyl-N''-nitroguanidinomethyl)-thiazole-2-sulfonate CAS Number: not issued Molecular formula: $C_6H_9N_5O_5S_2$ Molar mass: 295.29		Soil: Leaching (Field lysimeter, PGW) Water: N/A Plant: N/A
Carbonyl Sulfide CAS Number: 463-58-1	O=C=S	Soil : N/A Water : Phototransformation (major) Plant: N/A
Methylurea Molecular formula: $C_2H_6N_2O$ Molar mass: 74.08		Soil : N/A Water : Phototransformation (minor) Plant: Metabolism (minor)

Italic font was used when transformation process was observed in a study carried out with a thiamethoxam transformation product rather than thiamethoxam itself.
The following transformation products are thought to be common to both thiamethoxam and clothianidin: CGA 265307 = TZNG, CGA 353968 = TZMU, NOA 405217 = MNG and NOA 421275 = TMG.

[a] NOA 501406 and SYN 501406 are believed to be the same compound; both names are used in documentation provided by the registrant.

Table 2 Fate and behaviour in the terrestrial environment – Registrant Submitted Studies

Property	Test substance	Value	Comments	Reference (PMRA #)
Abiotic transformation				
Hydrolysis	Thiamethoxam	At 25°C : t½ pH 5 : stable t½ pH 7: 559 - 939 days t½ pH 9: 4.1 - 8.0 days	Major transformation products, formed at pH 9, were CGA 355190 and NOA 404617 (for both the guanidine and thiazolyl radiolabels). In the study with the thiazolyl label, NOA 404617 further hydrolyzed to CGA 309335, which was still increasing at the end of the incubation period.	1178192 and 1178193
	CGA 322704 (Clothianidin)	Hydrolytically stable at 20°C from pH 4 to pH 9.	Results are similar to existing information submitted to support the registration of clothianidin.	1529731
Phototransformation on soil	Thiamethoxam	DT_{50} = 79 - 97 days (continuous irradiation)	There were no major transformation products other than CO_2. Several minor products were formed including CGA 322704, CGA 355190, CGA 353968 and CGA 282149 (all of which are also formed in aerobic soil). Other minor components were not identified. Transformation products were similar in the irradiated and dark samples (irradiation increased the rate of transformation, but did not produce any significant new transformation products).	1196656 and 1196657
Phototransformation in air	Thiamethoxam	Not required – thiamethoxam is not volatile		
Biotransformation[1]				
Biotransformation in aerobic soil	Thiamethoxam	Sandy loam soil: DT_{50} = 286 - 346 days Representative half-life: 447 - 507 days Clay loam soil: DT_{50} = 91 days Representative half-life: 122 days	Moderately persistent to persistent. No major transformation products were formed in sandy loam soil. CGA 355190 was a major transformation product in clay loam soil, which further transformed to CGA 353968 with a half-life of 459 days (as reported in study; not recalculated by reviewer at this time). Several minor transformation products were formed in both test soils, including CGA 322704, CGA 353968, CGA 282149 and CGA 309335. Under sterile conditions, the DT_{50} ranged from 286 - 686 days (as reported in study; not recalculated by reviewer at this time).	1178196, 1178197 and 1178198
	Thiamethoxam	DT_{50} at 20ºC = 143 days (40% FC, high test dose), 74 days (60% FC, high test dose) and 34 days (60% FC, low test dose).	Tests systems were incubated at different combinations of temperature and humidity; drier soil conditions and a lower temperature slowed down the degradation. Also, two test concentrations were used;	1529738 / 2529330

Property	Test substance	Value	Comments	Reference (PMRA #)
		DT_{50} at 10ºC = 233 days (60% FC, high test dose) Representative half-lives: same	degradation was more rapid with a low concentration. CGA 322704 was a major transformation product. At 20ºC, this compound degraded with a DT_{50} of 187 - 495 days depending on test conditions. Minor transformation products included CGA 355190, CGA 265307 and CGA 353968.	
	Thiamethoxam	DT_{50} = 3727 days Representative half-life: $5.9x10^8$ days	Persistent. No major transformation products were formed in loamy sand soil (Gartenacker soil identified as Borstel soil in study report). CGA 322704 (clothianidin), CGA 355190 and CO_2 were minor transformation products.	1529745 / 2741625
	Thiamethoxam	DT_{50} = 78 - 158 days Representative half-life: 110 - 258 days	Moderately persistent. CGA 322704 was a major transformation product. CGA 355190 was a minor transformation product. Tests were also performed with soils maintained in a greenhouse for months/years prior to the experiment. For these, the DT_{50} was longer (153 - 274 days).	1529741
	Thiamethoxam	DT_{50} = 60.1 days Representative half-life: same	Moderately persistent. CGA 322704 was a major transformation product. CGA 265307 was a minor transformation product.	1529744
	Thiamethoxam	DT_{50} = 78.7 days Representative half-life: same	Moderately persistent CGA 322704 was a major transformation product. Minor transformation products were CGA 355190, CGA 265307 and CGA 353968. This study also included tests with treated seeds. The radioactivity quickly moved from the treated seed to the surrounding soil. The DT_{50} in soil was 60.6 days; the more rapid dissipation attributed to the uptake by the growing plant.	1529749
	CGA 322704 (Clothianidin)	Between 60 and 80% of the test substance degraded by the end of the study period of 120 days. CGA 265307 was identified as a minor transformation product.		1529745 and 1529746
	CGA 322704 (Clothianidin)	DT_{50} = 258 days Representative half-life: 317 days	No transformation products were identified.	1529747
	CGA 355190	DT_{50} = 9.16 - 89.7 days	Non-persistent to moderately persistent, depending on soil type.	1529748

Property	Test substance	Value	Comments	Reference (PMRA #)
		Representative half-life: 22.7 - 141 days	CGA 353968 was identified as a major transformation product.	
	NOA 407475	DT_{50} = 376 - 443 days Representative half-life: 419 - 461 days	Persistent. NOA 421275 was identified as a minor transformation product.	1529739 and 1529740
Biotransformation in anaerobic soil	Thiamethoxam	See biotransformation in anaerobic water/sediment system (one study used soil rather than sediment).		
	CGA 322704 (Clothianidin)	DT_{50} = 11.5 days Representative half-life: 22 days	Flooded soil, water was spiked. Radioactivity rapidly moved from the water to the soil layer. Major transformation products in anaerobic soil were NOA 421275 and one unidentified product. Minor transformation products were CGA 353968, CGA 265307 and several other unidentified components.	1529750
Mobility[2]				
Adsorption / desorption in soil	Thiamethoxam	Ads K_d = 0.21 - 2.3 mL/g Ads K_{oc} = 33 - 177 mL/g	Moderate to very high mobility. Six soils. A leaching assessment was previously carried out; the most recent assessment can be found in PMRA# 1695212 and included the following information: - GUS[3] of 4.3 to 6.3 depending on the soil type (leacher) - Most of the Cohen criteria[4] are met	1178199
		Ads K_{oc} = 33 - 151 mL/g	Additional information. Values not verified / recalculated since acceptable data were already available. Values are within range of existing information.	1529758, 1196652/152976 8, 1529769 and 1529770
		Time dependant sorption (incubation time ranging from 30 and 91 days): The K_{oc} increased with time with a factor of 2.4 - 7.6.	Additional information. Supports results of column leaching study with aged soil.	1196652/152976 8, 1529769 and 1529771
	CGA 322704 (Clothianidin)	Ads K_d = 0.82 - 6.8 mL/g Ads K_{oc} = 58 - 273 mL/g	Moderate to high mobility. Six soils.	1196669
		Ads K_{oc} = 62 - 77 mL/g	Additional information. Values not verified / recalculated since acceptable data were already available. Values are within range of existing information.	1529772 and 1529774
		Time dependant sorption (total incubation time of 91 days): The K_{oc} increased with time with a factor of	Additional information.	1529759

Property	Test substance	Value	Comments	Reference (PMRA #)
		2.8.		
	CGA 355190	Ads K_d = 0.45 - 3.3 mL/g Ads K_{oc} = 28 - 125 mL/g	High to very high mobility. Six soils.	1196670
	NOA 404617	Ads K_d = 0.13 - 1.05 mL/g Ads K_{oc} = 8 - 43 mL/g	Very high mobility. Six soils.	119667
	NOA 407475	Ads K_d = 2.5 - 44 mL/g Ads K_{oc} = 400 - 1453 mL/g	Low to moderate mobility. Six soils.	1196667
	CGA 353042	Ads K_d = 1.8 - 24 mL/g Ads K_{oc} = 173 - 1413 mL/g	Low to moderate mobility. Six soils.	1196666
	NOA 459602	Adsorption increased with time to reach K_{oc} of 18 - 52 mL/g with incubation time of 71 days.	Additional information. Very high mobility. The registrant has postulated that these compounds are transformation products of thiamethoxam in soil, as these were observed at low levels in lysimeter studies.	1529765 and 1529766
Column leaching (unaged soil)	Thiamethoxam	Up to 59% of radioactivity recovered in leachate (amounts varied with soil type). Radioactivity was attributed to thiamethoxam.	Additional information. This compound was classified as moderately mobile in soil, based on the Relative Mobility Factor (RMF = leaching distance of test substance / leaching distance of reference substance). No transformation products were found in the soil or in the leachate.	1529777
Column leaching (aged soil)	Thiamethoxam	At the end of the aging period (30 days), the majority of the soil radioactivity was attributed to thiamethoxam; low amounts of CGA 282149, CGA 322704 and CGA 355190 were observed and less than 2% of the applied radioactivity was recovered in volatile traps. The estimated DT_{50} for thiamethoxam was 124 - 320 days. The majority of the radioactivity remained in the soil after leaching and was mostly found in the 0-6 cm soil layer. Soil radioactivity was primarily thiamethoxam. Radioactivity in the leachate was 0 - 26 % of the applied amount. K_d = 2.01 - 197.53 mL/g	Thiamethoxam is less mobile in soil after ageing.	1178249

Property	Test substance	Value	Comments	Reference (PMRA #)
	Thiamethoxam	At the end of the ageing period (56 days), soil radioactivity was primarily attributed to thiamethoxam and CGA 322704 (55 - 63 % and 18 - 25 % of the applied amount, respectively); volatiles represented more than 30% of the applied radioactivity. The estimated DT_{50} for thiamethoxam was 65 -94 days. Most of the radioactivity remained in the soil after leaching. Thiamethoxam reached a depth of 30 cm (length of column), with highest amounts found at a depth of 12 - 24 cm. CGA 322704 was not found below 18 cm. Radioactivity in the leachate was 1.7 - 3.4 % of the applied amount.	Additional information.	1529778
Volatilization	Thiamethoxam WG 25	2.2% of thiamethoxam volatilized within 3h of application to soil surface. After 6 and 24 hours, volatilization was less than 1%.	Additional information. The volatilization was determined indirectly by measuring the residual radioactivity in the soil.	1529779
	Thiamethoxam	Estimated half-life from the atmospheric oxidation by hydroxyl radicals: 0.5 - 2.5 hours	Additional information. Estimated using the procedure described in Atkinson, R. 1998. Environ. Toxicol. Chem. 7: 435-442.	1529799
	CGA 322704 (Clothianidin)	Estimated half-life from the atmospheric oxidation by hydroxyl radicals: 0.94 hours	Additional information. Estimated using the procedure described in Atkinson, R. 1998. Environ. Toxicol. Chem. 7: 435-442, as developed in the Atmospheric Oxidation Program v1.8.	1529800
Field studies				
Field dissipation in site relevant to Canadian conditions: Alberta, Saskatchewan, Manitoba, Ontario	Helix Seed Treatment	Treated canola seeds at a rate of 500 g a.i./100kg seed: DT_{50} = 161 days in Ontario. There was no clear pattern of dissipation at the Saskatchewan site and a DT_{50} was not determined. While dissipation was observed in Alberta and Manitoba, rate calculations were not conclusive (high variability in concentrations and theDT_{50} varied markedly depending on the model).	Moderately persistent to persistent in some sites. Major transformation products were CGA 355190 and CGA 322704 (clothianidin). These were detected at all sites in the 0-10 cm soil layer. Thiamethoxam generally remained in the top 10 cm of soil, with occasional detections in the 10-25 cm layer.	1178359
Field dissipation in site relevant to Canadian	Actara 25 WG (25.1% a.i.)	Two broadcast applications at 26.3 g a.i./ha on bare ground:	Persistent.	860996, 860997,

Property	Test substance	Value	Comments	Reference (PMRA #)
conditions: Manitoba		While some degradation is apparent in the first 100 days of the study, rate calculations were not conclusive because of an increase in measured concentrations the following spring.	No major transformation products were formed. Minor transformation products were detected a low levels, generally below the limit of quantification. CGA 355190 was most often detected. Other minor transformation products include CGA 322704 (clothianidin), CGA 309335, CGA 353968, CGA 353042 and NOA 404617. Transformation products were mostly observed in the 0-10 cm soil layer. No residues of thiamethoxam or its transformation products were found below 25 cm depth. Residues of thiamethoxam are expected to carry-over. Up to ~ 85% of the applied amount was remaining in the soil at the end of the growing season.	860998, 860999 and 1074854
	Actara 240 SC (240 g a.i./L)	One broadcast application at 118 g a.i./ha on bare ground: Rate calculations not conclusive (low initial concentrations and no dissipation pattern)		
Field dissipation in site relevant to Canadian conditions: Ontario	Actara 25 WG (25.1% a.i.)	Two broadcast applications at 26.3 g a.i./ha on bare ground: DT_{50} = 49.8 days	Slightly to moderately persistent. No major transformation products were formed. CGA 322704 (clothianidin) was observed in measurable amounts at many sampling events. Other minor transformation products include CGA 353042, CGA 353968 and NOA 407475. Transformation products were mostly observed in the 0-10 cm soil layer. No residues of thiamethoxam or its transformation products were found below 25 cm depth. Residues of thiamethoxam are expected to carry-over. Up to ~ 34% of the applied amount was remaining in the soil at the end of the growing season.	
	Actara 240 SC (240 g a.i./L)	One broadcast application at 118 g a.i./ha on bare ground: DT_{50} = 18.7 days		
Field dissipation in site relevant to Canadian conditions: PEI	Actara 25 WG (25.1% a.i.)	Two broadcast applications at 26.3 g a.i./ha on bare ground: DT_{50} = 18.3 days	Slightly persistent. No major transformation products were formed. CGA 322704 (clothianidin) was observed in measurable amounts at many sampling events. Other minor transformation products include CGA 353968 and NOA 407475. Transformation products were mostly observed in the 0-10 cm soil layer. No residues of thiamethoxam or its transformation products were found below 25 cm depth. Residues of thiamethoxam are expected to carry-over. Up to ~ 22% of the applied amount was remaining in the soil at the end of the growing season.	
	Actara 240 SC (240 g a.i./L)	One broadcast application at 118 g a.i./ha on bare ground: DT_{50} = 32.4 days		
Field dissipation in site relevant to Canadian conditions: Michigan	Actara 25 WG (25.5% a.i.)	Two broadcast applications at 112 g a.i./ha on bare ground: DT_{50} = 26.9 d	Slightly persistent. CGA 322704 (clothianidin) was a major transformation product. Quantifiable levels of thiamethoxam were not observed beyond 30 cm (broadcast) and 90 cm (in-furrow). Quantifiable levels of CGA	861000, 861001, 861002, 861003 and 861004
	Actara 4L (39.8%	One in-furrow application at 157 g a.i./ha (941		

Property	Test substance	Value	Comments	Reference (PMRA #)
	a.i.)	g a.i./ha within the furrow): DT_{50} = 26.8 d	322704 were not observed beyond 15 cm (broadcast) and 30 cm (in-furrow). These compounds were detected up to depths of 76 cm (broadcast) and 120 cm (in-furrow).	
Field dissipation in site relevant to Canadian conditions: Switzerland [5]	Thiamethoxam WG 25 formulation	One broadcast application at rate of 207 g a.i./ha on bare ground: DT_{50} = 52.9 d	Moderately persistent. Radiolabeled material was used. No major transformation products were formed. Minor transformation products were CGA 322704 (found in greater amounts, observed up to 20 cm depth), CGA 265307 and CGA 355190 (observed in 0-10 cm soil layer). Quantifiable amounts of thiamethoxam were found up to a depth of 50 cm. Amounts below the level of quantification were detected up to a depth of 60 cm.	1529782
Field dissipation in site relevant to Canadian conditions: Switzerland [5]	Thiamethoxam WG 25 formulation	One broadcast application at 200 g a.i./ha on bare ground: DT_{50} = 6.84	Additional information. Short report of 5 pages summarizing analytical results. Quantifiable levels of thiamethoxam were not observed beyond a depth of 10 cm. Quantifiable levels of CGA 322704 were observed once in the 0-10 soil layer but not at any other sampling event.	1529793
Field dissipation in site relevant to Canadian conditions: Switzerland [5]	A9700B (350 g a.i./L)	Barley seed treatment at 70 g a.i./100 kg seed (equivalent to 150.5 g a.i./ha): DT_{50} = 61.1 days	Moderately persistent. CGA 322704 was the only transformation product. Quantifiable levels of thiamethoxam and CGA 322704 were observed up to a depth of 30 cm.	2446857
Field dissipation in site relevant to Canadian conditions: Switzerland [5]	A9584C 25 WG	One broadcast application at 200 g a.i./ha on bare ground: DT_{50} = 12.1 days	Non-persistent. Transformation products were CGA 322704, CGA 355190 and NOA 407475. Quantifiable levels of thiamethoxam and CGA 322704 were observed up to a depth of 45 cm. NOA 407475 was not found beyond a depth of 30 cm.	2446861
Field dissipation in site relevant to Canadian conditions: France [5]	Thiamethoxam WG 25 formulation	One broadcast application at 200 g a.i./ha on bare ground: DT_{50} = 14.5 - 205 days	Additional information. Short reports of 13 - 15 pages summarizing analytical results. Quantifiable levels of thiamethoxam and CGA 322704 were found up to 30 cm in some study sites. Crops had recently been sown at the time the pesticide was applied (corn, soybean or grass depending on the plot). Crop uptake was not assessed.	1529794, 1529795, 1529796, 1529797, 1529783 and 1529784
Field dissipation in site	A9700B (350 g	Barley seed treatment at 70 g a.i./100 kg seed	Slightly persistent.	2446859

Property	Test substance	Value	Comments	Reference (PMRA #)
relevant to Canadian conditions: France [5]	a.i./L)	(equivalent to 148.4 g a.i./ha): DT_{50} = 22.4 days	Transformation products were CGA 322704 and CGA 355190. Quantifiable levels of thiamethoxam and CGA 322704 were observed up to a depth of 30 cm. CGA 355190 was not found beyond 10 cm.	
Field dissipation in site relevant to Canadian conditions: Spain [5]	Actara 25 WG	One broadcast application at 200 g a.i./ha on bare ground: DT_{50} = 36.1 days	Slightly persistent. On bare ground, quantifiable levels of thiamethoxam were not observed beyond a depth of 20 cm. In the cropped plot, quantifiable levels of thiamethoxam were observed up to a depth of 30 cm (both in treated row and between rows). Quantifiable levels of CGA 322704 were not observed at any sampling event in either plot.	1529789
Field dissipation in other site: California	Platinum 75SG (75% a.i.) Actara 25 WG (25% a.i.)	In-furrow application at 328 g a.i./ha followed 31 and 38 days later by two broadcast sprays at 106 g a.i./ha (bare soil): DT_{50} = 16.3 days (after last spray application) In-furrow application at 328 g a.i./ha followed 31 and 38 days later by two broadcast sprays at 106 g a.i./ha (cropped with spinach): DT_{50} = 5.51 days (after last spray application)	Non-persistent (cropped) to slightly persistent (bare soil). In the bare soil plot, CGA 322704 and CGA 355190 were major transformation products. Only CGA 322704 was a major transformation product in the cropped plot. NOA 404617, CGA 353042 and NOA 407475 were minor transformation products in the bare soil plot. These, in addition to CGA 355190 were minor transformation products in the cropped plot. Thiamethoxam was detected up to 36 inches in both the bare soil and cropped plots. CGA 322704 and CGA 355190 were also detected in deeper soil layers.	2446854
Multi-year accumulation study: Switzerland	A9584A or A9584C (25% a.i.)	Field trials in Switzerland (site relevant to Canadian conditions). Thiamethoxam was applied for 10 years as a foliar spray (four applications of 50 g a.i./ha) to plots sown with potatoes, common beans or peas. Soil was analyzed for thiamethoxam (all years), clothianidin (all years but the first), CGA 355190 (last three years of the study) and NOA 407475 (last three years of the study): Concentrations of thiamethoxam in the 0-10 cm soil layer peaked yearly, immediately after the last application of the year, and then dissipated over the course of the growing season. The maximum residue concentration observed in the 0-10 cm soil layer was 0.116 mg/kg dry soil. The latter was observed in the last year of the study, however, the overall results do not suggest that thiamethoxam accumulates in soil with multiple years of use. Thiamethoxam concentrations further decreased with deeper soil layers, with maximum concentrations of 0.017 and 0.005 mg/kg dry soil in the 10-20 and 20-30 cm soil layers, respectively. No quantifiable residues were observed at depths below 30 cm. Concentrations of clothianidin fluctuated over time. Clothianidin was formed following application of thiamethoxam each year, but the dissipation of clothianidin was often incomplete within a given crop cycle, contrary to what was generally observed for thiamethoxam. Maximum average concentrations of clothianidin were 0.014, 0.017 and 0.011 mg/kg dry soil in the 0-10 cm, 10-20 cm and 20-30 cm soil depths, respectively. At depths below 30 cm, residues were generally below the level of quantification. Concentrations of CGA355190 were generally below the level of quantification in all soil layers. NOA407475 reached concentrations of 0.004, 0.003 and 0.002 mg/kg dry soil in the 0-10, 10-20 and 20-30 cm soil layers, respectively, and no quantifiable residues were observed in layers deeper than 30 cm.		2446853

Property	Test substance	Value	Comments	Reference (PMRA #)
Field lysimeter	Thiamethoxam WP 25 formulation	The formulation was sprayed 4 times during the growing season at 50 g a.i. on potatoes. This treatment was repeated for a second year for one of the two lysimeter plots. Lysimeters were placed at a depth of 130 cm. Crops were harvested at maturity for analysis. The amount of total radioactive residues in soil, leachate and treated crop represented approximately 33%, 2.6-3.0% and 16-21% of the applied radioactivity, respectively. Approximately 63% of the applied radioactivity was attributed to losses due to mineralization. The majority of the total radioactive residues in soil were in the top layers (mainly the 0-20 cm layers). Detectable amounts of thiamethoxam were only found in the 10-20 cm layer of one of the two lysimeters and represented 1.9% of the applied amount. CGA 322704 (clothianidin) was observed in all layers from 0 to 40 cm and represented 5.5-6.7% of the applied amount. Thiamethoxam, CGA 322704 and unidentified residues were found in the leachate.		1529775
	Thiamethoxam WS 70 seed treatment formulation	Crops sown in the first year: spring barley seeds treated at a rate of 35 g a.i./100 kg seed (equivalent to 52.5 g a.i./ha). After the harvest of barley, planted winter wheat seeds treated at a rate of 63 g a.i./ha. Second year: Planted winter rape seeds treated at a rate of 420 g a.i./100 kg seed, equivalent to 21 g a.i./ha, in one of the two lysimeters plots. Crops were harvested at maturity for analysis. Lysimeters were placed at a depth of 120 cm. The amount of total radioactive residues in soil, leachate and treated crop represented 50-57%, 3.7-4.2% and 1.4-1.6% of the applied radioactivity, respectively. Approximately 38-44% of the applied radioactivity was attributed to losses due to mineralization. The majority of the total radioactive residues in soil were in the 0-40 cm layers. Overall, thiamethoxam and CGA 322704 (clothianidin) in soil represented 3.4-3.8% and 20-25% of the applied radioactivity, respectively. Thiamethoxam, CGA 322704, NOA 459602 and SYN 501406 were found in the leachate.		1529776
Small Scale Prospective Groundwater Monitoring – Michigan[6]	Platinum 2SC	One in-furrow spray application of the test substance at 193 g a.i./ha when planting cucumber seeds, followed by one ground spray application (without incorporation) of a potassium bromide tracer at 101 kg/ha. Monitoring was carried out for a period of 59 months after treatment (MAT). Surface soil (0-6 inch), soil pore water (suction lysimeters at 3, 6, 9 and 15 feet below ground surface) and groundwater samples (wells at 20-30 and 30-35 feet below ground surface) were collected. Rapid movement of the bromide tracer was observed (aquifer recharge at approx. 6 MAT), confirming permeability of the soil. Also, tracer concentrations peaked and then declined back to background levels in lysimeters and wells (i.e. showing movement through the vardose zone and into the groundwater where it continued to decline). In lysimeters: Thiamethoxam peaked at 14 MAT (max: 3.5 ppb, observed at 9 feet) and declined thereafter. CGA 322704 peaked at 38 MAT (max: 0.57 ppb, observed at 9 feet) and declined thereafter. CGA 355190 was found sporadically (max: 0.078 ppb, observed at 9 feet). In groundwater - shallow wells: Thiamethoxam was first observed at 27 MAT, peaked at around 43 MAT (0.16 ppb) and declined thereafter. NOA 459602 was first observed at 12 MAT, peaked at 13-27 MAT (max: 0.089 ppb) and declined thereafter. SYN 501406 was first observed at 12 MAT, peaked at 21-38 MAT (max: 0.13 ppb) and declined thereafter. In groundwater - deep wells: Thiamethoxam residues were not found. There were only two detections of NOA 459602 at 28-29 MAT (max: 0.063 ppb). SYN 501406 was first detected at 28 MAT and peaked at around 33MAT (max: 0.096		1108402 (progress report) and 1751758 (final report)

Property	Test substance	Value	Comments	Reference (PMRA #)
		ppb) and declined thereafter. CGA 322704, CGA 355190, CGA 353042, NOA 404617, and NOA 407475 were not found in groundwater.		

[1] Classification of the relative persistence of pesticide in soils is based on Goring et al. (1975).
[2] Classification of soil mobility potential is based on McCall et al. (1981)
[3] GUS = Groundwater Ubiquity Score, based on Gustafson (1989)
[4] Described in Cohen et al. (1984)
[5] The relevance of European test sites to Canadian ecoregions was evaluated using ENASGIPSV230_Arc10.2. All European sites from studies shown in this table were found to be relevant to Canada. Other European studies were in an ecoregion not found in North America (Baltic mixed forest) and are not shown in this table: Riepsdorf, Germany [PMRA# 1529785]; Middelfart, Denmark [PMRA# 1529787] and Bjärred, Sweden [PMRA# 1529788].
[6] Another small scale prospective groundwater monitoring study was performed in Georgia [PMRA# 1751760]. This study was not reviewed, as site is not relevant to Canada.

Table 3 Fate and behaviour in the aquatic environment – Registrant Submitted Studies

Property	Test substance	Value	Comments	Reference (PMRA #)
Abiotic transformation				
Hydrolysis	Thiamethoxam	At 25°C : t½ pH 5 : stable t½ pH 7: 559 - 939 days t½ pH 9: 4.1 - 8.0 days	Major transformation products, formed at pH 9, were CGA 355190 and NOA 404617 (for both the guanidine and thiazolyl radiolabels). In the study with the thiazolyl label, NOA 404617 further hydrolyzed to CGA 309335, which was still increasing at the end of the incubation period.	1178192 and 1178193
Phototransformation in water	Thiamethoxam	DT_{50} = 2.3 – 3.1 days (continuous irradiation)	Major transformation products were CGA 353042 (guanidine label) and carbonyl sulfide (volatile product from thiazolyl label). Identified minor transformation products were CGA 355190, CGA 322704, NOA 407475, CGA 353968 and methyl urea. Other minor products were not identified.	1196653 and 1196654
	Thiamethoxam	DT_{50} from 0.76 - 0.84 days in summer to 3.3 -7.8 days in winter in natural sunlight at 40°N - 50°N (annual mean of 1.2 - 1.6 days)	Additional information. Not fully reviewed. No information on transformation products.	152973

Property	Test substance	Value	Comments	Reference (PMRA #)
	CGA 322704 (clothianidin)	DT_{50} from 7.2 hours in summer to 8.5 days in winter in natural sunlight at 52°N	No major transformation products were formed. Identified minor transformation products were CGA 353968 and NOA 404617. The estimated environmental half-life was not verified by the reviewer since existing data for the phototransformation of clothianidin were consistent with results from this study.	1529737
Biotransformation[1]				
Biotransformation in aerobic water	Thiamethoxam	Pond water at 25°C: DT_{50} = 9.7 - 24 days Representative half-life: 9.7 - 24 days	Non-persistent to slightly persistent in water. Major transformation products were CGA 355190 and NOA 404617. Minor transformation products were CGA 353968 and one unidentified product. The DT_{50} was 12 - 16 days under sterile conditions and the same transformation products as in viable samples were formed. This suggests that transformation was from hydrolysis, which is possible given slightly basic conditions during the study (pH 8.22 to pH 8.67). Major products formed in viable samples were also observed in hydrolysis study.	1196651 and 1196660
Biotransformation in aerobic water-sediment system	Thiamethoxam	Pond water - loam sediment system at 25°C: DT_{50} = 7.2 - 15.0 days (water), 8.3 - 16.3 (whole system) Representative half-life: 9.1 - 15.0 days (water), 8.3 -16.3 (whole system)	Non-persistent to slightly persistent in whole system. NOA 407475, a major transformation product for both the guanidine and thiazolyl labels, was detected primarily in the sediment. CGA 355190 was a major transformation product with the thiazolyl label, but a minor transformation product with the guanidine label. NOA 404617 was a minor transformation product for both labels. CGA 355190 and NOA 404617 are thought to have been formed from the hydrolysis of the parent (pH 8.22 - pH 8.67 in water). Under sterile conditions, the DT_{50} was 28 - 35 days (water phase) and 29 - 38 days (whole system). CGA 355190 and NOA 404617 were major transformation products (hydrolysis). Only low levels of NOA	1196651 and 1196660

Property	Test substance	Value	Comments	Reference (PMRA #)
			407475 were formed.	
	Thiamethoxam	River water - sediment system at 20°C: DT_{50} = 11.9 - 12 days (water), 35 - 42.8 days (whole system) Representative half-life: 35.9 - 45.5 days (water), 42.8 - 59.4 (whole system) Pond water - sediment system at 20°C: DT_{50} = 8.3 - 10.6 days (water), 26.2 - 31.7 days (whole system) Representative half-life: 23.7 - 23.8 days (water), 31.7 - 40.4 (whole system)	Slightly to moderately persistent in whole system. NOA 407475, a major transformation product for both labels, was formed in the sediment. CGA 355190 was a minor transformation product for both labels observed in both the water and sediment phases. A mean sediment/water distribution coefficient was estimated as K_d = 2.1 - 2.7 mL/g.	1529752 and 1529753
	Thiamethoxam	River - sandy loam sediment system at 20°C: DT_{50} = 16.8 - 20.5 days (water), 51.5 - 60.8 days (whole system) Representative half-life: 35.6 - 42.1 days (water), 143 - 194 (whole system)	Slightly to moderately persistent in whole system. In water, NOA 404617 and CGA 355190 were minor transformation products. In the sediment, NOA 407475 was a major transformation product; NOA 404617 and CGA 355190 were identified as minor transformation products.	2529331
	CGA 322704 (clothianidin)	River water - sediment system at 20°C: DT_{50} = 23.1 days (water), 45.2 days (whole system) Representative half-life: 34.4 days (water), 45.2 (whole system) Pond water - sediment system at 20°C: DT_{50} = 10.9 days (water), 25.1 days (whole system) Representative half-life: 16.5 days (water), 25.1 (whole system)	Slightly persistent in whole system. NOA 407475 was a major transformation product in the sediment. No major transformation products were formed in the water phase. Minor transformation products were not identified. Other information provided in study but not verified by reviewer: CGA 322407 DT_{50} in the sediment = 67.9 d (river) and 63.1 d (pond) NOA 421275 DT_{50} in the sediment = 248 d (river) and 102 d (pond)	1529754

Property	Test substance	Value	Comments	Reference (PMRA #)
Biotransformation in anaerobic water-sediment system	Thiamethoxam	Sandy loam soil flooded with water at 25°C: DT_{50} = 15.9 - 18 days (water), 29 - 70.5 days (soil), 27.2 - 28.1 days (whole system) Representative half-life: 18 - 19.5 days (water), 29 - 70.5 days (soil), 27.2 - 28.1 days (whole system)	Slightly persistent in whole system. NOA 407475 was the only major transformation product in the soil layer. No major transformation products were formed in the water phase. Minor transformation products in the soil were CGA 322704, CGA 355190, NOA 404617, and CGA 353968. Minor transformation products in the water phase were NOA 407475, CGA 322704, CGA 355190 and NOA 404617.	1196658 and 1196659
	Thiamethoxam	River - silt loam sediment system at 20°C: DT_{50} = 27.5 - 28.1 days (water), 81.8 - 85.1 days (whole system) Representative half-life: 51.1 - 57.1 days (water), 81.8 - 85.1 (whole system)	Moderately persistent in whole system. In water, CGA 355190 was a major transformation product; NOA 407475 and NOA 404617 were minor transformation products. In the sediment, NOA 407475 and CGA 355190 were major transformation products; NOA 404617 was identified as minor transformation product.	2529332
Biotransformation in anaerobic water at low temperature	Thiamethoxam	Pond water at 5°C: DT_{50} = 12.6 days	Not recalculated (degradation at low temperature not currently a requirement and is not used for modelling). Slightly persistent. Major transformation products were CGA 355190 and NOA 404617. NOA 407475 was identified as a minor transformation product. The DT_{50} was also 12.6 days under sterile conditions and the same transformation products as in viable samples were formed. Hydrolysis is the likely route of dissipation in both sterile and viable samples given basic conditions (pH 9.09 to pH 9.95). Also, hydrolysis at pH 9 is rapid, which may explain why degradation was not slower at lower temperatures.	1196650

Property	Test substance	Value	Comments	Reference (PMRA #)
Biotransformation in anaerobic water-sediment system at low temperature	Thiamethoxam	Pond water - loam sediment system at 5°C: DT_{50} = 39.8 days (water), 53.3 days (sediment), 43.9 days (whole system)	Not recalculated (degradation at low temperature not currently a requirement and is not used for modelling). Slightly persistent in the whole system. NOA 407475 was the only major transformation product formed in the sediment. No major transformation products were formed in the water phase. Minor transformation products in sediment were CGA 355190, NOA 404617, and CGA 282149. Minor transformation products in the water phase were NOA 407475, CGA 355190, NOA 404617 and CGA 282149. Under sterile conditions, the DT_{50} was 126 and 204 days for the water phase and the whole system, respectively. Major transformation products were NOA 404617 and CGA 355190 (both found mostly in water).	1196650

1 Classification of the relative persistence of pesticides in water is based on McEwen and Stephenson, 1979.

Table 4 Fate Information – Additional Information from Scientific Literature

Type of information	Cited information	Comments	Reference
Physical and chemical properties			
Water solubility	4100 mg/L	Original source: pesticide properties database (http://sitem.herts.ac.uk/aeru/ppdb/en/index.htm)	As cited in Bonmatin et al. (2015)
Log K_{oc}	-0.13		
pK_a	No dissociation		
Abiotic transformation			
Hydrolysis	Stable at pH1 to pH7	Original source: de Urzedo et al. 2007. Photolytic degradation of the insecticide thiamethoxam in aqueous medium monitored by direct infusion electrospray ionization mass spectrometry. Int J Mass Spectron 42: 1319-1325	As cited in Simon-Delso et al. (2015)

Type of information	Cited information	Comments	Reference
	Quickly hydrolyzed at pH9 and 20°C	Original source: European Commission 2006. Review report for the active substance thiamethoxam. Accessible at: http://ec.europa.eu/food/plant/protection/evaluation/newactive/thiamethoxam_en.pdf	
Aqueous photolysis	DT_{50} = 2.7 days	Original source: pesticide properties database (http://sitem.herts.ac.uk/aeru/ppdb/en/index.htm)	As cited in Bonmatin et al. (2015)
	Susceptible to direct photolysis	Original source: Peña et al. 2011. Persistence of two neonicotinoid insecticides in wastewater, and in aqueous solutions of surfactants and dissolved organic matter. Chemosphere, 84(4), 464-470 [picked up by our literature search] A cursory examination of the above article provided more context: Aqueous solutions (MilliQ water) containing thiamethoxam were placed outdoors and exposed to sunlight for 10 h a day. The UV spectrum of thiamethoxam showed a high intensity absorption band at 250–255 nm, extending >290 nm, which means that the insecticide absorbs in the tropospheric range of sunlight, being thus susceptible to direct photolysis. A DT_{50} of 18.7 hours is reported by the authors. There was no degradation in dark controls.	
	Almost completely degraded (ca. 96%) under UV radiation in about 10 min	Original source: de Urzedo et al. 2007. [see above]	As cited in Simon-Delso et al. (2015)
Biotransformation			
Biotransformation in soil	DT_{50} = 7 - 335 days	Original source: Goulson D. 2013. An overview of the environmental risks posed by neonicotinoid insecticides. J Appl Ecol 50(4):977-987 Reported by Goulson (misreported in Bonmatin et al.): 7-353 days. Most values reported by Goulson were drawn from the Australian (APVMA) review of thiamethoxam and Cruiser 350 FS. The 7 day value is likely that calculated by the registrant based on data PMRA# 1529793.	As cited in Bonmatin et al. (2015)

Type of information	Cited information	Comments	Reference
	DT_{50} = 46 - 75 days (submerged soil), 91 - 94 days (field moisture capacity) and 201 - 301 days (dry soil)	Original source: Gupta et al. 2008. Soil dissipation and leaching behaviour of a neonicotinoid insecticide thiamethoxam. Bull Environ Contam Toxicol 80:431-437 [picked up in our literature search] Notes from cursory examination of article: Analytical grade thiamethoxam was applied to soil with varying moisture levels at concentrations of 0.01 and 0.1 µg/L. Dissipation is reported to be biphasic; the SFO half-life was 16.1 - 115.5 days and 60.2 - 376.3 days for the first and second phase, respectively, when considering all test concentrations and moisture regimes. Rates were faster at the low test concentration. Ranges are within currently available data for thiamethoxam.	
Biotransformation in water-sediment	DT_{50} = 40 days	Original source: pesticide properties database (http://sitem.herts.ac.uk/aeru/ppdb/en/index.htm)	As cited in Bonmatin et al. (2015)
Mobility			
Groundwater ubiquity score	3.82	Original source: pesticide properties database (http://sitem.herts.ac.uk/aeru/ppdb/en/index.htm)	As cited in Bonmatin et al. (2015)
Soil column leaching	65 cm of rainfall resulted in the leaching of 66-79% of the applied thiamethoxam and no residues were detected in the soil	Original source: Gupta et al. 2008. Soil dissipation and leaching behaviour of a neonicotinoid insecticide thiamethoxam. Bull Environ Contam Toxicol 80:431-437 Notes from cursory examination of article: Analytical grade thiamethoxam and two thiamethoxam formulations (Actara and Cruiser) were applied to column soil from India, with little difference in leaching behaviour, although slightly higher amount was recovered in leachate of analytical grade than formulation treatment.	
Sorption	Detection of contamination of groundwater is only a matter of time	Original source: Kurwadkar et al. 2013. Time dependent sorption behavior of dinotefuran, imidacloprid and thiamethoxam. Journal of Environmental Science & Health - Part B, 48: 237-242 A Notes from cursory examination of article: The time-dependant sorption of thiamethoxam (and other neonicotinoids) was studied ion the lab using soil from a vineyard, sampling interval varied of 0, 2, 4, 8, 12, 24, 60 and 96 hours. Sorption increased with time, but remained low.	
Field studies			

Type of information	Cited information	Comments	Reference
Field lysimeter	Various thiamethoxam treatments were made on potato in Wisconsin. Trials were carried out for two years (different location each year). Treatments were: (1) one in-furrow application of Platinum 75SC, containing 75% thiamethoxam, at a rate of 140 g a.i./ha; (2) seed treatment with Cruiser 5FS, containing 47.6% thiamethoxam, at a rate of 112 g a.i./ha at planting density of 1793 kg seed/ha; (3) thiamethoxam-impregnated polyacrylamide horticultural granules at 16 kg (of granules)/ha (with a ratio of 0.834g of Platinum 75SG per 75 g granules); and (4) Two foliar applications of Actara 25WG, containing 25% thiamethoxam, at a 7-day interval and a rate of 105 g a.i./ha/season. Lysimeters were placed at 75 cm below ground surface. Residues in leachates were higher at the end of the growing season. The highest residues resulted from impregnated polyacrylate granules. Based on graphical data, thiamethoxam residues in leachate reached up to approximately 17.5 µg/L for impregnated polyacrylate granules (observed 154 days after planting), approximately 12 µg/L for in-furrow application (observed 123 days after planting), approximately 11 µg/L for seed treatment and foliar applications (observed 123 days after planting). Low levels of thiamethoxam residues were also found in leachate from control plots; these were attributed to the contamination of wells from which irrigation water was drawn.		Huseth and Groves (2014)

Appendix IV Pollinator risk assessment framework

The pollinator risk assessment for clothianidin followed a tiered framework developed jointly by the PMRA, USEPA and CDPR in 2012 with guidance published in 2014 (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 and whether additional data could address scientific questions or data gaps.

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: Is 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. There were also 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-CFS were considered for comparison with residues from pollen and/or estimated bee bread residues. Effect parameters measured varied between pollen-CFS studies,

making interpretation difficult. 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:
  - Clothianidin: No effects were detected in the closed pollen-CFS (No effects: 5, 10 and 20 µg/kg); whereas effects were detected in several open pollen-CFS testing either clothianidin alone (Effects at 4.9 µg/kg; exposure was a declining range of 4.9-2.0 µg/kg over 12 weeks), or a mixture of thiamethoxam and lesser amounts of clothianidin (to represent formation of the transformation product) (Effects at 4.5-6.6 µg c.e./kg).
  - Thiamethoxam: Effects were detected in several open pollen-CFS testing a mixture of thiamethoxam and lesser amounts of clothianidin (to represent formation of the transformation product) (Effects at 4.5-6.6 µg/kg).

- ***Apis* Nectar-CFS:** Effects endpoint values derived from an open nectar-CFS were considered for comparison with nectar residues. While the nectar-CFS was robust, there was high control colony overwintering loss; therefore, only effects observed prior to overwintering were considered. Effects following overwintering, including potential for recovery, were not considered. The nectar-CFS study was repeated but a final report was not completed in time for this review. Analysis of available summary information from the repeated nectar-CFS, indicates the effects endpoints selected from the first-CFS are conservative**.**
  - Specific nectar-CFS endpoints considered were as follows:
    - Clothianidin: Effects were detected in open nectar-CFS (No effects at 19 µg/kg; Effects at 35.6 µg/kg).
    - Thiamethoxam: Effects were detected in open nectar-CFS (No effects at 25.3 µg c.e./kg; Effects at 34 µg c.e./kg).
- **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.
  - For clothianidin, the range of effects endpoints for *Apis* and non-*Apis* CFS were similar.
  - For thiamethoxam, the range of effects endpoints for *Apis* and non-*Apis* CFS included some effects endpoints that were more sensitive for non-*Apis* compared to *Apis*.
  - Specific CFS endpoints considered were as follows:
  - Thiamethoxam: Non-*Apis* information included closed nectar-CFS (Effects at 2.05 – 85 c.e. µg/kg (thiamethoxam only, with BB) and 2.9 c.e. µg/kg (thiamethoxam + clothianidin, with red mason bee); closed nectar plus pollen-CFS (Effects at 4.9 (thiamethoxam + clothianidin) – 8.6 c.e.µg/kg (thiamethoxam only)); open nectar-CFS (Effects at 2.1 c.e. µg/kg (thiamethoxam only)).
  - Clothianidin: Non-*Apis* information included open nectar-CFS testing clothianidin alone (No effects at 17 µg/kg; Effects at 39 µg/kg with BB); closed nectar plus pollen-CFS testing a mixture of thiamethoxam and lesser amounts of clothianidin (Effects at 4.9 c.e. µg/kg with BB).

- 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.

Additional consideration of bee bread in the risk assessment

Exposure: pollen and estimation of residue levels in bee bread

Because honeybees 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 thiamethoxam and clothianidin (expressed as clothianidin equivalents) 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 first adjustment involves multiplying the thiamethoxam concentrations by 0.856 (ratio of clothianidin to thiamethoxam molecular weights) to calculate clothianidin-equivalents. The second 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 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 clothianidin-equivalents 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 thiamethoxam and clothianidin do 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 fields. 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 honeybees, 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. In most cases, the risk from bee bread is similar to that of pollen alone.

It is also noted that when using honeybee 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 store 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 honeybee bee bread estimate.

Conversion of thiamethoxam to clothianidin

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. Some toxicity information suggests similar effects, particularly to adult bees, and in some crops, residues of clothianidin were detected in high amounts in pollen and/or nectar from application of thiamethoxam. As such, both thiamethoxam and clothianidin are considered in this risk assessment.

Thiamethoxam is assessed by considering thiamethoxam effects endpoints (at the individual and colony level) compared to thiamethoxam exposure (expected environmental concentrations and residues). To also consider potential toxicity from clothianidin, thiamethoxam was converted to clothianidin equivalents (by adjusting both the effects endpoint and exposure by the molar ratio of clothianidin to thiamethoxam, 0.856). At the Tier I level, individual bee toxicity was compared for thiamethoxam converted to clothianidin equivalents, and clothianidin. The most sensitive of these two toxicity endpoints was used in the risk assessment, and compared to exposure levels in terms of clothianidin. At the colony level (tier II), the thiamethoxam colony feeding study endpoints were converted to clothianidin equivalents and assessed against residues which were converted to clothianidin equivalents as well. In crops where clothianidin residues were high and contributed to the overall total residues of thiamethoxam and clothianidin, both residues were added together in terms of clothianidin equivalents. In most cases, thiamethoxam contributed to the majority of the total residues (and clothianidin residues were low).

Appendix V Pollinator Study Reviews

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

Species	Study	Test substance*	Endpoint (converted to µg a.i./bee)	Degree of toxicity	Notes	Reference (PMRA#)
Adult						
Honey bee adult	Acute oral 48 hour study, dosed in sugar solution	Actara 240 SC	48 hr LD50: 0.0039 µg a.i./bee	Highly toxic	Mortality at 48 hours was 4, 2, 6, 46, 92 and 98% at control, 0.01, 0.00562, 0.00316, 0.00177 and 0.001 µg a.i./bee, respectively (= 0.00647, 0.00463, 0.00316, 0.00179 and 0.00101 µg a.i. was consumed per bee)	2364826
Honey bee adult	Acute oral 48 hour study, dosed in sugar solution	TGAI	48 hr LD50: 0.005 µg a.i./bee	Highly toxic	Mortality at 48 hours was 0, 0, 43, 83, 87, 97 and 97% in the control, 0.002, 0.004, 0.008, 0.12, 0.016 and 0.02 µg a.i./bee, respectively. **NOTE: previously used in the PMRA risk assessment and used by EFSA 2013 review**	1196699
Honey bee adult	Acute oral 48 hour study, dosed in sugar solution	Cruiser 350 FS	48 hr LD50: 0.0115 µg a.i./bee	Highly toxic	Mortality at 48 hours was 0, 0, 14, 38, 58, and 76 of bees exposed to control, 2, 4, 8, 16 and 32 ng ai/bee, respectively (= 2.31, 4.59, 7.46, 13.4 and 25.1 ng a.i. consumed per bee)	2364804
Honey bee adult	Acute oral 48 hour study, dosed in sugar solution	A9549C (75% TGAI)	48 hr LD50: 0.00668 µg a.i./bee	Highly toxic	Mortality at 48 hours was 0, 4, 2, 50, 68, 92 and 96% dose levels were control, 1.5, 3, 6, 12, 24 and 48 ng a.i./bee (= 1.60, 3.12, 5.90, 10.1, 14.1 and 25.0 ng a.i. consumed per bee) Not a Canadian relevant end-use formulation	2364846
Honey bee adult	Acute oral 96 hour study with residues in bees, dosed in sugar solution	TGAI	**96 hr LD50: 0.0044 µg a.i./bee, as calculated by reviewer**.	Highly toxic	Mortality at 96 hours was 10, 0, 6.7, 60 and 93% at 0.27, 0.8, 2.4, 7.3 and 22.4 ng a.s./bee. (= 22.4, 7.3, 2.4, 0.8 and 0.27 ng a.s. consumer per bee) *residues are included as part of the assessment for incidents	2286963

Species	Study	Test substance*	Endpoint (converted to µg a.i./bee)	Degree of toxicity	Notes	Reference (PMRA#)
Honey bee adult	Acute oral 48 hours, dosing unknown	Cruiser 350 FS	48 hr LD50: 0.63 mg/L	Extreme high toxicity according to Chinese classificati on	NOTE: Summary in English but study in Chinese. *Information to be used as supportive information in risk assessment only.* ***Dose cannot be converted to µg/bee.***	2364861
Honey bee adult	Acute oral 48 hours, dosing unknown	Cruiser 70 FS	48 hr LD50: 0.52 mg/L	Not reported	NOTE: Summary in English but study in Chinese. *Information to be used as supportive information in risk assessment only.* ***Dose cannot be converted to µg/bee.***	2364843
Honey bee adult	Acute oral 48 hour study, dosed in sugar solution	A 12005 b	48 hr LD50: 0.085 µg wm /bee (48 hr LD50: 0.014 µg ai/bee)	Highly toxic	Mortality range from 0 to 100% in treatment groups and 0% in control group. NOTE: not a Canadian registered end-use product (A1200 5b). Product contains thiamethoxam (81.9 g/L) and citrine (418 g/L)	2364824
Honey bee adult	Acute oral Dust was applied to sugar water solution **The purpose of the study was to examine residues in bees.** (120 hour study at 0, 1 and 5 ng ai/bee for 6 hours)	Dust from treated corn seed	The study author did not determine an endpoint.	n/a	0% mortality in the 1 ng/bee group, and 63.3% in the 5 ng/bee group after 1 day of feeding. Majority of the samples showed no detection of thiamethoxam and clothianidin in bees above the LOD. *NOTE: This study was submitted through PMRA incident reporting program and reviewed as part of IR program. Summary available.*	2197611
Honey bee adult	Acute oral 48 hour study, dust from Cruiser 350 treated maize applied to sugar water solution	Dust from treated corn seed (Cruiser 350)	48 hour LD50: 0.00936 µg ai/bee	Highly toxic	Mortality at 48 hours was 0, 0, 0, 20, 56, 90 and 80% in the control, 1.65, 3.03, 6.29, 10.27, 18.37 and 29.77 µg ai/bee, respectively, based on consumption.	2364839
Honey bee	Acute oral	Actara	48 hour LD50:	Highly	Mortality at 48 hours was 0, 0, 2, 44, 74, 92 and 86%	2364839

Species	Study	Test substance*	Endpoint (converted to µg a.i./bee)	Degree of toxicity	Notes	Reference (PMRA#)
adult	48 hour, dosed in sugar solution	25WG	0.0063 µg ai/bee	toxic	in the control, 1.64, 2.91, 5.79, 8.05, 13.44 and 30.13 ng ai/bee, respectively, based on consumption.	
Honey bee adult	Acute oral 48 hour, dosed in sugar solution	Cyantranilip role/ thiamethoxa m WG (A16901B)	48 hour LD50: 0.00639 µg ai/bee (0.031 µg formulation/bee)	Highly toxic	93% mortality in highest test group at 24 and 48 hours	2071403
Honey bee adult	Acute oral 48 hour, dosed in sugar solution	Chlorantrani liprole/ thiamethoxa m WG (A15452B)	48 hour LD50: 0.01 µg ai/bee (0.062 µg formulation/bee)	Highly toxic	Mortality at 48 hours was 0, 4, 14, 38, 66 and 100% at 0, 0.017, 0.038, 0.083, 0.182 and 0.4 µg formulation/bee, respectively.	2364833
Honey bee adult	Acute oral **The purpose of the study was to examine residues in bees.** (120 hour study at 0, 1 and 5 ng ai/bee for 6 hours)	Cruiser 350 FS	5 day LD50>0.005 µg/bee, and NOEL: 0.001 µg/bee, as reported by the evaluator. The study author did not calculate an endpoint.	n/a	The highest observed mortality in the oral toxicity test in the 1 and 5 ng ai/bee treatment groups was 3.3% and 40%, respectively after 5 days. Thiamethoxam residues in bees decreased rapidly to < 50% of the 1 hr concentration within 6 hrs. As thiamethoxam decreased the concentration of clothianidin (the major transformation product of thiamethoxam) increased. *NOTE: This study was submitted through PMRA incident reporting program and reviewed as part of IR program. Summary available.*	2197610
Bumble bee adult	Acute oral 72 hour study, dosed in sugar solution with residues in bees	Actara 25 WG	72 hr LD50: 0.02 µg a.i./bee	Highly toxic	Mortality at 72 hours was 0, 0, 3, 53, 90 and 100% at 0, 0.000025, 0.00005, 0.0001, 0.0002 and 0.0004% w/v (active ingredient/sucrose solution), (= 0.005, 0.01, 0.02, 0.04 and 0.08 ug a.i. ingested per bumble bee)	2364856
Honey bee adult	Acute contact - direct 72 hour study, sprayed solution	Actara 25WG	72 hr LC50: 0.234 ppm	n/a	Mortality at 72 hours was 0, 1, 10, 28, 56, 73, 95 and 97% at 0, 3.125, 6.25, 12.5, 25, 50, 100 and 200 ppm. NOTE: It is not clear from the study how honey bees were exposed to the test substance. It indicates that test solutions were sprayed 20 cm in front of test cages	2364835

Species	Study	Test substance*	Endpoint (converted to µg a.i./bee)	Degree of toxicity	Notes	Reference (PMRA#)
					containing bees. It is not clear whether the test substance was sprayed in the direction of the cages (increasing the likelihood of direct contact exposure) or whether bees were exposed through inhalation. While a dose response relationship was observed, the actual residues in which bees were exposed to is unknown. Non GLP study	
Honey bee adult	Acute contact - direct 48 hour study, dosed once on thorax	Cruiser 600 FS	48 hr LD50: 0.066 µg a.i./bee	Highly toxic	Mortality at 48 hours was 10, 17, 17, 20, 80 and 80% at control, 0.0125, 0.025, 0.05, 0.1, and 0.2 µg a.i./bee, respectively.	2364822
Honey bee adult	Acute contact - direct 48 hour study, dosed once on thorax	Cyantraniliprole/ thiamethoxam WG (A16901B)	48 hour LD50: 0.0597 µg ai/bee (0.29 µg formulation/bee)	Highly toxic	100% mortality in highest test group. After 4 hours exposure, 86.7% mortality in highest test group. (contact: 0.13, 0.25, 0.5, 1 and 2 µg product/bee)	2071403
Honey bee adult	Acute contact - direct 48 hour study, dosed once on thorax	Chlorantraniliprole/ thiamethoxam WG (A15452B)	48 hour LD50: 0.023 µg ai/bee (0.129 µg formulation/bee)	Highly toxic	Mortality at 48 hours was 2, 6, 18, 62, 94 and 100% at 0, 0.0375, 0.075, 0.15, 0.3 and 0.6 µg formulation/bee, respectively.	2364833
Honey bee adult	Acute contact - direct 48 hour study, dosed once on thorax	A 12005 b	48 hr LD50: 0.50 µg wm /bee (48 hr LD50: 0.08 µg ai/bee)	Highly toxic	Mortality range from 0 to 73% in treatment groups and 0% in control group. NOTE: not a Canadian end-use product (A1200 5b). Product contains thiamethoxam (81.9 g/L) and citrine (418 g/L)	2364824
Honey bee adult	Acute contact - direct 48 hour study, dosed once on thorax	Actara 25 WG	48 hr LD50: 0.023 µg a.i./bee (0.093 µg EUP/bee).	Highly toxic	Mortality at 48 hours was 7, 33, 50, 87, 100 and 100% at control, 0.043, 0.094, 0.207, 0.455, 1.0 µg/bee, respectively. Note: It is assumed that the results in the report are based on EUP and were thus converted to TGAI.	2364808

Species	Study	Test substance*	Endpoint (converted to µg a.i./bee)	Degree of toxicity	Notes	Reference (PMRA#)
Honey bee adult	Acute contact - direct 48 hour study, dosed once on thorax	Actara 75WG	48 hr LD50: 0.46 µg a.i./bee	Highly toxic	Mortality at 48 hours was 3, 10, 30, 30, 33 and 90% at control, 0.063, 0.13, 0.25, 0.50 and 1.0 µg a.i./bee	2364812
Honey bee adult	Acute contact - direct 48 hour study, dosed once on thorax	Actara 240 SC	48 hr LD50: 0.0198 µg a.i./bee	Highly toxic	Mortality at 48 hours was 2, 98, 96, 82, 36 and 16% in the control, 0.1, 0.0562, 0.0316, 0.0177 and 0.01 µg a.i. /bee, respectively.	2364826
Honey bee adult	Adult contact - direct 48 hour study, dosed once on thorax	Cruiser 350 FS	48 hr LD50: 0.0173 µg a.i./bee	Highly toxic	Mortality at 48 hours was 0, 4, 42, 76, 88 and 94% of bees exposed to control (tap water), 6.25, 12.5, 25, 50 and 100 ng ai/bee, respectively.	2364804
Honey bee adult	Adult contact - direct (48 hour study, dosed once on thorax)	Cruiser 70 WS	48 hr LD50: 0.014 µg a.i./bee	Highly toxic	Mortality at 48 hours was 0, 0, 0, 20, 27, 80, 100 and 100% in the control, 0.003, 0.0054, 0.0096, 0.017, 0.031, 0.056 and 0.1 µg a.i./bee, respectively. Summary in English but study in Chinese. Information to be used as supporting information in risk assessment only.	2364828
Honey bee adult	Acute contact with residues - direct (96 hour study, dosed once on thorax, residues were measured in bees)	TGAI	96 hr LD50: 0.034 µg a.i./bee	Highly toxic	Mortality at 96 hours was 100.0, 53.3, 0.0, 3.3 and 0.0 % at dose levels of 200, 40, 8.0, 1.6 and 0.32 ng a.i./bee, respectively. *residues are included as part of the assessment for incidents	2286963
Honey bee adult	Acute contact with residues - direct (48 hour study,	TGAI	**48 hr LD50: 0.024 µg a.i./bee**	Highly toxic	Mortality at 48 hours was 0, 0, 7, 23, 70, 87 and 100% in the solvent control, 0.005, 0.01, 0.02, 0.03, 0.04 and 0.05 µg a.i./bee, respectively.	1196699

Species	Study	Test substance*	Endpoint (converted to µg a.i./bee)	Degree of toxicity	Notes	Reference (PMRA#)
	dosed once on thorax, residues were measured in bees)				**NOTE: previously used in the PMRA risk assessment and by EFSA 2013 review**	
Honey bee adult	Acute contact - direct **The purpose of the study was to examine residues in bees.** Doses of 0.01 and 0.025 µg ai/bee	Cruiser 350 FS	None determined. Two dose groups.	n/a	Residues of the transformation product clothianidin was below level of detection, and residues of thiamethoxm remained detectable during study. The highest mortality was 33.3% and 66.7% in the 0.01 and 0.025 µg ai/bee treatments, respectively. *NOTE: This study was submitted through PMRA incident reporting program and reviewed as part of IR program. Summary available.*	2197610
Bumble bee adult	Acute contact - direct 72 hour study, dosed once on thorax	Actara 25WG	72 hr LD50: 0.11 µg a.i./bee	n/a	Mortality at 72 hours was 0, 3, 13, 47, 97 and 100% for bees exposed to 0.0313, 0.0625, 0.125, 0.25 and 0.50 µg ai/bee, respectively.	2364816
Honey bee adult	Acute contact - indirect 72 hour study, dust from Cruiser 350 applied to cherry leaves	Dust from treated corn seed (Cruiser 350)	72 hour LD50: 0.0133 kg/ha	Highly toxic	Mortality at 72 hours was 0, 6, 10, 14, 64 and 86% in the control, 2, 4, 8, 16 and 32 g/ha, respectively	2364839
Honey bee adult	Acute contact - indirect applied to cherry leaves	Actara 25WG	72 hour LD50: 0.0055 kg/ha	Highly toxic	Mortality at 72 hours was 0, 4, 26, 74, 98 and 100% in the control, 2, 4, 8, 16, and 32 g/ha, respectively	2364839
Honey bee adult	Acute contact - indirect dust was sprinkled on cherry leaves	Dust from treated corn seed	The study author did not determine an endpoint.	n/a	The highest mortality was observed in the 4 and 20 g ai/ha treatment group at 13.3% and 73.3%. Majority of the samples showed no detection of thiamethoxam and clothianidin above the LOD.	2197611

Species	Study	Test substance*	Endpoint (converted to µg a.i./bee)	Degree of toxicity	Notes	Reference (PMRA#)
	The purpose of the study was to examine residues in bees. Dosing of 4 g ai/ha and 20 g ai/ha.				*NOTE: This study was submitted through PMRA incident reporting program and reviewed as part of IR program. Summary available.*	
Honey bee adult	10 day Chronic feeding Bees were fed for 10 hours per day with 0 (control), 0.1, 1 and 10 µg a.i./L. The ingested rate was 0.02, 0.2 and 2 ng ai/bee NOTE: on a per day basis the endpoints are divided by 10.	TGAI	LD50: > 0.0002 µg a.i./bee per day NOEC= 0.0002 µg a.s./bee per day	n/a	There was up to 19% mortality in the control group by day 10. The study author "corrected" for control mortality. Based on corrected mortality there was less than 7% mortality in test groups. Even without the "correction", mortality was less than 50%.	2364970
Honey bee adult	**10 day Chronic feeding** **Bees were fed continuously with 0 (control), 36.2, 65.2, 117.3, 211.1 and 380 µg a.i./kg diet** **Equivalent to corresponding average daily dose of 0, 1.19, 1.77, 2.45, 4.85 and 7.02 ng a.i./bee/day, based on consumption**	**TGAI**	**NOEC: 117 µg ai/kg diet** **NOED: 0.00245 µg ai/bee/day**	**n/a**	**Corrected mortality in the treatment groups were -2.7, -8.1, 5.4, 70.3 and 100%in the 1.19, 1.77, 2.45, 4.85 and 7.02 ng a.i./bee/day dose groups, respectively.** **There was a decrease in food consumption with increasing dose.**	**2694874**
Honey bee	10 day Chronic feeding	TGAI	NOEC: 0.00089 µg	n/a	There was only 1% mortality at the end of the study in the highest test dose (32 µg a.i./L) and only 1.3%	2364876

Species	Study	Test substance*	Endpoint (converted to µg a.i./bee)	Degree of toxicity	Notes	Reference (PMRA#)
adult	Bees were fed for 10 hours per day with 0 (control), 12, 16, 20, 24, 28 and 32 µg a.i./L Equivalent (based on consumption) to 0, 2.619, 3.628, 4.920, 6.329, 7.855 and 8.978 ng a.i./bee. NOTE: on a per day basis the endpoints are divided by 10.		ai/bee/day adjusted for consumption		mortality in the control group. Based on consumption, the dose is: 8.978 ng ai/bee. There was a decrease in food consumption across all treatments, including the control group, which was potentially attributed to the study design. Because there was less ingestion of food in the control, the effect was not attributed to repellency. Adults were only fed for 10 hours per day.	
Honey bee adult	Foliage residue study 0, 5 and 100 g ai/ha applied at 72, 48 and 24 hours pre-harvest to alfalfa foliage. Bees were exposed for 24 hours.	Actara 25 WG	RT25 for 100 g ai/ha was > 72 hours, since there was still 80% mortality after 72 hours. RT25 for 5 g ai/ha < 24 hours.	n/a	Mortality at 5 g ai/ha and aged for 72, 48 and 24 hours was <1%, <1%, and 2%, respectively. Mortality at 100 g ai/ha and aged for 72, 48 and 24 hours was 80%, 85%, and 89%, respectively. Mortality in control for 24 hours was 1%. NOEL: 0.004 µg ai/bee (converted from 5 g ai/ha) used in previous PMRA assessment.	2365343
Honey bee adult	Foliage residue study 0 and 96.6 g ai/ha applied to alfalfa and aged for 4, 5 and 6 days. Bees were exposed for 24 hours.	Actara 25 WG	RT25 was estimated between 5 and 6 days as 24 hour mortality was <25% on day 6 post application.	n/a	Mortality at 96.6 g/ha was 27, 51 and 11% after 4, 5 and 6 days. Control mortality was 1, 3 and 1%, respectively.	2610250

Species	Study	Test substance*	Endpoint (converted to µg a.i./bee)	Degree of toxicity	Notes	Reference (PMRA#)
Brood						
Honey bee brood	Sub-chronic study Larvae were placed in cells containing contaminated food at measured concentrations of 7.23, 16.3, 35, 51.5 and 113 µg ai/g diet. Mortality and defecation (indicating end of larval stage) were recorded daily for 5 days.	TGAI	LC50: >113 µg a.i./g diet	n/a	Mortality at day 5 was 0, 0, 2, 8, 21, and 29% in the control, 7.23, 16.3, 35, 51.5 and 113 µg ai/g diet (measured). Note: It is assumed renewed food (conducted on a daily basis) was treated. NOEC was not calculated in the study. Based on visual approximation, the NOEC is set at 35 µg a.i./g diet by the PMRA based on 21 and 29% mortality at the two highest concentrations. However, potential sublethal effects on defecation may preclude NOEC derivation. Non-GLP study.	2364814
Honey bee brood	Chronic study Larvae were fed contaminated royal jelly from Day 1 to Day 6. Mortality was recorded on Days 3-6, 7, 8 and 22.	TGAI	NOEC: 12.5 ppb (=0.0125 µg a.i./g diet)	n/a	Mortality at day 22 was 25, 29, 31, 36 and 40% in the water control, 6.25, 12.5, 25 and 50 ppb treatment groups respectively. EFSA report indicated the same endpoint. PMRA NOTE: The new OECD guidance was based on Aupinel et al, which is the guidance used in this study, and thus is relevant. However, the control mortality was 25%. The study is non-GLP. Registrant indicated that this study was based on an early version of guidance (Aupinel et al 2005, Aupinel 2007) which was criticised for lack of robustness with respect to mortality in the control. Larvae were exposed to the chemical every day through pupation and considered chronic exposure. The method to assess chronic exposure has not been fully ring-tested, not validated and was not, at the time, adopted by OECD.	2364814

Species	Study	Test substance*	Endpoint (converted to µg a.i./bee)	Degree of toxicity	Notes	Reference (PMRA#)
Honey bee brood	Chronic exposure but limited observation period Larvae were fed on Days 3-6: 0, 0.0217, 0.0539, 0.134, 0.336 and 0.840 µg a.i./larva/day.	TGAI	Day 8 NOEC (mortality): 5.45 mg ai/kg diet NOED: 0.840 µg ai/larva/day	n/a	Control mortality was 9.5%. Mortality rates in the treatment groups were 16.7, 21.4, 23.8, 16.7 and 23.8 % for the application doses of 0.141, 0.350, 0.873, 2.182 and 5.455 mg a.i./kg diet, respectively. Uneaten food was observed in the solvent control, test item and reference item treatment groups.	2702496
Honey bee brood	Chronic study Larvae were fed on Days 3-6: 0, 0.0157, 0.0313, 0.0625, 0.125, 0.251 and 0.501 µg thiamethoxam/larva.	TGAI	Day 8 NOEC (mortality): 1.63 mg ai/kg diet NOED: 0.251 µg ai/larva/day Day 22 NOEC (emergence): 0.102 mg ai/kg diet **NOED: 0.0157 µg ai/larva/ day**	n/a	Day 8 Corrected mortality in the treatment groups was 4.8, 21.9, 9.7, 14.7, 17 and 19.5% in the 0.0157, 0.0313, 0.0625, 0.125, 0.251 and 0.501 µg thiamethoxam/larva groups, respectively. Adult emergence on day 22 in the treatment groups was 81, 66.7, 61.9, 64.3, 47.6 and 14.2% in the 0.0157, 0.0313, 0.0625, 0.125, 0.251 and 0.501 µg thiamethoxam/ larva groups, respectively. Adult emergence in the control was 88.1%.	2694875
Honey bee brood	Chronic exposure but limited observation period Larvae were fed on D3, D4, D5 and D6 to 0, 0.12, 0.37, 1.11, 3.33 and 10.0 µg a.i./ larva/day.	TGAI	NOAEL < 0.12 µg a.i./larva/day equivalent to <3.6 µg ai/g diet **LD50 was calculated as 0.78 µg a.i./larva/day**	n/a	Control mortality was below 8.3% in the water control, and 0% in the solvent control. Mortality in the treatment groups on day 7 were 50, 43, 75, 85 and 100% in the 0.12, 0.37, 1.11, 3.33 and 10 µg/larvae groups. Study was not carried until emergence (day 22); and the dosing regime was not in accordance with OECD guidance.	2529337

*all end-use products are registered in Canada unless stated otherwise
Toxicity classification according to Atkins et al 1981. < 2 µg/bee is highly toxic.
Grey shading indicate studies where endpoints were considered in the risk assessment.

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**				
LD_{50}=0.0121 µg a.i./bee (thorax) LD_{50}=0.0270 µg a.i./bee (wing)	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, 25, 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 lambdacyhalothrin/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 LD50 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 were reported for some of the other test chemicals, including thiamethoxam and clothianidin. The ratio of the contact LD50 (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 summary
LD_{50}=0.0229 µg a.i./bee)	Thiamethoxam (>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 to 7 tested) with a minimum of 30 bees/experiment Caste of bees tested: adult, older workers Observation period: 24 hours	**REVIEW:** Acute Contact Topical Endpoint: LD_{50}=0.0229 µg a.i./bee) The toxicity reported in this study is similar to those observed in other open literature and from the registrant. **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:

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		Effect parameters: mortality		371-378.
LD_{50}: 0.026 µg/bee	Thiamethoxam 25 (25%)	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}: 0.026 µg/bee The LD_{50} endpoint values are from the laboratory component of th is journal article. A bioassay test conducted in the lab was also presented but the results of the bioassay will not be presented since percent mortality decreased as time went on, indicating there is a mistake in the analysis. The toxicity reported in this study is similar to those observed in other open literature and from the registrant. **MAJOR UNCERTAINTIES:** There was no control data for the laboratory study. 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.
LD_{50}: 0.124 µg/bee	Thiamethoxam (99.7%)	CONTACT TOPICAL Test species: *Apis mellifera* Application method: *Dose-response trial:* same application method as above but thiamethoxam at an unknown dose level was tested in combination with the fungicide propiconazole at doses of 0, 0.0224, 0.224, 2.24 and 22.4 µg/bee 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	**REVIEW:** Acute Contact Topical Endpoint: LD50: 0.124 µg/bee *Dose-response trial:* By increasing the contact propiconazole dose in relation with the contact thiamethoxam dose, the ratio went from 0.6:1 to 600:1 resulted in a 1.3- to 3.6-fold increase in toxicity of thiamethoxam. **MAJOR UNCERTAINTIES:** No measure of control mortality.	Thompson H.M., S.L. Fryday, S. Harkin, S. Milner. 2014. Potential impacts of synergism in honeybees (*Apis* mellifera) of exposure to neonicotinoids and sprayed fungicides in crops. Apidologie 45(5):545-553.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		Effect parameters: mortality		
LD_{50}: 0.04 µg/bee	Thiamethoxam (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} = 25.02 mg a.i./L 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. Reported here are endpoints in 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
No endpoints determined.	Thiamethoxam (97%)	CONTACT TOPICAL Test species: *Apis mellifera* Application method: 1 µL of the test solution was deposited onto the thorax of the honey bee; doses tested were doses of 0.0001, 0.0005, or 0.001 µg/bee. Number of bees tested: unknown, experiments were repeated at least three times Caste of bees tested: adult bees, age unknown Observation period: 1 hour after application observations were made Effect parameters: locomotor activity, sucrose sensitivity and olfactory learning via PER	**REVIEW:** *Locomotor activity* Although, after topical delivery of thiamethoxam, the locomotor activity of the bees was not significantly modified compared to that of control bees, the bees treated topically moved significantly less in the box (compared to oral route) and consequently they covered a shorter distance than orally treated animals. *Sucrose sensitivity* Bees treated with thiamethoxam presented identical sucrose responsiveness before and after topical treatment, regardless of dose. *Olfactory learning* Overall, no significant effect was observed on retrieval performance after thiamethoxam was applied topically. However, a significant increase in performance was observed at the third acquisition trial to the dose of 0.0005 µg/bee applied topically.	El Hassani A.K., Dacher M., Gary V., Lambin M., Gauthier M. and Armengaud C. 2008. Effects of sublethal doses of acetamiprid and thiamethoxam on the behavior of the honeybee (*Apis* mellifera). Arch Environ Contam Toxicol 54(4):653-661

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
			MAJOR UNCERTAINTIES: Limited information on the laboratory conditions during the conduct of the study. Appears bees were caught from outside hives and from hives maintained in an apiary. Therefore bees were collected from different sources. It is unclear if bees were randomly assigned. The previous exposure of bees to chemicals from the "outside" hives is unknown. Control data was not graphically or numerically represented for the locomotor activity. The control group performed poorly in the olfactory and learning experiment conducted with thiamethoxam, and thus resulted in increased PER for thiamethoxam, which may not truly represent potential effects.	
No endpoints determined.	Actara (presumed to be 25% thiamethoxam)	MULTIPLE CONTACT TESTS Test species: *Apis mellifera* Application method: *Contact topical:* a manual sprayer at 0.58 mL/s and an average spraying rate of 0.00583 mL/cm^2 applied thiamethoxam at a dose of 0.15 g a.i./L *Contact transfer from leaf:* five plants were used for each treatment and a manual sprayer at 0.58 mL/s and an average spraying rate of 0.00583 mL/cm^2 was used, After spraying, plants were air dried in a shaded room for 1 h and three dry leaves were placed in each arena with the regular diet and water Number of bees tested: *Contact topical:* 10 bees/treatment *Contact transfer from leaf:* presumed to be 10 bees/treatment Caste of bees tested: adult bees Observation period: bee mortality was assessed at 1, 2, 3, 4, 5, 6, 12, 15, 18, 21, 24, 30, 36, 42, 48, 60, and 72 h after treatment Effect parameters: mortality and behaviour	**REVIEW:** *Contact topical:* In the first hour after direct spray exposure, 100% of honey bees showed prostration followed by death. Bees rapidly died soon after the loss of motor coordination, tremors, and prostration. LT_{50} = 1 hour *Contact transfer from leaf:* Had similar intensity and equivalent mortality as direct spraying. Bees rapidly died soon after the loss of motor coordination, tremors, and prostration. However it took longer for bees to reach 50% mortality in the test with dried residues (LT_{50} = 2.61 hours) when compared to direct contact with spray (LT_{50} = 1 hour). LT_{50} = 2.61 hour **MAJOR UNCERTAINTIES:** In this study, bees were sprayed with a manual sprayer; therefore the specific amount per bee is unknown. Age of bees tested is unknown.	Costa, E.M., Araujo, E.L., Maia, A.V.P., Silva, F.E.L., Bezerra, C.E.S. and Silva, J.G. 2014. Toxicity of insecticides used in the Brazilian melon crop to the honey bee *Apis* mellifera under laboratory conditions. Apidologie 45(1):34-44
No endpoints	Actara 25 WG	MULTIPLE CONTACT TESTS	**REVIEW:** *Contact transfer*	Stanley J., K. Sah,

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
determined.	(25% a.i.)	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 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	*A. mellifera*: 43 and 73% mortality in 24 and 48 h *A. cerana*: 23 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 24 and 48 h time periods. **MAJOR UNCERTAINTIES:** Very little information on methodology. Age of foragers not uniform. No LD_{50} value determined. **REVIEW:** *Contact topical assay* *A. mellifera*: 100% mortality in 24 and 48 h *A. cerana*: 100% mortality in 24 and 48 h The same level of mortality was achieved in both species by the 24 h assessment point. **MAJOR UNCERTAINTIES:** Very little information on methodology. Age of foragers not uniform. No LD_{50} value determined. **REVIEW:** *Bees foraging on treated plants* *A. mellifera*: 95 and 100% in 1 and 24 h *A. cerana*: 85 and 100% in 1 and 24 h **MAJOR UNCERTAINTIES:** Very little information on methodology. No control data for comparison. Age of foragers not uniform. Minimal cage size, colonies not located in the "tent" in this trial only individual bees. The design of this trial would cause stress on individual bees since they were unable to return to colony for 48 h. This level of stress could have contributed to unreliable mortality results. No residue analysis was conducted to confirm exposure level.	S.K. Jain, J.C. Bhatt, S.N. Sushil. 2015. Evaluation of pesticide toxicity at their field recommended doses to honeybees, *Apis* cerana and A. mellifera through laboratory, semi-field and field studies. Chemosphere 119:668-674

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		Bees foraging on treated potted plants: observations made 1, 24 and 48 hours after exposure Effect parameters: mortality		
No endpoints determined.	Thiamethoxam 25 WG (25% 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}: 12.83 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.
LC_{50}: 15.16 ppm	Thiamethoxam 25 WG (25% a.i.)	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 200 ppm 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	**REVIEW:** Acute Contact Transfer Endpoint: LC_{50}: 15.16 ppm This study provides relative toxicity information for imidacloprid and thiamethoxam. Only thiamethoxam is presented here. The method of exposure tested is different than the OECD method for contact exposure, and also for an RT_{25} study. **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.	Singh, N., A.K. Karnatak. 2005. Relative toxicity of some insecticides to the workers of *Apis* mellifera L. Shashpa 12(1):23-25.
24 hour:	Actara 25 WG	CONTACT TRANSFER	**REVIEW:** Acute Contact Transfer Endpoints:	Laurino, D., A.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
LD_{50}=5.36, 5.27 and 6.03 ppm for Colony Lig 1, 3,4 respectively. LD_{50}=3.38 ppm for Colony Mel 1 LD_{50}=4.44 ppm for Colony Car 1a 48 hour: LD_{50}=3.53, 5.30 and 4.61 ppm for Colony Lig 1, 3,4 respectively. LD_{50}=3.31 ppm for Colony Mel 1 LD_{50}=3.75 ppm for Colony Car 1a 72 hour: LD_{50}=2.75, 5.27, 4.17 ppm for Colony Lig 1, 3,4 respectively. LD_{50}=3.09 ppm for Colony Mel 1 LD_{50}=3.110 ppm for Colony Car 1a	(thiamethoxam 25%)	Test species: *Colony Lig 1, 3, 4: Apis mellifera lingustica* *Colony Mel 1: Apis mellifera mellifera* strain D *Colony Car 1a: Apis mellifera carnica* strain E Application method: chestnut (*Castanea sativa*) leaves were sprayed to drip, and left to dry for at least three hours. The honey bees were allowed to walk freely on the cage bottom covered with leaves for three hours. Leaves were treated with 2, 5, 10 or 20 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	24 hour: LD_{50}=5.36, 5.27 and 6.03 ppm for Colony Lig 1, 3, 4 respectively. LD_{50}=3.38 ppm for Colony Mel 1 LD_{50}=4.44 ppm for Colony Car 1a 48 hour: LD_{50}=3.53, 5.30 and 4.61 ppm for Colony Lig 1, 3, 4 respectively. LD_{50}=3.31 ppm for Colony Mel 1 LD_{50}=3.75 ppm for Colony Car 1a 72 hour: LD_{50}=2.75, 5.27, 4.17 ppm for Colony Lig 1, 3, 4 respectively. LD_{50}=3.09 ppm for Colony Mel 1 LD_{50}=3.110 ppm for Colony Car 1a Approximately 42% of the data presented in this study are from 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. For example, the same colonies were not tested across all chemicals tested. The authors stated that trials with more than 10% control mortality were discarded but no indication of how often this occurred. The most sensitive (*A.m. lingustica* – strain C) strain from the oral study was not used in the contact study for comparison of sensitivity.	Manino, A. Patteta, M. Porporato. 2013. Toxicity of neonicotinoid insecticides on different honey bee genotypes. Bulletin of Insectology. 66 (1) 119-126

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
No endpoints determined.	Thiamethoxam 25 WG (presumed to be 25%)	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 x 20 x 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 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	**REVIEW:** Mortality of *A. cerana* increased with time. 6 hours: 28.8% mortality 12 hours: 48.9% mortality 24 hours: 67.8% morality 48 hours: 78.3% mortality **MAJOR UNCERTAINTIES:** 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
No endpoints determined.	Actara 250 WG (thiamethoxam 250g/kg) + the spreader-sticker Haiten 200 (dodecyl benzene sulphonate 0.02%)	CONTACT TRANSFER Test species: *Apis mellifera* and *Protonectarina sylveirae* (Hymenoptera: Vespidae) Application method: leaves of *Citrus sinensis* were immersed in each treatment solution for 5 seconds and dried for 2 hours, then dried leaves were placed in Petri dishes (9 x 2 cm) with 15 adults of each species. Honey bees and wasps were fed with an aqueous solution of 10 % honey. Doses tested were 0.1 and 0.2 mg a.i./mL. Number of bees tested: 15 adults/species were placed on each	**REVIEW:** Significant differences in the mortality of *A. mellifera* and *P. sylveirae* as a function of insecticides, of the species and the interactions between insecticides and species were detected. No significant differences in mortality were found as a function of the dosages applied per species, of the exposure time or interactions between insecticides and exposure time. *Apis mellifera:* 100% mortality at 0.2 and 0.1 mg/mL solution dried on leaves. *Protonectarina sylveirae:* 79% and 78% % mortality at 0.2 and 0.1 mg/mL solution dried on leaves. **MAJOR UNCERTAINTIES:** Data was not provided for the control group, and it is unclear if there was a comparison with the	Fernandes ME de S, Fernandes FL, Picanço MC, Queiroz RB, Da Silva RS and Huertas AAG. 2008. Physiological selectivity of insecticides to *Apis* mellifera (Hymenoptera: Apidae) and Protonectarina sylveirae (Hymenoptera:

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		of the two different dosed plates; experiment repeated four times. Caste of bees tested: adult bees and wasps, unspecified age Observation period: mortality was recorded at 12, 24, 36 and 48 hours after treatment application. Effect parameters: mortality	control group. The study did include a control to assess the potential effects of a spreader-sticker sodium dodecyl benzene sulphonate 320 EC (Haiten 200) which was utilized at 0.02% in all treatments. It is not clear if there were effects from the 'sticker'. The insects were collected from random nests around the campus, and thus the historical exposure and condition of the insects are unknown. It is unclear if citrus trees (leaves used in the experiment) were previously sprayed with any other chemicals. It is unclear which time period the results are for (e.g. 12, 24, 36, or 48 hours). This review has presumed that honey bees were combined with wasps in the same bioassay container.	Vespidae) in citrus. Sociobiology 51(3):765-774.
LC_{50}: 0.0000052 µg/µL (5.2 ppm) after 24 hours LC_{50}: 0.0000033 µg/µL (3.3 ppm) after 48 hours LC_{50}:0.0000025 µg/µL (2.5 ppm) after 72 hours	Actara 25 WG (thiamethoxam 25%)	CONTACT TRANSFER Test species: *Apis mellifera* Application method: Spanish chestnut (*Castanea sativa* Mill.) leaves were sprayed to drip with a high-volume pneumatic hand sprayer and were left to dry in the shade for at least 3 hours, doses tested were 1, 2, 5, 10, 100 ppm , bees were exposed for 3 h Number of bees tested: 10 bees/treatment; experiment was repeated 4 times Caste of bees tested: adult bees, age unknown, unstarved Observation period: bee mortality was assessed at 3, 6, 24, 48 and 72 h after treatment Effect parameters: mortality and behaviour	**REVIEW:** Acute Contact Transfer Endpoints: LC_{50}: 0.0000052 µg/µL (5.2 ppm) after 24 hours, LC_{50}: 0.0000033 µg/µL (3.3 ppm) after 48 hours, LC_{50}:0.0000025 µg/µL (2.5 ppm) after 72 hours Thiamethoxam caused total mortality within 6 hours at the field concentration of 100 ppm (ng/µL) and within 72 h at the concentration of 10 ppm. The product caused statistically significant mortality up to 2 ppm. LC_{50} decreased when the time of exposure was increased indicated a dose-response. LD_{50} was not determined because the absorbed amount of the active ingredient could not be determined. Symptoms of poisoning were exhibited such as shaking and tremors, uncoordinated and uncontrolled movements, inability to take up a correct position of the body, and prolonged frenetic movement of the legs and rotation when being in the supine position. **MAJOR UNCERTAINTIES:** The condition of the bees, and the source/origin (sister queen status) etc. are unknown.	Laurino D, Porporato M, Patetta A and Manino A. 2011. Toxicity of neonicotinoid insecticides to honey bees: Laboratory tests. Bull Insect 64(1):107-113.
LC_{50} = 3.21 mg/mL in newly emerged bees LC_{50} = 3.50 mg/mL in 7 day old bees	Thiamethoxam (not reported)	CONTACT TRANSFER Test species: *Apis mellifera* Application method: test cages contained a sheet of filter paper moistened in a solution of the following concentrations 2.0, 4.0, 4.1, 4.2, 4.4. 4.6 and 5.0 mg/mL Number of bees tested: 20	**REVIEW:** Acute Contact Transfer Endpoints: LC_{50} = 3.21 mg/mL in newly emerged bees, LC_{50} = 3.50 mg/mL in 7 day old bees, LC_{50} = 4.51 mg/mL in 14 day old bees LC_{50} >5.0 mg/mL in 21 day old bees LC_{50} demonstrated that the highest toxicity was observed in the newly emerged workers and the least in honeybees with 21 days. LC_{50} by contact for honeybees of 21 days cannot be estimated due to greater resistance of the honey bees to thiamethoxam (> 5.0	Hashimoto J.H., Ruvolo-Takasusuki M.C.C., Toledo Vde A.A. 2003. Evaluation of the use of the inhibition

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
LC_{50} = 4.51 mg/mL in 14 day old bees LC_{50} >5.0 mg/mL in 21 day old bees		bees/cage, experiment repeated 4 times Caste of bees tested: adult bees of different age cohorts: newly emerged, 7, 14 and 21 days old Observation period: unknown Effect parameters: mortality	mg/ml). In addition to toxicity tests, this study looked at alterations in esterase activity of honey bees exposed to thiamethoxam. Results indicated total esterase inhibition was not observed in the concentrations used in the contact toxicity experiments. **MAJOR UNCERTAINTIES:** Control treatment was not clearly described. Amount of product applied to filter paper was not stated. Percent mortality was not reported. Observation period was unclear. It is unclear how the esterase inhibition results can be used in the risk assessment.	esterases activity on *Apis* mellifera as bioindicators of insecticide thiamethoxam pesticide residues. Sociobiology 42(3):693-639.
No endpoints determined	Thiamethoxam (various levels of a.i.)	CONTACT TOPICAL Test species: *Apis mellifera* compared to 19other 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 or/and 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 Contact 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 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 thiamethoxam endpoints were compared in 4 cases and the resulting sensitivity ratio was 1.14 (range 1.089 – 1.53). Acute contact endpoints ranging from 0.004 – 0.0061 µg/bee with the *A. mellifera* endpoint being used as the highest. The analysis examined *A. mellifera* compared to *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 summary
No endpoints determined.	Actara 250 WG (thiamethoxam 25%)	CONTACT TRANSFER Test species: *Apis mellifera* Application method: potted cotton plants were sprayed during flowering with 200 g a.i./ha (with	**REVIEW:** Total mortality (100%) occurred after 330 minutes (5.5 h) with thiamethoxam (Actara 250 WG). **MAJOR UNCERTAINTIES:** Effects on the behaviour of the	Thomazoni D., Soria M.F., Kodama C., Carbonari V., Fortunato R.P.,

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		400 L/ha of water) and left to dry in the field for 3 h before being placed into a screened-off plot with bees that was in a greenhouse Number of bees tested: 4 potted plants were sprayed/treatment; 30 bees were released/potted plant Caste of bees tested: adult, 5-6 days old Observation period: observations were made every 0.5 h for a total of 6 h Effect parameters: mortality	honey bees after treatment application were not documented. Control mortality was presented in a graph only; results were not stated in the article for comparison. However, graphically they appear to be >1%. The rate in the study is higher than Canadian rates (maximum of 150 g ai/ha), and the crop is not relevant to Canada, however, the exposure scenario in the study provides a conservative exposure scenario. Cotton provides a constant source of extra-floral nectaries. The study focused on acute effects (only 6 hours of observation) and did not include sublethal observations.	Degrande P.E. and Valter Junior V.A. 2009. Selectivity of insecticides for adult workers of *Apis* mellifera (Hymenoptera: Apidae). Revista Colombiana De Entomologia 35(2):173-176
No endpoints determined.	Thiamethoxam (97%)	CONTACT TOPICAL Test species: *Apis mellifera* Application method: 1 µL of solution containing a dose of either 0.001 or 0.0001 µg/bee was applied to the thorax daily Number of bees tested: 22-49 bees/treatment cage Caste of bees tested: adult, newly emerged Exposure period: 11 days Observation period: observations were made on day 12 Effect parameters: mortality, locomotion, water consumption, sucrose sensitivity with PER, olfactory learning experiments with PER	**REVIEW:** *Mortality:* At the end of the 11 day exposure period, mortality was 10% in the 0.001 µg/bee treated group and 10% in the control and 20% in the 0.0001 µg/bee treated group and 20% in the control. No significant mortality effects were seen between the treatments and their respective control groups. *Locomotion:* There was no significant effect on the three parameters of locomotor activity compared to controls, regardless of dose. *Water consumption:* Thiamethoxam induced no effect on water consumption and responsiveness. *Sucrose sensitivity:* Contact exposure to thiamethoxam had no effect on sucrose responsiveness. *Olfactory learning:* At a dose of 0.0001µg/bee, the learning curve of topically treated animals was not different from the control curve, and the 1-h retention level was equivalent in the two groups, with a performance approximately of 50%. However in the memory test performed 24 h after learning, a significant decrease in performance in the treated group compared to control was seen that by 48 h, had recovered. At a dose of 0.001 µg/bee, thiamethoxam induced a	Aliouane., Y., A. K. el Hassani, V. Gary, C. Armengaud, M. Lambin, and M. Gauther. 2009. Subchronic exposure of honeybees to sublethal doses of pesticides: effects on behavior. Environmental Toxicology and Chemistry, 28 (1): 113-122

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
			significant decrease in learning performance for the third and fourth trials as seen in the learning curves. At the end of the learning session, control bees reached 70% response rate, whereas thiamethoxam-treated bees reached only 50% response rate. Numerically memory performance was lower than that of controls at 1, 24, and 48 h, when compared to the controls. **MAJOR UNCERTAINTIES:** The solvent acetonitrile was used to dissolve the active ingredient. For some experiments the amount of bees tested was lower than 25 which is the recommended number in the lab based toxicity test guidelines.	
***APIS* - Tier I Acute Oral Trials**				
No endpoints determined	Clothianidin (99.6%), Thiamethoxam (99.6%), Boscalid (99.9%), Linuron (99.7%)	ACUTE ORAL Test species: *Apis* mellifera Application method: 50% sugar solution was provided for 4 hour in a 200 µL feeder at nominal doses of 0.000925, 0.00185, 0.0037, 0.0074 and 0.0148 µg clothianidin/bee (mean measured 0.009, 0.00184, 0.0031, 0.0045 and 0.0061 µg/bee) or 0.00125, 0.0025, 0.005, 0.01 and 0.02 µg thiamethoxam/bee alone or in combination with 0.0637 µg/bee boscalid or 0.0009 µg/bee linuron. At least 3 controls were tested. Number of bees tested: 10 bees/treatment, experiment was replicated 3 times Caste of bees tested: adult, foragers Observation period: observations made at 24 hours Effect parameters: mortality	**REVIEW:** The LD_{50} estimated for clothianidin and thiamethoxam was within the range found in the literature (clothianidin 1.24-6.76 ng/bee and thiamethoxam 1.99-9.0 ng/bee). Field-realistic levels of the herbicide linuron did not affect the acute oral toxicity (i.e. LD_{50}) of clothianidin and thiamethoxam to honey bees. Field-realistic levels of the fungicide boscalid substantially increased the acute oral toxicity of clothianidin and thiamethoxam to honey bees; the LD_{50} of these two NNIs was approximately half in the presences of field realistic levels of boscalid (note - a 50% reduction in LD_{50} reflects a doubling in toxicity). **MAJOR UNCERTAINTIES:** The age of test bees is unknown. Bees were shaken from honey frames for use in tests. The study author indicated that worker bees on honey frames are largely forager bees. Measurements of mortality were made at 24 hours only.	N. Tsvetkov, O. Samson-Robert, K. Sood, H. S. Patel, D. A. Malena, P. H. Gajiwala, P. Maciukiewicz, V. Fournier, A. Zayed. 2017. Chronic exposure to neonicotinoids reduces honey bee health near corn crops. Science 356, 1395–1397.
No endpoints determined.	Thiamethoxam (% 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 0.5 mg/L (reviewer estimated:	**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: 10.2, 14.8, 17.1, 19.5% mortality in 1, 2, 3 and 4 days	Chandramani, P., B.U. Rani, C. Muthiah, S. Kumar. 2008. Evaluation of toxicity of certain

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		0.5 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	**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 x 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%)".	insecticides to India honeybee, *Apis* cerana indica F. Pestology, 32(8):42-43.
No endpoints determined.	Actara (presumed to be 25% thiamethoxam)	ACUTE ORAL Test species: *Apis mellifera* Application method: 20 mL of honey and 50 g of sugar, which were mixed and homogenized to form a paste, the insecticides were applied to the diet surface (7.06 cm^2). Equivalent to 0.150 g ai/L. Number of bees tested: presumed to be 10 bees/treatment Caste of bees tested: adult bees Observation period: bee mortality was assessed at 1, 2, 3, 4, 5, 6, 12, 15, 18, 21, 24, 30, 36, 42, 48, 60, and 72 h after treatment Effect parameters: mortality and behaviour	**REVIEW:** A total of 100% of honey bees showed prostration followed by death. Bees rapidly died soon after the loss of motor coordination, tremors, and prostration. Similar intensity and equivalent mortality as direct spraying was seen. It took longer for bees to reach 50% mortality in the acute oral test (LT_{50} = 1.5 hours) when compared to direct contact with spray (LT_{50} = 1 hour). **MAJOR UNCERTAINTIES:** The dose in the study is difficult to compare with the Canadian label rate, with the information presented in the study. In this study, the insecticides were applied on the surface of the food (paste solution), to simulate field spraying. It is unknown if the exposure would be uniform. Age of bees tested is unknown.	Costa, E.M., Araujo, E.L., Maia, A.V.P., Silva, F.E.L., Bezerra, C.E.S. and Silva, J.G. 2014. Toxicity of insecticides used in the Brazilian melon crop to the honey bee *Apis* mellifera under laboratory conditions. Apidologie 45(1):34-44
No endpoints determined.	Thiamethoxam (not stated)	ACUTE ORAL Test species: *Apis mellifera* Application method: fed for 24 h with feeder containing a honey mixture and thiamethoxam solution (1:1), six concentrations were tested: $1.5x10^{-3}$; $3x10^{-3}$; $6x10^{-3}$; $5x10^{-4}$; $5x10^{-5}$; and $5x10^{-6}$ mg/ml that were dissolved in water before incorporated into feeding mixture Number of bees tested: 20 bees/treatment (presumed 5 of each of the 4 age classes were in each	**REVIEW:** Younger bees had higher mortality. In general, mortality increased with increasing dose in all bees. Across all concentrations tested the following are the mortality percent ranges: Mortality of 0 days old: 0-100% Mortality of 7 days old: 12.5 – 95% Mortality of 14 days old: 1-95% Mortality of 21 days old: 5 – 95% No dose-response could be established. Behavioral effects of thiamethoxam included contraction of abdomen, regurgitation of the consumed food, disorientation,	Falco JRP, Hashimoto JH, Fermino F and Toledo VAA. 2010. Toxicity of thiamethoxam, behavioral effects and alterations in chromatin of *Apis* mellifera L., 1758 (Hymenoptera; Apidae). Research Journal

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		bioassay of 20) Caste of bees tested: adult workers with different ages were tested and marked (0, 7, 14 and 21 days after emergence) Observation period: bee mortality was assessed at 24 h after treatment Effect parameters: mortality and behaviour	extended proboscis and legs protracted, and eventually death. **MAJOR UNCERTAINTIES:** It was unclear which dose levels caused the behavioural effects. It is assumed that all doses elicited this effect since bees consumed lower concentrations of thiamethoxam but did not feed with higher thiamethoxam concentrations. Consumption of the lower concentrations led to death in some cases. Bees were located in a greenhouse and not a laboratory.	of Agriculture and Biological Sciences 6(6):823-828.
LD_{50}=0.00786 µg a.i./bee)	Thiamethoxam (dissolved in acetone)	ACUTE ORAL Test species: *Apis mellifera* (Carniolan honey bee Application method: oral dose administered individually to bees in 2 µL of a 1:1 sugar solution. Number of bees tested: 5 replicates (each containing 20 bees) in each treatment (n=5) and control (n=2) group. Dose: 42.8, 21.4, 10.7, 5.35 and 2.68 ng/bee. Control bees were each individually fed 2 µl of sugar solution in water (1:1) Caste of bees tested: newly emerged adult worker bees (24 h) Observation period: 48 hours Effect parameters: mortality ACUTE ORAL + *Nosema* Test species: *Apis mellifera* (Carniolan and Africanized honey bees) Application method: oral dose administered individually to bees in 2 µL of a 1:1 sugar solution + 2 µL of *Nosema ceranae* spore suspension. Number of bees tested: 5 replicates (each containing 15 bees) in each test group.	**REVIEW:** Acute Oral Endpoint: LD_{50}=0.00786 µg a.i./bee) Toxicity data (LD_{50}) values considered in the other experiments for the Africanized honey bees were derived from Oliveira, R. A., Roat, T. C., Carvalho, S. M. and Malaspina, O. (2014), Side-effects of thiamethoxam on the brain and midgut of the africanized honeybee *Apis* mellifera (Hymenopptera: Apidae). Environ. Toxicol, 29: 1122–1133.) (0.00428 µg a.i./bee). This comparison (from two different studies) suggests that Carniolan bees are less sensitive than Africanized bees. **REVIEW:** ACUTE ORAL + *Nosema* *Nosema* infection For bees inoculated with *Nosema* spores only, Carniolan honey bees had a much lower number of *Nosema* spores 5 days after inoculation (30 000 spores per bee) compared to Africanized honey bees (300 000 spores/bee). For Carniolan, 5 days after inoculation the number of spores was similar in the bees inoculated with *Nosema* only and the bees inoculated with *Nosema* + low dose of thiamethoxam The number of spores was higher in the bees inoculated with *Nosema* only than in bees inoculated with *Nosema* plus the high dose of thiamethoxam. However, 10 days after inoculation, the bees inoculated with *Nosema* plus high dose of thiamethoxam, showed higher spores compared to bees inoculated with *Nosema* only and bees inoculated with *Nosema* + low dose of thiamethoxam. Bees exposed to thiamethoxam only (no spores) did not have *Nosema* spores after 10 days. For Africanized, 5 days after inoculation, the number of spores was lower (210 000 spores/bee) in bees treated with spores plus a low	Gregorc, A., Silva-Zacarin E., Malfitano Carvalho S., Kramberer D., Teixeira EW., Malaspina O. 2016. Effects of *Nosema ceranae* and thiamethoxam in *Apis mellifera*: A comparative study in Africanized and Carniolan honey bees. Chemosphere. 147: 328-336.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		Dose: 0.0856 ng/bee (high dose), 0.00856 ng/bee (low dose), 0.0856 ng/bee (high dose) + 60 000 *Nosema* spores, 0.00856 ng/bee (low dose) + 60 000 *Nosema* spores Control bees were fed 2 µl of sugar solution in water (1:1), or 2 µl of sugar solution in water (1:1) + 60 000 *Nosema* spores. Caste of bees tested: newly emerged adult worker bees (24 h) Observation period: 48 hours Effect parameters: mortality and *Nosema* infection IMMUNOHISTOLOGICAL ANALYSIS Test species: *Apis mellifera* (Carniolan and Africanized honey bees) Application method: oral dose administered individually to bees in 2 µL of sugar solution + 2 µL of *Nosema* spore suspension. Number of bees tested: 30 bees in each cage (each dose). Dose: 0.0856 ng/bee (high dose), 0.00856 ng/bee (low dose), 0.0856 ng/bee (high dose) + 60 000 *Nosema* spores, 0.00856 ng/bee (low dose) + 60 000 *Nosema* spores Control bees were fed 2 µl of sugar solution in water (1:1), or 2 µl of sugar solution in water (1:1) + 60 000 *Nosema* spores. Caste of bees tested: newly emerged adult worker bees (24 h) Observation period: 48 hours Effect parameters:	dose of thiamethoxam compared to bees inoculated with only *Nosema* spores (300 000 spores/bee). Comparatively, bees treated with *Nosema* plus a high dose of thiamethoxam had lower spore numbers (160 000 spores per bee). Bees exposed to thiamethoxam only (no spores) no *Nosema* spores were found. Mortality There was no difference in bee mortality rates between treatment and control groups. **REVIEW:** IMMUNOHISTOLOGICAL ANALYSIS Control group (no Nosema inoculation or thiamethoxam treatment) Percent cell death in the midgut for control bees was estimated to be predominantly sporadic or low (5-15% for Carniolan honey bees on day 5). Thiamethoxam exposure A similar trend was observed for midgut cell death between Carniolan and Africanized honey bees on days 5 and 10. Bees exposed to thiamethoxam only had a similar percent cell death (20-55%) compared to bees exposed to *Nosema* spores only (60-90% on day 5 and 20-55% on day 10) between 5 and 10th days of the bioassay. On day 17 and 20 cell death in the midgut of Carniolan honey bees was considered sporadic in the low thiamethoxam dose group, Nosema only group and control group. In contrast, bees exposed to the high dose of thiamethoxam had higher cell death (20-55%) on the 17th day of the bioassay compared to the Nosema only and control groups but was sporadic by the 20th day similar to the low thiamethoxam dose group, Nosema only group and control group. Thiamethoxam and *Nosema* Bees exposed to both thiamethoxam and *Nosema* comparatively exhibited less cell death (sporadic) compared to the other treatments with the exception of cell death recorded in the high thiamethoxam dose + Nosema group on day 10. Cell death at this time point was estimated to be 20-55% for both Carniolan and Africanized honey bees which was the same percentage reported for bees in the *Nosema* only group	

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		immunohistochemcial analysis. At different times post inoculation (5, 10, 17 and 20 days), 3 bees had their midgut removed, preserved and observed for abnormalities (cell death).	**MAJOR UNCERTAINTIES:** Some of representation of the data in the graphs appeared to combine the results of both species of honey bee. It is unclear how the results of this study would translate to the field. Results were not presented for Africanized honey bee for immunohistochemical analysis for day 17 and 20. *Nosema* inoculation for Carniolan bees were followed for up to 40 days post inoculation, whereas Africanized bees were followed for only 10 days post inoculation.	
LC_{50} = 0.000047 mg/mL in newly emerged bees LC_{50} = 0.000074 mg/mL in 7 day old bees LC_{50} = 0.000081 mg/mL in 14 day old bees LC_{50} = 0.00010 mg/mL in 21 day old bees	Thiamethoxam (not reported)	ACUTE ORAL Test species: *Apis mellifera* Application method: bees were kept for 24 hours in test cages with a feeder that contained a honey mixture and a solution with the insecticide at 1:1 proportion at concentrations of 0.00005, 0.0005 0.00015, 0.0003 mg/ml Number of bees tested: 20 bees/cage, experiment repeated 4 times Caste of bees tested: adult bees of different age cohorts: newly emerged, 7, 14 and 21 days old Observation period: 24 hours Effect parameters: mortality and esterase activity.	**REVIEW:** Acute Oral Endpoints: LC50 = 0.000047 mg/mL in newly emerged bees, LC50 = 0.000074 mg/mL in 7 day old bees, LC50 = 0.000081 mg/mL in 14 day old bees, LC50 = 0.00010 mg/mL in 21 day old bees LC_{50} demonstrated that the highest toxicity was observed in the newly emerged workers and the least in honeybees with 21 days. In addition to toxicity tests, this study looked at alterations in esterase activity of honey bees exposed to thiamethoxam. Results indicated total esterase inhibition was not observed in the concentrations used in the oral toxicity experiments. **MAJOR UNCERTAINTIES:** Control treatment was not clearly described. Amount of product applied to filter paper was not stated. Percent mortality was not reported. Observation period was unclear. It is unclear how the esterase inhibition results can be used in the risk assessment.	Hashimoto J.H., Ruvolo-Takasusuki M.C.C., Toledo Vde A.A. 2003. Evaluation of the use of the inhibition esterases activity on *Apis* mellifera as bioindicators of insecticide thiamethoxam pesticide residues. Sociobiology 42(3):693-639.
LD_{50}=0.0028, 0.0026, 0.0026 µg/bee for 24, 48 and 72 hours: Beehive 1 LD_{50}=0.0033, 0.0030, 0.0029 µg/bee for 24, 48 and 72 hours:	Actara 25 WG (thiamethoxam 25%)	ACUTE ORAL Test species: *Apis mellifera ligustica* (3 different strains) Application method: 35 µL of 25% sucrose solution was provided for 1 hour in a feeder at doses of 0.01, 0.02, 0.05, 0.1, 0.2, 0.5, 1, 100 ppm Number of bees tested: 10 bees/treatment, experiment was repeated 4 times Caste of bees tested: adult, foragers Observation period: observations	**REVIEW:** Acute Oral Endpoints: Reviewer calculated mean 48 h LD_{50}=0.003 µg a.i./bee This study showed a slight variability of the LD_{50} values for different strains of bees, but in the same range of toxicity. Each beehive tested a different strain of bees. Thiamethoxam caused the death of all the tested honey bees even at the concentration of 0.5 ppm within 6 h after the beginning of the test. This product caused a statistically significant mortality up to 0.05 ppm in two strains and up to 0.02 ppm in the third. Symptoms of poisoning in the honey bees included shaking and	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.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
Beehive 2 LD_{50}=0.0045, 0.0044, 0.0032 µg/bee for 24, 48 and 72 hours: Beehive 3		made 1, 3, 6, 24, 48 and 72 hours Effect parameters: mortality	tremors, uncoordinated and uncontrolled movements, inability to take up a correct position of the body, and prolonged frenetic movement of the legs and rotation when being in the supine position. Direct observation of the behaviour of the honey bees in cages was transient at a lower concentration but the highest concentrations caused extensive vomiting by honey 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.	
LD_{50}=0.0036, 0.0022, 0.0045, 0.0043, 0.0024, 0.0016 µg/bee: Colony Lig 1-6 after 72 h LD_{50}=0.0034 µg/bee: Colony Mel 1 after 72 h LD_{50}=0.0089, 0.0055, 0.0054 µg/bee: Colony Car 1a, b and Car 2 after 72 h	Actara 25 WG (thiamethoxam 25%)	ACUTE ORAL Test species: *Colony Lig 1-6: Apis mellifera lingustica* *Colony Mel 1: Apis mellifera mellifera* strain D *Colony Car 1a, b and Car 2: Apis mellifera carnica* strain E Application method: 35 µL of 25% sucrose solution was provided for 1 hour in a feeder at doses of 0.02, 0.05, 0.1, 0.2, 0.5, 1, 2 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	**REVIEW:** Acute Oral Endpoints: LD_{50}=0.0036, 0.0022, 0.0045, 0.0043, 0.0024, 0.0016 µg/bee: Colony Lig 1-6 after 72 h, LD_{50}=0.0034 µg/bee: Colony Mel 1 after 72 h, LD_{50}=0.0089, 0.0055, 0.0054 µg/bee: Colony Car 1a, b and Car 2 after 72 h Approximately 42% of the data presented in this study are from 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. There are genetic differences in response to neonicotinoid toxic action. However, the most sensitive **(*A.m. lingustica – strain C*)** strain from the oral study were not used in the contact study for comparison of sensitivity. **MAJOR UNCERTAINTIES:** Testing procedures used throughout were uneven and therefore no definitive statement can be made about subspecies differential toxicity for a given chemical. For example, the same colonies were not tested across all chemicals tested. The authors stated that trials with more than 10% control mortality were discarded but no indication of how often this occurred. All tests were conducted in June and July except for the two of the tests on A. m. carnica which were performed in August and September.	Laurino, D., A. Manino, A. Patteta, M. Porporato. 2013. Toxicity of neonicotinoid insecticides on different honey bee genotypes. Bulletin of Insectology. 66 (1) 119-126
LC_{50}=0.00186 µg/mL/mg: Italian bee	Thiamethoxam (>98%)	ACUTE ORAL Test species: *Apis mellifera* 3 day old adults. 3 honey bee stocks	**REVIEW:** Acute Oral Endpoints: The reported LC50s for thiamethoxam were 1.86, 2.7, and 6.34 ng/ml/mg bee respectively for Italian, Russian and Carniolan bees.	Rinkevich FD, Margotta JW, Pittman JM,

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
stock LC_{50}=0.0027µg/mL/mg: Russian bee stock LC_{50}=0.00634 µg/mL/mg: Carniolan bee stock		(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 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	For thiamethoxam, the variation was smaller, Carniolan and Russian bees were 1.4- and 3.4-fold less sensitive than Italian bees, respectively. **MAJOR UNCERTAINTIES:** LD50s 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.	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
LD_{50}=0.0112 µg/bee	Thiamethoxam (99.7%)	ACUTE ORAL Test species: *Apis mellifera* Application method: *Acute oral toxicity:* single application of 200 µL/10 bees of spiked 50% sucrose was given in a feeder for 4 hours; 5 doses tested (treatment level not reported) 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}=0.0112 µg/bee *Acute oral toxicity:* Thiamethoxam was tested in combination with several ergosterol biosynthesis inhibitor (EBI) fungicides: none of which increased the toxicity significantly (LD_{50} = 0.0074 µg/bee + myclobutanil; LD_{50}=0.0083 µg/bee + propiconazole; LD_{50} = 0.0103 µg/bee + flusilazole; LD_{50}=0.0085 µg/bee + tebuconazole). Stumbling and/or knockdown was observed at 4 h in almost all thiamethoxam-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 honeybees (*Apis* mellifera) of exposure to neonicotinoids and sprayed fungicides in crops. Apidologie 45(5):545-553.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
No endpoints determined.	Thiamethoxam (not stated)	ACUTE ORAL Test species: *Apis mellifera* Application method: proboscis extension reflex (PER); bees fed 0.4 µ l 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 thiamethoxam over 6 conditioning trials *NOTE:* 10 nM solution of TMX equates to 2.91 pg/µ l. The entire dose received during conditioning for bees trained with 10 nM IMD would be 43.56 pg/bee or 0.00004 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,	**REVIEW:** Thiamethoxam did not significantly affect the proportion of bees that failed to exhibit learned responses. Providing honeybees with sucrose solution containing thiamethoxam as a reward did not enhance learning in either the massed or spaced learning tasks. *Massed conditioning:* Bees fed with 1 nM TMX during massed conditioning had a statistically slower rate of learning than the control. Therefore an acute dose of 6.9 X 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. *Spaced conditioning:* Thiamethoxam did not affect learning in the spaced conditioning task. *STM and LTM:* Bees fed thiamethoxam were less likely to respond to the test odour at 10 min than at 24 h. On average, the responses at each time point of the bees fed with thiamethoxam, were not different to the controls. However, comparisons within groups revealed that bees conditioned with thiamethoxam in rewards were more likely to respond during the LTM test than the STM test except for the spaced conditioning at the 0.1 nM dose level. **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.	Wright, Geraldine A.;Softley, Samantha; Earnshaw, Helen. 2015. Low doses of neonicotinoid pesticides in food rewards impair short-term olfactory memory in foraging-age honeybees. Scientific Reports | 5:15322 | DOI: 10.1038/srep15322 summary

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		and short term and long term learning response during memory test		
LD_{50} = 0.0047 µg ai/bee for 24 h LD_{50} = 0.0044 µg ai/bee for 48 h LD_{50} = 0.0043 µg ai/bee for 72 h	Actara 25 WG (thiamethoxam 25%)	ACUTE ORAL Test species: *Apis mellifera* Application method: 35 µL of 25% sucrose solution was provided for 1 hour in a feeder at doses of 0.01, 0.05, 0.1, 0.2, 0.5, 1, 2, 5, 10, 100 ppm Number of bees tested: 10 bees/treatment, experiment was repeated 4 times Caste of bees tested: adult bees, age unknown, unstarved Observation period: bee mortality was assessed at 1, 3, 6, 24, 48 and 72 h after treatment Effect parameters: mortality, behaviour and residues from dead bees	**REVIEW:** Acute Oral Endpoints: LD50 = 0.0047 µg ai/bee for 24 h, LD50 = 0.0044 µg ai/bee for 48 h, LD50 = 0.0043 µg ai/bee for 72 h From oral exposure, thiamethoxam caused 100% mortality within 6 hours at doses 0.01, 0.05, 0.1, 0.2 and 0.5 ppm.. Statistically significant mortality was seen in doses up to 0.1 ppm. At the concentration of 10 ppm the mortality grew more slowly than at the concentrations of 5 ppm, 2 ppm, and 1 ppm. Symptoms of poisoning were exhibited such as shaking and tremors, uncoordinated and uncontrolled movements, inability to take up a correct position of the body, and prolonged frenetic movement of the legs and rotation when being in the supine position. The highest concentrations of thiamethoxam caused extensive regurgitation in the honey bees. Dead honey bees were removed from the cages, frozen and sent for residue analysis. Results showed that higher amounts of thiamethoxam were detected in the honey bees that had been subjected to higher concentrations. The 2 ppm dose (ingested dose (ID) = 0.07 µg/bee, detected amount (DA) = 0.0014 µg/bee), the 5 ppm (ID = 0.175 µg/bee, DA = 0.0023 µg/bee), the 10 ppm (ID = 0.350 µg/bee, DA = 0.0062 µg/bee) and the 100 ppm (ID = 3.5 µg/bee, DA 0.019 µg/bee) were reported. **MAJOR UNCERTAINTIES:** The condition of the bees, and the source/origin (sister queen status) etc. are unknown. A lack of dose response was seen at the 10 ppm treatment. No details about the residue analysis were reported.	Laurino D, Porporato M, Patetta A and Manino A. 2011. Toxicity of neonicotinoid insecticides to honey bees: Laboratory tests. Bull Insect 64(1):107-113.
No endpoints determined.	Thiamethoxam (97%)	ACUTE ORAL Test species: *Apis mellifera* Application method: honey bees were fed 10 µL of 40% sucrose solution containing doses of 0.0001, 0.0005, or 0.001 µg/bee. Number of bees tested: unknown, experiments were repeated at least	**REVIEW:** *Locomotor activity* By contrast, after oral delivery of thiamethoxam, the locomotor activity of the bees was not significantly modified compared to that of control bees. Bees treated topically moved significantly less in the box and consequently they covered a shorter distance than orally treated animals. *Sucrose sensitivity*	El Hassani A.K., Dacher M., Gary V., Lambin M., Gauthier M. and Armengaud C. 2008. Effects of sublethal doses of acetamiprid and

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		three times Caste of bees tested: adult bees, age unknown Observation period: 1 hour after application observations were made Effect parameters: locomotor activity, sucrose sensitivity and olfactory learning via PER	Bees treated with thiamethoxam presented identical sucrose responsiveness before and after oral treatment, regardless of dose. *Olfactory learning* Overall, no significant effect was observed on retrieval performance after thiamethoxam was applied orally. **MAJOR UNCERTAINTIES:** Limited information on the laboratory conditions during the conduct of the study. Appears bees were caught from outside hives and from hives maintained in an apiary. Therefore bees were collected from different sources. It is unclear if bees were randomly assigned. The previous exposure of bees to chemicals from the "outside" hives is unknown. Control data was not graphically or numerically represented for the locomotor activity. The control group performed poorly in the olfactory and learning experiment conducted with thiamethoxam, and thus resulted in increased PER for thiamethoxam, which may not truly represent potential effects.	thiamethoxam on the behavior of the honeybee (*Apis* mellifera). Arch Environ Contam Toxicol 54(4):653-661
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. This study was conducted with nicotine and not a neonicotinoid (imidacloprid, clothianidin or thiamethoxam) although nicotine and neonicotinoids are considered to have similar modes of action in insects. 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
LC_{50} = 0.00428 µg a.i./µL	Thiamethoxam (92.5%)	ACUTE ORAL Test species: *Apis mellifera* (Africanized honey bee)	**REVIEW:** Acute Oral endpoint: The LC_{50} of thiamethoxam for newly emerged Africanized honey bee was 4.28 ng a.i./µL diet (0.00428 µg a.i./µL diet).	Oliveira R.A., Roat T.C., Carvalho S.M.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		Application method: each bee was provided with 10 µL of sucrose solution for 24 h containing a concentration of 0.001, 0.002, 0.004, 0.005, 0.006, 0.008 µg a.i./µL, a solvent control containing acetone, or a straight diet control Number of bees tested: 25 bees/cage; repeated 3 times Caste of bees tested: adult, newly emerged Observation period: observations were made after 24 h Effect parameters: mortality	**MAJOR UNCERTAINTIES:** There may be subtle differences in how Africanized honey bees and regular honey bees develop; this data may not be representative or comparable with the common *A. mellifera* beekeeping strains.	and Malaspina O. 2013. Side-effects of thiamethoxam on the brain and midgut of the Africanized honeybee *Apis* mellifera (Hymenoptera: Apidae). Environ Toxicol 13(4).
No endpoints determined.	Thiamethoxam (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 thiamethoxam at doses of 1, 10, 100 nM and 1 µM 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 thiamethoxam for a total of 24 h *Honey bee antennal and mouthpart assays:* Assay 1 – individual honeybees were lightly tapped on the antenna with a solution containing 0.105, 1.05, 10.3, 33.6 ng/bee corresponding to 1, 10, 100 nM and 1 µM of thiamethoxam to elicit proboscis	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 thiamethoxam at 10nM, 100 nM and 1 µM doses when presented with both sucrose control and treated choice feeding tube. The total food consumption of forager honey bees was reduced only when bees fed from solutions containing 100nM (1.07 ng/bee) or 1µM (10.3 ng/bee). Bumble bee Bumble bees showed a significant preference for solutions containing thiamethoxam over sucrose alone at the 1 nM (0.105 ng/bee consumed) and 10 nM (1.05 ng/bee) dose when compared to the sucrose control choice. *Honey bee antennal and mouthpart assays:* None of the sucrose solutions containing thiamethoxam affected proboscis extension or retraction. *Electrophysiology experiment:* Stimulation with thiamethoxam did not elicit spikes from any of the neurons in the galeal sensilla of either bumble bees or honeybees 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,	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

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		extension reflex (PER) *Electrophysiology experiment:* Electrophysiological recordings were made from taste neurons located in the first 11 sensilla on the honeybee's proboscis and in the first 6 sensilla in bumblebees. : 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. <u>Number of bees tested:</u> *Behavioural two-choice assays:* Bumble bees - (38, 39, 36 and 40) corresponds to 1, 10, 100nM 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 <u>Caste of bees tested:</u> *Behavioural two-choice assays:* *Bumble bee:* newly emerged bees *Honey bee:* foragers *Honey bee antennal and mouthpart assays:* foragers *Electrophysiology experiment:* not stated <u>Observation period:</u> *Behavioural two-choice assays*: 24 h *Honey bee antennal and mouthpart assays:* not stated	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
		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		
No endpoints determined.	Thiamethoxam (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 2.92 (10 nM; 0.481 ng/bee/day) and 29.2 ppb (100 nM; 3.62 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 (+ 1 min to acclimatize) 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	**REVIEW:** *Acute toxicity:* Bees fed the 100 nM dose were on average more likely to die overnight than those fed the 10 nM dose. Bees fed thiamethoxam had significantly greater mortality (approximately 80%) in the 29.2 ppb treatment compared to the 2.92 ppb treatment (approximately 15%) and when compared to the control. *Sucrose solution consumption:* Within the thiamethoxam treatment, there was a numerically lower amount of solution consumed between the 29.2 (mean volume = 0.124 mL/bee/24 hours) and 2.92 ppb (mean volume = 0.164 mL/bee/day) treatments. *Behaviour:* The 2.92 ppb thiamethoxam 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. The mean number of bouts of behaviour and the mean duration of each bout was also significantly greater for bees exposed to 2.92 ppb clothianidin when compared to the control. Bees exposed to thiamethoxam at 2.92 ppb resulted in more time spent, more bouts of and a longer mean duration of grooming 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. **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	Williamson, S. M.; Willis, S. J., and Wright, G. A. Exposure to Neonicotinoids Influences the Motor Function of Adult Worker HoneybeesEcotoxicology. 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
			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.	Thiamethoxam (and imidacloprid)	Test species: *Apis mellifera* 3 day old adults. 3 honey bee stocks (Russian, Italian, and carniolan) Test chemical: imidacloprid and thiamethoxam TGAI Application rate: Various, 4 concentrations and control Test conditions: dark, 33 ± 0.1°C, 70 ± 5% relative humidity. Treatments: 1 ml of 50% sucrose solution containing pesticides was provided to each group of 20 test bees for 24 hours. Replicates: 20 bees per treatment group. Repeated tests in 2-4 separate treatment days using 3-5 colonies from each stock. Exposure period: short 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	**REVIEW:** For thiamethoxam, the variation was smaller than imidacloprid, Carniolan and Russian bees were 1.4- and 3.4-fold less sensitive than Italian bees, respectively. The reported LC50s for thiamethoxam were 1.86, 2.7, and 6.34 ng/ml/mg bee respectively for Italian, Russian and Carniolan bees. **MAJOR UNCERTAINTIES:** LD50s could not be calculated due to the lack of measurement of food consumption during the study. In addition, raw data was not provided, including control mortality. It is noted that Abbots 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
***APIS* - Tier I Chronic Adult Oral Trials**				
Bee nurse physiology (hypopharyng	Thiamethoxam 98% (dissolved in acetone)	CHRONIC ADULT ORAL Test species: *Apis mellifera ligustica* (aged 0 to 24 hours old).	**REVIEW:** Young honeybees were exposed to either 0 (control), 10 or 40 µg/L thiamethoxam in sucrose solution along with either a high or low quality (uncontaminated) pollen diet, under laboratory	Renzi M.T., Rodriguez-Gasol N., Medrzycki P.,

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
eal glands development and protein content) in the head		Bees were reared in the laboratory and randomly assigned to test groups. Application method: oral dose administered in sucrose solution. Two uncontaminated pollen diets were supplied. One with higher levels of crude protein content and pollen diversity (high-quality), and the other with lower protein content and pollen diversity (low- quality). Dose: 0 (control), 10 and 40 µg/L. Exposure and observation period: 12 days Number of bees tested: 20 bees per cage in 5 cages per treatment for survival . 10 bees per treatment for HPG measurement. 16 bees per treatment for head protein measurment Effect parameters: Syrup consumption (every 2-3 days)(amount of pesticide consumed per bee was calculated after 8 and 12 days of exposure. On day 8 and 12, bees were dissected for acini measurements from the hypopharyngeal glands which were extracted from honeybee heads. Bee heads were also measured for protein content. Pollen diet quality: The **"Low diet"** consisted mainly of pollen belonging to *Graminaceae* (84.14 %) followed by *Medicago* (12.87 %), *Zea* (2 %), *Helianthus* (1 %), *Compositae Taraxacum* -type (0.01 %) and	conditions for 12 days. Following 8 and 12 days nurse bee hypopharyngeal gland development, protein content in the bee heads, and mortality was assessed. Overall, the hypopharyngeal gland size was larger at 8 days following exposure to a high quality pollen diet. By 12 days, bees had smaller glands, possibly owing to a lack of brood (and nursing duties), and this pattern was observed regardless of pollen type. In contrast, doses of thiamethoxam caused a reduction in hypopharyngeal gland size at both 8 and 12 days, with a bigger reduction in bees exposed to 40 µg/L. In addition, the high dose group appeared to have malformed acini shape. Protein content in bee heads was not affected by pollen quality. However, exposure to thiamethoxam resulted in a decrease in head proteins. Although these sublethal endpoints were affected, there was no impact on survival from either pollen type or exposure to thiamethoxam. **MAJOR UNCERTAINTIES**: Bias control in the visual assessment of acini size is not ensured (e.g. choice of acini, ability to extract and measure them). There was no raw data to confirm results. Large variations in some parameters between observation dates. It is unknown if evaporation was accounted for during the test. It is noted that for some endpoints, low quality pollen and 40 µg/L exhibited levels similar to the controls. This would not be expected.	Porrini C., Martini A., Burgio G., Maini S., and F Sgolastra. 2016. Combined effect of pollen quality and thiamethoxam on hypohparyngeal gland development and protein content in *Apis mellifera*. Apidologie. INRA, DIB and Springer-Verlag France, 2016. DOI: 10.1007/s13592-016-0435-9.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		Lagerstroemia spp. (0.01 %). This diet had 16.5% crude protein. The **"High diet"** showed a larger variety of pollen types, from the following botanic origins: *Rubus* (60.28 %), *Cruciferae* (31.15 %), *Helianthus* f. (3.01 %), *Papaver* (2.01 %), *Melilotus* (1.51 %), *Galega* (1 %), *Compositae Taraxacum-type* (0.5 %), *Convolvulus* (0.5 %), *Dipsacaceae* (0.01 %), *Eucalyptus camaldulensis* (0.01 %), *Liriodendron* (0.01 %), *Lotus* (0.01 %), *Parthenocissus* (0.01 %) and *Rosaceae* (0.01 %). This diet had 25.2% crude protein. Laboratory conditions: disposable cardboard cages (9.5 × 6.5 × 5 cm) maintained at 30 ± 1 °C, 50–70 % relative humidity, darkness) and all food was provided ad libitum.		
No endpoints determined.	Thiamethoxam (% not reported)	CHRONIC ADULT ORAL Test species: *Apis cerana indica* Application method: 1 mL of honey and test substance solution was provided to bees at a concentration of 0.5 mg/L (reviewer estimated: 0.5 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 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 acute oral *Apis* table and below is the results from day 5 for the *APIS* – Tier I Chronic Adult Oral *Apis* table: 24.6% mortality by 5 days after exposure. **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 x 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 honeybee, *Apis* cerana indica F. Pestology, 32(8):42-43.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
No endpoints determined.	Thiamethoxam (97%)	CHRONIC ADULT ORAL Test species: *Apis mellifera* Application method: a dose of 0.001 µg was provided in 50% sucrose solution and adjusted daily depending on the number of bees remaining to always be 33 µL/bee/day Number of bees tested: 24-65 bees/treatment cage Caste of bees tested: adult, newly emerged Observation period: observations were made daily for a total of 11 days Effect parameters: mortality, locomotion, water consumption, sucrose sensitivity with PER, olfactory learning experiments with PER	**REVIEW:** *Mortality:* At the end of the 11 day exposure period, mortality was 10% in the 0.001 µg/bee treated group and 4% in the control and 20% in the 0.0001 µg/bee treated group and 15% in the control. No significant mortality effects were seen between the treatments and their respective control groups. *Locomotion:* There was no significant effect on the three parameters of locomotor activity compared to controls, regardless of dose. *Water consumption:* Thiamethoxam induced no effect on water consumption and responsiveness. *Sucrose sensitivity:* Oral exposure to 0.001 µg/bee induced a decrease of honeybees' sucrose responsiveness to 3% and 10% sucrose concentrations. However exposure to 0.0001 µg/bee had no effect on sucrose responsiveness *Olfactory learning:* Oral treatment of thiamethoxam at both doses induced a slight numerical and non-significant decrease of performance during learning and in retrieval tests. **MAJOR UNCERTAINTIES:** The solvent acetonitrile was used to dissolve the active ingredient. For some experiments the amount of bees tested was lower than 25 which is the recommended number in the lab based toxicity test guidelines. The authors assumed that the amount of diet consumed per day and per bee was always the same amount at 33 µL/bee/day.	Aliouane., Y., A. K. el Hassani, V. Gary, C. Armengaud, M. Lambin, and M. Gauther. 2009. Subchronic exposure of honeybees to sublethal doses of pesticides: effects on behavior. Environmental Toxicology and Chemistry, 28 (1): 113-122
LC_{50} = 0.00428 µg a.i./µL LT_{50} = 8.04 days at a concentration of 0.0000428 µg/µL/bee/day LT_{50} = 5.22	Thiamethoxam (92.5%)	CHRONIC ADULT ORAL Test species: *Apis mellifera* (Africanized honey bee) Application method: 10 µL of sucrose solution per day containing either 0.000428 or 0.0000428 µg/µL/bee/day, an acetone solvent control, or an untreated control was provided Number of bees tested: 25 bees/cage; repeated 3 times	**REVIEW:** Chronic Adult Oral Endpoint: LC_{50} = 0.00428 µg a.i./µL Honey bees exposed to thiamethoxam presented morphological and histochemical alterations of the mushroom bodies and optical lobes of their brains; however, alterations of the antennal lobe were not observed. *Mushroom bodies* Day 1 – alteration of the Kenyon cells in the mushroom bodies was observed in the 0.000428 µg/µL/bee/day treatment 24 hours after exposure	Oliveira R.A., Roat T.C., Carvalho S.M. and Malaspina O. 2013. Side-effects of thiamethoxam on the brain and midgut of the Africanized honeybee *Apis* mellifera

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
days at a concentration of 0.000428 µg/µL/bee/day		Caste of bees tested: adult, newly emerged Observation period: observations were made after bees were destructively sampled 1, 3, 5 and 8 days after the start of the experiment Effect parameters: cytotoxic effects in midgut and brain (electron microscopy images from 1, 3, 5 and 8 days after experiment start), honey bee survival	Day 3 - alteration of the Kenyon cells in the mushroom bodies was observed in the 0.0000428 µg/µL/bee/day treatment 72 hours after exposure Day 5 – Kenyon cells appeared to be recovering *Optical lobe* Day 1 – alteration of the lobes appeared in the 0.0000428 µg/µL treatment 24 hours after exposure Day 3-8 – over time the effects on cells appeared to intensify *Midgut* Day 1 - increased apocrine secretion, and increased cell elimination in 0.0000428 µg/µL treatment 24 hours after exposure which increased over time Day 3 - increased apocrine secretion, and increased cell elimination in 0.000428 µg/µL treatment 72 hours after exposure which increased over time *Regenerative cells* Day 1 – cytoplasmic vacuolization was seen in the 0.000428 µg/µL treatment until day 5 Day 3 - cytoplasmic vacuolization was seen in the 0.0000428 µg/µL treatment **MAJOR UNCERTAINTIES:** There may be subtle differences in how Africanized honey bees and regular honey bees develop; this data may not be representative or comparable with the common *A. mellifera* beekeeping strains. The cytotoxic portion of the study was not validated. It is unclear how these morphological results can be used in the risk assessment.	(Hymenoptera: Apidae). Environ Toxicol 13(4).
***APIS* - Tier I Acute Larvae Trials**				
$_{50}$ = 0.4302 µg a.i./bee for 48 hours	Thiamethoxam (99.6%)	ACUTE LARVAE Test species: *Apis mellifera* (Africanized honey bee) Application method: *Acute toxicity and larval development:* thiamethoxam was added to 30 µL of diet C (36% sugar (D-glucose and D-fructose) and 4% yeast	**REVIEW:** Acute Larvae Endpoint: *Acute toxicity and larval development:* 48 hour LC_{50} = 0.01434 µg a.i./µL x 30 µL of diet (0.4302 µg a.i./bee) with a 95% confidence interval of 0.00275– 0.02594 µg a.i./µL of diet. During the bioassay, the mortality rate for the control group did not exceed 10% (which is required for test validation). The concentration of 0.005 µg/µL (0.15 µg/bee) statistically accelerated larval growth (numerically accelerated larval growth	Tavares D.A.,T.C. Roat, S.M. Carvalho, E.C.M. Silva-Zacarin and O. Malaspina. 2015. In vitro effects of thiamethoxam on larvae of

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		extract) and fed on the 4th day in 7 concentrations ranging from 0.0001 – 0.2 µg a.i./µL *Acute exposure to sublethal concentration:* 0.0014 µg a.i./µL of thiamethoxam was added to 30 µL of diet C (36% sugar (D-glucose and D-fructose) and 4% yeast extract) and fed on the 4th day *Subchronic exposure to sublethal concentration:* 0.00047 µg a.i./µL per day was fed to larvae on the 4th, 5th and 6th day in 30, 40 and 50 µL of contaminated food NOTE: 0.00047 x 3 = 0.0014 µg/µL is the same concentration as the acute sublethal 1 day exposure experiment Number of bees tested: 12 larvae/concentration, repeated three times Caste of bees tested: first instar larvae Observation period: 48 hours Effect parameters: mortality, larval development, morphology changes in brain tissue	was seen in the 0.00005 and 0.0005 µg/µL treatments and numerically decelerated larval growth was seen in the 0.01, 0.02, 0.05 and 0.1 µg/µL treatments). *Morphology changes in brain tissue (from the acute and subchronic sublethal exposure):* Through morphological analysis of the brain the authors found that the optic lobes were most prominently affected by the insecticide in all samples (acute and subchronic sublethal exposure), and showed cell properties which were typical of cells in the process of death. **MAJOR UNCERTAINTIES:** The source of the royal jelly for the larval diet was not discussed and may have been a source of contamination. Our review has assumed that the larvae were in excellent health; no information on the health or the genetic source (i.e. if they were from one or multiple hives) of the larvae was provided. The amount of diet consumed was not quantified and the authors noted that not all of it was consumed. There may be subtle differences in how Africanized honey bees and regular honey bees develop; this data may not be representative or comparable with the common *A. mellifera* beekeeping strains.	Africanized honey bee *Apis* mellifera (Hymenoptera: Apidae).. Chemosphere 135 (2015) 370–378
NON-*APIS* - Tier I Acute Contact Trials				
No endpoints determined	Thiamethoxam (various levels of a.i.)	Study Methodology presented previously under : *APIS* – Tier I Acute Contact Trials	See non-*Apis* and *Apis* information from this study in the section: *APIS* - Tier I Acute Contact Trials	Arena, M. and F. Sgolastra. 2014. A meta-analysis comparing the sensitivity of bees to pesticides. Ecotoxicology 23:324–334 DOI 10.1007/s10646-

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
				014-1190-1 summary
LD_{50}: 0.004 µg/bee	Thiamethoxam (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}: 0.004 µg/bee **MAJOR UNCERTAINTIES:** This study has a very limited number of replicates (only 2). The age of foragers was unknown. However, the chi-square tests indicated that the models did not fit the data for thiamethoxam in which there were significant differences between the model and the calculated slopes. The authors suggested that the results for thiamethoxam should be interpreted with caution.	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.
No endpoints determined.	Actara WG 25 (thiamethoxam 25%)	CONTACT TRANSFER Test species: *Bombus terrestris* Application method: *Contact transfer on glass plates:* *Experiment 1:* glass plates were sprayed with 50 ppm (authors stated it was equivalent to 10 g a.i./ha) , and then bees were confined to a Plexiglas cylinder placed on top of the sprayed slide *Experiment 2:* glass plates were sprayed with 50 ppm (authors stated it was equivalent to 10 g a.i./ha) and left to dry for 4 days, then bees were confined to a Plexiglas cylinder placed on top of the sprayed slide *Contact transfer on tomato plants:* plants sprayed with equivalent of 40	**REVIEW:** *Contact transfer on glass plates:* *Experiment 1:* 100% of the bumble bees died 7 days after exposure, 0% of the bumble bees died in the control and significant mortality differences were seen between the treated and control groups. *Experiment 2:* After 10 days, 100% of the bumble bees died exposed to the 4-day old residues, 3% of the bumble bees died in the control and significant mortality differences were seen between the treated and control groups. *Contact transfer on tomato plant:* *Experiment 1:* 95% of the bumble bees died exposed to the tomato plants right after spray residue dried (by 14 days after exposure), 20% of the bumble bees died in the control and significant mortality differences were seen between the treated and control groups. *Experiment 2:* 68% of the bumble bees died exposed to the tomato plants 2 days after application (by 14 days after exposure), 20% of the bumble bees died in the control and significant mortality differences were seen between the treated and control groups.	Sechser B, Reber B, Freuler J. 2002. The safe use of thiamethoxam by drench or drip irrigation in glasshouse crops where bumble bees Bombus terrestris (L.) are released. Mitteilungen Der Schweizerischen Entomologischen Gesellschaft 75(3/4):273-287.

Endpoint	Test Substance	Study Methodology	Review Comments		Reference
		g a.i./ha were placed in a cage with bees *Experiment 1:* bees were placed in cages as soon as residue dried *Experiment 2:* bees were placed in cages 2 days after applicationNumber of bees tested: 5 bees/treatment, experiment was repeated 4 times Caste of bees tested: adult, age unknown Observation period: *Contact transfer on glass plates:* *Experiment 1:* observations were made 7 days after exposure *Experiment 2:* observations were made 10 days after exposure *Contact transfer on tomato plant:* *Experiment 1:*observations were made 14 days after application *Experiment 2:*observations were made 14 days after application (which was 12 days of bee exposure) Effect parameters: mortality	**MAJOR UNCERTAINTIES:** There was no mention as to when the studies were conducted other than between 1994-1998. The actual amount of product that the bees were exposed to on the tomato plants is unknown – only a related field rate was available. The growing conditions, size, health of the tomato plants was not stated. Greenhouse applications of Actara 25 WG are not registered for use in Canada.		
NON-*APIS* - Tier I Acute Oral Trials					
No endpoints determined.	Thiamethoxam (not reported)	Study Methodology presented previously under : *APIS* – Tier I Acute Oral Trials	Information from this study is also in the section: *APIS* - Tier I Acute Oral Trials		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

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
No endpoints determined.	Thiamethoxam (>99%)	ACUTE ORAL Test species: *Bombus terrestris* Application method: bees fed 1.5 mL/bee/day in 30% sucrose solution for 4 days with the feeding amount replenished daily; 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 after 4 days of exposure Effect parameters: mortality and feeding rate	**REVIEW:** 10, 10, 10, and 100% mortality after 4 days exposure to control, 1, 10 and 100 µg/L. In the 100 µg/L treatment mortality was 55% by day 2 and reached 100% by day 3; these data were excluded from the statistical analysis. There was no significant effect of day or dose on consumption in the 0, 1 and 10 µg thiamethoxam/L treatments . The authors state that there was also no significant effect of thiamethoxam on consumption on day 1, but our review indicated, a numerical effect was seen between the control and low doses (1 and 10 µg/L) with the high dose (100 µg/L) by day 2 through to day 4. **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 bumblebees (Bombus terrestris): Effects on nectar consumption in individual workers. Pest Manage Sci, 71(7):946-950.
No endpoints determined.	Thiamethoxam (not stated)	ACUTE ORAL Test species: *Bombus terrestris* Application method: bees were fed with 10 µLof 40% sucrose solution at doses of control, 2.4, 10, 250 ppb Number of bees tested: an average of 35.5 bees tested per treatment (34 in control, 37 in 250 ppb, 36 in 10 ppb and 35 in 2.4 ppb treatment groups). Caste of bees tested: adult bees, foragers Observation period: 1 hour Effect parameters: learning (PER), body size, and memory	**REVIEW:** *Trainability and Learning Level* More bees were trainable to the conditioned odour in the control and 2.4 ppb groups compared to the 250 ppb treatment group. Control bees also displayed a higher learning level than those from both the 10 ppb and 250 ppb treatment groups. While there was no significant difference between control and 2.4 ppb groups, post-hoc comparisons revealed that 2.4 ppb treated bees showed a higher learning level than both the 250 ppb and 10 ppb groups. *PER* The PER learning ability of trainable bees was not affected by treatment. Control bees neither learned the task quicker, nor displayed the conditioned response more frequently than the other treatment groups, with the average bee responding to the odour for the first time at trial 8. *Worker Body Size* There was no difference in worker body size across treatment groups. *Memory Task* The performance of bees in the memory task was not significantly different after three hours compared to the end of the training period for any treatment group indicating there was no overall impact of	Stanley D.A., Smith K.E., Raine N.E.. 2015. Bumblebee learning and memory is impaired by chronic exposure to a neonicotinoid pesticide. Scientific Reports 5, Article number: 16508 (2015)

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
			acute pesticide exposure on memory performance. Overall, thiamethoxam (2.4 – 10 ppb) had minimal effects on bumble bee learning and memory following acute exposure. **MAJOR UNCERTAINTIES:** It is unclear how these learning results can be related to field level bumble bee exposure, or how the 2.4 ppb application rate can be correlated with the Canadian use patterns.	
NON-*APIS* - Tier I Chronic Oral Trials				
Not reported. See reviewer comments for results.	Thiamethoxam	Test species: *Bombus terrestris audax* Application method: oral dose administered in pollen and nectar. Protein content of pollen was similar between the mono- and poly-floral varieties. The polyfloral pollen was made up of (Asteraceae Taraxacum type, 23.4%; Rosaceae Rubus type, 20.3%; Rosaceae Crataegus/Malus type, 18.6%; Papaveraceae Papaver type, 14.9%). The remaining 22.8% was made up of 7 more pollen types, each representing less than 5% of the total volume. Cistus pollen was added to the polyfloral blend so that it was at a similar proportion to the 5 main pollen groups. The monofloral pollen consisted of cistus pollen only. Number of bees tested: 10 queenless microcolonies with 5 workers per treatment group. Dose: 3.5 ppb in pollen and nectar Exposure period: 17 days (+ an additional 18 days of observation without contaminated food) Number of bees tested: Four	**REVIEW:** Neither a monotonous diet nor exposure to thiamethoxam at 3.5 ppb were sufficient to cause significant worker mortality during the study period. However, sub-lethal effects were noted from exposure to a monofloral pollen diet, and/or pesticides. Micro-colonies receiving monofloral pollen gained less weight, exhibited lower reproductive effort, produced fewer males which were smaller with a lower lipid content, and had fewer larvae and pupae. Pesticide exposure had fewer effects than diet. Micro-colonies fed contaminated pollen and sucrose gained less weight, but their total reproductive output was similar to uncontaminated micro-colonies. Size of males (as measured by the thorax) was smaller in pesticide exposed colonies. **MAJOR UNCERTAINTIES:** Pollen was sterilized as to avoid nosema spore contamination. However, different sterilization methods were used for the polyfloral pollen versus the monofloral pollen. It is unknown if this affected the quality of the pollen/study. Details were lacking on the housing of bees during the experiment. It is unclear what the proportion of nectar vs pollen was in the diet, and if it was meant to mimic pollen patties. There are no details on the sugar syrup contamination. The protein content of the pollen may have resulted in smaller bees, and may have confounded the interpretation of pollen type on bee size.Study was conducted using queen-less small colonies in the lab, it is uncertain how these results would be reflected in the field.	Dance, C., Botias, C., Goulson, D. 2017. The combined effects of a monotonous diet and exposure to thiamethoxam on the performance of bumblebee micro-colonies. Ecotoxicol Environ Saf. 139:194-201.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		colonies each with 100 workers were purchased. Forty queenless micro-colonies were established by placing 5 workers from one of the four queenright colonies into plastic boxes. Observation period: 5 weeks Effect parameters: Worker mortality, micro-colony growth, reproductive effort and food collection. Observations included daily worker mortality, number of newly emerged males, thorax measurements of males, lipid content. As well, the number of larvae, pupae, workers, nectar pots was counted and weighed. Every three days, syrup and pollen feeders were weighed to measure collection and fresh pollen and syrup were provided **Note:** Every three days, syrup and pollen feeders were weighed to measure collection and fresh pollen and syrup were provided. Data on food collection were also used to calculate the average amount of active compound collected by each bee. We consider this pollen and syrup collection rather than consumption as some syrup was stored in nectar pots and pollen was used to provision brood. Five identical plastic boxes to those used for the bee micro-colonies were kept with full syrup feeders and weighed every 3 days in order to control for any effects of		

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		evaporation in syrup collection analyses. Laboratory conditions: Micro-colonies were kept in a dark room with controlled conditions throughout the entire study period (50 ± 5% humidity and 24 ±1°C.		
Not reported as NOEC or LOEC values. 1 ppb (1.87 ppb measured) did not result in any effects to any species. 4 ppb (5.32 ppb measured) resulted in decreased food consumption in *B pascurorum* only, and smaller occytes. 4 ppb (5.32 ppb measured) did not cause increased mortality, change waxing	Thiamethoxam (dissolved in acetone)	CHRONIC ADULT (QUEEN) ORAL Test species: Bumble bee queens (4 species, *B. terrestris, B. lucorum, B. pratorum* and *B. pascurorum*). Bees with parasite infection were excluded. Queens were established in boxes, during which time they were fed sugar syrup and pollen pellets. Application method: oral dose administered in sucrose solution. Dose: 0 (control), 1 and 4 ppb (measured amount: 1.87 ppb and 5.32 ppb). Average amount of thiamethoxam (µg) was 0 for the control, and approximately 0.0025 for the low dose and 0.006 for the high dose. Exposure period: 14 days Number of bees tested: 38 to 50 depending on species and endpoint. Observation period: 14 days exposure plus an additional 14 days observation (4 week total). Effect parameters: Mortality (daily), signs of waxing behaviour (wax is produced by queens as part of natural nesting behaviour), and egg laying. After 4 weeks all queens were dissected and analysed for mites, nematodes, development of	**REVIEW:** Syrup consumption: Consumption was significantly reduced in *B pascurorum* and *B. pratorum* exposed to the high dose of thiamethoxam (4 ppb). There were species level differences in feeding, with *B pratorum* consuming more syrup than other species ($p<0.05$). Ovary development: Exposure to the high dose (4 ppb) caused a reduction in the length of terminal oocytes of queens by 8.1% (*B. lucorum*), 13.8% (*B. pascuorum*), 5.9% (*B. pratorum*) and 4.6% (*B. terrestris*), when compared with controls. Ovary development was found to be influenced by pesticide treatment even the effect on feeding reduction was considered as a covariate. Survival: There were no treatment related effects for survival or size. Eighty-eight percent of queens survived during the study. Waxing behavior: Over half of the queens (53%) exhibited waxing behavior during the experiment. There were species-level differences in the presence or absence of waxing, but no treatment effects were detected. Egg laying: There were differences in egg laying among species. More *B. terrestris* queens initiated a colony within four weeks than other species, and *B. pratorum* had the lowest colony initiation rate. However, there was no treatment related effects. **MAJOR UNCERTAINTIES:** Queens used in the study were	Baron G., Raine N., and MJF Brown. 2017. General and species-specific impacts of a neonicotinoid insecticide on the ovary development and feeding of wild bumblebee queens. Proceedings of the Royal Society B.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
behaviour or reduce egg laying.		oocytes and length of terminal oocyte (as a sign of ovarian development), and thorax width. Laboratory conditions: Not reported.	potentially exposed to a number of pesticides prior to the study. The number of bees tested for various endpoints was variable between species and endpoint. Laboratory conditions and housing were not included in the report (only queen rearing conditions). The study considered sucrose exposure only. The species used in the study are not North American species, and may have differing sensitivities.	
No endpoints determined.	Actara WG 25 (thiamethoxam 25%)	CHRONIC ADULT ORAL Test species: *Bombus terrestris* Application method: 2 mL of 70% sugar solution that had 50 ppm (or the equivalent of 10 g a.i./ha) was applied to a glassplate placed at the bottom of a cylinder for feeding; the food was not renewed over the 7 day exposure period Number of bees tested: 5 bees/treatment, experiment was repeated 4 times Caste of bees tested: adult, age unknown Observation period: observations were made 7 days after exposure Effect parameters: mortality	**REVIEW:** 100% of the bumble bees died 7 days after oral exposure, 0% of the bumble bees died in the control and significant mortality differences were seen between the treated and control groups. **MAJOR UNCERTAINTIES:** There was no mention as to when the studies were conducted other than between 1994-1998. Greenhouse applications of Actara 25 WG are not registered for use in Canada. Food was not renewed during the testing period and this might have caused weakness and starvation in the bumble bee population which led to death.	Sechser B, Reber B, Freuler J. 2002. The safe use of thiamethoxam by drench or drip irrigation in glasshouse crops where bumble bees Bombus terrestris (L.) are released. Mitteilungen Der Schweizerischen Entomologischen Gesellschaft 75(3/4):273-287.
No endpoints determined.	Thiamethoxam (not stated)	CHRONIC LARVAE Test species: *Scaptotrigona aff. depilis* (stingless bee) Application method: one time application of thiamethoxam was added to 35 µL of larval diet in each <24 hours old larval rearing cell; doses tested were negative control with no solvent (NC), control with solvent (CS), T1:0.000004, T2:0.000044, T3:0.0044 µg a.i./larvae Number of bees tested: 50 larvae/treatment; repeated 4 times Caste of bees tested: larvae, approximately 24 h old	**REVIEW:** *Survival* *0.0044 µg/larva:* significant decrease in survival from larvae to last pupal stage (43.7 %), comparing to the other treatment groups: NC (80.3 %), CS (74.6 %) and the lowest dose 0.000004 (68.5 %). *0.000044 µg/larva:* survival from larvae to last pupal stage was 45.0 %, and similar to the highest dose of 0.0044 µg/larva (43.7%) *Controls:* No differences were found between the groups NC (with 20% mortality) and CS (with 25% mortality). *Decrease in survival of thiamethoxam exposed to the NC was 12, 35, and 37% for the 0.000004, 0.000044 and 0.0044 µg a.i./larvae treatments, respectively.* *Developmental time* There was a significant difference in the larval (shorter) and pupal (longer) stage development, in the 0.000044 and 0.0044 µg/larvae treatments. The duration of the pre-pupal stage was not significantly	de Souza Rosa, A., J. S. G. Teixeira, A. Vollet-Neto., E. P. Queiroz, B. Blochtein, C. S. S. Pires and V. L. Imperatriz-Fonseca. 2016. Consumption of the neonicotinoid thiamethoxam during the larval stage affects the survival and development of

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		Observation period: observations were made daily until adult emergence Effect parameters: mortality, developmental time, morphometric analysis on emerging adult workers	different between groups. *Morphometric Analysis* The adult workers that emerged were collected for morphometric analysis. Specimens fed with the higher doses of thiamethoxam (0.000044 and 0.0044 µg/larvae) exhibited significantly lower values for both the head width and the intertegular span compared to other treatments and controls. Exposure to thiamethoxam at all treatment levels resulted in some developmental wing asymmetry. **MAJOR UNCERTAINTIES:** Control mortality was 20 and 25% in the NC and CS treatments. The number of resulting adults that survived and emerged in the controls appears low for both the negative control with no solvent (73/200; 37% survival) and the control with solvent (83/200; 42%). Food consumption was not quantified. It was unclear if the larvae consumed their entire dose of food and how long this may have taken them, or if additional feeding was required. The source, health, or other information about the line of bees used was not discussed.	the stingless bee, Scaptotrigona aff. depilis. Apidologie. DOI: 10.1007/s13592-015-0424-4

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

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
2 – tunnel Foliar application before hives were placed in tents. Bumble bees	Test crop: Tomatoes Test species: Small bumble bee hives Test chemical: Actara 25 WG (25% thiamethoxam) Application rate: 100 g ai/ha x 1 Number of hives tested: 3 tunnels in the same field for control and treatment and 1 tunnel for reference (imidacloprid, applied at 100 g ai/ha). Plot size: 3 x 3 x 3 metres Exposure and observation period: 28 days Effect parameters: Behaviour, mortality (number of dead bees found in the tent), and vitality (measured by dead or alive queen, dead and alive young queens, dead and alive	Following one foliar application of 100 g ai/ha to tomato plants prior to hives being placed in the tunnels, there was high mortality (within 4 days) and strongly reduced pollination activity in bumble bees; compared to control tunnels. Affected bumble bees showed irritation, uncontrollable motions, were paralyzed and in a dorsal position before dying. Many affected bumble bees were hanging on the tomato leaves and died afterwards. In the imidacloprid treated bees, pollination activity was affected similarly to thiamethoxam, and mortality (in the hive and in the tent) was similar but slightly lower compared to thiamethoxam treated bees. Total study length and observation period was 28 days. Some uncertainties included that the longer study length could have led to stress from confinement. Residues in pollen were not measured to confirm exposure levels.	2364900 (similar to study 2364898 with different application method)

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	workers, dead and alive males, eggs, dead and alive larvae (L1 to L4), white and black pupae and unhatched adults, empty cells and nectar cells), pollination activity (when bees land on tomato flowers to collect pollen, they injure the stamen which turns brown from oxidation). Residue samples: No Location: Switzerland Year: 1998 *Fruiting vegetables (including tomatoes) are registered for outdoor foliar spray and soil application (drench and irrigation).Maximum foliar rate for tomatoes of 2 x 26.25 g ai/ha (52.5 g ai/ha). Tomatoes are not registered for greenhouse use in Canada (although peppers are).*		
2 – tunnel Pre-bloom foliar application Honey bees	Test crop: Melon Test species: Small honey bee hives Test chemical: Actara 25 WG (25% thiamethoxam) Application rate: 100 g ai/ha x 1 applied pre-bloom either 5 days or 10 days before bees were introduced into tunnels. Number of hives tested: 3 tunnels (repeated measures) for control and treatment and 1 replicate for reference (dimethoate). Plot size: 150 m^2 Exposure and observation period: 29 days Effect parameters: Flight intensity, mortality (dead bee traps and sheets), behaviour, colony condition (presence of queen, presence of eggs, presence of queen cells; visual assessment of pollen storage area and area with nectar (%), visual assessment of area containing cells with eggs, larvae and capped cells (%) Residue samples: Yes. During the exposure phase, forager bees were collected in C, T1 and T2 on Days 1, 4 and 5 after bee exposure began for	A single foliar application 10 days (T1) before start of full flowering and the start of bee exposure with an application rate of 100 g a.i./ha, caused increased mortality and reduced flight intensity when compared with the control, during some observation periods. The proportion of brood decreased between the start of exposure and the assessment on DAE+14; however, afterwards almost all colonies recovered and the colonies regained all brood stages by the final assessment on DAE+29. A single foliar application 5 days (T2) before the start of full flowering and the start of bee exposure with an application rate of 100 g a.i./ha, caused increased mortality over 7 days after start of exposure. Therefore, mortality was observed for a longer time period the closer the application was made to bloom. However, no reduction of flight intensity was observed. Colony strength (*i.e.* number of bees) decreased, and the proportion of brood decreased between the start of exposure until the assessment on DAE+14 and then increased again by DAE+29 to control levels. No abnormal bee behaviour was observed. Based on the residue information, it appears that there was some exposure of bees to the test chemical and residues appeared to decline over time. Residues of thiamethoxam in melon flowers were detected on the days of applications in T1 (28.287 mg/kg) and T2 (29.555 mg/kg). As well, residues of thiamethoxam in pollen collected by	2364950

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	residue analysis. Flower samples were also collected for residue analysis on treatment day for T1 and T2 and subsequently on Days 0, 2, 4 and 6 after bee exposure began. Location: Italy Year: 2010 *Melons are not registered for greenhouse use or outdoor foliar application in Canada. Cucurbits (crop group 9) are registered for outdoor in- furrow application. Maximum rate is 150 g ai/ha.* *Maximum foliar rate for other crops is 150 g ai/ha.*	forager bees were 0.039 mg/kg (T1). For T2, residues of thiamethoxam in nectar samples taken at DAE+1 were at 0.016 mg/kg and declined to 0.008 mg/kg at DAE+4 and DAE+6. Residues of CGA322704 were below the limit of quantification (0.005 mg/kg). Further analysis of pollen samples was not possible due to small sample sizes. No residues of thiamethoxam or CGA322704 at or above the respective limit of quantification (LOQ) were found in any of the untreated flower, nectar and pollen samples. Some uncertainties include different amounts of available forage between control, T1 and T2 groups, and low number of replicates. In addition, the longer study length could have led to stress from confinement.	
2 – tunnel Foliar application – applied during bloom while bees were foraging. Honey bees	Test crop: *Phacelia tanacetifolia* Test species: Small hives of honey bees. 5000 bees. Test chemical: Actara 25 WG (25% thiamethoxam) Application rate: 80 g/ha (first experiment) and 20 g ai/ha (second experiment) Number of hives tested: One replicate. Plot size: 4.58 metres x 4.5 metres x 2 metre height Exposure and observation period: 10 days in first experiment and 7 days in second experiment Effect parameters: mortality, flight density, and behaviour. Residue samples: No Location: Germany Year: 1996 *Phacelia is an attractive flowering plant and may be considered for exposure in the risk assessment.*	Following a foliar application of Actara 25WG (thiamethoxam) at 80 or 20 g ai/ha on *phacelia*, during bee flight, mortality was higher in both treatment groups compared to controls (with more dead bees in the higher application rate), and foraging activity was reduced in both treatment groups. The study length was between 7 and 10 days. The reference toxicant also displayed effects. Some uncertainties include different lengths of time for confinement of bees for the different dose hives. The longer study length (including up to 12 days of acclimation before exposure) could have led to additional stress. There were a low number of replicates, and residues in pollen and nectar were not measured to confirm exposure levels.	2364874
2 – tunnel Foliar application –	Test crop: *Phacelia tanacetifolia* Test species: Small hives of honey bees. Test chemical: Actara 25 WG (25%	One application of Actara 25 WG at 1 g ai/ha (*Phacelia tanacetifolia*) during or after bee flight resulted in similar mortality to the control group. In contrast, one application of Actara 25WG at 5 g ai/ha	2364881

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
applied during bloom during or after bee flight. Honey bees	thiamethoxam) Application rate: 1 g a.i./ha (first experiment) and 5 g ai/ha (second experiment) Number of hives tested: Two replicates. Plot size: 4.8 metres x 3.6 metres x 2 metre height Exposure and observation period: 27 days Effect parameters: mortality, foraging activity, behaviour and condition of colonies and development. Strength of colony (number of combs covered with bees) Presence of a healthy queen (presence of eggs, presence of queen cells) Estimate of the pollen storage area and area with nectar Estimate of the area containing eggs, larvae and capped cells The amount of eggs, larvae and capped brood were given in percent of total brood population for each type of brood. Residue samples: No. Location: Germany Year: 1997 *Phacelia is an attractive flowering plant and may be considered for exposure in the risk assessment.*	(*Phacelia tanacetifolia*) during or after bee flight, resulted in increased mortality for up to one day after application. In both treatments (applied during bee flight), foraging activity was slightly decreased on the day of application when. No effects on brood were observed. The study length was 27 days. In some instances the control hive performed more poorly than the treated hives, which may indicate issues with the test design. The longer study length could have led to stress from confinement. Additional uncertainties include that there was a low number of replicates, the application rate was very low, and residues in pollen and nectar were not measured to confirm exposure levels.	
2 – tunnel Drench application before hives were placed in the greenhouse at various time intervals (either 1 day, 8 days, or 24 days after application) Bumble bees	Test crop: Tomatoes Test species: Small bumble bee hives Test chemical: A9795B (Actara 240) (240 g/L thiamethoxam) Application rate: 200 g ai/ha x 1 Number of hives tested: 4 tunnels for control and treatment and 1 tunnel for reference (imidacloprid, applied at 148 - 168 g ai/ha)(applied as a spray and drench at the same rate) Plot size: 3 x 3 x 3 metres	Hives were placed in tunnels (for 28 days) with tomatoes treated by drip irrigation with A9795B (Actara 240) at 200 g ai/ha either 1 day after drip application (first assay), 8 days after application (second assay), or 24 days after application (third assay). Total study length and observation period was 28 days. Following the first assay, mortality was similar between thiamethoxam, control and reference toxicant (imidalcoprid applied at 148 to 168 g ai/ha via drip or spray) groups. However, it is noted that control mortality was high. Foraging activity was lower for imidacloprid when applied as a spray, and also for thiamethoxam treated hives (although not statistically different). There were also less	2365420

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	Exposure and observation period: 28 days Effect parameters: Behaviour, mortality (number of dead bees found in the tent), and vitality (measured by dead or alive queen, dead and alive young queens, dead and alive workers, dead and alive males, eggs, dead and alive larvae (L1 to L4), white and black pupae and unhatched adults, empty cells and nectar cells), pollination activity (when bees land on tomato flowers to collect pollen, they injure the stamen which turns brown from oxidation). Residue samples: No Location: Switzerland Year: 1998 *Tomatoes are not registered for greenhouse use in Canada (although peppers are). Fruiting vegetables (including tomatoes) are registered for outdoor foliar spray and soil application (drench and irrigation). Maximum soil rate of 150 g ai/ha (PCP 30900).*	pupae and larvae in the reference toxicant and thiamethoxam treated hives compared to control. Following the second assay, there was higher mortality in the thiamethoxam treated hives, compared to the control and reference toxicant. No difference in foraging activity was observed between the control and reference toxicant, and although thiamethoxam was lower (up to 46% reduction) compared to control, it was not statistically different. There were no difference in brood development between the reference toxicant, thiamethoxam, or control hives. Following the third assay, there was no difference among groups for mortality, or foraging activity. Hives were not analysed for brood development for the third assay. Some additional uncertainties include that hives were treated differently for the different assays (for example, colonies were fed pollen before the test in assay 1, but not for assay 2 or 3); there were inconsistent approaches for brood observations, and in some instances the control hive performed more poorly than the treated hives, which may indicate issues with the test design. The longer study length could have led to stress from confinement. Residues in pollen were not measured to confirm exposure levels.	
2 – tunnel Drip irrigation before hives were placed in tents. Bumble bees	Test crop: Tomatoes Test species: Small bumble bee hives Test chemical: Actara 25 WG (25% thiamethoxam) Application rate: 150 g ai/ha x 1 Number of hives tested: 3 tunnels in the same field for control and treatment and 1 tunnel for reference (imidacloprid, applied at 150 g ai/ha by drip irrigation). Plot size: 3 x 3 x 3 metres Exposure and observation period: 28 days Effect parameters: Behaviour, mortality (number of dead bees found in the tent), and vitality (measured by dead or alive queen, dead and alive young queens, dead and alive workers, dead and alive males, eggs, dead and	Following one drip irrigation application of 150 g ai/ha to tomato plants prior to hives being placed in the tunnels, there was high mortality in all groups, including the control during the study. No eggs or larvae were present by study termination. The author indicated that high mortality is normal for bees which have intense foraging, and are maintained in hive boxes. Total study length and observation period was 28 days. In most instances the control hive performed more poorly than the treated hives, which may indicate issues with the test design. The longer study length could have led to stress from confinement. Residues in pollen were not measured to confirm exposure levels.	2364898

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	alive larvae (L1 to L4), white and black pupae and unhatched adults, empty cells and nectar cells), pollination activity (when bees land on tomato flowers to collect pollen, they injure the stamen which turns brown from oxidation). Residue samples: No Location: Switzerland Year: 1998 *Tomatoes are not registered for greenhouse use in Canada (although peppers are). Fruiting vegetables (including tomatoes) are registered for outdoor foliar spray and soil application (drench and irrigation). Maximum soil rate of 150 g ai/ha (PCP 30900).*		
2- tunnel Drip irrigation Bumble bees	Test crop: Tomatoes Test species: Small bumble bee hives Test chemical: CGA 293343 WG 25 (Actara 25 WG (25% thiamethoxam)) Application rate: 100 g ai/ha x 2 applied by drip irrigation 21 and 14 days before hives were introduced (Treatment 1), or 100 g ai/ha x 2 applied by drip irrigation 9 and 2 days before hives were introduced (Treatment 2). Number of hives tested: 4 replicates (or tunnels) for each treatment; control, Treatment 1 of thiamethoxam drip irrigation, Treatment 2 of thiamethoxam drip irrigation and the reference imidacloprid applied by foliar application during flower. Hives were covered but BB were allowed to forage during spraying. Plot size: 7220 m^2 Exposure and observation period: 27 days Effect parameters: Sugar solution consumption, weight of hives, development of bee colonies, mortality of larvae and adults, foraging activity (assessed by bite marks on flower), condition of colonies and brood development (number of eggs and small larvae, L1-L3, and big larvae,	Following two drip irrigation applications of 100 g ai/ha to tomato plants prior to hives being placed in the tunnels (at 21 and 14 days before (Treatment 1), or 9 and 2 days before (Treatment 2), the hive weights, foraging activity (measured by bees entering and leaving the hives), sugar consumption, and mortality (total number of adults and larvae of field and hive) were similar between all groups (including reference toxicant, imidacloprid, for some endpoints). There were also no apparent effects for brood, with a higher number of dead larvae observed in control compared to thiamethoxam and reference toxicant. Total study length and observation period was 27 days. Pollination (measured by the number of bite marks) was significantly lower in Treatment 2 (treatment occurring closer to application) immediately following application when compared to the control; however, by one day later the pollination capabilities of the bees in Treatment 2 had recovered. In some instances the control hive performed more poorly than the treated hives, which may indicate issues with the test design. The longer study length could have led to stress from confinement. Residues in pollen were not measured to confirm exposure levels.	2364997

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	L4), dead and live young queens, weight of surviving workers, dead and surviving males, pupae and unhatched adults, and empty cells and nectar cells. Residue samples: No. Location: Spain Year: 2000 *Tomatoes are not registered for greenhouse use in Canada (although peppers are). Fruiting vegetables (including tomatoes) are registered for outdoor foliar spray and soil application (drench and irrigation). Maximum soil rate of 150 g ai/ha (PCP 30900).*		
2 – tunnel **Dust exposure** & Foliar application during bee flight Honey bees	Test crop: *Phacelia tanacetifolia* Test species: Small honey bee hives Test chemical: A9700B (Cruiser 350 FS) and Actara Application rate: T1 = 13.81 g dust/ha (1 g ai/ha based on analysed content of a.i.)(A9700B) during bee flight, T2 = 69.06 g dust/ha (5 g ai/ha based on analysed content of a.i.)(A9700B) during bee flight, T3 = 20 g product/ha (Actara)(5 g ai/ha based on analysed content of a.i.) during bee flight. Number of hives tested: 3 tunnels for each treatment group, except for reference group which only had 1 replicate. Tunnels appear to be on same field. Plot size: 45 m^2 Exposure and observation period: 27 days Effect parameters: Mortality (bee traps and sheets in field), flight intensity (counted on a 1 m^2 section over a short time period of approximately 10-15 seconds), condition of colonies and brood (colony strength, estimate of number of bees), presence of a healthy queen (e.g. presence of	A single application of dust formulation (Cruiser 350FS) at 5 g ai /ha or 1 g ai/ha or spray formulation (Actara 25WG) at 5 g ai/ha on phacelia during bee flight, caused increased mortality and also a decrease in colony strength (number of bees). Flight intensity was significantly reduced in bees exposed to 5 g ai/ha dust (not the lower application rate) and also in bees exposed to 5 g ai/ha spray formulation. There were few effects observed for food resources. Residues in pollen indicated some exposure to bees (from < 0.001 (T1) to 0.016 (T2) mg/kg on DAA+7, and from 0.012 to 0.028 mg/kg on DAA+27, respectively). The longer study length could have led to stress from confinement. Additional uncertainties include that the application rate was very low (although the rate could represent potential drift of spray or dust).	2364974

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	eggs), estimate of pollen storage area and area with nectar or honey area containing cells with eggs, larvae and capped cells), and behaviour. Residue samples: Yes. Residues were collected in pollen. Location: Germany Year: 2009 *Phacelia is an attractive flowering plant and may be considered for exposure in the risk assessment.*		
2 – tunnel Seed treatment **Potential carry over from previous seed treatment** Honey bees	Test crop: Treated maize was sown in spring 2008, followed by treated winter barley in autumn 2008, and then followed by untreated alfalfa, *Phacelia* and oilseed rape in spring 2009. Test species: Small honey bee hives Test chemical: A9700B (thiamethoxam)(Cruiser 350 FS) + A9638A Application rate: 76.8 g/ha in maize and 71.78 g/ha in barley. MAIZE (A9700B + A9638A): Thiamethoxam = 287 g/100 kg seed; fludioxonil = 2.51 g/100 kg seed; and metalaxyl-M = 1.73 g/100 kg seed. BARLEY (A9700B): Thiamethoxam = 66.4 g/100 kg seed. Number of hives tested: 3 tunnels in the treatment plot in each flowering crop and 1 tunnel in the control plot. Plot size: 200 m² Exposure and observation period: 27 days Effect parameters: Mortality (bee traps and sheets in field), flight intensity (counted on a 1 m^2 section over a short time period of approximately 10-15 seconds), condition of colonies and brood (colony strength, estimate of number of bees), presence of a healthy queen (e.g. presence of eggs), estimate of pollen storage area and area with nectar or honey, area	The main objective of the study was to evaluate carry over by measuring residues in crop, soil and honey bee products in untreated alfalfa, oilseed rape and *phacelia* grown in fields which were planted the previous year with treated maize seed, followed by treated barley seed. In addition, there was an effects component. Maximum residues in alfalfa plants, nectar and bee pollen were 0.005, <0.0005 (LOQ) and <0.001 (LOQ) mg/kg, respectively. Maximum residues in *phacelia* plants, nectar and bee pollen were 0.006, 0.014 and <0.001 (LOQ) mg/kg, respectively. Maximum residues in oilseed rape plants, nectar and bee pollen were 0.012, 0.0052, and 0.008 mg/kg, respectively. Therefore, residues were generally low from possible carry-over, and thus there was low exposure to the bees from thiamethoxam. *Phacelia* and oilseed rape were higher than alfalfa. Following exposure to untreated alfalfa, oilseed rape and *phacelia* which were planted in fields which were planted the year before with treated maize seed (A9700B + A9638A at 287 g/100 kg seed thiamethoxam; 2.51 g/100 kg seed fludioxonil and 1.73 g/100 kg seed metalaxyl-M) and then treated barley seed (A9700B at 66.4 g/100 kg seed thiamethoxam); the average number of bees in the alfalfa and *phacelia* increased, and numbers in the oilseed rape decreased. In general, the number of eggs decreased, and the larvae were lower in all tents except for the control *phacelia* tent. In some instances, the control hive performed more poorly than the treated hives. There were clothianidin residues detected in a control sample for alfalfa, which the study author indicated was likely the result of an interference with the alfalfa matrix, not contaminated	2365330

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	containing cells with eggs, larvae and capped cells), and behaviour. Residue samples: Yes. Soil samples for residue analysis were taken pre-planting of each crop in both the control and test item field plots from the relevant part. Whole plants of all three flowering crop species (oilseed rape, alfalfa and *Phacelia tanacetifolia*) were collected inside the tunnels on three sampling dates during the experimental period at the time of bee sampling. After set-up of the colonies, forager bees were collected on three sampling days. Location: France, Picardie Year: 2009 *Corn is registered seed treatment in Canada at a maximum rate 100 g ai/100 kg seed (23.7 g ai/ha).*	samples. The longer study length could have led to stress from confinement. In addition, the removal of hive matrices for residue analysis could have also affected the colony.	
2 – tunnel Seed treatment **Potential carry over from previous seed treatment** Honey bees	Test crop: Treated maize was sown in spring 2008, followed by treated winter barley in autumn 2008, and then followed by untreated alfalfa, *Phacelia* and oilseed rape in spring 2009. Test species: Small honey bee hives Test chemical: A9700B (thiamethoxam)(Cruiser 350 FS) + A9638A Application rate: A9700B (thiamethoxam): 60 g/ha in maize and 83.37 g/ha in barley. MAIZE (A9700B + A9638A): Thiamethoxam = 287 g/100 kg seed; fludioxonil = 2.51 g/100 kg seed; and metalaxyl-M = 1.73 g/100 kg seed. BARLEY (A9700B): Thiamethoxam = 66.4 g/100 kg seed. Number of hives tested: 3 tunnels in the treatment plot in each flowering crop and 1 tunnel in the control plot. Plot size: 200 m²	The main objective of the study was to measure residues in crop, soil and honey bee products in untreated alfalfa, oilseed rape and *phacelia* grown in fields which were planted the previous year with treated maize seed, followed by treated barley seed. In addition, there was an effects component. Maximum residues in alfalfa plants, nectar and bee pollen were 0.005 and 0.0022 mg/kg but almost all were <0.005 (LOQ) and 0.001 (LOQ) mg/kg, respectively. Maximum residues in *phacelia* plants, nectar and bee pollen were <0.001 (LOQ), <0.005 (LOQ) and <0.001 (LOQ) mg/kg, respectively. Oilseed rape plants were not included. Overall, residues were low from possible carry-over, and thus there was low exposure to the bees from thiamethoxam in alfalfa and *phacelia*. Following exposure to untreated alfalfa, oilseed rape and phacelia which were planted in fields which were planted the year before with seed treated maize (A9700B + A9638A at 287 g/100 kg seed thiamethoxam; 2.51 g/100 kg seed fludioxonil and 1.73 g/100 kg seed metalaxyl-M) and then seed treated barley (A9700B at 66.4 g/100 kg seed thiamethoxam); the average number of bees per hive in the	2365332

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	Exposure and observation period: 27 days Effect parameters: Mortality (bee traps and sheets in field), flight intensity (counted on a 1 m^2 section over a short time period of approximately 10-15 seconds), condition of colonies and brood (colony strength, estimate of number of bees), presence of a healthy queen (e.g. presence of eggs), estimate of pollen storage area and area with nectar or honey, area containing cells with eggs, larvae and capped cells), and behaviour. Residue samples: Yes. Soil, whole plants of all three flowering crop species (alfalfa and *Phacelia tanacetifolia*), forager bees of two flowering crop species (alfalfa and *Phacelia tanacetifolia*) NOTE: these residues represent residues from carry over into alfalfa and oilseed rape following a previous years seed treatment application to corn and barley. Location: France, Burgandy Year: 2009 *Corn is registered seed treatment in Canada at a maximum rate 100 g ai/100 kg seed (23.7 g ai/ha).*	*phacelia* tent increased while the numbers in alfalfa decreased. The number of eggs, larvae, and capped brood in the hives decreased for most of the hives, which may be the result of confinement. In addition, the removal of hive matrices for residue analysis could have also affected the colony.	
2 – tunnel Seed treatment **Potential carry over from previous seed treatment** Honey bees	Test crop: Treated maize was sown in spring 2008, followed by treated winter barley in autumn 2008, and then followed by untreated alfalfa, *Phacelia* and oilseed rape in spring 2009. Test species: Small honey bee hives Test chemical: A9700B (thiamethoxam)(Cruiser 350 FS) + A9638A Application rate: A9700B (thiamethoxam): 75 g/ha in maize and 72.27 g/ha in barley. MAIZE (A9700B + A9638A): Thiamethoxam = 287 g/100 kg seed; fludioxonil = 2.51 g/100 kg seed; and metalaxyl-M = 1.73 g/100 kg seed.	The main objective of the study was to measure residues in crop, soil and honeybee products in untreated alfalfa, oilseed rape and *phacelia* grown in fields which were planted the previous year with treated maize seed, followed by treated barley seed. In addition, there was an effects component. Maximum residues in alfalfa plants, nectar and bee pollen were 0.005 and 0.0022 mg/kg but almost all were <0.005 (LOQ) and 0.001 (LOQ) mg/kg, respectively. Maximum residues in phacelia plants, nectar and bee pollen were <0.001 (LOQ), 0<0.005 (LOQ) and <0.001 (LOQ) mg/kg, respectively. Oilseed rape plants were not included. Therefore, residues were low from possible carry-over, and thus there was low exposure to the bees from thiamethoxam in alfalfa and *phacelia*.	2365321

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	BARLEY (A9700B): Thiamethoxam = 66.4 g/100 kg seed. Number of hives tested: 3 tunnels in the treatment plot in each flowering crop and 1 tunnel in the control plot. Plot size: 200 m² Exposure and observation period: 7 days Effect parameters: Condition of the colonies and development of bee brood (colony strength (estimated number of bees, presence of a healthy queen (e.g. presence of eggs), pollen storage area and area with nectar or honey, estimated area containing cells with eggs, larvae and capped cells. Residue samples: Yes. Soil samples and samples of whole plants of all three flowering crop species (oilseed rape, alfalfa and *Phacelia tanacetifolia*) were collected. Forager bees of two flowering crop species (alfalfa and *Phacelia tanacetifolia*) were collected. All specimen collected were sent for analysis of thiamethoxam and its metabolite CGA322704. NOTE: these residues represent residues from carry over into alfalfa and oilseed rape following a previous year's seed treatment application to corn and barley. Location: France, Alsace Year: 2009 *Corn is registered seed treatment in Canada at a maximum rate 100 g ai/100 kg seed (23.7 g ai/ha).*	Following exposure to untreated alfalfa, oilseed rape and *phacelia* which were planted in fields which were planted the year before with seed treated maize (A9700B + A9638A at 287 g thiamethoxam/100 kg seed; 2.51 g fludioxonil/100 kg seed and 1.73 g/100 kg seed metalaxyl-M) and then seed treated barley (A9700B at 66.4 g thiamethoxam/100 kg seed); the number of bees in all hives declined in oilseed rape and *phacelia*, with a larger difference for treatment hives. In contrast, hives in the alfalfa control hives increased from pre to post exposure, and hives in the alfalfa treatment hives remained relatively similar. Brood numbers were variable and relatively similar between control and treatment hives (eggs were higher in treatment hives in many cases). It is noted that there was potential contamination in the control hives for *phacelia*, and many hives in the oilseed rape hives had no pollen at study termination in both the treatment and control hives, which may have led to effects in the study. No residues were included for oilseed rape. In some instances, the control hive performed more poorly than the treated hives. There were clothianidin residues detected in all of the control samples for alfalfa, which the study author indicated was likely the result of an interference with the alfalfa matrix, not contaminated samples. There were also residues of thiamethoxam and clothianidin in the *phacelia* control hives. The longer study length could have led to stress from confinement. In addition, the removal of hive matrices for residue analysis could have also affected the colony.	
2 – tunnel Seed treatment Honey bees	Test crop: Sunflowers Test species: Small hives of honey bees. 10000 bees. Test chemical: A-9567 B (70% TGAI) Application rate: 25.32 g ai/ha; 339 g ai/100 kg seed measured Number of hives tested: 3 tunnels for treatment and control group	Following exposure for 7 days to sunflowers treated as seeds with A9567B (0.5 kg A9567 B/100 kg seeds), there was higher mortality only on the third day after exposure. Mortality during the rest of the study was similar, and the overall mean was similar between the treatment and control tunnels (9.9 to 11.8 dead bees). It is noted that no mortality observations were taken on Day 1 or 2 after exposure began, and thus the trend in mortality is unknown. Brood development and flight intensity were similar between treatment and control bees.	2364919

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	Plot size: 100 m^2 Exposure and observation period: 7 days Effect parameters: mortality, flight activity, behaviour and colony condition, and brood assessments. Residue samples: Yes (in sunflower heads). Location: Germany Year: 1997 *Sunflowers are not registered in Canada for seed treatment (or foliar or soil applications).*	Residue analysis of sunflower heads indicated low levels of exposure (<0.001 mg/kg for thiamethoxam and clothianidin). However, plant samples were taken on Day 3 only.	
2 – tunnel Seed treatment Honey bees	Test crop: Sunflowers Test species: Small hives of honey bees. 10000 bees. Test chemical: A-9567 B (70% TGAI) Application rate: One tunnel with 350 g ai/100 kg seed and another tunnel with 700 g ai/100 kg seed. Reference product (Gaucho applied at 1050 g ai/100 kg seed) was also included in study. Number of hives tested: One tunnel for treatment and control group Plot size: 136 m^2 Exposure and observation period: 12 days Effect parameters: mortality, flight activity, behaviour and colony condition and brood assessments. Residue samples: No. Location: France Year: 1998 *Sunflowers are not registered in Canada for seed treatment (or foliar or soil applications).*	Following exposure for 12 days to sunflowers treated as seeds with A9567B (either at 0.35 or 0.70 kg A9567 B/100 kg seeds), there was no difference between control, thiamethoxam and reference toxicant (imidacloprid) for flight intensity. Observations on colony condition at the end of the study appeared to show a variation in the production of pollen and honey in those hives exposed to sunflowers grown from seed treatments. The reduction was greatest in the tunnel in which seeds were treated with the reference product. Sunflowers grown from seeds treated with thiamethoxam at both 0.35 and 0.70 kg ai/100 kg seed, had less of an effect on both pollen and honey production, particularly at the lowest treatment rate. However, it should be noted that the variation in food production was based on qualitative observations and not quantitative, and only a single hive was used for each treatment and the study author considered the tunnels to be an unnatural bee environment. The control hives did more poorly than treated hives in some instances. Residue analysis was not conducted, and therefore, the level of exposure is unknown.	2364923
2 – tunnel Seed treatment Honey bees	Test crop: Spring oilseed rape (*Brassica napus*) Test species: Small hives of honey bees. Test chemical: A-9700 B (Cruiser 350 FS) Application rate: 1200 mL/100 kg seed(Number of hives tested: Three tunnels with one colony in each, for treatment and control. Plot size: 8.64 m^2	Following exposure for 9 days to spring oilseed rape treated as seeds with A9700B (at 1200 mL/100 kg seed), the mortality, foraging activity, and brood development were similar between the treatment and control hives. A decline in capped brood and a low number of larvae were observed in both treatment and control tunnels, which may also be the result of confinement. Residue analysis was not conducted, and therefore, the level of exposure is unknown. In addition, there was	2364887

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	Exposure and observation period: 9 days exposure and 28 days observation. Effect parameters: Mortality (edge of crop and bee trap), flight activity (observations were about 5 minutes per tent over a square of 1 metre squared), avoidance behaviour, condition of the colonies, development of bee brood. Strength of the colony, presence of a healthy queen, estimate of pollen storage and area with nectar and estimated of area containing eggs, larvae and capped cells. Residue samples: No. Location: Germany Year: 1998 *Rapeseed is registered for seed treatment in Canada at a maximum rate of 403.5 g ai/100 kg seed (32 g ai/ha).*	a lack of a reference toxicant for comparison.	
2 – tunnel Seed treatment Honey bees	Test crop: Oilseed rape (*Brassica napus*) Test species: Small hives of honey bees. 8000 - 10000 bees. Test chemical: A-9807C Application rate: Various rates of application ranging from 1 x rate (420 g ai/100 kg seed) up to 8 x rate (3360 g ai/100 kg seed); 181,000 seeds are in 1 kg seed, rate range is = 0.02 – 0.19 mg a.i./seed Number of hives tested: One plot/one replicate per treatments and controls. Plot size: 25 m^2 Exposure and observation period: 10 days exposure and up to 19 days of observation. Effect parameters: mortality (edge of crop and bee traps), flight intensity (25 flower heads per spot), condition of colonies (strength of colony), number of combs covered with bees, presence of a healthy queen (presence of eggs, presence of queen cells), estimate of the pollen storage area and area with nectar, estimate of the area containing eggs, larvae and capped	Following exposure for 10 days to spring oilseed rape treated as seeds with A9700B (from 1 x rate (0.42 kg ai/100 kg seed) up to 8 x rate (3.36 kg ai/100 kg seed)), the mortality, behaviour, and brood development were similar between the treatment and control hives. Foraging activity was reduced at the 8 x rate only during the study. Residue levels (0.027 mg/kg in flower heads) indicate a potential for exposure. Some uncertainties include the use of only one replicate in the study, and in some instances the control performed more poorly than the treated hives. The longer study length could have led to stress from confinement.	2364914

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	cells, and behaviour. Residue samples: Yes. Analysis was not part of this study. Samples of flower heads, rape (blossom) and rape leaves were taken for analysis. Samples were taken but no results were included in this study. However, the EFSA report included residues and thus they are presented in this summary. Location: Germany Year: 2000		
2 – open feeding study Treated sugar solution Honey bees	**Design for testing of return flight ability:** Test crop: Not applicable. Bees were fed thiamethoxam in sugar solution. Test species: Pollen foragers of honey bees. Test chemical: Thiamethoxam (TGAI) Application rate: 0 (control), 0.1, 1, 10, 25, 50 and 100 µg ai/kg sucrose solution (pollen foragers were captured and fed for 3 hours, prior to being released) Number of hives tested: 6 bees per cage Plot size: not applicable Exposure and observation period: 1 hour after release of bees Effect parameters: return flight ability and stomach honey content Residue samples: No. Not applicable. Bees were dosed in the lab. Location: Germany Year: 1999 **Study Design for feed consumption and exchange – cage experiments.** Test crop: Not applicable. Bees were exposed to thiamethoxam in sugar solution. Test species: Honey bees. Test chemical: Thiamethoxam (TGAI) Application rate: 0 (control), 0.1, 1, 10, 25, 50 and 100 µg ai/kg sucrose solution (pollen foragers were captured and fed between 1 and 3	Following oral exposure of bees to thiamethoxam at 0 (control), 0.1, 1, 10, 25, 50 and 100 µg ai/kg sucrose solution, the return flight ability of bees was affected at a concentration of 50 µg/kg (based on consumption, 5.56 ng ai/bee) and 100 µg/kg (based on consumption, 13.64 ng a.i./bee). Out of 6 bees, none returned in the two highest test groups, and in the 25 µg/kg dose group, 2 bees did not return (33%). Therefore, owing to the uncertainty with affected bees in the 25 µg/kg dose group, the NOEC (based on flight return) is 10 µg ai/kg feeding solution corresponding to a mean measured value of 1.13 ng ai/bee. In the 10 µg/kg all bees returned. Following oral exposure of bees to thiamethoxam at 0 (control), 0.1, 1, 10, 25, 50 and 100 µg ai/kg sucrose solution for either 3 hours in daylight (to test for feed consumption), or for 1 hour in darkness (to test for feed consumption and trophallaxis), no effects were noted up to the maximum concentration tested (100 µg ai/kg sucrose)(5.03 ng ai/bee). The NOEC (based on feed consumption and exchange) is the highest concentration tested, 100 µg ai/kg sucrose, corresponding to the mean consumed value of 5.03 ng ai/bee.	2365400

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	hours prior to release) Number of hives tested: Twelve cages were set up with approximately 30 bees/cage. [Four replicates/study] Plot size: not applicable Exposure and observation period: Approximately 1 day. Effect parameters: Feed consumption and exchange, weight of dissected honey stomach, and presence/absence of blue colour to indicate if trophallaxis occurred. Residue samples: No. Not applicable. Bees were dosed in the lab. Location: Germany Year: 1999		
2 - open feeding with **clothianidin** Artificially fed bees with 50% w/v spiked sugar solution Honey bees	Test crop: not applicable, open field Test species: *Apis mellifera ligustica*; hives started at 5,000 bees in size Test item: clothianidin technical (99.0% w/w) Dose rate: 0 (2x control), 10, 20, 40, 80 and 160 µg a.i./kg Number of hives tested: 96 (12 apiary sties, 8 hives/apiary) Exposure period: *ad libitum* 6 weeks Observation period: 350 days Effect parameters: total frame area covered by honey/nectar, bee bread/pollen, eggs, open brood (larvae), capped brood (pupae), and adult bees. Symptoms of disease or pests (e.g., Varroa, Nosema, foulbrood or small hive beetle), hive weights Residues: uncapped nectar, pollen from pollen traps Location: North Carolina, U.S.A Year: 2014-2015	The overall quantitative NOAEC and LOAEC for this study is 20 and 40 µg/L (19 and 35.6 ug ai/kg sucrose), respectively, based on impacts on pollen storage, number of adults, and number of pupae and, total brood and total live bees in the ≥40 µg/L treatment groups that were sustained across multiple CCAs prior to overwintering (effects on larvae, though not significant at 40 µg/L were also suggestive of an impact from this dose). These effect levels include the understanding that evaluation of overwintering was not possible which limits the ability to fully evaluate potential long-term effects in the two lower treatments groups, and therefore, remains a major source of uncertainty. In addition, bee bread residues were used from CCA5 to assess potential effects from bee bread (pollen) routes of exposure. However, it is noted that the concentration in bee bread is the result of feeding from sucrose solution (and not pollen). The sucrose-based LOEC of 40 ug a.i./L can be expressed as 12.2 (± 5.5) ug a.i./kg (in bee bread)(upper bound residue level of 17.7 ug a.i./kg bee bread). The study is considered to be informative and will be used as a line of evidence in the pollinator risk assessment. While there were uncertainties that were generally related to inherent aspects of any semi-field or full field study design (such as dilution of the test chemical through alternative sources of forage, detection of other chemicals in the monitoring hives), this study still provides	2610259

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
		information on a number of colony health parameters about the long term (however excluding overwintering) exposure to clothianidin at the colony level.	
2 - open feeding with thiamethoxam Artificially fed bees with 50% w/v spiked sugar solution Honey bees	Test crop: not applicable, open field Test species: *Apis mellifera ligustica*; hives started at approximately 10,000 adult bees in size Test item: thiamethoxam technical (99.0% w/w) Dose rate: 0 (2x control), 12.5, 25, 37.5, 50 and 100 µg a.i./kg; (no verified dose available) Number of hives tested: 96 (12 apiary sties, 8 hives/apiary) Exposure period: *ad libitum* 6 weeks Observation period: 325 days Effect parameters: total frame area covered by honey/nectar, bee bread/pollen, eggs, open brood (larvae), capped brood (pupae), and adult bees. Symptoms of disease or pests (e.g., Varroa, Nosema, foulbrood or small hive beetle), hive weights Residues: uncapped nectar, pollen from pollen traps Location: North Carolina, U.S.A Year: 2016-2017	**Preliminary Review:** Based on preliminary data, overwintering appeared successful in the control hives with a 12.5% loss (in April 2017). The LOAEL, reported by the study author was 100 ppb based on brood, larval and pupae coverage. It is noted that pollen coverage was significantly lower in the 100 ppb dose group from CCA 3 to 7, and it was also lower in the 50 ppb dose group for CCA 3 and 4 only. The NOAEL is reported as 50 ppb. There did not appear to be any difference in any parameters after overwintering (CCA 8 and 9) between the control and treatment doses. *Based on limited data from the presentation, the amount of thiamethoxam based on sucrose consumption or bee bread levels, were not available.*	Interim and final reports were not available at the time of this review
2 - open feeding Artificially fed bees with 50% w/v spiked sugar solution Honey bees	Test crop: not applicable, open field Test species: *Apis mellifera ligustica*; hives started at 10,000 bees in size Test item: clothianidin technical (99.0% w/w) Dose rate: 0 (2x control), 10, 20, 30, 40 and 80 µg a.i./L (9.5, 19.0, 29, 37 and 76 µg/kg) in 50% w/v aqueous sucrose solution Number of hives tested: 96 (12 apiary sties, 8 hives/apiary) Exposure period: *ad libitum* 6 weeks Observation period: 350 days Effect parameters: total frame area covered by honey/nectar, bee bread/pollen, eggs, open	**Preliminary Review:** Based on preliminary data, overwintering colony survival in the control hives appeared successful with colony loss reported at 17% at the last assessment date in April 2017. Overwintering colony survival at the last assessment date was 83, 75, 67, 92, 75 and 25% in the control, 9.5, 19, 29, 37 and 76 ppb groups, respectively. The study authors reported a statistically significant difference in overwintering colony survival from the control at 76 ppb. Most surviving colonies were in the process of swarming at the last assessment date (60, 56, 88, 55, 67 and 33% of surviving colonies in the control, 9.5, 19, 29, 37 and 76 ppb groups, respectively). The NOAEC is reported as 20 µg/L. The LOAEC appears to be 30 µg/L, based on significant adverse effects on pollen storage that were sustained across multiple CCAs and on brood (both capped and	Interim and final reports were not available at the time of this review

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	brood (larvae), capped brood (pupae), and adult bees. Symptoms of disease or pests (e.g., Varroa, Nosema, foulbrood or small hive beetle), hive weights, overwintering survival Residues: uncapped nectar, pollen from pollen traps Location: North Carolina, U.S.A Year: 2016-2017	uncapped) prior to overwintering. **Major Uncertainties:** This is a cursory review of information submitted in a presentation. Interim and final reports were not available at the time of this review. Background clothianidin exposure in the control hives was present indicative of some robbing.	
2 - open feeding with **thiamethoxam** Artificially fed bees with 50% w/v spiked sugar solution Honey bees	Test crop: not applicable, open field Test species: *Apis mellifera ligustica*; hives started at 5,000 bees in size Test item: thiamethoxam technical (99.0% w/w) Dose rate: 0 (2x control), 12.5, 25, 37.5, 50 and 100 µg a.i./kg; (verified doses of 9.3, 24.1, 29.5, 39.7 and 73.7 ppb) Number of hives tested: 96 (12 apiary sites, 8 hives/apiary) Exposure period: *ad libitum* 6 weeks Observation period: 350 days Effect parameters: total frame area covered by honey/nectar, bee bread/pollen, eggs, open brood (larvae), capped brood (pupae), and adult bees. Symptoms of disease or pests (e.g., Varroa, Nosema, foulbrood or small hive beetle), hive weights Residues: uncapped nectar, pollen from pollen traps Location: North Carolina, U.S.A Year: 2014-2015	Based on limitations of this study, a NOAEC derived from this study is considered highly uncertain. Key limitations include: 1) late timing of exposure that coincides with ramping down trends of colony endpoints, 2) lower than expected performance of controls, and 3) lack of overwintering success. However, based on definitive effects on total number of individuals, pupae, larvae, and pollen stores at 100 ug a.i./L, 85.6 ug a.i./L-clothianidin equivalents (63 ug ai/kg sucrose-clothianidin equivalents) and similar effects at 50 ug a.i./L, 42.8 ug a.i./L-clothianidin equivalents (34 ug ai/kg sucrose- clothianidin equivalents) at CCA 5 with an inability to assess recovery since at the next CCA (CCA 6) all hives including the control were in decline, these endpoints will be considered in the risk assessment as effect levels. In addition, at the 37.5 ug a.i./L, few effects were observed at the colony level and therefore, this would be the tentative NOEC value (32 ug a.i./L-clothianidin equivalents; NOEC: 25.3 ug ai/kg sucrose-clothianidin equivalents). The study is considered to be informative and will be used as a line of evidence in the pollinator risk assessment along with the results of the clothianidin open colony feeding study. There were also uncertainties that were generally related to inherent aspects of any semi-field or full field study design (such as dilution of the test chemical through alternative sources of forage, detection of other chemicals in the monitoring hives), this study still provides information on a number of colony health parameters about the long term (however excluding overwintering) exposure to thiamethoxam at the colony level.	2586559

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

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
3 – field Foliar application after bee flight. Hives were placed in the field before application. Honey bee	Test crop: *Phacelia tanacetifolia* (purple tansy) Test species: Honey bee hives Test chemical: Actara 25 WG (25% thiamethoxam) Application rate: 25 g ai/ha x 1 Number of hives tested: 4 hives on treatment and control (not true replicates). Plot size: Treatment field was 3213 m^2 and control field was 3438 m^2 Exposure and observation period: 1 day for exposure due to high mortality in the treatment hives. Effect parameters: Behaviour, mortality, and flight activity. Residue samples: No Location: Northern Germany Year: 2005	It was concluded that A9584C applied at an application rate of 25 g ai/ha in 200 mL water/ha after daily bee-flight on flowering *Phacelia* caused reduction of the flight intensity, and high mortality. Mortality in the test item treatment increased on a higher level in all colonies on the first day after the application and the trial was cancelled due to the high number of dead bees. Some uncertainties include a lack of replication, lack of details surrounding distance between fields and surrounding landscape, and a lack of residue analysis to determine exposure.	2364935
3 – field Foliar application after bee flight. Hives were placed in the field before application. Honey bee	Test crop: *Phacelia tanacetifolia* Test species: Honey bee hives Test chemical: Actara 25 WG (25% thiamethoxam) Application rate: 25 g ai/ha x 1 Number of hives tested: 4 hives on treatment and control (not true replicates). Plot size: Treatment field was 2700 m^2 and control field was 2400 m^2 Exposure and observation period: 8 days Effect parameters: Behaviour, mortality, and flight activity. Residue samples: None taken Location: Eastern Germany Year: 2005	It was concluded that A9584C applied at an application rate of 25 g ai/ha in 200 mL water/ha after daily bee-flight on flowering *Phacelia* caused no effect on the flight intensity, the development of bee brood and the behaviour of the bees under field conditions. However, the mortality in the test item treatment increased on a higher level in all colonies on the first day after application and in two colonies on the second day after application compared to the control colonies. On the other assessment days, mortality was similar to control. Some uncertainties include a short exposure period (8 days), lack of replication, lack of details surrounding distance between fields and surrounding landscape, and a lack of residue analysis to determine exposure.	2364932
3 – field Foliar application in the	Test crop: Cucumber Test species: Honey bee hives Test chemical: Test substance is A-9567 B;	It was concluded that following exposure of bees to cucumber treated with in furrow application of Platinum 2SC at 140 g ai/ha, the mortality and foraging activity were similar between the treatment	2365392

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
morning or evening and also from in-furrow soil application. Honey bee	Platinum 2SC at planting or Actara 25WG for foliar applications. Application rate: In furrow application: 140 g ai/ha Foliar application in evening and morning: 52.7 g ai/ha Number of hives tested: 6 hives on treatment and control (not true replicates). Plot size: Treatment field and control fields were 3 acres. Exposure and observation period: 30 days. Effect parameters: Mortality, and foraging. Residue samples: None taken Location: location unknown Year: 1999 (assumed by date of final report)	and control hives. Following exposure of bees to cucumber treated with a foliar application of Actara 25 WG at 52.7 g ai/ha in the evening or in the morning, there was higher mortality in treated hives for one day only. Foraging activity was similar between treatment and control hives throughout the study. It is noted that for both the in-furrow and spray experiments, in some instances the control mortality was higher than treatment hives. Some uncertainties include a lack of brood assessments, limited replicates, close proximity between control and field plots, and lack of residue analysis to determine exposure.	
3 – field Foliar application POST BLOOM Hives were placed in the field before application. Honey bee	Test crop: Pome fruit (apples) Test species: Honey bee hives Test chemical: Actara 25 WG (25% thiamethoxam) (A9584 C) Application rate: 100 g ai/ha x 1 (post bloom) Number of hives tested: 4 hives on treatment and control (not true replicates). Plot size: Treatment and control were 0.35 ha Exposure and observation period: 29 days Effect parameters: Mortality (linen sheets and dead bee trap), flying intensity, behaviour, foraging activity, brood status (counting number of brood covered combs and area covered with different brood stages), weight of hives. Residue samples: No. Pollen was collected to determine food source. Location: Germany Year: 1997	It was concluded that following exposure of bees in apple orchards treated post bloom with Actara 25 at 100 g ai/ha, mortality, brood development, behaviour and foraging activity was similar between pre and post application levels. No control hives were included for comparison. It is however, noted that the maximum number of writhing and staggering bees (43 bees), was found in front of the hives 50 minutes after start of application. By the design of this study contamination of open flowers attractive to foraging honey bees may have been excluded to a large extent, since forage under the apple trees was mowed (which is recommended on the label to reduce pollinator exposure). Bees appeared to forage mostly on clover and dandelions. Residues were not collected to assess potential exposure (potentially from drift onto non-target plants).	2364885
3 – field Foliar application PRE BLOOM	Test crop: Pome fruit (apples) Test species: Honey bee hives – 15 000 to 20 000 bees per colony Test chemical: Actara 25 WG (25%	It was concluded that following exposure of bees for 17 days in apple orchards treated 7 days before bloom with Actara 25 at 100 g ai/ha, mortality, brood development, behaviour, and foraging activity was similar between control and treatment groups. There was lower flight	2364910

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
Hives were placed in the field after application. Honey bee	thiamethoxam) (A9584 C) Application rate: 100 g ai/ha x 1 (7 days before bloom) Number of hives tested: 4 hives on treatment and control (not true replicates). Plot size: Treatment field was 30000 m^2 and control field was 32000 m^2 Exposure and observation period: 30 days. Effect parameters: Mortality (linen sheets and dead bee trap), flying intensity, behaviour, foraging activity, brood status (counting number of brood covered combs and area covered with different brood stages), weight of hives. Residue samples: Yes. Pollen was collected from flowers and a pollen trap was included to determine food source. Location: Spain Year: 2002	intensity (foraging activity) in the first part of the study in both control and treatment hives, which was attributed to rainfall and low temperatures. Some uncertainties include a lack of replication, close proximity between control and field plots, and a lack of residue analysis to determine exposure. A low amount of pollen (15 to 33%) was collected from apple trees, which may have resulted in reduced exposure.	
3 – field Foliar application during bee flight. POST BLOOM Hives were placed in the field before application. Honey bee	Test crop: Pome fruit (apples) Test species: Honey bee hives Test chemical: Actara 25 WG (25% thiamethoxam) (A9584 C) Application rate: 100 g ai/ha x 2 (7 days apart) post bloom Number of hives tested: 4 hives on treatment and control (not true replicates). Plot size: Treatment field was 11 000 m^2 and control field was 10 400 m^2 Exposure and observation period: 21 day. Post treatment assessments were made over 21 days following the 1st application and 14 days after the 2nd application. Effect parameters: Mortality (linen sheets and dead bee trap), flying intensity, behaviour, foraging activity, brood status (counting number of brood covered combs and area covered with different brood stages), weight of	It was concluded that following exposure of bees in apple orchards treated post bloom with Actara 25 at 2 x 100 g ai/ha (7 days apart), mortality, brood development, hive weight, behaviour and foraging activity was similar between control and treatment hives. Foraging activity was low in both treatment and control hives owing to a lack of nectar source. By the design of this study contamination of open flowers attractive to foraging honey bees may have been excluded to a large extent, since forage under the apple trees was mowed (which is recommended on the label to reduce pollinator exposure). Bees appeared to forage mostly on *phacelia* and *vicia* type plants (vetch). Residues were not collected to assess potential exposure (potentially from drift onto non-target plants).	2364966

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	hives. Residue samples: No Location: Eastern Germany Year: 2000		
3 – field Foliar application. PRE BLOOM Hives were placed in the field after application. Honey bee	Test crop: Stone fruit (peach) Test species: honey bee hives Test chemical: Actara 25 WG (25% thiamethoxam)(A9584 C) Application rate: 62.5 g ai/ha x 1 (T1: 15 days before flowering) OR 62.5 g ai/ha x 1 (T2: 6 days before flowering) Number of hives tested: 6 hives on treatment and control (not true replicates). Plot size: Control plot was 1.19 ha, the T1 plot was 0.95 ha and T2 plot was 1.22 ha. Exposure and observation period: 10 days Effect parameters: Mortality (linen sheets and dead bee trap), flying intensity, behaviour, foraging activity, condition of colonies and brood development (strength of colony, presence of eggs, queen cells, visual assessment of pollen storage area and area with nectar (in %), visual assessment of area containing cells with eggs, larvae and capped cells (in %). Residue samples: Forager bees were collected on days 3, 5 and 7 after exposure began for pollen source determination and residue analysis (in pollen and nectar from honey stomachs). Samples of peach flowers were also collected on days 0, 2, 3, 5 and 7 after exposure began for residue analysis. Location: Italy Year: 2010	At the start of flowering, bee hives were placed in peach orchards which had been treated pre-bloom with Actara 25 at 62.5 g ai/ha either 15 days before start of flower (T1), or 6 days before start of flower (T2). Bees were exposed for 10 days and then hives were moved to another location for continued brood assessment (up to 27 days). Following exposure of bees to T1 (treated 15 days before flowering), mortality and colony strength was similar between the treatment and the control hives. However, foraging activity was slightly lower in the treatment hives, compared to controls. Following exposure of bees to T2 (treated 6 days before flowering), mortality was slightly higher (<20 dead bees) in treatment hives for up to 5 days, compared to control hives. As well, foraging activity was lower in the treatment hives compared to controls. Colony strength was similar between all hives. It is noted that control bees did not have a high percentage of peach pollen or nectar. Residues in whole flowers of treated plants ranged from 0.017 to 0.034 mg/kg and bees did have a significant amount of peach pollen and nectar collected in T1 and T2 during the study, which would support exposure. Residues declined in the flowers from 0.017 mg/kg in T1 and 0.034 mg/kg in T2, to less than 0.004 mg/kg by day 7. No residues of thiamethoxam or clothianidin were detected in the control samples.	2364948
3 – field Foliar application (PRE BLOOM). Hives were placed in fields after	Test crop: Bartlett pear Test species: honey bee hives Test chemical: Actara 25 WG (25% thiamethoxam) Application rate: 95 g ai/ha x 1 (either 1, 3, 5,	Bee hives were placed in pear orchards treated pre-bloom with Actara 25 at 95 g ai/ha either 1 day, 3 days, 5 days, 8 days, or 11 days before bloom. Bees were exposed for 18 days. Following exposure at various time intervals, bees exposed to	2364868

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
application, during bloom. Honey bee	8 or 11 days before bloom) Number of hives tested: 8 hives on treatment and control. Plot size: Each treatment and control site was 10 acres. Exposure and observation period: 18 days Effect parameters: Mortality (with Todd bee traps) Foraging Colony strength (no definition) Residue samples: None taken Location: Washington Year: 2003	treatments made 1 or 3 days before bloom had a higher mortality compared to the control. Bees exposed to treatments made 5 days before bloom also had some mortality, but for only one time point. There was no difference at 8 and 11 days before bloom. Therefore, hives were more affected when applications were made closer to bloom. It is noted that there was a high degree of variability in the foraging data which made a comparison between the control and treatment hives difficult, there were limited replicates, and a lack of residue analysis to determine exposure.	
3 – field Drip irrigation Honey bee	Test crop: Honeydew melon Test species: Honey bee hives – 20 000 to 30 000 bees. Test chemical: Actara 25 WG (25% thiamethoxam) Application rate: 200 g ai/ha x 1 (either 7 days before hive exposure (T1), or 1 day before hive exposure (T2)) Number of hives tested: 4 hives on treatment and control (not true replicates). Plot size: Each test field was at least 2000 m^2 (2000 m^2 for T1, 2250 m^2 for T2, 2100 m^2 for reference item and 2200 m^2 for control). Exposure and observation period: 14 days Effect parameters: Mortality in front of the bee hives and in the field, flight intensity, condition of colonies, development of brood, behaviour, yield and quality of fruits, strength of colony (number of combs covered with bees), presence of a healthy queen (presence of eggs, presence of queen cells), estimate of the pollen storage area with nectar, estimate of area containing eggs, larvae and capped cells (%), weight of hives. Residue samples: No Location: Spain	It was concluded that following exposure of bees in melon fields treated by drip irrigation with Actara 25 at 200 g ai/ha, either 7 days before hive exposure (T1), or 1 day before hive exposure (T2); brood development and foraging activity was similar between control and treatment hives. A reference toxicant (tau-fluvalinate) was also included in the study which was sprayed. Yield of harvested fruit was similar between the control and reference toxicant, which were both lower than the thiamethoxam treated hives. Mortality was higher in T2 after application on Day 2 of exposure, compared to other groups, however, it is noted that there was damage to a number of hives which led to hive replacement, and possible hive stress (at the same time period). Other uncertainties in the study include close proximity between control and field plots (2 km) which could have led to cross foraging, limited replicates, short exposure duration (14 days), and lack of residue analysis to determine exposure. Pollen analysis indicated that Treatment 1 hives and control hives did not contain any melon pollen, and Treatment 2 hives contained only 15% melon pollen, which suggests low exposure. However, the study author postulated that the bees could get through the traps without losing pollen. Therefore, there is some uncertainty in the exposure level during the study.	2364916

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	Year: 2002		
3 – field **Dust and guttation** Seed treatment (Alsace France - maize) Honey bee	Test crop: Oil seed rape was grown adjacent to the seeded maize field. Test species: Honey bee hives 8381 to 18012 bees per colony Test chemical: A9700B Application rate: thiamethoxam (246 g ai/100 kg seed), fludioxonil (2.5 g ai/100 kg seed), and metalaxyl (1 g ai/100 kg seed) (78.8 g ai/ha thiamethoxam) Driller: Calibrated Monosem pneumatic single seed drilling machine *with a deflector* Number of hives tested: 6 colonies each year for control and treatment fields (not true replicates). Plot size: Control field = 1.8 ha, treatment field = 1.4 ha Exposure and observation period: 41 days exposure and additional 6 days at monitoring site (total of 47 days) Effect parameters: Conditions of the colonies Brood assessments (last assessment made on the 3rd September). Colony strength (number of bees). Mortality in front of hives (linen sheets and dead bee traps). Flight intensity during guttation period (0 - 39 DAE). If guttation occurrence and bee flight was noted then flight intensity assessments were performed. Residue samples: Soil cores. Dead bees. Dust generated at drilling using Petri dishes and collection of oilseed rape heads. Dust from control exhaust was collected but not analysed. Oilseed rape heads. Bee pollen loads and nectar honey stomachs. Pollen from combs in the hives (collected but analysis was not performed) Guttation fluid (sampled on 1, 2, 4, 10, 16, 32 and 40 DAE). Time of day sampling was performed was not reported.	Honey bee hives were exposed for 41 days to oil seed rape which was grown adjacent to a seeded maize fields (treated with thiamethoxam (246 g ai/100 kg seed), fludioxonil (2.5 g ai/100 kg seed), and metalaxyl (1 g ai/100 kg seed)), in Alsace France. Seeding equipment included a deflector. The main objective of the study was to examine potential effects from guttation and dust during planting. Control and treatment hives were located only 2.5 km apart. Overall mortality was low but slightly higher in the treatment hives (up to 58 bees), with the highest mortality being observed prior to the first guttation event. The study author proposed the mortality was the result of a brood assessment taking place the previous day. Colony strength was similar between the treatment and control hives, and was variable throughout the study. Guttation was present and varied from 0 to 100% in the fields, however, over the course of the study only 3 bees were observed taking up guttation fluid. Guttation residues were very high (nearly 28 mg/L thiamethoxam and 1.9 mg/L clothianidin) at the beginning of the study, and by study termination, residues declined to 0.028 mg/L thiamethoxam and 0.012 mg/L clothianidin. Residue analysis of dust indicated there were some residues in soil, with lower residues the farther away the drilling occurred. Residues of thiamethoxam in pollen and nectar samples were found in both control and treatment samples taken 7 days after seeding. In the control, only samples from non-rape plants contained any residues. Eight dead bee samples were taken from dead bee traps after seeding and before emergence of the crop. Only one sample in the treated field contained residues of thiamethoxam and CGA322704. The residue levels were 0.006 mg thiamethoxam/kg and 0.002 mg CGA322704/kg. Overall, the control contamination of pollen and nectar introduces some uncertainty with respect to possible exposure of bees to thiamethoxam in the control hives, and possible effects. However, the results of the guttation portion of the study suggest that despite high residues, the bees may not be affected since they are not visiting	2365336

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	Location: Alsace, France Year: 2009	guttation droplets. Other potential water sources in the study could have been a pond located 170 m from the hives, or rainfall, or dew.	
3 – field **Dust and guttation** Seed treatment (Alsace France - maize) Honey bee	Test crop: Non-attractive off crop field adjacent to the seeded maize field. Test species: honey bee hives 4880 - 11506 bees per colony Test chemical: A9700B Application rate: thiamethoxam (246 g ai/100 kg seed), fludioxonil (2.5 g ai/100 kg seed), and metalaxyl (1 g ai/100 kg seed) (78.8 g thiamethoxam /ha) Driller: Monosem (6 rows) *with Syngenta deflector* Number of hives tested: 6 colonies each year for control and treatment fields (not true replicates). Plot size: Control field = 2.38 ha, treatment field = 1.97 ha Exposure and observation period: Exposure phase II and III lasted up to 79 days after drilling. In addition the colony was checked until the following spring (March 21st 2011) Effect parameters: Mortality in front of the bee hives and in the field. Guttation and honey bees collecting guttation droplets in the field Flight intensity in front of the bee hives and in the field. Behaviour of the bees at the entrance of the hives and in the field. Assessments on the condition of the colonies and brood development. Assessments of bee colony health and strength. Overwintering success Residue samples: Yes. Dead bees. Pollen source and residue of bee pollen loads. Guttation fluid. Residues in soil. Location: Alsace, France Year: 2010	Hives were moved to another location for overwintering and observed until the spring. All hives were treated for *varroa* and *nosema*, and all hives were given supplemental feeding starting in September. The main objective of the study was to examine potential effects from guttation and dust during planting. Control and treatment hives were located 4.75 km apart. Mortality was low and similar between treatment and control hives (11 to 16.9 dead bees/day) for the pre-drilling and post drilling phase. However, there was increased mortality around the time of maize emergence (up to 237 dead bees) in treatment hives which lasted for a few days; all the dead bee samples contained residues of thiamethoxam and metabolite CGA322704. Colony strength was similar between the treatment and control hives, and was variable throughout the study. In spring 2010, all colonies increased their breeding activity indicating a sufficient food supply from flowering plants. Infestation of *varroa* and *nosema* were also similar between treatment and control hives. Guttation was present and varied from 0 to 100% in the fields, however, over the course of the study no bees were observed taking up guttation fluid. Guttation residues were very high (nearly 28 mg/L thiamethoxam and 3.5 mg/L clothianidin) at the beginning of the study, and at later sampling dates, residues declined to 0.098 mg/L thiamethoxam and 0.06 mg/L clothianidin. Residue analysis indicated there were some residues of thiamethoxam in soil (up to 0.004 mg/kg) in the treatment field. There were also some residues in maize plants which ranged between 0.002 and 0.003 mg/kg in treated corn. However, there were no residues in pollen from plants or pollen collected from forager bees (<LOQ, 0.001 mg/kg). In addition there was a low percentage of maize pollen collected for both treatment (up to 11%) and control hives (up to 18%) on most days. The one exception is that one treatment hive contained up to 64% pollen. Other sources of pollen included *hydrangea*, *trifolium* and *heracleum.* One dead bee sample from a control hive contained a low (0.002 mg/kg) amount of thiamethoxam. No other residues were detected in any control sample matrix. It appeared that bees did not forage to a large extent on maize pollen,	2365365

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
		and therefore exposure may have occurred from foraging on other plants. The results of the guttation portion of the study suggest that despite high residues, the bees may not be affected since they are not visiting guttation droplets. It is noted that there were no water sources (radius 300 m) in the area around the treated field.	
3 – field **Dust and guttation** Seed treatment (Lorraine France - maize) Honey bee	Test crop: Non-attractive off crop field adjacent to the seeded maize field. Test species: honey bee hives 8255 - 15316 bees per colony Test chemical: A9700B Application rate: thiamethoxam (0.68 mg thiamethoxam/seed) and A9638A (1.12 g a.i. metalaxyl-M/100 kg seed + 2.54 g a.i. fludioxonil/100 kg seed Driller: Monosem/Nodet Gougin - upgraded *with a deflector* provided by Syngenta in order to lead the outlet air towards the ground. Number of hives tested: 6 colonies each year for control and treatment fields (not true replicates). Plot size: Control field = 1.9 ha, treatment field = 3.208 ha Exposure and observation period: Exposure phase II and III lasted up to 79 days after drilling. In addition the colony was checked until the following spring (March 25th 2011) Effect parameters: Mortality in front of the bee hives and in the field Flight intensity of bees in front of hives and in the field Brood disease Guttation and honey bees collecting guttation droplets in the field Behaviour of the bees at the entrance of the hives and in the field Assessments on the condition of the colonies and brood development Assessments of bee colony health and strength Overwintering success	Honey bee hives were exposed for 79 days to seeded maize fields (treated with thiamethoxam (246 g ai/100 kg seed), fludioxonil (2.5 g ai/100 kg seed), and metalaxyl (1 g ai/100 kg seed) using seeding equipment with deflectors, in Lorraine France. Fields were adjacent to non-attractive crops to promote foraging on corn pollen. All hives were treated for *varroa* and *nosema*, and all hives were given supplemental feeding starting in September. Hives were moved to another location for overwintering and observed until the following spring for effects. The main objective of the study was to examine potential effects from guttation and dust during planting. Control and treatment hives were located only 2.78 km apart. Mortality was higher (up to 75 dead bees) in the treatment hives compared to control after drilling on a number of days. Mortality was also higher in the treatment hives for a few days around the time of emergence (between 205 and 259 dead bees). Colony strength was similar between the treatment and control hives, and was variable throughout the study. In spring 2010 all colonies were increasing their breeding activity indicating a sufficient food supply from flowering plants. Infestation of *varroa* and *nosema* were low in treatment and control hives. Single bees from the treatment and control hives were observed showing uncoordinated movements and/or intensive cleaning behaviour. Guttation was present and varied from 0 to 99% in the fields, however, over the course of the study only one bee was observed taking up guttation fluid. Guttation residues were high (nearly 16 mg/L thiamethoxam and 2 mg/L clothianidin) at the beginning of the study, and at later sampling dates, residues declined to 0.040 mg/L thiamethoxam and 0.02 mg/L clothianidin. Residue analysis indicated no residues of thiamethoxam or clothianidin in soil, or pollen samples from plants or forager bees at the treatment or control fields. However, there were some residues detected in maize plants (up to 0.003 mg/kg) at the treatment site.	2365370

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	Residue samples: Yes. Dead bees Pollen residue of bee pollen loads Guttation fluid Residues in soil Location: Lorraine, France Year: 2010	Residues of thiamethoxam were detected in bee samples at treatment sites ranging from 0.001 to 0.0736 mg/kg. Residues of clothianidin were detected at 0.001 to 0.0810 mg/kg. No residues were detected in any control sample matrix. The results of the guttation portion of the study suggest that despite high residues, the bees may not be affected since they are not visiting guttation droplets. It is noted that the bees had natural water sources close to each field. Despite a lack of apparent foraging on maize and low residues in maize plants, bees were exposed to thiamethoxam from another source, which was evident by the residues detected in bee samples. The source of pollen was not confirmed.	
3 – field **Dust and guttation** Seed treatment (Stade Germany - maize) Honey bee	Test crop: Non attractive off crop field adjacent to the seeded maize field. Test species: Honey bee hives 10185 - 17388 bees per colony Test chemical: A9700B Application rate: thiamethoxam 0.69 mg a.i. thiamethoxam/seed) and A9638A (0.91 g a.i. metalaxyl-M/100 kg seed + 2.55 g a.i. fludioxonil/100 kg seed (76.61 g ai/ha thiamethoxam) Driller: The drilling machine used (Becker, model: Aeromat) was upgraded with a deflector in order to lead the outlet air towards the ground. Number of hives tested: 6 colonies each year for control and treatment fields (not true replicates). Plot size: Control field = 1.53 ha, treatment field = 1.75 ha Exposure and observation period: Exposure phase II and III lasted up to 85 days after drilling. In addition the colony was checked until the following spring (March 29th 2011) Effect parameters: Mortality in front of the bee hives and in the field. Flight intensity of bees in front of hives	Honey bee hives were exposed for 85 days to seeded maize fields (treated with thiamethoxam (0.69 mg ai/ seed), fludioxonil (2.5 g ai/100 kg seed), and metalaxyl (1 g ai/100 kg seed) using seeding equipment with deflectors, in Stade Germany. Fields were adjacent to non-attractive crops to promote foraging on corn pollen. All hives were treated for *varroa*, and given supplemental feeding starting in August. Hives were moved to another location for overwintering and observed until the following spring for effects. The main objective of the study was to examine potential effects from guttation and dust during planting. Control and treatment hives were located 12 km apart. Mortality and flight intensity was similar between control and treatment hives, with higher mortality after drilling at all sites. Colony strength was similar between the treatment and control hives, and was variable throughout the study. In spring 2010 all colonies were increasing their breeding activity indicating a sufficient food supply from flowering plants. One treatment hive did not overwinter successfully, however, this hive had a high *varroa mite* infestation. Guttation was present and varied from 0 to 100% in the fields, however, over the course of the study no bees were observed taking up guttation fluid. Guttation residues were high (nearly 29 mg/L thiamethoxam and 4 mg/L clothianidin) at the beginning of the study, and at later sampling dates, residues declined to 0.045 mg/L thiamethoxam and 0.02 mg/L clothianidin.	2365373

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	and in the field. Brood disease. Guttation and honey bees collecting guttation droplets in the field. Behaviour of the bees at the entrance of the hives and in the field. Assessments on the condition of the colonies and brood development. Assessments of bee colony health and strength. Overwintering success. Residue samples: Yes. Dead bees. Pollen source and residue of bee pollen loads. Guttation fluid. Residues in soil. Location: Stade, Germany Year: 2010	Residue analysis indicated there were no residues of thiamethoxam or clothianidin in soil, or pollen samples from maize plants or forager bees at the treatment fields. However, there were some residues detected in maize plants (up to 0.005 mg/kg) at the treatment site. There was also pollen from the control field plants which contained 0.261 mg/kg thiamethoxam and 0.036 mg/kg metabolite CGA322704. As well, residues of thiamethoxam were found in dead bees from the control hives ranging from 0.0005 to 0.0249mg/kg (prior to drilling) and the treatment hives (from 0.0001 to 0.0249 mg/kg). The control site was in the vicinity of an apple orchard, and thus exposure could have occurred from orchard spraying. The percentage of pollen collected from maize ranged from 4 to 53% in the control and 3 to 13% in treatment hives T1 to T5; T6 had higher amounts of maize pollen, which ranged from 27 to 71%. Other sources of pollen included *trifolium repens and platnago sp.* The results of the guttation portion of the study suggest that despite high residues, the bees may not be affected since they are not visiting guttation droplets. Overall, the control contamination of control bees introduces some uncertainty with respect to possible exposure of bees to thiamethoxam in the control hives, and possible effects.	
3 – field Seed treatment (4 year study in Alsace France - maize) Honey bee	Test crop: Maize Test species: Honey bee hives 4 438 to 22 875 bees per colony (and split in late spring) Test chemical: A9700B and A9638A, a formulation containing thiamethoxam (350 g/L), fludioxonil (25 g/L), and metalazyl (10 g/L) Application rate: 315 g thiamethoxam + 2.5 grams fludioxonil + 1 g metalaxyl-M per 100 kg seeds Number of hives tested: 6 colonies each year for control and treatment fields (not true replicates). Plot size: 2-3 ha Exposure and observation period: 4 years Effect parameters: Mortality (in front of hives	Honey bee hives were exposed over four consecutive years in Alsace France, to maize grown from treated seed (A9700B + A9638A containing 315 g thiamethoxam + 2.5 g fludioxonil + 1 g metalaxyl-M/100 kg seeds). All hives were placed in the fields at the start of flower, and moved to another site at the end of exposure for additional monitorinng. All hives were treated for *varroa* and *nosema*, and all hives were given supplemental feeding starting in September. According to the study author, the control and treatment hives were 5 km apart to prevent cross foraging, and sites were located away from bee attractive habitats to promote foraging on corn pollen. The study examined effects on mortality, flight intensity, hive weight, disease, and colony development (including overwintering observations). Overall, mortality was low (<50 dead bees) and similar between control and treatment sites. Flight intensity and behaviour was also	2364945

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	on linen sheets and dead bee traps) observed daily, foraging activity (number of bees entering, and leaving the hive over 1 minute, and foraging or flying around marked flowering plants) during the day until late afternoon, and behaviour of the bees and the condition of the colonies were assessed during the period of flowering (up to BBCH 69). Assessments of brood development were done once before the start of exposure and once at the end of exposure. During these assessments samples of bees and brood combs were taken for bee disease and virus analysis. Bee Colony health and strength: -estimate of adult worker bee numbers based on Liebefeld method. -presence of healthy egg laying queen -estimate of the pollen storage area and area with nectar -estimate of area containing eggs, larvae and capped cells -weight of colony -indicators of bee diseases. Residue samples: Yes. Samples of plants, pollen taken directly from plants and forager bees were collected for residue analysis. Furthermore, pollen samples from pollen traps were collected for pollen source identification. Location: Alsace, France Year: 2006 to 2009	similar between all groups. Three hives died over the 4 years in the treatment groups and one died in the control. By end of overwintering in 2010, all colonies were approximately the same strength. Bee health (analysis of *Nosema sp., Malpigamoeba melificae, Acarapsis woodi, Varroa destructor, Paenibacillus* larvae and different viruses (e. g. DWV (deformed wing virus), SBV (sacbrood virus), KBV (Kashmir bee virus), ABPV (acute bee paralysis virus) and CBPV (chronic bee paralysis virus)) were similar among groups. Hive weights were variable over the four year study. There appeared to be a general trend of lower pollen/nectar in the treatment colonies, particularly in 2009. Thiamethoxam residues in bee pollen and plant pollen were <0.001 mg/kg (LOQ) for all years except 2008, whereby thiaemthoxam was 0.002 mg/kg in bee pollen. Thiamethoxam and clothianidin were not detected in control sites. It is noted that matrices for residue analysis was different between years, and thus a direct comparison over the 4 years is difficult. However, based on the available residue data there appeared to be limited exposure to bees. By design, the study does not evaluate the effects to the colony during planting, but rather the potential oral effects during pollen shed of the maize plants.	
3 – field Seed treatment (4 year study in Southern France - maize) Honey bee	Test crop: Maize Test species: Honey bee hives Test chemical: A9700B and A9638A, Thiamethoxam (220.5 g ai/100 kg seed), fludioxonil (2.5 g ai/100 kg seed)(69.3 g thiamethoxam /ha) Number of hives tested: 6 colonies each year for control and treatment fields (not true replicates). Plot size: 2 hectares (4.9 acres) for the treated	Honey bee hives were exposed over four consecutive years in Lorraine France, to maize grown from treated seed (A9700B and A9638A, Thiamethoxam (220.5 g ai/100 kg seed), fludioxonil (2.5 g ai/100 kg seed)). All hives were placed in the fields at the start of flower, and moved to another site at the end of exposure for additional monitoring. All hives were treated for *varroa* and *nosema*, and all hives were given supplemental feeding starting in August. According to the study author, the control and treatment hives were 12 km apart to prevent cross foraging, and sites were located away from bee attractive habitats to promote foraging on corn pollen. The	2364957

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	field and 3 (7.4 acres) hectares for the control field. Exposure and observation period: 4 years Effect parameters: Mortality (in front of hives on linen sheets and dead bee traps) observed daily, foraging activity (number of bees entering, and leaving the hive over 1 minute, and foraging or flying around marked flowering plants) during the day until late afternoon, and behaviour of the bees and the condition of the colonies were assessed during the period of flowering (up to BBCH 69). Assessments of brood development were done once before the start of exposure and once at the end of exposure. During these assessments samples of bees and brood combs were taken for bee disease and virus analysis. Bee Colony health and strength: -estimate of adult worker bee numbers based on Liebefeld method. -presence of healthy egg laying queen -estimate of the pollen storage area and area with nectar -estimate of area containing eggs, larvae and capped cells -weight of colony -indicators of bee diseases. Residue samples: Yes. Samples of plants, pollen taken directly from plants and forager bees were collected for residue analysis. Furthermore, pollen samples from pollen traps were collected for pollen source identification. Location: Lorraine, France Year: 2006 to 2009	study examined effects on mortality, flight intensity, hive weight, disease, and colony development (including overwintering observations). Mortality in the control hives was much higher during the first week of exposure in 2006 and 2007 (between 61 and 355 dead bees) compared to treatment hives. Flight intensity and behaviour was similar between all groups. Three hives died over the 4 years in the treatment groups and one died in the control. By end of overwintering in 2010, all colonies were approximately the same strength. Overall, hive weights and brood development were variable over the four year study, which made comparison between treatment and control colonies difficult. Bee health (analysis of *Nosema sp., Malpigamoeba melificae, Acarapsis woodi, Varroa destructor, Paenibacillus* larvae and different viruses (e. g. DWV (deformed wing virus), SBV (sacbrood virus), KBV (Kashmir bee virus), ABPV (acute bee paralysis virus) and CBPV (chronic bee paralysis virus)) were similar among groups. Thiamethoxam residues in bee pollen and plant pollen were low (<0.001 mg/kg (LOQ)) for all years except 2008, whereby thiaemthoxam was 0.002 mg/kg in bee pollen. In plants, residues in the treatment fields were up to 0.01 mg/kg. Thiamethoxam and clothianidin were not detected in control sites. It is noted that matrices for residue analysis was different between years, and thus a direct comparison over the 4 years is difficult. Except for 2006 whereby up to 42% of forager bees had maize pollen, most bees did not appear to forage on pollen. Other sources of pollen included *centaurea jacea* and *sedum sp* in the treatment hives, and *mercurialiis sp* and *papaver sp* in the control hives.	
3 – field Seed treatment (4 year study in Lorraine France - maize)	Test crop: Maize Test species: Honey bee hives 8500 to 15000 bees per colony Test chemical: A9700B and A9638A, a formulation containing thiamethoxam (350 g/L), fludioxonil (25 g/L), and metalazyl (10	Honey bee hives were exposed over four consecutive years in Lorraine France, to maize grown from treated seed (A9700B and A9638A, Thiamethoxam (315 g ai/100 kg seed), fludioxonil (2.5 g ai/100 kg seed) and metalaxyl-M (1 g ai/100 kg seed)). All hives were placed in the fields at the start of flower, and moved to another site at the end of exposure for additional monitoring. All hives were treated	2364952

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
Honey bee	g/L) Application rate: 315 g thiamethoxam + 2.5 grams fludioxonil + 1 g metalaxyl-M per 100 kg seeds Number of hives tested: 6 colonies each year for control and treatment fields (not true replication). Plot size: 2-3 ha Exposure and observation period: 4 years Effect parameters: Mortality (in front of hives on linen sheets and dead bee traps) observed daily, foraging activity (number of bees entering, and leaving the hive over 1 minute, and foraging or flying around marked flowering plants) during the day until late afternoon, and behaviour of the bees and the condition of the colonies were assessed during the period of flowering (up to BBCH 69). Assessments of brood development were done once before the start of exposure and once at the end of exposure. During these assessments samples of bees and brood combs were taken for bee disease and virus analysis. Bee Colony health and strength: -estimate of adult worker bee numbers based on Liebefeld method. -presence of healthy egg laying queen -estimate of the pollen storage area and area with nectar -estimate of area containing eggs, larvae and capped cells -weight of colony -indicators of bee diseases. Residue samples: Yes. Samples of plants, pollen taken directly from plants and forager bees were collected for residue analysis. Furthermore, pollen samples from pollen traps were collected for pollen source identification. Location: Lorraine, France Year: 2006 to 2009	for *varroa* and *nosema*, and all hives were given supplemental feeding started from September. According to the study author, the control and treatment hives were 5 km apart to prevent cross foraging, and sites were located away from bee attractive habitats to promote foraging on corn pollen. The study examined effects on mortality, flight intensity, hive weight, disease, and colony development (including overwintering observations). Overall, mortality in the control and treatment hives were low and similar for most years, except for 2007, whereby treatment hive T6 had a high mortality (up to 561 dead bees) which the study author proposed was the result of the hive rebuilding. Foraging was similar in the control and treatment hives for all years, except for 2007, whereby activity was lower in the treatment hives. Hive weight was also similar in the control and treatment hives for all years, except 2008, whereby mean hive weight was lower in the treatment hives. Colony strength and brood development was very similar over the 4 years. Six colonies died in the test item group in 2007 compared to three colonies in the control group in 2008 over the four years of observations. Residues of thiamethoxam in plants were 0.006 mg/kg in 2006 and declined to 0.003 mg/kg in 2009. Residues were at the LOD (0.001 mg/kg) in bee pollen. Maize pollen collected by forger bees was generally low (0 to 18% in the treatment fields in 2006, and <1% all other years); and 0 to 75% in the control field (with the highest amount being collected in 2006). No thiamethoxam or CGA 322704 residues were detected in control samples. Overall, exposure of bees to thiamethoxam appeared low.	

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
3- field Seed treatment – Germany, Tubingen and Niefern) **Field and tunnel study** Red mason bee	Field and tunnel study Test crop: Winter oilseed rape Test species: Red mason bee nests – 8 nesting units with 100 nest cavities each Test chemical: A980F (thiamethoxam, metalaxyl-M/fludioxonil) at 3.5 kg seeds/ha with a seed dressing rate of 75 mL A980F/1000000 seeds (nominal: 0.021 mg a.i./seed; measured: 20.1 µg a.i./seed) Application rate: Thiamethoxam (0.02 mg ai/seed) Number of hives tested: In the field, 8 nesting units with 100 nest cavities (one replicate in the field) and in the tunnel test, one nesting unit per tunnel per site. Plot size for field test: 2.10 and 2.32 ha (control sites) 2.4 and 2.45 ha (treatment sites) The control field was located either 6 or 7.7 km away from the treated fields. Tunnel size: 5 m x 12 m. Tunnels were placed in one corner of each of the field sites. Exposure and observation period: approximately 30 days Effect parameters: Bees were assessed for hatching success (mean number of hatched females and males), nest occupation rate (number of occupied cavities), offspring production (number of closed cells) cell production per occupied cavity, and flight activity of females at entrance of nesting units and foraging activity in the crop, number, weight and sex ratio of offspring (cocoons), and hatching success of offspring (based on fully developed *Osmia* adults, over the winter and into the following spring). Residue samples: Yes. Nectar, pollen, plant and flower samples from the oil seed rape, soil from the field site and pollen provisions from *Osmia* cells.	Two identical red mason bee studies were conducted in Germany in two different regions (Tubingen and Niefern) in 2015. In both studies, winter soil seed rape seeds were treated with thiamethoxam at 0.021 mg ai/seed in both the field and in tunnels. In both studies, bees were exposed to flowering plants and observed for potential long term impacts to hatching, nest occupation, offspring production, cell production, flight activity, and foraging activity, as well as hatching success of offspring (based on fully developed *Osmia* adults, over the winter and into the following spring). Development, reproductive success and foraging activity were similar between the control and the treatment sites in both studies. Effects followed a similar trend in the tunnel studies, as compared to field studies, although development and reproductive success were slightly lower in the tunnel studies, potentially owing to confinement and/or lack of alternative food sources. There did not appear to be any treatment related effects in either study. However, it is noted, that based on field residue analysis in the plants and amount of rape pollen collected by mason bees, that there was limited exposure to thiamethoxam and/or clothianidin in both studies. In the field study conducted at Tubingen (PMRA 2394873) there were more parasites in the cells of the control field hives (12.3) compared to the treatment hives (1.5) and there was also more mortality in cocoons in the control field hives (26) compared to the treatment hives (1.2). Residues: In the treated plants, pollen and nectar was <LOQ (0.001 and 0.0005 mg/kg, respectively) for thiamethoxam at most sampling periods at both sites. Clothianidin was detected at 8 DAE in the Tubingen site at 0.004 mg/kg in rape plants. At 14 DAE thiamethoxam was detected at 0.0041 mg/kg in nectar at the Niefern site. Thiamethoxam and clothianidin were <LOQ (0.001 mg/kg) in pollen mass stored by female *Osmia* in cavities over the study at both sites (except one treatment sample in the Niefern site, whereby thiamethoxam was detected at 14 DAE at 0.002 mg/kg). There were no residues detected in controls. Overall, there appeared to be limited exposure of bees to thiamethoxam and/or clothianidin from treated winter oil seed rape.	2694873 and 2694872

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	Location: Germany (Tubingen and Niefern) Year: 2015		
3 – field Seed treatment – Germany Honey bee	Test crop: Winter oilseed rape Test species: Honey bee hives - 3000 bees per colony Test chemical: A9807C, a formulation containing thiamethoxam (282 g/L), fludioxonil (8.00 g/L), and mefenoxam (33.4 g/L) Application rate: Thiamethoxam (416 g/100 kg seeds), fludioxonil (12.4 g/100 kg seeds), metalaxyl-M (48.5 g/100 kg seeds). (16.6 g thiamethoxam /ha) Number of hives tested: 4 colonies each year for control and treatment fields (not true replicates). Plot size: 6000 m^2 Exposure and observation period: 31 days Effect parameters: Mortality (edges of fields and dead bee traps), flight intensity, condition of colonies (presence of eggs, presence of queen cells, and presence of eggs, larvae and capped cells), behaviour, weight of colonies, number of nectar sections of rape flowers, Residue samples: No Location: Germany Year: 2000	Honey bee hives were exposed to winter rapeseed grown from treated seed (A9700B and A9638A, Thiamethoxam (416 g ai/100 kg seed), fludioxonil (12.4 g ai/100 kg seed) and metalaxyl-M (48.5 g ai/100 kg seed)) during full bloom in Germany. The control and treatment hives were 7 km apart to prevent cross foraging, and sites were located away from bee attractive habitats to promote foraging. The study examined effects on mortality, flight intensity, hive weight, and colony development. Overall, mortality was similar but variable between the treatment and control hives and ranged from 2 to 653 dead bees in the treatment hives, and 0 to 538 dead bees in the control. There was higher forging in the treatment hives, and the hive weight was similar between the treatment and control hives. Some uncertainties include a lack of replication, a fungal infection in both control and treatment hives, which make potential treatment effects (or lack thereof) difficult to interpret, and a lack of residue analysis to determine exposure.	2364931
3 – field Seed treatment – Lincolnshire - UK Honey bee and Bumble bee	Test crop: Winter oilseed rape Test species: Honey bee hives - 5000 bees Test chemical: Cruiser OSR 466 g thiamethoxam/100 kg seed Number of hives tested: There were a total of 12 queen right honeybee colonies per treatment group, 4 located at edge of field (on-field site), and 4 at 500 and 1000 m away from the field. Plot size: 2 ha Exposure and observation period: Approximately 45 days with observations the	Honey bee hives were placed at fields grown with rape seed treated with thiamethoxam (Cruiser OSR 466 g thiamethoxam/100 kg seed), either located at the fields edge, 500 metres from field, or 1000 metres from field. Hives were placed in fields during flower and then moved to monitoring sites for the winter. Hives were assessed for foraging activity and homing behaviour, and colony strength (and overwinter survival). Overall, foraging activity, homing behaviour and colony survival was similar between the treatment and control hives. Four colonies died in the control (from disease, queen failure and	2487496 and 2487497

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	following spring. Effect parameters Adult worker bees which were newly emerged were 'tagged' with Radio Frequency Identification Transponders (RFID tags). Three cohorts emerged one week apart were tagged. An AI (Activity index) was calculated (AI= bees remaining/total bees detected). Foraging activity The numbers and species of bees, including non-*Apis*, were recorded. Colonies were assessed for the following parameters: -Weight of each colony -Strength of the colony (number of combs covered with bees) -Presence of a healthy queen (presence of eggs, presence of queen cells) -Visual assessment of the pollen storage area and area with nectar (%) -Visual assessment of area containing eggs, larvae and capped cells (%) The frames were based on a modification of the Liebefeld method. Residue samples: Yes. Residues were collected from flowers, pollen and nectar, and palynological analysis of pollen. Location: Lincolnshire, UK Year: 2013-2014	robbing), and two died in the treatment (from disease and queen failure). Following overwinter, a total of 5 colonies died in the control and 4 died in the treatment. According to the study author, the colonies died due to a flooding event. The majority of the colonies tested positive for Nosema and black queen cell virus, at the start of the study. At the end of the exposure period levels of both species had reduced greatly in all treatments and there were no apparent differences between the treatment groups. Residues of 1.0 µg thiamethoxam /kg and 3.0 µg CGA322704 (metabolite)/kg were detected in pollen from the treated crop. Nectar from the treated crop contained 1.8 µg thiamethoxam/kg. No residues of either thiamethoxam or CGA322704 were detected in any of the samples of plants, flowers, pollen or nectar collected from control fields above the level of quantification (LOQ for thiamethoxam in whole plants, flowers and pollen was 1 µg/kg and 0.5 µg/kg in nectar; LOQ for CGA322704 in all samples was 1 µg/kg). Within all but one of the treatment group (control 1 km) the palynological analysis indicated that a substantial proportion of the pollen collected from the returning foragers was collected from oilseed rape. Honey bees were also seen to be foraging for nectar and/or pollen, on the crop or flying within the crop, during observations; no abnormal behaviour of the bees was noted. Exit and entrance of bees from the hive appeared to be related to weather, with increased activity on warmer days. Other bee species; *Bombus terrestris* (bufftailed bumble bee), *B. pascuorum* (common carder bee) and *B. lapidarius (*red-tailed bumble bee) were seen to be actively foraging and flying within the crop throughout the exposure phase. Therefore, based on foraging activity and residue data, bees were potentially exposed to thiamethoxam from oilseed rape. No difference in foraging behaviour was noted between the control and treatment hives.	
	Same as above except the following: Test species: Bumble bees (*Bombus terrestris audax*) queen and between 10-20 adult bees. Test chemical: Cruiser OSR	Bumble bee hives were placed in fields grown with rape seed treated with thiamethoxam (Cruiser OSR 466 g thiamethoxam/100 kg seed). Hives were placed in fields during flower and then moved to monitoring sites at the end of the season. Hives were assessed for	2487497

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	420 g thiamethoxam/100 kg seed Exposure and observation period: Approximately 38 days exposure and up to 61 days for observation. Number of replicates: 1 treatment field and 2 control fields (limited replicates) Effect parameters Colony development (weight) Activity at the colony entrance Foraging activity Colony dissection (emerged adult bees including queen, drones and workers; and eggs, larvae and pupae and queens)	colony development and weight. *Bombus terrestris* were seen actively foraging on rape within all three groups during the exposure period. Pollen from rape (*Brassica napus*) accounted for 45 to 92% pollen in the control hives, and 40 to 93% in the treatment hives. Colonies within all three treatment groups also showed similar rates of average weight gain during the exposure phase. It is noted that some colonies on site T1 did appear to still be increasing in mass and had not started to produce queens and were in the region of a week behind other colonies. The mean number of eggs, and large and small pupae in the treated colonies was higher than the control sites by the end of the experiment. The colonies from the treated site contained approximately double the mean numbers of eggs compared to the averages from the two control sites. Residues of 1.0 µg thiamethoxam /kg and 3.0 µg CGA322704 (metabolite) /kg were detected in pollen from the treated crop. Nectar from the treated crop contained 1.8 µg thiamethoxam/kg. No residues of either thiamethoxam or CGA322704 were detected in any of the samples of plants, flowers, pollen or nectar collected from control fields above the level of quantification (LOQ for thiamethoxam in whole plants, flowers and pollen was 1 µg/kg and 0.5 µg/kg in nectar; LOQ for CGA322704 in all samples was 1 µg/kg). Based on foraging activity and residue data, bees were potentially exposed to thiamethoxam from oilseed rape	NOTE: This study was conducted at the same location and time as PMRA 2487496 (homing behaviour of honeybees)
3 – field Seed treatment (Northern Germany - rape) Honey bee	Test crop: Spring oilseed rape Test species: Honey bee hives Test chemical: A-9567 B (WS 70 with 70% thiamethoxam) Application rate: 0.432 kg ai/100 kg seed with a sowing rate of 5.94 kg seed/ha (25.7 g ai/ha) Number of hives tested: 6 colonies each year for control and treatment field (not a true replicate). Plot size: Treatment site was approximately 18720 m^2 and an untreated control was 24942 m^2. Exposure and observation period: 11 days. In addition brood development was checked at 18	Honey bee hives were placed at fields grown with spring rape seed treated with thiamethoxam (CGA 293343 WS70, 432 g ai/100 kg seed), in Northern Germany. Hives were located only 2 km apart. Hives were assessed for foraging activity mortality, hive weight, and colony strength. Mean mortality was higher in the treatment hive compared to the control (but on a low mean level of 22.5 dead bees/colony in the treatment compared to 7.8 dead bees/colony in the control). The majority of the mortality was attributed to high mortality on day 5 of the exposure period (95 dead bees), which the author attributed to robbing. It is uncertain if the robbing event was caused by a weak hive, and potentially treatment related. Overall, foraging activity, colony development, and hive weight were similar between the	2364905

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	and 46 days after bees were set up. Effect parameters: Mortality, foraging activity, brood development (strength of colony, presence of healthy queen, pollen storage and nectar storage, area containing eggs, larvae and capped cells), weight of colonies and behaviour. Residue samples: Yes. Honey stomachs, plant leaf samples, blossom samples; and pollen analysis. **Samples for residue analysis were taken, but not conducted.** Location: Northern Germany (near Celle) Year: 1999	treatment and control hives. A mean of 44.6 % of nectar foraging bees sampled contained oilseed rape nectar in their honey stomachs and 60.3% of pollen bees had oilseed rape pollen in their pollen loads, which indicates potential exposure (although it is unknown if there was cross foraging between control and treatment fields. Some uncertainties include a short exposure period (11 days), lack of replication, lack of residue analysis to confirm exposure, and a short distance between control and treatment fields.	
3 – field Seed treatment (southern Germany - rape) Honey bee	Test crop: Spring oilseed rape Test species: Honey bee hives Test chemical: A-9567 B (WS 70 with 70% thiamethoxam) Application rate: 0.432 kg ai/100 kg seed with a sowing rate of 7 kg seed/ha (30.3 g ai/ha) Number of hives tested: 6 colonies each year for control and treatment field (not true replicates). Plot size: Test item field was 21250 m^2 and the control field was 20960 m^2. Exposure and observation period: 17 days. In addition brood development was checked at 39 - 50 days after bees were set up. Effect parameters: Mortality, foraging activity, brood development (strength of colony, presence of healthy queen, pollen storage and nectar storage, area containing eggs, larvae and capped cells), weight of colonies and behaviour. Residue samples: Yes. Honey stomachs, plant leaf samples, blossom samples; and pollen trap analysis. **Residues are part of another study report. EFSA report contained residues.** Location: Southern Germany Year: 1999	Honey bee hives were placed at fields grown with spring rape seed treated with thiamethoxam (CGA 293343 WS70, 432 g ai/100 kg seed), in Northern Germany. Hives were located only 2 km apart. Hives were assessed for foraging activity mortality, hive weight, and colony strength. Overall, mortality, foraging activity, hive weight and colony strength appeared similar between the control and treatment hives, however, it is noted that the treatment and control tests were not run concurrently. Residues of thiamethoxam (treated field, trial G99067B) in bee pollen was 0.0042 mg/kg and 0.0021 mg/kg in honey stomachs, and <0.001 mg/kg for metabolite CGA322704. . Some additional uncertainties include a short exposure period (17 days), and lack of replication. A direct comparison between control and treatment hives was difficult since they were not run concurrently.	2364909

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
3 – field Seed treatment (4 year study in Northern France - rape) Honey bee	Test crop: Winter oilseed rape Test species: Honey bee hives - 10,000-20,000 bees Test chemical: A9807C, a formulation containing thiamethoxam (282 g/L), fludioxonil (8.00 g/L), and mefenoxam (33.4 g/L) Application rate: 100 kg seed and kg seed planted per acre (Actual seeding rates ranged from 2.80 to 3.26 kg/ha in the treatment fields and from 2.77 to 3.41 kg/ha in the control fields) -1.5 L product/100 kg seed Number of hives tested: 6 colonies each year for control and treatment fields (not true replicates). Plot size: 2-3 ha Exposure and observation period: 4 years Effect parameters: Mortality (in front of hives on linen sheets and dead bee traps) observed daily, foraging activity (number of bees entering, and leaving the hive over 1 minute, and foraging or flying around marked flowering plants) during the day until late afternoon, and behaviour of the bees and the condition of the colonies were assessed during the period of flowering (up to BBCH 69). Assessments of brood development were done once before the start of exposure and once at the end of exposure. During these assessments samples of bees and brood combs were taken for bee disease and virus analysis. Bee Colony health and strength: -estimate of adult worker bee numbers based on Liebefeld method. -presence of healthy egg laying queen -estimate of the pollen storage area and area with necar -estimate of area containing eggs, larvae and capped cells	Honey bee hives were exposed over four consecutive years in Northern France, to rape grown from treated seed (thiamethoxam (423 g/100 kg seed), fludioxonil (12 g/100 kg seed), and mefenoxam (50 g/100 kg seed)). All hives were placed in the fields at the start of flower, and moved to another site at the end of exposure for additional monitoring. All hives given supplemental feeding started from August. The control and treatment hives were separated by only 2 to 3.2 km. The study examined effects on mortality, flight intensity, hive weight, disease, and colony development (including overwintering observations). Overall, mortality was similar between the control and treatment hives for most time periods (2007 and 2009), except in 2005 and 2006, whereby mortality (measured by collection of dead bees on linen sheets) was significantly greater in the treatment colonies on three occasions the end of May (end of exposure period) relative to the control colonies. Foraging activity, bee health, and colony development appeared similar and variable in the control and treatment hives for all years. In 2006, 2007, and 2008, nectar samples from the treatment colonies were found with thiamethoxam residue levels of 0.0007 mg/kg. No other residues of thiamethoxam or its metabolites were detected in pollen or plant samples through the definitive testing period. No thiamethoxam or CGA 322704 residues were detected in control samples. Of the bees that contained pollen (which was low), between 23.8 and 46.8% of bees contained rape pollen in the honey stomach in the treatment hives, and between 32.4 and 42.4% in the control hives. Overall, exposure of bees to thiamethoxam appeared low.	1983053

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	-weight of colony -indicators of bee diseases. Residue samples: Yes. Samples of plants, pollen taken directly from plants and forager bees were collected for residue analysis. Furthermore, pollen samples from pollen traps were collected for pollen source identification. Location: Northern, France. In 2004/2005, the exposure phase was conducted in Meistratzheim (treatment and control), in 2005/2006 in Krautergersheim (treatment) and Meistratzheim (control), in 2006/2007 in Gertwiller (treatment) and Zellwiller (control) and in 2007/2008 in Sand (treatment) and Herbsheim (control). Year: 2006 to 2009		
3 – field Seed treatment (4 year study in Alsace France - rape) Honey bee	Test crop: Winter oilseed rape Test species: Honey bee hives - 10,000-20,000 bees Test chemical: A9807C, a formulation containing thiamethoxam (282 g/L), fludioxonil (8.00 g/L), and mefenoxam (33.4 g/L) Application rate: 100 kg seed and kg seed planted per acre (Actual seeding rates ranged from 3.07 to 6.81 kg/ha in the treatment fields and from 3.21 to 6.22 kg/ha in the control fields) -1.5 L product/100 kg seeds Number of hives tested: 6 colonies each year for control and treatment fields (not true replicates). Plot size: 2-3 ha Exposure and observation period: 4 years Effect parameters: Mortality (in front of hives on linen sheets and dead bee traps) observed daily, foraging activity (number of bees entering, and leaving the hive over 1 minute, and foraging or flying around marked	Honey bee hives were exposed over four consecutive years in Alsace France, to rape grown from treated seed (thiamethoxam (423 g/100 kg seed), fludioxonil (12 g/100 kg seed), and mefenoxam (50 g/100 kg seed)). All hives were placed in the fields at the start of flower, and moved to another site at the end of exposure for additional monitoring. All hives given supplemental feeding started from August. The control and treatment hives were separated by 1.8 to 7.5 km to minimise cross foraging. Selected field plots were isolated from other honeybee attractive crops flowering during the same time as flowering. The study examined effects on mortality, flight intensity, hive weight, disease, and colony development (including overwintering observations). Overall, mortality was similar between the control and treatment hives for most time periods, except in 2006, whereby mean mortality during the exposure period was lower in treatment levels (10 dead bees per hive) compared to controls (29 dead bees/hive). Foraging activity, bee health, and colony development appeared similar and variable in the control and treatment hives for all years. A maximum residue level of 0.001 mg/kg (treated bee pollen) to 0.003 mg/kg (treated bee nectar) of thiamethoxam was detected in samples taken in the test item field from 2006 to 2008. A single	1983053

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	flowering plants) during the day until late afternoon, and behaviour of the bees and the condition of the colonies were assessed during the period of flowering (up to BBCH 69). Assessments of brood development were done once before the start of exposure and once at the end of exposure. During these assessments samples of bees and brood combs were taken for bee disease and virus analysis. Bee Colony health and strength: -estimate of adult worker bee numbers based on Liebefeld method. -presence of healthy egg laying queen -estimate of the pollen storage area and area with nectar -estimate of area containing eggs, larvae and capped cells -weight of colony -indicators of bee diseases. Residue samples: Yes. Samples of plants, pollen taken directly from plants and forager bees were collected for residue analysis. Furthermore, pollen samples from pollen traps were collected for pollen source identification. Location: Alsace, France, In 2005, the exposure phase was conducted near Vingre in 2006 near Retheuil, in 2007 near Chelles and Mortefontaine and in 2008 near Vingre and Christophe á Berry, for the test item and the control treatment, respectively Year: 2006 to 2009	residue of CGA322704 was detected in the treated oil seed rape specimen at a level of 0.001 mg/kg in 2007 and 2008. No thiamethoxam or CGA 322704 residues were detected in control samples. Of bees that contained pollen (which was low), between 33.6 and 42.3% of bees contained rape pollen in the honey stomach in the treatment hives, and between 7.5 and 39.4% in the control hives. Overall, exposure of bees to thiamethoxam appeared low.	
3 – field Seed treatment – Saskatchewan, Canada Honey bee	Test crop: Canola Test species: Honey bee hives (uncertainty with numbers, could range between 24000 and 45000 bees) Test chemical: Helix contains Thiamethoxam (10.3%), Difenoconazole (1.24%), Metalaxyl-M and S-isomer (0.39%) and Fludioxonil (0.13%).	Honey bee hives were placed at fields grown with canola seed treated with thiamethoxam (Helix® XTra Seed Treatment (thiamethoxam at 400 g a.i./100 kg seed), in Saskatchewan, Canada and assessed for sealed brood production, adult worker bee populations, disease incidence, pollen collection, and honey production, including overwinter survival. Hives were located 10 km apart, and given medicated supplemental feeding beginning in September.	2533585

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	Application rate: (rate: 400 g a.i./100 kg seed). Number of hives tested: 3 hives x 3 apiaries for the treatment and 3 hives x 1 apiary for the control. Plot size: 3 treatment sites at 160 acres each, and one untreated site at 15 acres. Exposure and observation period: Approximately 1 year Effect parameters: Sealed brood (Sealed brood were measured with a cell estimate using a Plexiglas grid.) Adult worker bee population assessments using both the weight method and the frame method. The weight method estimated adult colony populations by shaking the bee from the hives and converting these weights into population estimates based on an assumption of 7,733 bees per kilogram of bees (Hambleton, 1940; Moeller, 1952; Sammataro and Avitabile, 1998). The frame estimation method calculated the adult bee population as the summation of individual frame estimates based on: 1) the percentage of the frame that the bees would have covered if they had been densely covering the frame and 2) the number of bees that were deemed to cover one side of a densely covered Langstroth frame. After the initial population estimates, subsequent adult populations were estimated using the frame method and the Harris population method (Harris 1980). The Harris population method calculated a colony's adult bee population as: 1) the survival of the founding adult bee population plus 2) the summation of the survival estimates for adult bees emerging from sealed brood measured at twelve day intervals as determined from worker bee life tables (Harris unpublished - submitted to the Journal of Apicultural Research for publication review, January 2014 – draft manuscript	Overall, control colonies had high varroa infestation, low honey yield and poor development which made a comparison difficult with the treatment hives. It is unclear if the low acreage for the control, 15 acres, compared to 160 acres for the treatment hives resulted in a lack of forage. Additional uncertainties included a large amount of clover and mustard collected from bees at the treatment sites and control compared to canola, which may have reduced exposure, a lack of replication, a lack of residue of analysis to confirm exposure, and exposure of some bees (unknown if colony #8 was control or treatment) to carbaryl, which may have resulted in effects. Canola in the control fields had an application of lambda cyhalothrin, which was not given to the treatment crop.	

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	available on request). Pollen identification using pollen traps. Disease monitoring for the presence of sac brood, American foul brood, European foul brood, chalk brood, Nosema, tracheal mites, and Varroa mites. Residue samples: No Location: Saskatchewan, Canada Year: 2013 – 2014		
3 – field Seed treatment – Alberta, Canada Honey bee	Test crop: Canola Test species: Honey bee hives Test chemical: Helix contains Thiamethoxam (10.3%), Difenoconazole (1.24%), Metalaxyl-M and S-isomer (0.39%) and Fludioxonil (0.13%). Application rate: 15 mL/kg seed (equivalent to 1.5 L/100 kg seed). Equivalent to 403.5 g ai/100 kg seed. Number of hives tested: 3 groups of 5 hives at each of the treatment and control site. Plot size: 15 ha Exposure and observation period: 15 days at Site 1 and 17 days at Site 2, with observations up to 21 days. Effect parameters: Bees were assessed for mortality and hive weight. Visual inspection included extent of brood, and egg laying Hives were also assessed for *varroa* mites and tracheal mites. Residue samples: Yes. Whole bees (returning to the hive), pollen traps, hive honey, nectar and pollen samples from flowers and whole flowers. Location: Alberta, Canada Year: 1999	Honey bee hives were placed at fields grown with canola seed treated with thiamethoxam (Helix® XTra Seed Treatment (thiamethoxam at 403.5 g a.i./100 kg seed), for 15 to 17 days in Alberta Canada. The bee colonies were placed in areas where they had access to both treated, untreated and reference (Vitavax RS fungicide, lindane, mixed with carbathiin and thiram) canola. Hives were either placed in the treated crop area, or along the edge of the treated crop. An additional control field was located 4 km away. Surrounding area contained no other major source of pollen. Overall, mortality (which was low), brood development, number of supercession, hive weight, disease and foraging activity was similar between the treatment and control hives. Based on foraging activity, it appeared that bees were actively foraging on the treated canola flowers. Flowers contained between 0 and 7.6 ppb of active ingredient, and a few isolated samples contained traces of the major degradation product (up to 0.95 ppb). The pollen and honey collected at the HELIX-exposed hives contained only traces (<1 ppb) of parent compound and no detectable degradate. The foraging bees collected at the hive entrance contained possible traces of parent compound (< 0.1 ng/bee). Two samples of 40 from the exposed hives contained traces of degradate (<0.03 ng/bee). Therefore, bees were likely exposed to thiamethoxam from the treated crop.	2364936
3 – field Seed treatment	Test crop: Sunflower Test species: Honey bee hives – 25000 - 35000 bees Test chemical: Cruiser WS 70 : A9567B	Honey bee hives were placed at fields grown with sunflower seed treated with thiamethoxam (Cruiser WS 70 Seed Treatment (thiamethoxam at 500 g a.i./100 kg seed), for approximately 10 days in Bologna Italy. The bee colonies were placed in areas where they	2364922

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
Honey bee	Application rate: 500 g/100 kg seeds (measured:0.3399 kg a.i./100 kg seeds= 0.02 lbs ai/A Number of hives tested: 6 colonies for control and treatment fields (not true replicates). Plot size: 20,000 m^2 Exposure and observation period: Observations were made at 0-10 days in the field. Brood assessed up to 49 days. Effect parameters: Mortality (dead bees traps and linen sheets) and foraging (flight intensity) were observed daily. Brood assessments (days 2, 9, and 40) included queen presence and estimations of pollen, nectar, eggs, larvae, and capped cell areas. Colony weights were determined on days 2-11. Residue samples: Yes. Samples included sunflower (2 kg blossoms and 2 kg leaves per treatment group), honey (honey combs and extractor), pollen (traps from 3 hives), and bee stomach honey (4 samples of approximately 100 bees/colony/day). Residues were not included as part of this report. Residues are summarized from EFSA report. Location: Bologna, Italy Year: 2001	had access to both treated, untreated and reference (Vitavax RS fungicide, lindane, mixed with carbathiin and thiram) canola. Hives were either in placed the treated crop area, or along the edge of the treated crop. An additional control field was located 4 km away. Surrounding area contained no other major source of pollen. Overall, mortality, brood development, number of supercession, hive weight, disease and foraging activity was similar between the treatment and control hives. Mortality was variable and on some occasions control mortality was higher than the treatment hives. Based on mean foraging activity (12.1 bees/25 sunflower heads), it appeared that bees were actively foraging on the treated sunflower flowers. In addition, between 80 and 95% sunflower pollen was collected at treatment, control and reference hives. Residues of thiamethoxam and CGA322704 (treated field) in hive pollen were 0.0032 mg/kg for thiamethoxam and <0.001 mg/kg for metabolite CGA322704. Therefore, it appears that bees were exposed to thiamethoxam from treated sunflowers (although hive honey had non-detectable levels, which the EFSA review considered support for a lack of exposure).	
3 – field Seed treatment Honey bee	Test crop: Sunflower Test species: Honey bee hives Test chemical: CRUISER 350 FS (A-9700B) Application rate: CRUISER 350 FS at 0.120 L product/150,000 seeds (0.02 lbs ai/A) (nominally:42 g a.i./150,000 seeds). Nominal rate of 18.67 g ai/ha. Number of hives tested: 15 replicate hives per treatment. Plot size: Control fields were 4.5 ha and 15 ha and the treatment group field measured 4.5 ha. Exposure and observation period: 13 days for all observations including brood development.	Honey bee hives were placed at fields grown with sunflower seed treated with thiamethoxam (Cruiser 350 FS Seed Treatment, 42 g thiamethoxam /150 000 seeds), for approximately 13 days in Hungary (location not clear). An additional reference field with imidacloprid and control field were also planted 4 km away. Overall, mortality was higher in the treatment hives on day 7. Brood development, colony strength, and foraging activity were similar between the treatment and control hives. Foraging activity in the treatment field was relatively high for the first 7 days of exposure with a maximum of 145 bees/400 sunflower heads on day 6. However, from day 9 to day 12, foraging activity was low in	1761443

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	Effect parameters: Mortality (dead bees traps) and foraging (flight intensity) were observed daily (days 2-12). Brood assessments (days 0 and 13) included the pollen and honey storage area, and the area with eggs, larvae, and capped cells. Residue samples: Yes. Samples included quarter parts of 20 sunflower heads, pollen from traps, and fresh nectar and honey from two hives (nectar from 2-3 hives). Residues were not included as part of this report. Residue information was taken from EFSA review. Location: Not clear, presumed to be Hungary in EFSA report. Year: 2001	the treatment and control fields (<4 bees/400 sunflower heads). Residues of thiamethoxam and CGA322704 (treated field) in hive honey, nectar and pollen were <0.001 mg/kg for thiamethoxam and <0.001 mg/kg for metabolite CGA322704. Therefore, it appears that bees were likely not exposed to thiamethoxam from treated sunflowers. It is noted that the exposure period was only 13 days, and the size of the fields and timing of planting were different among the sites.	
3 – field Seed treatment Honey bee	Test crop: Sunflower Test species: Honey bee hives Test chemical: Cruiser 70WS (A9567 B) Application rate: 0.5 kg product/100 kg seeds (0.35 kg ai/100 kg seeds) Number of hives tested: 6 hives per treatment (not true replicates). Plot size: 40 000 m^2 Exposure and observation period: 16 days for all observations and day 48 for brood development. Effect parameters: Mortality: The number of dead bees in front of the hives on linen sheets and in the dead bee traps was recorded. Flight intensity: Observations began one day after the set-up of the hives at the time of start of full bloom and took place in five marked squares in each treatment group (each 1 metre squared). Squares were marked and distributed over the field to cover different developmental stages of flowering. Bees were assessed for either foraging on flowers, or flying over the crop. Measurements were made for 16 days. Condition of the colony (including strength of	Honey bee hives were placed at fields grown with sunflower seed treated with Cruiser 70WS Seed Treatment (thiamethoxam at 350 g ai/100 kg seeds), for 16 days in Spain. An additional reference field with imidacloprid and a control were also planted. All fields were located 6 km apart to prevent cross contamination. Overall, mortality was slightly higher in the thiamethoxam treatment hives but on a low level (mean of 8 dead bees/colony). The control and reference hives exhibited similar levels of mortality (less than 3 dead bees/colony). Foraging activity was also higher at the treatment sites (0.6 bees/m^2) compared to the control (0.4 bees/m^2) and reference sites (0.2 bees/m^2). Weight of the colonies increased in thiamethoxam treated hives, whereas the reference hives decreased in weight. This was likely due to lower foraging activity in the imidacloprid treated sites. Brood development was similar between the treatment and control hives. Residues in the treated field for sunflower heads were 0.03 mg/kg for thiamethoxam and 0.0058 mg/kg for clothianidin; residues in treated field in pollen were 0.0011 mg/kg for thiamethoxam and <0.001 mg/kg for clothianidin. Residues were not reported for hive matrices. Some bees were observed foraging on the crop, and flight intensity indicated bees foraged on the crop. However, it was also noted that	2364896

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	colony = number of combs covered with bees, presence of eggs, queen cells, estimate of the pollen storage area and are with nectar, and estimate of area containing eggs, larvae and capped cells. Weight of the colonies: Hives were weighed with a beam scale. Residue samples: Yes. Samples of plants and their pollen, the contents of honey bee stomachs of the foraging bees and newly collected nectar and honey were collected from hives during the study, for possible chemical analysis. Pollen traps were set up on the hives. Plant material (leaf and blossom) and soil samples were collected. **NOTE: Despite indication that residues were collected, there are no results in the current report. Residue information was taken from EFSA review.** Location: Spain Year: 1999	pollen load analysis concluded that low numbers of bees had sunflower pollen (mean of 38%), and honey stomachs indicated variable amounts (mean of 38%). Overall, there was some potential for exposure.	
3 – field Seed treatment Honey bee	Test crop: Sunflower Test species: Honey bee hives Test chemical: Cruiser 350 FS (A9700 B) Application rate: 3.3 g a.i./A (0.210 kg a.i./100 kg seeds) which is equivalent to 0.007 lbs ai/A. Number of hives tested: 6 hives per treatment (not true replicates). Plot size: 20,448 m^2 to 22,050 m^2. Exposure and observation period: 9 days and 40 day recovery period. Effect parameters: Mortality: The number of dead bees in front of the hives on linen sheets and in the dead bee traps was recorded. Flight intensity: Observations were made 3 times per day by counting number of bees foraging and flying over the crop at marked squares. Condition of the colony, and bee behaviour: Brood condition and development was	Honey bee hives were placed at fields grown with sunflower seed treated with thiamethoxam (A-9700B Seed Treatment, 210 g thiamethoxam /100 kg seeds), for 9 days in Argentina. Overall, mortality, foraging behaviour and brood development were similar between thiamethoxam treatment and control hives. There was a trend of lower foraging activity in the treatment hives during the study. No residues of thiamethoxam or clothianidin were detected in pollen, nectar, blossom or nectar from bee stomachs from the treatment site. In addition, no residues of thiamethoxam or clothianidin were detected in nectar. However, control pollen from blossom contained residues of thiamethoxam in two samples at 0.0013 and 0.0044 mg/kg. Overall, the control contamination of pollen introduces some uncertainty with respect to possible exposure of bees to thiamethoxam in the control hives. The lack of residues detected in	2364985

Study type / Application method / Species	Study Methodology	Study Summary and Considerations	Reference (PMRA#)
	observed on days 3, 13, and 49 after treatment. The brood condition in all 6 test colonies included strength, presence of queen, the pollen and nectar storage area, and the area with eggs, larvae and capped cells. Weight of the colonies Residue samples: Yes. Pollen was collected from pollen traps located at one hive on days 4, 5, 6 and 9 and pollen was also collected from control and treatment plant blossoms on days 7 and 8. Honey was collected from one hive from the control and treatment group. Location: Argentina Year: 2001	the plants and bees at the treatment sites indicates a lack of exposure.	

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	Citation
APIS			
2 - Open Feeding Study Artificially fed hives with spiked pollen in open field for 12 weeks (2015) NOTE: This is the second year of a two year study. The first year of the study examined residues of neonicotinoids in various bee related matrices in corn and soybean regions of Ontario and Quebec. Honey bee	Test crop: N/A Test item: clothianidin (99% purity) Test species: *Apis mellifera* Application rate: Every 2-3 days (Mon, Wed, Fri) each colony received 200 g artificial pollen patty (56% FeedBee pollen supplement, 33% sugar syrup and 11% water) between chambers. Treatment hives were given pollen spiked with clothianidin as follows: 4.9 ppb (week 1), 4.2 ppb (week 2), 3.3 ppb (week 3), 2.2 ppb (week 4) and 2.0 ppb (weeks 5-12). Control hives received untreated pollen patties. Number of hives tested: 5 control and 5 treated hives were tested at a single apiary (located >>3 km away from agriculture) for a total of 10 hives. Test hives were disease free and contained two deep chambers (bottom brood/food stores, top empty	**REVEW:** The purpose of this study was to determine how chronic sub-lethal exposure to clothianidin influences the health of honey bee colonies. Colonies fed an artificial pollen diet containing declining concentrations of clothianidin (2.0-4.9 ppb) over a period of 12 weeks demonstrated a decline in hygienic behavior (removal of dead capped brood) and increased queenlessness over time relative to controls. Workers that were exposed to clothianidin as larva had a 23% reduction in age to last foraging flight relative to controls and exhibited a different flight pattern (time, duration) relative to controls. The results suggest that exposure to clothianidin in pollen at field realistic doses adversely effects worker behavior and colony health. **MAJOR UNCERTAINTIES:** Colonies were not treated with any chemicals to control pests and disease and no assessment was made to determine the level of infection within test hives. There is no indication whether robbing took place or whether measures were taken to prevent robbing. As treatment and control hives were in the same apiary and residue analysis of in-hive matrices were not conducted, it is not possible to determine whether control hives were exposed to clothianidin. Exposure from nectar source not investigated. No description of the surrounding vegetation within a 2-5km radius of the hives was provided to account for foraging exposure outside of the artificial feeders and a palynological analysis was not conducted in the year of the study. The study authors assume that the cessation of foraging flights corresponds with forager mortality; however bee mortality was not directly observed. While typically the final task performed by workers before their	Tsvetkov, N., O. Samson-Robert, K. Sood, H. S. Patel, D. A. Malena, P. H. Gajiwala, P. Maciukiewicz, V. Fournier, A. Zayed. 2017. Chronic exposure to neonicotinoids reduces honey bee health near corn crops. Science 356, 1395–1397.

Study type / Application method / Species	Study Methodology	Review Comments	Citation
	frames). Honey supers were added as needed. Exposure period: 12 weeks (June 1-August 24) Observation period: 12 weeks (June 1-August 24) Effect parameters: queen mortality, hygienic behavior, flight duration and number of flights, worker age at last flight Location: Ontario, Canada Year: 2015	death is foraging, workers may revert to other tasks within the colony. While supersedure tends to take place in late spring and summer, supersedure can occur anytime from early spring through to late fall. As the experiment ended in August, it is uncertain whether treated hives would have gone on to rear replacement queens before the overwintering period. The size of colonies at the start of the study was not reported. Colony strength measurements such as number of adults and brood and colony overwintering survival were not investigated in this study and therefore it is not possible to establish whether the adverse effects on worker behavior and colony health observed in this study would have had long-term impacts on colony survival.	
2 - Open Feeding Study Individual pollen foragers were captured, fed thiamethoxam at 1.34 ng/bee (67 ppb), tagged with RFID tags, and released away from the hive and monitored for return flights for 5-7 days. Honey bee	Test crop: *Experiment 1-3:* hives placed in area after oilseed rape bloom and before maize and sunflower *Experiment 4:* hives placed in a suburban area with mixed farming fields and orchards Test species: *Apis mellifera* Application rate: individual pollen foragers were captured, fed beekeeping candy, fasted for 90 min, and then fed with a pipette 20 µL of 50% (w/w) sucrose solution containing thiamethoxam at 1.34 ng/bee (67 ppb) for 40 min before experimentation. *Experiment 1:* foragers were released 1 km away from hives in a familiar location *Experiment 2:* foragers were released 1 km away from hives at random locations *Experiment 3:* foragers were released 70 m from hive *Experiment 4:* foragers were released 1 km from hives in a complex suburban environment Number of hives tested: 653 bees from 3 hives (one hive for Experiment 1 and 2, one hive for each Experiment 3 and 4) Exposure period: one time feeding for 40 min Observation period: 5-7 days Effect parameters: mortality, forager return rate (homing probability), number of released foragers, population modelling Location: France Year: 2011	**REVIEW:** A significantly lower proportion of treated bees returned to colonies when compared to control when bees were released 1 km away from a familiar or random location; a numerically higher percentage of bees failed to return when released at random locations than from a fixed familiar location. This homing data was then included in the Khoury et al (2011) honey bee population dynamic model where results suggested that hive populations would fall to an unsustainable level of 5,000 bees after one month of daily exposure. However, re-analysis of the model resulted in wide ranging results illustrating the unpredictability of using modelling data in risk assessment. **MAJOR UNCERTAINTIES**: The failure of a bee to return during a homing flight was scored as mortality but may have been due to drift, etc. The modeling conducted by the authors relies on the bees foraging exclusively on a source of nectar containing residues equivalent to those used in the study.	Henry, M., *et. al.* 2012. A Common Pesticide Decreases Foraging Success and Survival in Honey Bees. Science 336, 348; DOI: 10.1126/science.1215039 AND Cresswell, J.E and H. M. Thompson. 2012. Comment on "A Common Pesticide Decreases Foraging Success and Survival in Honey Bees." Science 337, 1453; DOI: 10.1126/science.1224618 AND Henry, M., *et. al.* 2012. Response to Comment on "A Common Pesticide Decreases Foraging Success and Survival in Honey Bees." Science 337, 1453; DOI: 10.1126/science.1224930

Study type / Application method / Species	Study Methodology	Review Comments	Citation
2 - Open Feeding Study Pollen trapped hives were fed spiked pollen patties (55% honey bee pollen, 5% yeast, 40% sucrose) three times/week that contained both 5.31 µg thiamethoxam/kg and 2.05 µg clothianidin/kg for 46 days; 400 g of pollen patty was provided at each week for a total of 8 kg/colony. Honey bee	Test crop: N/A; hives placed near a rural area outside if Zurich Test species: *Apis mellifera carnica* (Strain A; sourced from an agricultural area) and *Apis mellifera mellifera* (Strain B; sourced from an Alpine region) Application rate: 400 g of pollen patties (55% pollen, 5% brewer's yeast and 40% sucrose) was fed 3 times/week to hives containing both 5.31 µg thiamethoxam/kg and 2.05 µg clothianidin/kg; a total of 8 kg/colony was provided; prior to overwintering the hives were fed 12.5 kg of untreated sugar syrup during late July and late August 2011 (25 kg in total). Number of hives tested: 12 colonies were set up at the same apiary into a treated and untreated group; groups were separated by 20 m and a small clump of bushes Exposure period: 1.5 months (46 days) from mid-May to June Observation period: mid-May 2011 until June 2012 Effect parameters: number of adult bees, capped and uncapped brood, amount of honey and pollen stores, amount of trapped pollen; colony condition assessments occurred mid-May 2011 before treatment (CCA1), beginning of July 2 days after exposure was over (CCA2), mid-October 3.5 months after exposure (CCA3), overwintering success was measured in March 2012, late April long-term effects were measured (CCA4), and queens and swarms were monitored until June 2012 Residue samples: pollen trapped during the experiment, forager bees, pupae close to emergence, wax, bee bread, honey Location: Zurich, Switzerland Year: 2011-2012	**REVIEW:** After 2 days of feeding on pollen patties spiked with 5.31 µg/kg of thiamethoxam and 2.05 µg/kg of clothianidin, there were significantly lower numbers of adult bees, brood and stored honey in the exposed hives compared to the control. All control queens remained in the hive, whereas 60% of queens in the treatment group were superseded within a year. After overwintering, 90% of control hives swarmed, whereas only 20% of treatment hives swarmed. Treatment related effects were stronger in the *A. mellifera mellifera* strain when compared to the *Apis mellifera carnica*. **MAJOR UNCERTAINTIES**: Since only one concentration was tested, a NOEC and LOEC value would not be determined for this study. Exposure combined two active ingredients which affect the usefulness of this study in the clothianidin risk assessment but not necessarily the thiamethoxam since it contains parent and degradate compounds. No details were provided about the forage surrounding the test apiary location. The *A. m. carnica bees* population were stated to have come from an area characterized by intense agriculture yet there was no screen of potential pesticide exposure before feeding began.	Sandrock C, Tanadini M, Tanadini LG, Fauser-Misslin A, Potts SG, Neumann P. 2014. Impact of chronic neonicotinoid exposure on honeybee colony performance and queen supersedure. PLoS ONE 9(8):e103592.

Study type / Application method / Species	Study Methodology	Review Comments	Citation
2 - Open Feeding Study Hives were fed daily for a total of 36 days with 100 g spiked pollen patties (3:1; pollen:honey) that contained 4.16 and 0.96 ppb for thiamethoxam and clothianidin, respectively; hives were fitted with pollen traps to encourage pollen patty consumption. Honey bee	Test crop: N/A Test species: *Apis mellifera* Application rate: 100 g pollen patties (3:1 ratio of pollen and honey) spiked with 4.16 ppb of thiamethoxam and 0.96 ppb of clothianidin were fed daily to test hives for a total of 36 days Number of hives tested: 6 sister queen experimental colonies established in May resulted in 29 neonicotinoid and 28 control queens; The original sister queens were removed from colonies 27 days after exposure to create queenless nuclei, each composed of 2 food frames and 1 kg brood nest workers. One-day old larvae from each colony were grafted into artificial queen cells and subsequently placed in nuclei overnight. Contents of each cell-building nucleus, including artificial queen cells, were returned to their original experimental mother colony the following day to ensure proper queen development; colonies continued to receive pollen supplements until after queen cell-capping. Prior to emergence, queens were transferred to cages supplied with a food paste (1 part honey: 3 parts powdered sugar by mass) that were maintained in the laboratory. Emerged queens were visually inspected, numbered on the dorsal thoracic plate using queen marking numbers, and re-caged with five attendant workers from her mother colony during the expected period of queen emergence (~1 day). Subsequently, each queen was placed in a mating nucleus hive with 300 g apiculture candy and 100 g brood nest workers from her original mother colony, and confined for 3 days in darkness to promote colony formation prior to placement outdoors. Exposure period: 36 days Observation period: Queen cells were observed every 6 hours starting 11 days	**REVIEW:** Significant treatment effects on queens were seen when they were exposed to pollen patties containing 4.16 and 0.96 ppb of thiamethoxam and clothianidin, respectively. By 4 weeks after queens emergence 25% fewer neonicotinoid queens were alive compared to controls. Queens that survived had significantly fewer eggs (34%), stored spermatozoa (20%) and proportion of stored living sperm (9%). These queens also had significantly larger ovaries by 6.8%. No treatment effects were seen on the number of queens being reared or on any measured flight parameters. **MAJOR UNCERTAINTIES:** Only one concentration was tested and it combined two active ingredients. The amount of pollen patty consumed was not quantified and the authors noted that the bees never consumed the entire daily allotment. There was no mention if sucrose syrup was provided so our review has assumed that nectar was provided via foraging. Pollen and honey used in the pollen patties were bee-collected from non-intensive agricultural areas in Switzerland. Dose verification was conducted on the pollen patties but residues from in-hive storage products (i.e. honey, bee bread) was not conducted.	Williams, G.R., A. Troxler, G. Retschnig, K. Roth, O. Yanez, D. Shutler, P. Neumann, L. Gauthier. 2015. Neonicotinoid pesticides severely affect honey bee queens. Scientific Reports. 5:14621. DOI: 10.1038/srep14621

Study type / Application method / Species	Study Methodology	Review Comments	Citation
	post-grafting. Effect parameters: daily queen flights, presence of queens and developing workers, queen dissections Location: Bern, Switzerland Year: 2013		
2 - Open Feeding Study Honey bee colonies were fed 100 g of pollen paste that was either treated or untreated for 50 days; however after 38 days the queens were caged on organic drone or worker brood frames for 48h still within the experimental colonies. The resulting drone and worker brood were reared by worker bees that were exposed, and presumably fed the brood with contaminated pollen paste. Test drone and worker bee brood was removed and placed in an incubator about 24 hours prior to emergence. After emergence, drone and worker bees were then captured and placed in bioassay cages to be observed for effect parameters. Honey bee	Test crop: surrounding vegetation not stated Test species: honey bee Application rate: 100 g pollen paste (60% honeybee corbicular pollen, 10% organic honey + 30% powder sugar) was provided daily as per Williams et al., 2015; total = 100 g x 50 days = 5.0 kg of pollen paste provided; all hives were pollen trapped *Treated hives:* 4.9 ppb thiamethoxam + 2.1 ppb clothianidin (C.E. = 6.3 C.E. ppb) was added to pollen paste (dose verification confirmed these amounts) Number of bees tested: 20 colonies (each colony contained one laying sister queen, 1.8 kg of workers in 5 Dadant frames). Note: organic wax foundation for worker and drone cells were used in the study for rearing test bees. *Source of drone and workers:* After 38 days of pollen paste feeding, queens were caged for 48h on a drone brood frame followed by a worker brood frame to obtain same age cohorts of both bee castes: 6 cages/colony contained 10 newly emerged drones and 20 newly emerged workers (TOTAL = 60 drones per treatment) were maintained until all drones died and fed every 72 h with 50% sucrose solution and pollen paste (60% fresh corbicular pollen + 40% sugar powder) *ad libitum* Cage and laboratory conditions: 34.5°C, 60% relative humidity, under darkness. After 8 days, cages were exposed to natural light for 1 hour to promote and imitate initial orientation flight. Exposure period: based on the information provided it is assumed that the pollen paste	**REVIEW:** Because of this exposure scenario, it is difficult to interpret the results since effects could be attributed to both queen and drone pollen paste exposure through exposed workers who facilitated the queen and drone brood feeding. Significant effects were seen in declining drone survival/longevity for up to 14 days (the point of drone sexual maturity), an increase in median drone mortality, a decrease in sperm viability and the total amount of living sperm. No effects were seen in the drone weight immediately after emergence, the total amount of sperm, or worker survival. **MAJOR UNCERTAINTIES:** With pollen traps in place, the pollen exposure contamination is expected to be minimal. The amount of the pollen paste "patties" consumed was not quantified. There appeared to be large variation in the control data for the sperm assessments. The exposure scenario is unclear in this study. It appears that the colonies with the queens were fed for 50 days however; the queens were removed to begin laying drone and workers after only 38 days of feeding exposure. Afterwards, the reviewer assumed the drone and worker brood were reared by worker bees that were exposed to and fed the contaminated pollen paste to the test bees. Because of this exposure scenario, it is difficult to interpret the results since effects could be attributed to both queen and drone pollen paste exposure through exposed workers who facilitated the queen and drone brood feeding. Only one concentration was tested. The study authors did not measure thiamethoxam and clothianidin residues in bee matrices relevant to the queen (i.e., royal jelly).	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

Study type / Application method / Species	Study Methodology	Review Comments	Citation
	feeding occurred for 38 days before the queens were removed to lay drone eggs for 48 h and then lay worker eggs for 48h; next, the test drone and worker brood was presumably fed contaminated pollen paste by colony nurse bees for the remaining 8 days or until cells were capped. Total exposure period was 50 days. Observation period: from drone and worker emergence until death (control maximum age = 984 hours (41 days); treated maximum age = 648 hours (27 days)) Effect parameters: drone and worker mortality (assessed every 24 hours), drone weight after emergence, total sperm quantity and sperm viability (percentage living versus dead), and total living sperm quantity (calculated by multiplying total sperm quantity by sperm viability) was assessed after 14 days in the observation cages Residues: dose verification prior to experimentation Location: Bern, Switzerland Year: April – May 2015		
3 – Field Seed treatment Honey bee	Test crop: corn Test species: honey bee hives Application rate: corn seed treated with Cruiser (350 g/L) at 0.11 mg/seed; calculated by reviewer by using 7.35 g a.i./ha and 70,000 seeds/ha were planted); corn seeds were also dressed with fludioxonil (25 g/L) and metalaxyl-M (10 g/L) Number of hives tested: 2 treated hives (located at the field hedge boundary of 7 ha test field) and 4 control hives (located inside a farm garden approximately 200 m away from test field); all hives in place before seeds were planted Exposure period: seeds were planted on 24 June and hives were already in place (up to 17 days, may have included exposure to	**REVIEW:** At corn planting, hives exposed to planting of 0.11 mg a.i./seed showed an increase of mortality from an average of 21.3 before seed planting to an average of 45.5 on the day of planting. No changes in mortality were seen in the control hives on the day of seeding. The day after corn planting, the mean number of foragers dropped to 9.3 bees in the exposed hives and 23 in unexposed. Fifteen days after planting the control foraging numbers recovered to pre-planting numbers and in the exposed hives one hive recovered and the other did not providing conflicting results. **MAJOR UNCERTAINTIES:** The control hives were not exposed to untreated seed planting, they were only situated in a garden 200 m away from the treated seed planting and separated by a vegetative barrier. The location of the control hives was within foraging distance of the test crop. Pollen was not trapped from foragers to confirm exposure occurred.	Tremolada P., Mazzoleni M., Saliu F., Colombo M. and Vighi M. 2010. Field trial for evaluating the effects on honeybees of corn sown using Cruiser® and Celest XL® treated seeds. Bull Environ Contam Toxicol 85(3):229-234

Study type / Application method / Species	Study Methodology	Review Comments	Citation
	beginning of corn tasselling) Observation period: observations were collected from 22 – 24 June, 3 and 9 of July (up to 17 days, may have included exposure to beginning of corn tasselling) Effect parameters: mortality, foraging activity Location: Milan, Italy Year: 2008		
3 - Field Seed treatment Honey bee	Test crop: Maize and oilseed rape (multi exposure study) Test species: Honey bee hives 4 438 to 22 875 bees per colony (and split in late spring) Test chemical: A9700B and A9638A, a formulation containing thiamethoxam (350 g/L), fludioxonil (25 g/L), and metalazyl (10 g/L) Application rate: 0.85 mg ai/seed (maize), 0.03 mg ai/seed (spring barley) and 0.02 mg ai/seed (oilseed rape). Number of hives tested: 6 colonies each year for control and treatment fields (not true replicates). Plot size: 2-3 ha Exposure and observation period: 4 years Effect parameters: Mortality (in front of hives on linen sheets and dead bee traps) observed daily, foraging activity (number of bees entering, and leaving the hive over 1 minute, and foraging or flying around marked flowering plants) during the day until late afternoon, and behaviour of the bees and the condition of the colonies were assessed during the period of flowering (up to BBCH 69). Assessments of brood development were done once before the start of exposure and once at the end of exposure. During these assessments samples of bees and brood combs were taken for bee disease and virus analysis. Bee Colony health and strength: -estimate of adult worker bee numbers based on Liebefeld method.	**REVIEW:** A study by Pilling et al. (2013) was published in the open literature that contained some data that was already submitted by the registrant and reviewed. In the open literature, the Pilling et al. (2013) publication was openly debated among researchers in Hoppe et al. (2015) and Campbell et al. (2015). The Pilling et al. (2013) authors concluded that median residues of thiamethoxam in pollen collected from honey bees after foraging on flowering seed treated maize were found at 1-7 µg/kg, median residues clothianidin were 1-4 µg/kg. In oilseed rape, median residues of thiamethoxam found in pollen collected from bees were1-3.5 µg/kg and in nectar from foraging bees were between 0.65-2.4 µg/kg. Median residues of clothianidin in pollen and nectar in the oilseed rape trials were all below the LOQ=1 µg/kg. Residues in the hive were even lower in both the maize and oilseed rape trials, being at or below the LOD=1 µg/kg for bee bread and at or below the LOD 0.5 µg/kg for hive nectar, honey and royal jelly samples. Throughout the study, mortality, foraging behavior, colony strength, colony weight, brood development and food storage levels were similar between treatment and control colonies. Detailed examination of brood development throughout the year demonstrated that colonies exposed to the treated crop were able to successfully overwinter and had a similar health status to the control colonies in the following spring. The authors concluded that these data demonstrate there is a low risk to honey bees from systemic residues in nectar and pollen following the use of thiamethoxam as a seed treatment on oilseed rape and maize. In the maize trials, pollen collected on individual sampling days at the hive entrance varied from 0 to 82% in the treatment and 0 to 55% in the control over the 4 year study period. Hoppe et al 2015 criticized the study for a number of parameters including short duration period, application rates, presentation of data, lack of analysis for other pesticides in pollen and/or nectar, and distance between control and treatment sites. Following the criticism, Campbell et al 2015 responded with clarifications related to the data and study design.	Pilling, E. P. Campbell, M. Coulson, N. Ruddle and I. Tornier. 2013. A four-year field program investigating long-term effects of repeated exposure of honey bee colonies to flowering crops treated with thiamethoxam. PLoS ONE 8(10): e77193. doi:10.1371/journal.pone.0077193 AND Hoppe, P.P., A. Safer, V. Amaral-Rogers, J.-M. Bonmatin, D. Goulson, R. Menzel and B. Baer. 2015. Effects of a neonicotinoid pesticide on honey bee colonies: a response to the field study by Pilling et al. Environ. Sci. Eur. 27: 28 DOI 10.1186/s12302-015-0060-7. AND Campbell, P., M.Coulson, N. Ruddle,

Study type / Application method / Species	Study Methodology	Review Comments	Citation
	-presence of healthy egg laying queen -estimate of the pollen storage area and area with nectar -estimate of area containing eggs, larvae and capped cells -weight of colony -indicators of bee diseases. Residue samples: Yes. Samples of plants, pollen taken directly from plants and forager bees were collected for residue analysis. Furthermore, pollen samples from pollen traps were collected for pollen source identification. Location: Various locations in Europe Year: 2006 to 2009		I. Tornier and E. Pilling. 2015. Authors' response on Hoppe et al. (2015) "Effects of a neonicotinoid pesticide on honey bee colonies: a response to the field study by Pilling et al. (2013)." Environ Sci Eur (2015) 27-28. Environ. Sci. Eur. 27:31 DOI 10.1186/s12302-015-0064-3
3 - field Seed treatment Honey bee	Test crop: winter oilseed rape Test species: *Apis mellifera* hives Application rate: oilseed rape seeds were treated with Cruiser OSR (thiamethoxam 420 g/100 kg seed; 0.02 mg a.i./seed); one test field and two control fields Number of colonies tested: 36 colonies; 12 colonies/field with 3 apiary sites/field at distances of on-field, 0.5 km and 1 km away; 273 bees were tagged in each of the 36 colonies in 3 consecutive cohorts of newly emerged bees (<24 h old) approximately 1 week apart (100 bees/colony were tagged for the first 2 cohorts and 73/colony for the final cohort). Exposure period: approximately 5 weeks of flowering (16 May–20 June 2013; 35 days). Observation period: foraging observations collected from 16 May - 20 June 2013; one disease assessment, using a molecular screen of sampled RNA and DNA, occurred post-exposure Effect parameters: foraging activity, RFID tracked foraging behaviour, pollen analysis, bee disease monitoring Residue analysis: crop pollen and nectar from the field Location: Lincolnshire, UK	**REVIEW:** Although there were no obvious trends between the control and treated groups across the three tested distances from the fields, there were some indications of a potential slight negative influence of the treated field on mean foragers life span, total flying days and mean trip durations and mean total flying time per bee for foragers from hives at 1 km from the treated field. No such trends were evident for foragers that did not have to travel as far from their hives (on-field and hives at 0.5 km). However, the data and study design is not robust enough to conclude whether these differences are treatment-related. **MAJOR UNCERTAINTIES:** Up to 50% of bees from each colony were recorded as exiting but not returning to the colony within the study period (e.g., if they drifted to another colony within the same apiary site), and these were defined as "lost". Drifted and lost bees were not included in the data analysis. There was only 1 treatment replicate.	Thompson, H.,M. Coulson, N. Ruddle, S. Wilkins, S. Harkin. 2016. Thiamethoxam: Assessing flight activity of honeybees foraging on treated oilseed rape using radio frequency identification technology. Environmental Toxicology and Chemistry, Vol. 35, No. 2, pp. 385–393, 2016

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	Year: 2012-2013: Seeds sown October 2012, observations collected in 2013		
3 - Field 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. 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, beebread, honey, bees Location: Poland Year: 2010 (winter oilseed rape) and 2012 (spring oilseed 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 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 beebread (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 beebread) 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 beebread) 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.	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 materials from oilseed rape crops and their effect on bee colonies. Journal of Apicultural Science. 56(2): 115-133.

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		MAJOR UNCERTAINTIES: Other toxic pesticides were also applied to the treatment fields. The different detection sensitivity of 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.	
3 - Field Seed treatment Guttation water exposure Honey bee	Test crop: winter oilseed rape Test species: *Apis mellifera* hives Application rate: *2009:* 1 field planted with Cruiser OSR (0.0185 mg thiamethoxam/grain); 2 fields planted with Elado + TMTD Satec (0.04 mg clothianidin/grain) *2010:* 2 fields planted with Elado + TMTD Satec + DMM (0.044 mg clothianidin/grain) *2011:* 1 field planted with Cruiser OSR (0.0158 mg thiamethoxam/grain) Number of colonies tested: hives were 15,000-17,000 bees in size; *2009:*6 hives on 1 field of Cruiser OSR; 6 hives/field on 2 fields of Elado + TMTD Satec *2010:* 6 hives/field on 2 fields of Elado + TMTD Satec + DMM *2011:* 16 hives on 1 field of Cruiser OSR Exposure and observation period: Presumed by the reviewer to be: *2009 S. Germany:* Aug. – Dec. 2009 *2010 S. Germany:* Jan. – May 2011 *2011 N. Germany:* Aug. – Sept. 2011 Effect parameters: *2009 (thiamethoxam and clothianidin):*observation of occurrence of guttation in crop, residual analysis of guttation fluid *2010 and 2011:* observation of occurrence of guttation in crop, residual analysis of guttation fluid, observations of water-collecting honey bees on crop guttation and residual analysis of honey-sac contents Location: Southern and Northern Germany sites Year: 2009 - 2011	**REVIEW:** This study indicated that guttation in winter oilseed rape occurs regularly between the flush of first leaves through to winter dormancy, during winter very low volumes of guttation were observed and the following spring, guttation continued up to the end of flowering. Residues levels were higher in the Southern Germany sites (70-130 µg clothianidin/L) in first leaves when compared to the Northern sites (<19 µg a.s/L of both clothianidin + thiamethoxam). In Southern Germany, the highest residue levels were seen in autumn after planting and declined during winter dormancy. Residues of clothianidin were not detected in any honey-sacs from the bees located in the Southern Germany fields, in Northern Germany residues of thiamethoxam were detected in 38/141 (19%) of honey sac samples at levels of 0.3 – 0.95 µg/L and residues of clothianidin was detected in one sample at 0.13 µg/L. There were no detections of the clothianidin metabolites in the honey-sacs. The authors attributed the differences between the residue results between the Northern and Southern sites to the fact that in the North, the field location was in an intensive agriculture area where no alternative water sources were present while in the South, there were a lot of alternative water sources available to bees outside of guttation water. As a result, the authors felt that this study supported the conclusion that in a landscape with alternate water sources, guttation fluid of seed-coated winter oilseed rape does not represent an unacceptable risk to water-foraging honey bees. **MAJOR UNCERTAINTIES:** There were no control fields sampled for this study. The date of planting was not clearly stated, nor was the date of hive introduction to the fields or the length of flowering exposure/guttation leaf exposure. The main difference between the two study sites was the intensity of the winter oilseed rape cultivation: Hohenheim (South) presented a more structured landscape, which provided alternative water foraging areas for honey bees, whereas the honey bees in Roggendorf (North) were forced to forage water exclusively in winter oilseed rape. In order to increase the honey bees' water demand and for stimulating the water foraging activity, some sugar paste feed occurred but the details of when and how much were not stated. The LOD was not accurately stated for clothianidin, thiamethoxam or the TZMU or TZNG metabolites.	Reetz J.E., W. Schulz, W. Seitz, M. Spiteller, S. Zühlke, W. Armbruster and K. Wallner. 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

Study type / Application method / Species	Study Methodology	Review Comments	Citation
3- Hive Monitoring Residues from hives placed in open commercial fields for 20 weeks Honey bee	Test crop: N/A Test species: *Apis mellifera* Test sites: Honey bee colonies were randomly allocated to 5 apiaries close to commercial corn and soy crops (<500 m, hereafter called exposed sites) or 6 apiaries away from agriculture (>3 km, hereafter called unexposed sites). The study occurred after Health Canada mandated the use of seed-fluency agents while planting NNI-treated seeds, but before the Province of Ontario's regulation to reduce the use of NNI-treated seed took effect. Number of hives tested: 5 healthy, queen right hives (standard 10 frame Langstroth hive) were placed into each exposed (5 apiaries) and unexposed (6 apiaries) site for a total of 55 hives. Exposure period: 5 months (May-September) Observation period: 5 months Effect parameters: hygienic behavior, palynological analysis Residues: dead bees, pollen and nectar foragers, nurse bees, old larvae, freshly deposited pollen and nectar from hive comb. Samples from each colony were pooled per site. There were 6 sampling periods including (1) early May (pre-plant), (2) late May (post-plant Ontario, pre-plant Quebec), (3) June (post-plant Quebec, (4) July, (5) August and (6) September for a total of 36 samples/site. Location: Ontario and Quebec, Canada Year: 2014	**REVIEW:** The purpose of this study was to quantify typical levels of neonicotinoid insecticides (NNIs) and other pesticides in honey bee colonies placed near or far away from corn and soybean in Ontario and Quebec in 2014. Hygienic behavior was also observed during the study. Twenty-six different pesticides were detected in samples including miticides (n=91 samples), fungicides (n=64), herbicides (n=19) and insecticides (n=62) including neonicotinoid insecticides (NNIs) (n=49/62). Of the 396 samples taken over the 5 month period, 64% had no detectable residues of any pesticide (51% of samples from exposed sites (92 ND of 180 samples) and 75% of samples from unexposed sites (163 ND of 216 samples)). NNIs including clothianidin, thiamethoxam, imidacloprid and acetamiprid were not detected in 81% of samples taken from exposed sites (146 ND of 180 samples) and 97% of samples from unexposed sites (210 ND of 216 samples). Clothianidin residues were detected in 26 of 396 samples predominantly in pollen samples and from exposed sites (exposed: 20/180; unexposed: 6/216). The average detectable amount of clothianidin ±SD from exposed and unexposed sites was 4.27 ± 2.8 ppb (max 11.5 ppb) in pollen (exposed sites: 4.52 ±2.97 ppb, n=10/30 samples; unexposed sites: 3.78 ±2.83 ppb, n=5/36 samples), 0.55± 0.49 ppb (max 0.9 ppb) in nectar (exposed sites: n=2/30 samples; unexposed sites: 0/36 samples), 0.2 ppb in larvae (exposed sites: n=1/30 samples; unexposed sites: 0/36 samples), 0.5 ppb in foragers (exposed sites: n=1/30 samples; unexposed sites: 0/36 samples) and 3.5 ± 3.2 ppb (max 9.2 ppb) in dead bees (exposed sites: 4.03±3.08 ppb, n=6/30 samples; unexposed sites: 0.07 ppb, 1/36 samples). Clothianidin was not detected in nurse bees. Clothianidin residues were detected in sampling periods 1-4 for pollen, 4-5 for nectar, 2 for foragers and larvae and 1-3 for dead bees. Thiamethoxam residues were detected in 14 of 396 samples predominantly in pollen samples and from exposed sites (exposed: 11/180; unexposed: 3/216). The average detectable amount of thiamethoxam ±SD from exposed and unexposed sites was 3.5 ± 2.6 ppb (max 9.6 ppb) in pollen (exposed sites: 3.24 ± 2.39 ppb, n=11/30 samples; unexposed sites: 4.23 ± 3.87 ppb, n=3/36 samples) and 2.65± 2.2 ppb (max 4.2 ppb) in nectar (exposed sites: 2/30 samples; unexposed sites, 0/36 samples). Thiamethoxam was not detected in dead bees, foragers, nurse bees and larvae. Thiamethoxam residues were detected in sampling periods 1-5 for pollen and 3-4 for nectar. Imidacloprid was detected in a single forager bee sampled from an exposed site in early May (0.6 ppb) and not detected in any of the other sampling matrices including dead bees, nurse bees, larvae or freshly deposited pollen and nectar from hive comb. Overall, colonies near corn and soy were exposed to sub-lethal levels of NNIs for 3-4 months of the active season. Most pollen came from non-crop plants other than corn and soy. Pollen containing NNIs was almost always derived from non-target plants and very rarely (i.e. <1%) from corn or soy. Hygienic behavior was adversely affected in colonies placed near corn and soy. Exposed colonies near corn and soy (n=25) had significantly lower hygienic behavior (uncapped/removal of dead capped brood) relative to unexposed colonies (n=25) at the end of the season ($F_{(1,48)}$=6.42, p=0.015, n=50). **MAJOR UNCERTAINTIES:** The relationship between neonicotinoid insecticides and adverse effects on hygienic behavior observed in hives placed near corn and soy is confounded by the detection of other pesticides in residue samples, including other insecticides. Unexposed sites were	Tsvetkov, N., O. Samson-Robert, K. Sood, H. S. Patel, D. A. Malena, P. H. Gajiwala, P. Maciukiewicz, V. Fournier, A. Zayed. 2017. Chronic exposure to neonicotinoids reduces honey bee health near corn crops. Science 356, 1395–1397.

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		reported to be >3 km away from agricultural crops; however, honey bee flight range can extend beyond this distance. It is unknown if surrounding crops were treated with pesticides although for corn and soy it is assumed that seed treatment applications with neonicotinoids were made. It is noted that the field study was not designed to determine the effects of exposure on bees but rather the magnitude of exposure of agrochemicals using honey bee colonies as environmental sentinels.	
3 - Monitoring Honeybee, 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 (reproduction and survival), and also expression of residues. This study assessed interactions between locations, seed treatment and residues. Honey bee, Bumble bee, and Solitary bee	**Study Methodology** Test crop: Winter sown oilseed rape Test species: 1. Honey bees and 2. Bumble bees (*audax* (UK) or *terrestris* (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 ai/ha in UK, 18.05 g ai/ha in Germany and 17.71 g ai/ha in Hungary. 2. Thiamethoxam, Cruiser (field application of 10.07 g ai/ha in UK, 10.61 g ai/ha in Germany and 11.14 g ai/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: 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 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. terrestris. 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.		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 effects of neonicotinoid pesticides on honey bees and wild bees. Science 356, 1393-1395.

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	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 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. **Review Comments** **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 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 oil seed 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 bumblebees, 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 combined residues (clothianidin, thiamethoxam and imidacloprid). When excluding sites	

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	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 scientists criticisms indicate that data was omitted from the article. The review of this study is based on submitted data and the article.**		
3 - Hive monitoring Colonies were placed in apple orchards in the field during bloom to examine bee bread, and foraging habits. Honey bee	Test crop: Apple orchards (during typical pollination services) and surrounding landscape . Test species: Honey bees Application rate: The application rate and type was not reported (only the compound and number of applications was supplemented to the article in Table S3). **Thiamethoxam was applied 2 times during bloom in one of the 30 orchards.** Sites had between zero and 14 products sprayed. The study was a monitoring study (for foraging and residues in bee bread) resulting from typical apple orchard pollination. Number of hives tested, and exposure period: 120 colonies in 30 apple orchards during the bloom period (May 7 to 11). Hives were purchased from a local commercial beekeeper. Replicates: 4 colonies in each of total 30 orchards. Residue collection: Bee bread was collected after the bloom period (May 16 to 22) for pesticide analysis. Pollen identification: yes Landscape characterization: yes (natural	**REVIEW:** Following exposure of hives in apple orchards during bloom (from typical pollination services in the New York), Imidacloprid and clothianidin were not detected in bee bread. Although thiamethoxam was detected at 21 ppb, other insecticides and fungicides were detected at much higher levels. Although fungicides represented the majority of the residues which were detected, there was more potential calculated risk from insecticide exposure. Dominant pollen type in hives was buckhorn which comprised 38.6% of pollen, followed by apple pollen which only comprised 8.7% of pollen. The study indicated that the majority of pesticide exposure was not related to spraying apple orchards, but rather from non-focal plants in the surrounding landscape. **MAJOR UNCERTIANTIES:** This study represents a monitoring type study with limited use information. The application rate and type was not reported (only the compound and number of applications was supplemented to the article in Table S3). It is unknown if surrounding crops were treated with pesticides. It is unknown if hives were exposed to other pesticides prior to placement in the orchard, however, if bee bread is typically processed within 96 hours in the hive, then the residues likely represent recent exposure. Since colony effects were not measured, it is unsure how these pesticide levels would have impacted the hives. This also focuses on the acute endpoints, not chronic exposure or endpoints for the PHQ calculations, although there was mention of a comparison to the NOEC values in the article. Nectar foraging was not accounted for in this study. Sixty four percent of the pesticides detected in beebread were not sprayed at the respective sites during apple bloom	McArt S., Fersch A., Milano N., Truitt L., Boroczky K. 2017. High pesticide risk to honey bees despite low focal crop pollen collection during pollination of a mass blooming crop. Nature. Scientific reports/7:46554 | DOI: 10.1038/ srep46554.

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	areas included forests, grassland, developed, wetland, fallow and clover/wildflowers; agricultural land was all crops including corn, soybeans, barley, wheat, rye, oats, alfalfa, hay, buckwheat, beans tomatoes etc.) Effect parameters: None. The purpose of the study was to examine residues in bee bread and determine foraging habits, and calculate PHQ (Pollen Hazard Quotient) and PUI (Pesticide Use Index) following placement of hives in orchards under typical use scenario. $PUI = \sum_{i=1}^{n} (LD50_i \times \%ai_i \times app\ rate_i)$ PHQ = Total residues (ng/g pollen (ppb)) for each compound divided by the respective honey bee LD50 value (µg/bee). Location: West and Central New York Year: 2015 (Early May)		
3 - Hive monitoring Presumed foliar application 4 apiaries 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 Honey bee	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. 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	**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 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	Calatayud-Vernich P., Calatayud, F., Simó, E., Suarez-Varela, M.M., Picó Y. 2015. Influence of pesticide use in fruit orchards during blooming on honeybee mortality in 4 experimental apiaries. Science of the Total Environment, 541: 33-41. http://dx.doi.org/10.1016/j.scitotenv.2015.08.131

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		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.	
3 - Hive monitoring Seed treatment Honey bee	Test crop: maize Test species: honey bee hives Application rate: maize seed treated with 1.25 mg/kernel of clothianidin (talc was added at 240 cc talc/75 kg of maize seed) Number of hives tested: 8 hives placed along the border of a field that was planted with half treated and half with seed harvested from maize also grown from treated seed assumed to be untreated Exposure period: unknown Observation period: unknown Effect parameters: pollen collection Residue samples: *2010:* soil prior to planting from the surrounding area, waste talc after planting, pollen grains *2011 incident:* dead and alive bees, frames containing nectar and pollen, surface soil near affected hives, dandelion flowers Location: Indiana, USA Year: 2010 for experiment, 2011 for incident	**REVIEW:** Prior to experimentation clothianidin but not thiamethoxam was detected in soil samples. Pollen collection confirmed that bees were exposed to maize pollen with 10/20 samples having detectable levels of clothianidin (LOD=1.0 ppb) and 3/20 samples with detectable levels of thiamethoxam (LOD=0.5 ppb). From the 2011 honey bee incident in the same area, clothianidin was detected in all of the dead/dying bee samples, in the healthy hive and incident hive pollen samples, and in the soil and dandelions near the incidents. Thiamethoxam was only detected in pollen from the healthy and incident hives and in the dandelions near the incidents. **MAJOR UNCERTAINTIES:** This study did not have a clear control where confirmed untreated seed was planted in an area that was not adjacent to treated field plots. Length of time that the hives were placed in the field and that pollen was collected from pollen traps was not clearly stated. The methods to collect the waste talc were not clearly described.	Krupke CH, Hunt GJ, Eitzer BD, Andino G and Given K. 2012. Multiple routes of pesticide exposure for honey bees living near agricultural fields. Plos One 7(1):e29268.
3 - Hive monitoring Seed treatment Honey bee	Test crop: corn Test species: honey bee hives Application rate: corn seed treated with Cruiser (not stated which product) at a rate of 0.125 – 1.67 mg a.i./seed; calculated by reviewer by using 300,000 seeds/kg) Number of hives tested: 4 apiary locations (2 treated and 2 control), each had 8 hives Exposure period: hives were placed in experimental fields on 1 July 2012, flowering started 5 August, 2012, length of flowering period was not stated (assumed to be 2-3 weeks when corn is tasselling) Observation period: 1 July 2012 to 10 April 2013 (approximately 9 months) Effect parameters: AChE gene expression in	**REVIEW:** Significant treatment effects were seen in the AChE gene expression, BQCV infection levels, Varroa mite levels and hive weight gain however, the observations may have weak links to the seed treatment of thiamethoxam in corn field due to the low level of confirmed thiamethoxam exposure and the presence of other pesticides. The interactions between the seed treatment (thiamethoxam) in corn field and the pathogen loads in bees, as well as their effects on the hive health cannot be confirmed in the study. **MAJOR UNCERTAINTIES:** The exact exposure amount is unknown since the seed treatment rates were not recorded for the test fields; only the product applied was known. The acreage information of each cornfield near the test hives was not provided, and an incomplete crop and pesticide use history of the fields was provided with no information on the pesticide use in the surrounding fields. Exposure was low; corn pollen was identified only in five hives out of the 32 total test hives at an abundance of approximately 1% of total pollen. The difference in ACHE gene expression may not totally be attributed to the seed treatment since other pesticides were detected (clothianidin) which may also increase the AChE activity in bees. Colonies overwintered indoors. It is not clear what field the 7 hives were from that did not survive overwintering.	Alburaki M., Boutin S., Mercier P.-L., Loublier Y., Chagnon M., Derome N. 2015. Neonicotinoid-coated Zea mays seeds indirectly affect honeybee performance and pathogen susceptibility in field trials. Plos One.

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	bees, pathogen detection, Varroa mite infestation levels, pollen collection, hive weight, brood development, pathogen and treatment correlation Residue analysis: alive foragers, honey, corn flowers, trapped pollen Location: Quebec, Canada Year: 2012 - 2013		
3 - Hive monitoring Seed treatment Honey bee	Test crop: corn Test species: honey bee hives Application rate: corn seed treated with Cruiser (not stated which product) at a rate of 0.125 – 1.67 mg thiamethoxam/seed (calculated by reviewer by using 300,000 seeds/kg) and Poncho (presumed to be Poncho 600 FS) at a rate of 0.25 – 1.25 mg clothianidin/seed Number of hives tested: 4 apiary locations (2 treated and 2 control); 11 hives were in treated fields and 11 in control Exposure period: hives were placed in experimental apiaries on 10 April 2013 (planting dates were not noted) Observation period: 10 April 2013 to September 2013 (approximately 5 months) Effect parameters: Varroa mite infestation levels, pollen collection, hive weight, brood development Residue analysis: alive foragers, trapped pollen, screened corn pollen Location: Quebec, Canada Year: 2013	**REVIEW:** This study was conducted in 2013 on the 22 remaining colonies of an original 32 tested for the same parameters in 2012 (Alburaki et al. 2015). At the end of the indoor wintering, on 10 April 2013, 22 colonies survived and were divided into the same four apiaries of the previous year and redistributed to four different cornfields' clusters south-west of Quebec. All of the 2012's locations remained the same except for one apiary which was changed since no intensive treated cornfields were available in that area in 2013. Only 22 of the original 32 hives from 2012 survived overwintering and were examined in the experiment a second year. In 2013, significantly higher levels of Varroa mites were seen in the treated hives compared to the untreated; most prominently in the corn flowering period around 15 August 2013. No significant difference in colony weight or brood production was seen over time, although there was a noticeable trend in the treated hives where colony weight increased in May and June and then rapidly decreased from Aug to September when compared to the control hives. Detections of clothianidin in corn pollen occurred in both the treated and untreated apiary samples and thiamethoxam was detected in corn pollen from a control apiary. By the end of the observation period in September 4 treated colonies and 1 untreated colony died. Compared to 2012, exposure was confirmed with a total of 19.6% of the pollen collected over time was from corn. **MAJOR UNCERTAINTIES:** Corn planting and tasseling dates were not stated, the exact exposure period is unknown. It is unclear if planting occurred before or after the hives were placed in the test apiaries. The exact exposure amount is unknown since the seed treatment rates were not recorded for the test fields; only the product applied was known. The acreage information of each cornfield near the test hives was not provided, and an incomplete crop and pesticide use history of the fields was provided with no information on the pesticide use in the surrounding fields. Clothianidin was detected in corn pollen collected from an untreated apiary. No overwintering effects examined in 2013. The health of hives was not stated prior to experimentation. Hives were overwintered in 2012- 2013 indoors.	Alburaki, M., B. Cheaib, L. Quesnel, P.-L. Mercier, M. Chagnon and N. Derome. 2016. Performance of honeybee colonies located in neonicotinoid-treated and untreated cornfields in Quebec. J. Appl. Entomol. doi: 10.1111/jen.12336
3 - Hive monitoring 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-	**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	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

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	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 honeybees 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 from 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 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	exposure level - Residues were undetected in fields in the ≤ 8 exposure unit category. - 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. - 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 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. 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.	neonicotinoid toxicity to honey bees. Proceedings of The Royal Society B Biological Sciences, Published 18 November 2015.DOI: 10.1098/rspb.2015.2110
3 - Hive monitoring Brood effects Standard Langstroth frames with the center removed (22x11cm) were implanted with comb blocks of low or	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	**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	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

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high levels of pesticide residues and placed in hives with caged queens. Honey bee	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 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	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. **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.	Longevity. PLoS ONE 6(2): e14720.
3 - Field Various field studies with different application methods were reviewed for this article. Repeated in non-*Apis* section. 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 (imidacloprid, clothianidin, thiamethoxam) - 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 imidacloprid, clothianidin, and thiamethoxam 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 LOECs between field and laboratory data, 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: honeybees, bumblebees, and solitary bees. J. Plant. Dis. Prot. 124: 1-30. DOI 10.1007/s41348-016-0041-0
Non-Apis			

Study type / Application method / Species	Study Methodology	Review Comments	Citation
2 - Tunnel Drip irrigation 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). T2: Thiamethoxam, 2 applications of 100 g ai/ha, with intervals of 7 days. T3: Thiamethoxam, 1 application of 200 g ai/ha. T4: Imidacloprid foliar application, 1 application of 15 g ai/ha. Number of hives tested: 1st introduction: 1 hive/treatment placed on March 9 – April 26; 2nd introduction: 1 hive/treatment placed on April 27 – June 7 Exposure period: *1st introduction:* T2, T3 and T4 applied on March 11; 2nd application of T2 on March 18 *2nd introduction:* T2, T3 and T4 applied on April 29; 2nd application of T2 on May 5; approximately 6 weeks for each introduction Observation period: approximately 6 weeks for each introduction Effect parameters: count of flowers 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	**REVIEW:** No significant mortality effects were noted. Based on fruit set of the tomato plants, pollination rates were not affected regardless of treatment applied. No significant differences in sugar water consumption was observed in the hives that were exposed to two drip applications of 100 g a.i./ha and inconsistent results were seen in the hives that were exposed to one drip application of 200 g a.i./ha. After 6 weeks of exposure, no significant effects were seen in any of the parameters tested, however numerically, effects were noted in both treatments which resulted in lower counts in the treated hives compared to the control. More pronounced effects were seen in the hives exposed to one drip application of 200 g a.i./ha compared to the two drip applications of 100 g a.i./ha each. **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 introduction, the control hives performed worse than the reference toxicant imidacloprid hives.	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.
2 - Tunnel *Experiment 1:* drip irrigation in greenhouse, bees were provided with supplemental bumble bee food and pollen *Experiment 2:* drip	Test crop: tomato plant Test species: *Bombus terrestis* Application rate: *Experiment 1:* Actara 25WG was applied via drip irrigation to tomato plants at 161 g a.i./ha to a 450 m^2 sized greenhouse *Experiment 2:* Actara 25WG was applied via drip irrigation to tomato plants at 150 g a.i./ha to a 2300 m^2 tunnel (control tunnel	**REVIEW:** The results from the trial conducted in a greenhouse suggest that effects on adults, dead larvae and food storage and consumption in bumble bee hives exposed to drip irrigation could not be ruled out. Results from the tunnel trials suggest that effects on larvae and food consumption in bumble bee hives exposed to drip irrigation could also, not be ruled out. However, both of these trials had no replication and in the tunnels, there was evidence that the large hives out competed the small hives which affected the results. **MAJOR UNCERTAINTIES:** Only 1 small and 1 large hive/treatment was tested in the tunnel with no replication. The control and treated tunnels were different sizes. Residue analysis on the	Sechser, B., and J. Freuler. 2003. The impact of thiamethoxam on bumble bee broods (Bombus terrestris L.) following drip application in covered tomato cages. Journal

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irrigation in tunnel, bees were provided with supplemental bumble bee food and pollen Bumble bee	was 1800 m^2 in size) Number of hives tested: *Experiment 1:* 1 hive/treatment (hive size unknown) *Experiment 2:* 2 hives/tunnel; in each tunnel one hive was large the other small Exposure period: *Experiment 1:* 35 days (treated), 36 days (control) *Experiment 2:* 13 days (treated), 17 days (control) Observation period: *Experiment 1:* 35 days (treated), 36 days (control) *Experiment 2:* 13 days (treated), 17 days (control) Effect parameters: mortality, number of bees paralyzed, brood counts at the end of exposure, amount of food reserves Location: Switzerland Year: 1998	pollen was not conducted to confirm the amount of active ingredient present after drip irrigation.	of Pest Science, 76: 74-77.
2 - Closed Feeding Study Micro-colonies were fed weekly for 28 days with spiked honey-water solution and pollen dough. Bumble bee	Test crop: N/A Test species: *Bombus terretris* Application rate: micro-colonies were fed weekly with 60% w/v honey-water and 1 g of dried pollen soaked in honey water at rates of 1 or 10 µg/kg in nectar and pollen paste; a solvent control (2000 µg/kg of acetone) and untreated control Number of hives tested: 10 micro-colonies (3 adult worker bees) for each treatment Exposure period: 28 days Observation period: 28 days Effect parameters: honey-water consumption, mortality, nest-building activity, egg laying, bee behaviour Location: UK Year: not stated	**REVIEW:** More effects were seen in the 10 µg/kg treatment than in the 1 µg/kg dose. A significant reduction in nectar consumption and storage in both the 1 and 10 µg/kg treatments was seen. Colony development was also significantly delayed in the 10 µg/kg group. **MAJOR UNCERTAINTIES:** The results for the 1 µg/kg treatment for the number of eggs and larvae was not significant but with a value of p=0.051. Worker weights were measured but not stated in article. The mean consumption values for the controls were not stated.	Elston C, Thompson HM and Walters KFA. 2013. Sub-lethal effects of thiamethoxam, a neonicotinoid pesticide, and propiconazole, a DMI fungicide, on colony initiation in bumblebee (Bombus terrestris) micro-colonies. Apidologie 44(5):563-574.
2 - Closed Feeding Study Micro-colonies were housed in a colony box with an attached tube to a foraging box that was provisioned with *ad libitum* spiked sugar water and	Test crop: N/A Test species: *Bombus terretris* Application rate: small colonies were fed *ad libitum* with 35% sugar water and pollen patties made of 2/3 honey bee pollen and 1/3 sugar water. Four treatments were tested: parasite (*Crithidia bombi*) infection only, a neonicotinoid treatment containing	**REVIEW:** The results suggest that a chronic dietary exposure of thiamethoxam and clothianidin to bumble bees decreases colony worker production, decreases worker longevity, and reduces reproductive investment. There was also a significant reduction of neonicotinoid-spiked water collection across all weeks and pollen collection in the neonicotinoid groups during weeks 6-9 of exposure. There were no effects from parasite exposure alone, but mother queen longevity was affected by the combination of neonicotinoid and parasite exposure. **MAJOR UNCERTAINTIES:** Dose verification was not conducted. Bees were maintained in a nest attached to a foraging box for 63 days, which may have caused stress on the bees since the	Fauser-Misslin A, Sadd BM, Neumann P and Sandrock C. 2013. Influence of combined pesticide and parasite exposure on bumblebee colony traits in the laboratory. J Appl Ecol

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pollen patties for 9 weeks (63 days). Bumble bee	4 ppb thiamethoxam and 1.5 ppb clothianidin treatment, a combination parasite + neonicotinoid treatment, and untreated control. Number of hives tested: 10 small colonies (10 adult worker bees) for each treatment Exposure period: 63 days Observation period: 63 days Effect parameters: longevity, survival, colony fitness (sexual investment), amount of pollen and sugar collected was tracked over the experiment, parasitic infection level Location: Switzerland Year: not stated	space available for flight was severely limited. In general, most of the statistically significant results were attributed to thiamethoxam/clothianidin exposure and cannot be split up by active due to the combined exposure.	51:450-459.
2 - Closed Feeding Study Colonies were fed 40% sucrose solution in the laboratory for 27 days.	Test crop: N/A. Test species: *Bombus terrestris audax* Application rate: Colonies were fed 40% sucrose solution with 2.4 or 10 ppb thiamethoxam (dissolved in acetone) or control. Number of hives tested for each treatment: 8 colonies with 1 queen and an average of 99 workers. Hives were purchased. 8 control colonies, and 8 treatment colonies (for 2.4 and 10 ppb). Exposure period: 27 days. After treatment, all colonies were fed untreated sucrose until 13th of May. The beginning of dosing ranged from April 4th to 11th. Observation period: 27 days plus non-treatment period. Observation parameters: Colony weight, number and weight of workers, number and weight of queens produced, number and weight of males, and total biomass. Year: 2014 (April to May)	**REVIEW:** Colony weights: There was no difference in colony weight change over the course of the experiment (average weight change of 336.56, 348.99 and 322.46 g in the control, 2.4 and 10 ppb groups, respectively). Total number of bees produced over experiment: There was no difference in number of bees produced (number of workers ranged from 375 in control to 400 in 2.4 ppb treatment group; number of males ranged from 231 in 2.4 ppb group to 279 in 10 ppb group; and number of queens ranged from 1.75 in the control to 8.4 in the 2.4 ppb group). It is noted that in the control group, the number of queens ranged from 1 to 5, where as in the 2.4 ppb group, the number of queens ranged from 1 to 34. Dry weight of individuals produced: There were a trend of less males produced in the 2.4 ppb test group but average weight was higher (0.104 g) compared to control (0.083 g) and 10 ppb group (0.086 g). In the control and treatment groups, average weight of workers ranged from 0.052 to 0.057 g; and average queen weight ranged from 0.24 to 0.25 g. There was high variability in queen biomass, but the average total queen biomass was 0.37, 1.9 and 0.46 g in the control, 2.4 and 10 ppb groups, respectively. **Summary: Overall, there was no difference in weight gain, number of workers, males or queens produced between the control and treatment groups (2.4 and 10 ppb). Average weight of males was higher in the 2.4 ppb treatment group, but overall total biomass of castes produced was similar between treatment and controls.** **MAJOR UNCERTAINTIES:** The tests were started with relative larger colonies that were at a late stage in the colony development cycle, which may affect the ability of the colony to withstand more stress. There was a trend of higher queen biomass in the 2.4 ppb test group. It is noted that in the control group, the number of queens ranged from 1 to 5, where as in the 2.4 ppb group, the number of queens ranged from 1 to 34.	Stanley, D.A. and N.E. Raine (2017). Bumblebee colony development following chronic exposure to field-realistic levels of the neonicotinoid pesticide thiamethoxam under laboratory conditions. Scientific Reports 7:8005.

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		Colonies were treated and assessed under laboratory conditions. The start of dosing was staggered and ranged from a start date of April 3rd to 11.	
2 - Closed Feeding Study Chronic oral exposure to thiamethoxam in sucrose solution	Test species: To determine bumble bee species that were exposed to oil seed rape (OSR) field in United Kingdom: recoding bumble species observed during two field visits to two winter OSR fields. Studies on the effects thiamethoxam: *B. terrestris* queens without parasites infection. Application method: oral dose administered thiamethoxam in sucrose solution 3 days after emergence from hibernation. Dose: 0 (control, acetone), 2.4 ppb (average measured amount of 2.5± 0.085 µg/kg). Food was replenished after 7 days. Inoculation of *C. bombi*. New queens were inoculated with field strain of the parasites or not before hibernation. Exposure period: 14 days for pesticides. Number of bees tested (for dosing experiment): 15 colonies to start. Newly mated queens were either inoculated with field strain of the parasites *C. bombi* or not inoculated, and then hibernated under in the lab conditions for wither 6 weeks or 12 weeks. After hibernation, 231 queens (from eight colonies) were allocated to either the pesticide or control treatment. Observation period: queens were observed at 1 4 days during pesticide feeding period and then 30 additional days. Presence of *C. bombi:* at 4, 11 and 30 days after hibernation	**REVIEW:** Six of bumble bee species were actively foraging on OSR flowers, including *B. terrestris* and *Bombus lapidarius* . Following pesticide exposure, control queens had higher colony initiation (73%) following 12 weeks of hibernation, compared to control bees that hibernated for 6 weeks (32%), and compared to pesticide treated queens in the longer hibernation time (52%). Pesticide treated queens appeared to also have a lower colony initiation compared to controls in the shorter hibernation period (24%). Hibernation duration alone also had an impact on egg laying. Although control queens had higher colony initiation (following the longer hibernation period) the study did not detect impacts of any experimental treatment on the ability of queens to produce adult offspring during the 14-week experimental period. Pesticide-treated queens laid eggs earlier in the experiment than untreated queens. The percent of queens (including egg layers) which reared adults appeared higher in the pesticide treated queens. The study found that heavier queens before hibernation were more likely to survive, and post-hibernation queen survival was not predicted by any treatments. Queens lost more weight from the long hibernation group, and parasite exposure also caused an increase in weight loss. No difference on the amount of syrup consumed by queens was detected between treatment and control. The comparison of colony production (whereby treatment bees produced 26% less colonies) was used in a model (along with other endpoints) to predict bee populations. In the model, for bumblebee populations to persist, the colony capacity must be at least 1 in natural environments. According to the study author, after adding the impact of thiamethoxam,the probability of a colony capacity with a value below 1 was 28%. **UNCERTAINTIES**: The study was conducted under laboratory conditions, including mating, hibernation, and pesticide exposure, which are different from field conditions. There are uncertainties with extrapolating the study outcomes to the field scenario using mathematical models, and the assumptions used the model. Tested hibernation period in the study may be different to what may be seen in Canada.	Baron G., Jansen V., Brown., Raine. 2017. Pesticide reduces bumblebee colony initiation and increases probability of population extinction. Nature Ecology and Evolution. Science 1, 356, 1393-1395.

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	Effect parameters: Queen bumble bees were assessed for first date of egg laying (colony initiation), date of first worker adult worker eclosion, development of brood, presence of infection, pre- and post-hibernation weight, and thorax width, presence of *C. bombi*. Colony initiation(egg laying in 10 weeks after emergence). Laboratory conditions (for dosing experiment): Males and gynes (reproductive females) were removed from colonies as callows (newly emerged bees) and kept communally in single-sex wooden boxes (24 cm × 14 cm × 10.5 cm) with nest mates of the same age and fed ad libitum with untreated pollen and syrup. Mating took place in a 60 cm × 50 cm × 50 cm wooden framed arena with plastic mesh sides under natural light at a temperature of 22 °C. Once mating was complete, the mated queen was kept in an individual plastic box (13 cm × 11 cm × 6.8 cm) containing a small amount of tissue paper to remove excess moisture and immediately provided with 100 µ l of parasite inoculum. When this full amount had been consumed, the queen was provided with ad libitum food (pollen and syrup) for between two and four days after mating (depending on how quickly the inoculum was consumed), at which point it was weighed and placed into hibernation. Modeling: multiple parameters were used to create the model, including hibernation, pesticide, parasite exposure, and infection. Covariate of bee weight at different study period and thorax width also considered. Multiple assumptions were made in the model to calculate the colony capacity, the average number of colonies produced over one season.		

Study type / Application method / Species	Study Methodology	Review Comments	Citation
2 - Closed Feeding Study Micro-colonies were artificially fed *ad libitum* with spiked sugar syrup and untreated patties for 17 days. Bumble bee	Test crop: N/A Test species: *Bombus terretris* Application rate: micro-colonies were fed *ad libitum* with sugar syrup doses of control, 98.43, 39.37, 15.75, 6.30, 2.52, 1.01, 0.40, 0.16, 0.06 µg/kg and undosed pollen pellets mixed with water for 17 days. Number of hives tested: 100 micro-colonies (4 adult worker bees); at least 9 micro-colonies tested/treatment Exposure period: 17 days Observation period: 17 days Effect parameters: mortality, presence of oviposition (wax covered egg cells), brood production, sugar syrup and pollen consumption Residue samples: dose verification Location: UK Year: 2012	**REVIEW:** This study confirmed that when thiamethoxam was presented to micro-colonies at ≥39 µg/kg for 17 days, impaired feeding on syrup and pollen and brood production in bumble bees resulted. However, at lower dosages, micro-colonies consumed syrup and pollen at normal control rates and brood production was not detectably dose-dependent. **MAJOR UNCERTAINTIES:** This study only considered the effects of dietary thiamethoxam in nectar and not in pollen. The exposure duration was only done for 17 days which is not really realistic as bumblebees forage on mass-flowering crops throughout their bloom and this could extend for more than a month.	Laycock I, Cotterell KC, O'Shea-Wheller TA and Cresswell JE. 2014. Effects of the neonicotinoid pesticide thiamethoxam at field-realistic levels on microcolonies of Bombus terrestris worker bumble bees. Ecotoxicoly and Environmental Safety 100:153-158.
2 - Closed Feeding Study *Experiment 1 (chronic toxicity micro-colonies without foraging):* Micro-colonies were artificially fed spiked sucrose solution for 77 days. *Experiment 2: (chronic toxicity micro-colonies with foraging):* Micro-colonies were trained to forage at a feeder containing spiked sucrose solution for 77 days. Bumble bee	Test crop: N/A Test species: *Bombus terrestris* Application Dose: *Experiment 1:* Actara 25% WG spiked sucrose solution was fed to micro-colonies at doses 0.1, 0.2, 0.5, 1, 10 and 100 ppm and 10 ppb for 11 weeks (77 days) *Experiment 2:* Actara 25% WG spiked sucrose solution was placed in a feeder at dose of 0.1 ppm for 11 weeks (77 days) Number of hives tested: 4 micro-colonies/treatment (5 adult worker bees), the experiment was repeated twice Exposure period: 77 days Observation period: observations made every 3 days for the first 3 observations then weekly for the remainder of the 11 week period Effect parameters: mortality, drone production Location: Belgium Year: unknown, paper published in 2012	**REVIEW:** After 77 days of exposure, mortality was seen in both the non-foraging and foraging closed feeding bumble bee trials; there were no survivors at doses ≥ 0.5 ppm without foraging and mortality was 85% in the 0.1 ppm dose that allowed foraging to an enclosed feeder. Total loss of reproduction was seen in non-foraging bees exposed to ≥0.5 ppm and at 0.1 ppm there were significantly fewer drones when compared to the control in both the non-foraging and foraging trials. **MAJOR UNCERTAINTIES**: It is not clear if bees were fed *ad libitum*, or a specific amount per week. Our review has presumed *ad libitum.* The results of the control fed mico-colonies were not discussed. There was a large amount of stress on these 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. The trial with foraging only tested one dose.	Mommaerts, V., S. Reynders, J. Boulet, L. Besard, G. Sterk, G. Smagghe. 2010. Risk assessment for side-effects of neonicotinoids against bumblebees with and without impairing foraging behavior. Ecotoxicology 19: 207-215.

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2 - Closed Feeding Study Colonies were artificially fed sucrose solution *ad libitum* spiked with one of three treatments, control, 2.4 ppb or 10 ppb for an average of 24 days; untreated pollen was provided every 2-3 days and allowed daily foraging flights for 1-2 h to an outdoor cage filled with untreated apple trees. Bumble bee	Test crop: N/A; hives did have daily access for 1-2 h to untreated apple trees located in a foraging cage Test species: *Bombus terretris* Application rate: colonies were fed *ad libitum* with sucrose solution spiked with 2.4 or 10 ppb for approximately 24 days; a selection of bees from these colonies were then subjected to proboscis extension reflex (PER) tests Number of hives tested: 21 colonies (queen + approximately 70 worker bees) were tested; 34 (control), 29 (2.4 ppb) and 32 (10 ppb) bees were selected for the resulting PER tests Exposure and observation period: 22-26 days; average 24 Effect parameters: PER response, memory response, worker body size Location: presumed England, UK Year: 2014	**REVIEW:** These results suggest thiamethoxam fed to bumble bees in sucrose solution at either 2.4 or 10 ppb had minimal effects on learning and memory following acute exposure. However, workers were slower to learn and showed impaired 3-hour memory after 3–4 weeks of chronic exposure at a level of 2.4 and 10 ppb. **MAJOR UNCERTAINTIES:** The exposure scenario presented in this study is conservative since it only considered contaminated sugar exposure. Bumble bees were allowed to forage outside in an untreated apple orchard. Nothing was noted by the authors about the quality of the hives prior to the test.	Stanley D.A., Smith K.E., Raine N.E.. 2015. Bumblebee learning and memory is impaired by chronic exposure to a neonicotinoid pesticide. Scientific Reports 5, Article number: 16508 (2015)
2 - Closed Feeding Study Colonies were artificially fed 1 L of 40% sucrose solution that was spiked with 10 ppb of thiamethoxam and replenished every 2 days for a total of 9-10 days; untreated honey bee collected pollen was provided every 2 days Bumble bee	Test crop: *Lotus corniculatus* (bird's foot trefoil) and *T. repens* (white clover) Test species: *Bombus terretris audax* Application rate: colonies were fed 1 L of 40% sucrose solution that was spiked with 10 ppb of thiamethoxam; the solution was replenished every 2 days for a total of 9-10 days of feeding Number of hives tested: 10 colonies (queen + mean of 109 worker bees); a total of 73 forager bees were observed in the flight arena Exposure period: 9-10 days Observation period: 23 June – 3 July, 2014 Effect parameters: length of time spent foraging, average length of time between flower visits, average visit length, amount of time spent learning how to forage, number of flowers visited per bee, number of times a bee switches flower species, what flower species was visited first, proportion of bees foraging on pollen Location: presumed England, UK Year: 2014	**REVIEW:** This study shows that chronic 9-10 day exposure to 10 ppb of thiamethoxam in sucrose solution can also alter foraging behaviour of bumble bees on real wildflowers with complex morphology that were located in flight tunnels or "arena's". **MAJOR UNCERTAINTIES:** The exact calendar dates of when the exposure period occurred were not clearly stated in the article. The data were collected in an outdoor flight arena in which bees had to fly less than 50 cm to access their first flower, representing a relatively simple environment with little need to navigate, locate forage resources or avoid predators. It was presumed by the authors and the reviewers that the control bees had not yet fully learnt how to forage to the best of their ability, and so may not yet have been 'accurate' foragers during their initial foraging bout. Nothing was noted by the authors about the quality of the hives prior to the test.	Stanley, D.A. and N.E. Raine. 2016. Chronic exposure to a neonicotinoid pesticide alters the interactions between bumblebees and wild plants. Functional Ecology. Doi: 10.1111/1365-2435.12644

Study type / Application method / Species	Study Methodology	Review Comments	Citation
2 - Closed Feeding Study Solitary bees were allowed to forage and reproduce freely within a flight cage that had artificial flowers containing 50% sugar spiked with 2.87 and 0.45 ppb of thiamethoxam and clothianidin, respectively; untreated pollen pellets were also provided. Bumble bee	Test crop: N/A Test species: *Osmia bicornis* Application rate: 50% sugar spiked with 2.87 ppb of thiamethoxam and 0.45 ppb of clothianidin was provided in artificial flowers; solution was replenished every 3 days for approximately 4 months Number of bees tested: 125 females and 75 males; post-emergence 101 male and female offspring were examined Exposure period: unclear, appears to be approximately 40 days – the reproductive period of *O.* bicornis lasts approximately 3 months (April – June); average female lifespan was approximately 24 days, larvae was exposed longer through nest provisions collected by adults Observation period: unclear – observations on pupae emergence continued for 11 months after the last adults died Effect parameters: mortality, number of nests, hatching success of cocoons, sex ratio and body weights of offspring Residue analysis: dose verification, leftover larval provisions and newly emerged bees Location: presumed Zurich, Switzerland Year: unknown	**REVIEW:** Overall, the study documented statistically significant reduction of offspring production, number of nests, brood cells and male biased sex ratio in the group receiving thiamethoxam (2.87 ppb) and clothianidin (0.45 ppb) residues in sucrose solution. **MAJOR UNCERTAINTIES:** Only 2 populations of the *Osmia bicornis* were tested; the experiment was not repeated to test if results vary with different genetics. Exposure from pollen was not tested in this study. It was unclear if the outliers in the study were excluded from analysis. If they were, then there was one tube with a high number of offspring in the treatment group which may have increased the mean for comparison with the control (potentially resulting in a less pronounced effect). In addition, for weight comparison, there appeared to be approximately 4 outliers in the control males. If these were included in the analysis, then there may have been a difference between the male weights (resulting in higher weights in the control compared to treatment). The study indicated that female weight affected offspring production (including gender of offspring). It is unclear if smaller males also impacts reproduction. The offspring sex ratio was significant, however, it is unclear if 47% compared to 55% females would result in a significant effect in the field.	Sandrock, C., L. G. Tanadini, J. S. Pettis, J. C. Biesmeijer, S. G. Potts, P. Neumann. 2014. Sublethal neonicotinoid insecticide exposure reduces solitary bee reproductive success. Agricultural and Forest Entomology, 16: 119-128.
2 - Closed / Open Feeding Study Colonies were fed 40% sucrose solution in the laboratory for 6 weeks and were then permitted unrestricted access to forage on flowers outside. Bumble bee	Test crop: N/A. Bees were permitted to feed outside. The landscape consisted of suburban gardens, parkland and agricultural pasture. Test species: *Bombus terrestris audax* Application rate: Colonies were fed 40% sucrose solution with 2.4 ppb thiamethoxam (dissolved in acetone) 3 times per week for 6 weeks. Control colonies only received sucrose solution. Bees received half their daily intake of artificial nectar and no pollen in order to stimulate foraging. Number of hives tested: 8 hives with approximately 22 workers and 1 queen/hive. Hives were purchased. Replicates: 4 pesticide-exposed colonies	**REVIEW:** The study found that exposure to thiamethoxam (2.4 ppb) in sugar solution, caused changes in bumblebee foraging patterns. Pesticide exposed bees went on longer foraging bouts and collected pollen less often, but found their way back to their colonies from 1 km more frequently during homing trials than bees from control colonies. Although there was a trend for control colonies to produce new workers more quickly than pesticide-exposed colonies, and more dead bees found inside pesticide colonies (although not significant), the study found no significant impacts of pesticide exposure on overall colony size. **MAJOR UNCERTAINTIES:** The volume of sugar solution was not reported. Large confidence intervals may have led to lower statistical power. The distance between the control and treated colonies was not reported. In some instances in the summary of results the study author indicated effects to certain parameters despite of lack of statistical significance, which led to contradictory statements (i.e. the number of dead bees). These would be considered as 'trends' by the reviewer. The study assessed potential effects from oral consumption of sucrose solution only, not pollen. Bees were excluded from analysis if they had no prior foraging experience, if they drifted between colonies and if they took an excessively long time to return home. This resulted in less bees in the	Stanley, Russel, Morrison, Rogers and Raine. 2016. Investigating the impacts of field-realistic exposure to a neonicotinoid pesticide on bumblebee foraging, homing ability and colony growth. Journal of Applied Ecology 2016, 53, 1440-1449.

Study type / Application method / Species	Study Methodology	Review Comments	Citation
	and 4 control colonies Exposure period: 2 weeks (which is when homing ability observations started). Note, foraging activity observations started after 5 days of treatment. Observation period: *Foraging:* After 5 days of treatment the number of bees returning with pollen was recorded. The observation lasted 90 min 2 x per week. "foraging bout" is the trip from colony entrance that lasted more than 5 min (during daylight). *Homing:* After 2 weeks of treatment (which gave colonies time to grow in size), homing trials began. Starting at 9:30 in the morning, bees were caught before entering nest in order to read RFID tags, before giving them untreated sucrose solution (so they would be full and go back to the nest). Bees were released either 1 to 2 km away. Homing was observed for 5 weeks. Colony growth: 6 weeks Effect parameters: foraging activity (using RFID readers), homing ability (sugar consumption), body size, colony growth (the number of individuals in the colony over the experiment, including body size). Location: Guelph, Ontario (assumed based on study authors location) Year: 2013 (july and august)	pesticide colonies for the 2 km homing experiment.	
2 - 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	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	**REVIEW:** In this study, the authors compared all three EU-suspended neonicotinoids, imidacloprid, clothianidin, and thiamethoxam, for effects on bumblebees (Bombus terrestris audax) to determine whether they act consistently and in predictable ways, where clothianidin would be expected to be the most toxic, given its higher potency and thiamethoxam requiring metabolism to clothianidin 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	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 bumblebees. Scientific Reports. 6: 24764.

Study type / Application method / Species	Study Methodology	Review Comments	Citation
quasi-Poisson model with log link function (live bees, brood number and number of queens), a gamma error distribution 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	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	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* • 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 imidacloprid and thiamethoxam 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 clothianidin, 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.	DOI: 10.1038/srep24764
2 - Open Feeding Study Hives were fed 40% sucrose solution spiked with 2.4 or 10 ppb of thiamethoxam that was refilled every 2-3 days at first, and then reduced to every1-2 days for an average of 13 days total	Test crop: hives were fed in a laboratory and then placed in flight cages with potted apple trees (two varieties: Scrumptious (dessert) and Everest (polliniser) Test species: *Bombus terrestris audax* Application rate: 40% sucrose solution spiked with 2.4 or 10 ppb of thiamethoxam that was refilled every 2-3 days at first, and then reduced to every 1-2 days Number of hives tested: 24 colonies (queen	**REVIEW:** Bumble bee colonies fed sucrose solution spiked with 10 ppb pesticide provided significantly lower visitation rates to apple flowers, resulted in lower numbers of bees carrying pollen and the flowers pollinated produced fruit with significantly less seeds when compared to the controls. Individual bees exposed to 10 ppb pesticide spent longer foraging, visited more Scrumptious variety flowers and switched more frequently between varieties during each trip, which suggests a modification of their floral preferences compared to the control. **MAJOR UNCERTAINTIES:** The exposure scenario presented in this study is conservative since colonies were only exposed to contaminated sucrose. Details about the orchard (i.e. size, proximity to foraging tube, if it was certified organic or absolutely no agricultural inputs were added to the	Stanley DA, Garratt MP, Wickens JB, Wickens VJ, Potts SG, Raine NE. 2015. Neonicotinoid pesticide exposure impairs crop pollination services provided by bumblebees. Nature 528, 548–550 (24

Study type / Application method / Species	Study Methodology	Review Comments	Citation
exposure period; untreated pollen was provided every 2-3 days. . Bumble bee	+ average of 99 worker bees) Exposure period: 12-15 days (average 13 days) Observation period: *Individual and colony level measurements:* 60 minutes (repeated over 8 days of testing after 13 day exposure to spiked sucrose in the laboratory) *Estimation of pollination services:* May – early September, 2014 Effect parameters: duration of foraging trip, number of flowers of each apple variety visited, handling time of each flower, number of fruit set from marked flowers, how many flowers proceeded to fruit set or aborted, seed numbers counted/apple Location: England, UK Year: 2014	trees, etc.) were not provided. Our review has assumed there was no exposure risk from these trees.	December 2015)
3 - Field study 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: honeybees, bumblebees, and solitary bees. J. Plant. Dis. Prot. 124: 1-30. DOI 10.1007/s41348-016-0041-0
3 - Field Seed treatment Bumble bee	Test crop: corn Test species: *Bombus impatiens* and presence of other bees on tassels. Application rate: *Organic fields 1,2,3,4:* untreated corn seed *Test fields 1 and 2:* corn seed was treated with Poncho 250 at a rate of 0.25 mg clothianidin/seed *Test fields 3 and 4:* corn seed was treated with either Poncho 250 at a rate of 0.25 mg clothianidin/seed or Cruiser 5FS at a rate of 0.25 mg thiamethoxam/seed NOTE: all tests fields were planted with seed expressing *Bacillus thuringeiensis* and treated with fungicides ipconazole,	**REVIEW:** Very little corn pollen was collected by the bumble bees in this study and thiamethoxam and clothianidin residues from pollen collected directly from the corn plants was ≤0.8 ng/g (LOD=0.1 and LOQ=0.5 ng/g). These results indicate that exposure levels were low. The statistically significant effects reported in the study were that: (1) more solitary bees were observed on tassels in conventional than organic fields, (2) worker and drone weights were lower in colonies placed near conventional fields and (3) fewer workers were recovered from colonies placed next to conventional fields. **MAJOR UNCERTAINTIES:** The seed treatments used (all 0.25 mg a.i./seed, either thiamethoxam or clothianidin) are within rates labeled for use on corn seed in Canada. Corn pollen shed in a field can continue for up to 14 days. Therefore, the exposure that the study authors tested may not be representative of actual exposure conditions. No residue analysis was conducted on the bee collected pollen. The exposure level appears to be low based on the amount of corn pollen collected was <0.1-1.8%. Some conventional sites were not tested for residues of both clothianidin and thiamethoxam. They were only tested for one active ingredient which posed a problem for the sites	Cutler GC, Scott-Dupree CD. 2014. A field study examining the effects of exposure to neonicotinoid seed-treated corn on commercial bumble bee colonies. Ecotoxicology 23(9):1755-1763.

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	metalaxyl, trifloxystrobin, fludioxinil, azoxystrobin, mefanoxam, thiabendazole. Number of hives tested: one large box containing 3 bumble bee colonies were placed at the edge of each experimental field; total of 24 hives tested Exposure period: 5-6 days from 27 July to 9 August (pollen shed varied by corn hybrid and location); after exposure hives were moved 165 km away to be isolated from agricultural crops, hives remained there for 30-35 days Observation period: from 35-41 days before destructively sampled Effect parameters: foraging activity, forager collected pollen, colony weight, worker, drone and queen weight, honey pots, pollen pots and brood cell counts Residue analysis: corn pollen Location: Ontario, Canada Year: 2012	where combinations of neonicotinoid seed treatments were planted. Test sites did not all receive the same seed treatments. Organically grown corn plants were slower to develop than conventional.	
3 - Hive monitoring 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 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	**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 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	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/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

Study type / Application method / Species	Study Methodology	Review Comments	Citation
	(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	(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 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) *Residue-based analysis* *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	conclusions on neonicotinoids. EFSA Journal 11(6):3242. AND Goulson, D. 2015. Neonicotinoids impact bumblebee colony fitness in the field; a reanalysis of the UK's Food & Environment Research Agency 2012 experiment. Peer J 3:e854

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		data points were 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 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 bumblebees 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 bumblebees 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	

Study type / Application method / Species	Study Methodology	Review Comments	Citation
		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.	
3 - Field And Hive Monitoring Study Wild bumblebees were collected in five farms and five urban landscapes in East Sussex (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	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 *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 14 (midsummer). Residues: Ranges, frequencies and average levels of neonicotinoid and fungicide residues detected in wild bumblebee samples Location: South-East England, UK Year: 2014	**REVIEW:** The EU moratorium on the use of neonicotinoid insecticides started on the 1st 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. The residue results show evidence that wild bumblebees 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 bumblebee 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.	Botías, C., A. David, E.M. Hill and D. Goulson. Quantifying exposure of wild bumblebees to mixtures of agrochemicals in agricultural and urban landscapes, Environmental Pollution (2017), http://dx.doi.org/10.1016/j.envpol.2017.01.001
3 - Field Seed treatment Bumble bee	Test crop: winter oilseed rape Test species: *Bombus terrestris audax* hives Application rate: oilseed rape seeds were treated with Cruiser OSR (thiamethoxam 420 g/100 kg seed; 0.03 mg a.i./seed); one test field and two control fields	**REVIEW:** There was a mean increase in colony mass at the end of the exposure phase which was numerically higher in treated then compared to either of the control fields. Data suggests treated bees behaviour was affected by increased foraging (during the first 4 weeks of the exposure period) that likely lead to higher colony mass and prolonged period of ramped up foraging. Numerically there was a higher mean number of queens/gynes, workers, eggs, larvae, large pupae (gynes), small pupae (workers/drones) and net nest weight in the treated fields compared to the control. No	Thompson, H., M. Coulson, N. Ruddle, S. Wilkins, P. Harrington and S. Harkin. 2015. Monitoring the effects of thiamethoxam

Study type / Application method / Species	Study Methodology	Review Comments	Citation
	Number of colonies tested: 75 colonies (queen + 10-20 workers); started with 25 colonies/field then due to farm accidents 25 colonies were left in Control field 1, 23 in Control field 2 and 22 in Treated field. Exposure period: 38 days Observation period: 68 days Effect parameters: colony weight, forager activity, species count in the field, at the end of the exposure colonies were destructively sampled and all life stages and food stores were counted and weighed, pollen analysis Residue analysis: crop pollen and nectar from the field, Location: Lincolnshire, UK Year: 2012-2013: Seeds sown October 2012, observations collected in 2013	statistically significant effects in foraging activity seen compared to controls. **MAJOR UNCERTAINTIES:** There was only 1 treatment replicate (1 treated field, 2 control fields; with 25 hives located on each field for psuedoreplicates), preventing the use of statistical tests. The dates of bloom initiation, hives placement and removal were not included, only the total exposure period of 38 days was stated. Nothing was noted by the authors about the quality of the hives prior to the test.	applied as a seed treatment to winter oilseed rape on the development of bumblebee (Bombus terrestris) colonies. Pest Manag Sci. DOI 10.1002/ps.4202

Appendix VI Pollinator Risk Assessment for Foliar Application of Thiamethoxam

Tier I screening level risk assessment

Table 1 RQ (risk quotient) for contact exposure from thiamethoxam and clothianidin equivalents

Chemical	**Application rate (EEC)** (kg ai/ha)	**Koch and Weiber (adjustment factor)** (µg ai/bee per kg ai/ha)	**Exposure (EEC)** (µg ai/bee)	**Toxicity endpoint** (µg ai/bee)	**RQs (EEC/toxicity endpoint)**	**LOC exceeded?**
Thiamethoxam (TGAI)* **adults (acute)**	0.025	2.4	0.061	0.024	2.5	yes
	0.15	2.4	0.36	0.024	15	yes
Clothianidin equivalents** **adults (acute)**	0.021	2.4	0.05	0.021	2.4	yes
	0.13	2.4	0.31	0.021	15	yes

* Exposure= application rate (kg ai/ha) x adjustment factor (2.4 µg ai/bee per kg ai/ha)

** Exposure (based on c.e.)= application rate (kg ai/ha)(x 0.856) x adjustment factor (2.4 µg ai/bee per kg ai/ha) - lowest endpoint chosen from either thiamethoxam converted to c.e. or from clothianidin.

Note: LOC for bee is set at 0.4.

Table 2 RQ (risk quotient) for oral exposure from thiamethoxam and clothianidin equivalents

Chemical & Caste & Exposure duration	**Application rate (EEC)** (kg ai/ha)	**Koch and Weiber (adjustment factor)** (µg ai/bee per kg ai/ha)	**Exposure (EEC)** (µg ai/bee)	**Toxicity endpoint** (µg ai/bee)	**RQs (EEC/ toxicity endpoint)**	**LOC exceeded?**
Thiamethoxam* **adults (acute)**	0.025	28.6	0.715	LC50: 0.0044	163	yes
	0.15	28.6	4.29	LC50: 0.0044	975	yes
Thiamethoxam* **adults (chronic)**	0.025	28.6	0.715	10 day NOEC: 0.00245	292	yes
	0.15	28.6	4.29	10 day NOEC: 0.00245	1751	yes
Thiamethoxam* **brood**	0.025	12.15	0.304	LC50 = 0.78	0.40	yes
	0.15	12.15	1.82	LC50 = 0.78	2.3	yes
Thiamethoxam*	0.025	12.15	0.304	NOED = 0.0157	19	yes

Chemical & Caste & Exposure duration	Application rate (EEC) (kg ai/ha)	Koch and Weiber (adjustment factor) (µg ai/bee per kg ai/ha)	Exposure (EEC) (µg ai/bee)	Toxicity endpoint (µg ai/bee)	RQs (EEC/ toxicity endpoint)	LOC exceeded?
brood	0.15	12.15	1.82	NOED = 0.0157	116	yes
Clothianidin equivalents** **adults (acute)**	0.021	28.6	0.60	LC50: 0.00368	163	yes
	0.13	28.6	3.72	LC50: 0.00368	1011	yes
Clothianidin equivalents** **adults (chronic)**	0.021	28.6	0.60	NOEC: 0.000368	1630	yes
	0.13	28.6	3.72	NOEC: 0.000368	10103	yes
Clothianidin equivalents** **brood**	0.021	12.15	0.255	LC50 = >0.0018	<142	yes
	0.13	12.15	1.58	LC50 = >0.0018	<878	yes
	0.021	12.15	0.255	NOEC: 0.0009	283	yes
	0.13	12.15	1.58	NOEC: 0.0009	1756	yes

* Exposure= application rate (kg ai/ha) x consumption factor (29 µg ai/bee per kg ai/ha for adults and 12.15 µg ai/bee per kg ai/ha for brood)

** Exposure (based on c.e.)= application rate (kg ai/ha)(x 0.856) x consumption factor (29 µg ai/bee per kg ai/ha for adults and 12.15 µg ai/bee per kg ai/ha for brood);

Lowest endpoint chosen from either thiamethoxam converted to c.e. or from clothianidin.

Note: LOC for bee is set at 0.4 for acute endpoints and 1 for chronic endpoints.

Tier I refined level risk assessment

Table 3 Foliar Application: Acute and Chronic Dietary Risk to Different Bee Castes Based on Maximum and Mean Residues of Thiamethoxam (ppb) and also clothianidin equivalents (c.e.)

Sampled Crop & Considerations	EEC - Maximum residue value in ppb / Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb / Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Orchard crops											
Cherry Applied at 2 x 96 g a.i./ha, post-bloom 7 and 14 days before fruit harvest, Year 1 (Y1). Y1: 324, 304 and 314 DALA Y2: 321, 306 and 315 DALA	Y1: 77.4 pollen from flowers Y2: 382	Y1: 1.54 nectar from flowers Y2: 2.03	Y1: No (0.10) Y2:	Y1: No (0.22) **Y2:**	Y1: No (0.00) Y2:	Y1: 43.3 pollen from flowers Y2: 184	Y1: 0.74 nectar from flowers Y2: 0.88	Y1: No (0.09) Y2:	Y1: No (0.21) Y2:	Y1: No (0.02) Y2:	**CG 12: Cherry (Stone fruit)(for post bloom)** *Registered at 2 x 40 g a.i./ha, at 7 day intervals (maximum seasonal rate 80 g a.i./ha) (can apply anytime)*

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
Cherry is a registered crop. Post bloom study application is consistent with application timing for pear and apple and cherry (for post bloom only). Single study rate is consistent with maximum post bloom pear and apple rate. Single study rate is higher than cherry rate. Pre-bloom application timing scenario not represented for apple or cherry.	pollen from flowers c.e. Y1: 66.3 pollen from flowers Y2: 327 pollen from flowers	nectar from flowers c.e. Y1: 1.32 nectar from flowers Y2: 1.74 nectar from flowers	No (0.14) Y1: No (0.11) Y2: No (0.14)	**Yes (0.90)** Y1: No (0.22) **Y2:** **Yes (0.92)**	No (0.00) Y1: No (0.22) **Y2:** **Yes** **(0.77)**	pollen from flowers c.e. Y1: 37.1 pollen from flowers Y2: 157 pollen from flowers	nectar from flowers c.e. Y1: 0.63 nectar from flowers Y2: 0.75 nectar from flowers	No (0.11) Y1: No (0.50) Y2: No (0.61)	No (0.77) **Y1:** **Yes** **(1.21)** **Y2:** **Yes (4.38)**	No 0.05) Y1: No (0.23) Y2: No (0.73)	**Potentially Relevant for Other Labelled Crop(s):** **CG 12: Pome fruit (pear and oriental pear)** *Registered at 2 x 79-96 g a.i./ha, at 10 day intervals (maximum seasonal rate 192 g a.i./ha) (post-bloom)* **CG 12: Pome fruit (apple and crabapple) (for post bloom)** *Registered at 2 x 96 g a.i./ha, at 10 day intervals (maximum seasonal rate 192 g a.i./ha) (post-bloom)* *NOTE: pome fruit is also registered for pre-bloom application at one application of 40-79 g ai/ha.*
Peach Applied at 2 x 96 g a.i./ha, post-bloom 7 and 14 days before fruit harvest, Year 1 (Y1). Y1: 297, 300 and 168 DALA Y2: 266, 284 and 249 DALA Peach is not a registered crop, however stone fruits are registered. Post bloom study application is consistent with application timing for pear and apple and	Y1: 58 pollen from flowers Y2: 167 pollen from flowers c.e. Y1: 49.6 pollen from flowers	Y1: <LOQ nectar from flowers Y2: 1.77 nectar from flowers c.e. Y1: <LOQ nectar from flowers	Y1: No (0.03) Y2: No (0.12) Y1: No (0.04)	Y1: No (0.14) **Y2:** **Yes** **(0.42)** Y1: No (0.16)	Y1: No (0.00) Y2: No (0.00) Y1: No (0.13)	Y1: 34 pollen from flowers Y2: 108 pollen from flowers c.e. Y1: 29.1 pollen from flowers	Y1: <LOQ nectar from flowers Y2: 0.82 nectar from flowers c.e. Y1: <LOQ nectar from flowers	Y1: No (0.0) Y2: No (0.10) Y1: No (0.80)	Y1: No (0.13) Y2: No (0.47) **Y1:** **Yes** **(1.14)**	Y1: No 0.01) Y2: No (0.03) Y1: No (0.25)	**Potentially Relevant for Other Stone fruit labelled Crop(s):** **CG 12: Cherry (Stone fruit)(for post bloom)** *Registered at 2 x 40 g a.i./ha, at 7 day intervals (maximum seasonal rate 80 g a.i./ha) (can apply anytime)* **Potentially Relevant for Other Labelled Crop(s):** **CG 11: Pome fruit (pear and oriental pear)** *Registered at 2 x 79-96 g*

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
cherry (for post bloom only). Single study rate is consistent with maximum post bloom pear and apple rate. Single study rate is higher than cherry rate. Pre-bloom application timing scenario not represented for apple or cherry.	Y2: 143 pollen from flowers	Y2: 1.52 nectar from flowers	Y2: No (0.16)	**Y2:** **Yes** **(0.43)**	Y2: No (0.39)	Y2: 92.5 pollen from flowers	Y2: 0.70 nectar from flowers	Y2: No (0.57)	**Y2:** **Yes** **(2.68)**	Y2: No (0.46)	*a.i./ha, at 10 day intervals (maximum seasonal rate 192 g a.i./ha) (post-bloom)* **CG 12: Pome fruit (apple and crabapple) (for post bloom)** *Registered at 2 x 96 g a.i./ha, at 10 day intervals (maximum seasonal rate 192 g a.i./ha) (post-bloom)* *NOTE: pome fruit is also registered for pre-bloom application at one application of 40-79 g ai/ha.* **Outdoor Ornamentals** *Registered at 2 x 75 g ai/ha, at 14 day intervals (maximum seasonal rate of 150 g ai/ha)*
Peach Applied at 1 x 62.5 g a.i./ha, pre-bloom 15 or 6 days before bloom Several sampling events between 10 and 23 days after application. Peach is not a registered crop, however stonefruits are registered. Pre- bloom study application is consistent with application timing for pre bloom apple and pre-bloom cherry. Not as relevant for pear	<LOQ (5 ppb) pollen from flowers	<LOQ (5 ppb) nectar from flowers	No (0.33)	No (0.17)	No (0.00)	<LOQ (5 ppb) pollen from flowers	<LOQ (5 ppb) nectar from flowers	No (0.60)	No (0.31)	No 0.04)	**Potentially Relevant for Other Stone fruit labelled Crop(s):** **CG 12: Cherry (Stone fruit)(for pre bloom)** *Registered at 2 x 40 g a.i./ha, at 7 day intervals (maximum seasonal rate 80 g a.i./ha) (can be applied anytime)* **Potentially Relevant for Other Labelled Crop(s):** **CG 12: Pome fruit (pear and oriental pear)** *Registered at 2 x 79-96 g a.i./ha, at 10 day intervals*
	c.e. <LOQ (4.28 ppb) pollen from flowers	c.e. <LOQ (4.28 ppb) nectar from flowers	No (0.34)	No (0.17)	No (0.29)	c.e. <LOQ (4.28 ppb) pollen from flowers	c.e. <LOQ (4.28 ppb) nectar from flowers	**Yes** **(3.4)**	**Yes** (**1.74**)	No (0.59)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
post bloom, or post bloom apple. Single study rate is lower than maximum pre bloom apple rate (but within range) Pre-bloom application timing scenario not represented for pear.											*(maximum seasonal rate 192 g a.i./ha) (post-bloom)* **CG 12: Pome fruit (apple and crabapple) (for post bloom)** *Registered at 2 x 96 g a.i./ha, at 10 day intervals (maximum seasonal rate 192 g a.i./ha) (post-bloom)* *NOTE: pome fruit is also registered for pre-bloom application at one application of 40-79 g ai/ha.* **Outdoor Ornamentals** *Registered at 2 x 75 g ai/ha, at 14 day intervals (maximum seasonal rate of 150 g ai/ha)*
Plum Applied at 2 x 96 g a.i./ha, post-bloom 7 and 14 days before fruit harvest, Year 1 (Y1). Y1: 268, 287 and 286/195 DALA Y2: 234 and 231 DALA Plum is not a registered crop, however stone fruit (cheery) are registered. Post bloom study application is consistent with application timing for pear and apple and	Y1: 182 pollen from flowers Y2: 45.7 pollen from flowers	Y1: 6.31 nectar from flowers Y2: 0.5 nectar from flowers	**Y1:** **Yes** **(0.42)** Y2: No (0.03)	**Y1:** **Yes** **(0.60)** Y2: No (0.12)	Y1: No (0.00) Y2: No (0.00)	Y1: 110 pollen from flowers Y2: 26.2 pollen from flowers	Y1: 2.81 nectar from flowers Y2: 0.34 nectar from flowers	Y1: No (0.34) Y2: No (0.04)	Y1: No (0.59) Y2: No (0.12)	Y1: No (0.05) Y2: No (0.01)	**Potentially Relevant for Other Stone fruit labelled Crop(s):** **CG 12: Cherry (Stone fruit)(for post bloom)** *Registered at 2 x 40 g a.i./ha, at 7 day intervals (maximum seasonal rate 80 g a.i./ha) (can be applied anytime)* **Potentially Relevant for Other Labelled Crop(s):** **CG 12: Pome fruit (pear and oriental pear)** *Registered at 2 x 79-96 g a.i./ha, at 10 day intervals*
	c.e. Y1:	c.e. Y1:	**Y1:** **Yes**	**Y1:** **Yes**	**Y1:** **Yes**	c.e. Y1:	c.e. Y1:	**Y1:** **Yes**	**Y1:** **Yes**	Y1: No	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
cherry (for post bloom only). Single study rate is consistent with maximum post bloom pear and apple rate. Single study rate is higher than cherry rate. Pre-bloom application timing scenario not represented for apple or cherry.	156 pollen from flowers Y2: 39.1 pollen from flowers	5.40 nectar from flowers Y2: 0.428 nectar from flowers	**(0.43)** Y2: No (0.10)	**(0.61)** Y2: No (0.12)	**(0.67)** Y2: No (0.11)	94.2 pollen from flowers Y2: 22.4 pollen from flowers	2.41 nectar from flowers Y2: 0.29 nectar from flowers	**(1.92)** Y2: No (0.23)	**(3.37)** Y2: No (0.69)	(0.70) Y2: No (0.13)	*(maximum seasonal rate 192 g a.i./ha) (post-bloom)* **CG 12: Pome fruit (apple and crabapple) (for post bloom)** *Registered at 2 x 96 g a.i./ha, at 10 day intervals (maximum seasonal rate 192 g a.i./ha) (post-bloom)* *NOTE: pome fruit is also registered for pre-bloom application at one application of 40-79 g ai/ha.*
Apple Applied at 1 x 96.41 g ai/ha pre-bloom. Three sampling events after last application ranging from 5 to 13 DAA). Apple is a registered crop. Pre-bloom study application is consistent with application timing for pear and apple and cherry. Single study rate is above pre bloom pome and stone fruit rate. During bloom timing is not represented for stone fruit.	1690 to 2410 Pollen from flowers	53.5 to 756 Nectar from flowers	**3.6** **to** **50**	**5.4** **to** **29**	0.02 to 0.13	1593 to 2000 Pollen from flowers	44 to 568 Nectar from flowers	**5.3** **to** **68**	**8.8** **to** **40**	**0.7** **to** **4.8**	**CG 12: Pome fruit (apple and crabapple)(for pre bloom)** *Registered at 2 x 96 g a.i./ha, at 10 day intervals (maximum seasonal rate 192 g a.i./ha) (post-bloom)* *NOTE: pome fruit is also registered for pre-bloom application at one application of 40-79 g ai/ha.* **Potentially Relevant for Other Stone fruit labelled Crop(s):** **CG 12: Cherry (Stone fruit)(for post bloom)** *Registered at 2 x 40 g a.i./ha, at 7 day intervals (maximum seasonal rate 80 g a.i./ha) (can be applied anytime)*
	c.e. 1447 to 2063 Pollen from flowers	c.e. 45.8 to 647 Nectar from flowers	**3.7** **to** **51**	**5.5** **to** **30**	**6** **to** **47**	c.e. 1364 to 1712 Pollen from flowers	c.e. 37.7 to 486 Nectar from flowers	**30** **to** **386**	**50** **to** **230**	**10.5** **to** **72**	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Cucurbit crops											
Pumpkin Applied at 1 or 2 x 96 g a.i./ha during bloom Study conducted for 2 consecutive years. Sampling occurred 7-10 DALA Cucurbits are not registered for foliar applications in Canada (only soil)	1 app 2010 16.8 2 apps 2009 **127** 2 apps 2010 29.6 pollen from flowers	1 app 2010 2.5 2 apps 2009 **9.1** 2 apps 2010 7 nectar from flowers	No (0.17) **Yes** **(0.61)** **Yes** **(0.46)**	No (0.12) **Yes (0.57)** No (0.29)	No (0.00) No (0.00) No (0.00)	1 app 2010 15.3 2 apps 2009 **95.2** 2 apps 2010 25.2 pollen from flowers	1 app 2010 1.6 2 apps 2009 **8.2** 2 apps 2010 4.3 nectar from flowers	No (0.19) No (0.98) No (0.51)	No (0.15) No (0.84) No (0.34)	No (0.02) No (0.08) No (0.04)	**Potentially Relevant for Other Labelled Crop(s):** **Potato from Crop Group 1: Root and Tuber vegetables** *Registered at 2 x 26 g ai/ha, at 7-10 day intervals (maximum seasonal rate of 52 g ai/ha)* **Field peppers from Crop group 8: Fruiting vegetables** *Registered at 2 x 70 g ai/ha, at 7 day intervals (maximum seasonal rate of 140 g ai/ha)* **Outdoor Ornamentals** *Registered at 2 x 75 g ai/ha, at 14 day intervals (maximum seasonal rate of 150 g ai/ha)*
During-bloom application timing scenario represented (for vegetable crops) Higher rate than vegetables crops Maximum residues were from two years of application which is a relevant use scenario.	c.e. 1 app 2010 14.4 2 apps 2009 **109** 2 apps 2010 25.3 pollen from flowers	c.e. 1 app 2010 2.14 2 apps 2009 **7.8** 2 apps 2010 6.00 nectar from flowers	No (0.17) **Yes** **(0.62)** **Yes** **(0.48)**	No (0.12) **Yes** **(0.58)** No (0.29)	No (0.17) **Yes** **(0.74)** **Yes** **(0.45)**	c.e. 1 app 2010 13.1 2 apps 2009 **81.5** 2 apps 2010 21.57 pollen from flowers	c.e. 1 app 2010 1.37 2 apps 2009 **7.02** 2 apps 2010 3.68 nectar from flowers	**Yes** **(1.09)** **Yes** **(5.58)** **Yes** **(17.1)**	No (0.86) **Yes** **(4.80)** **Yes** **(8.3)**	No (0.24) **Yes** **(1.26)** **Yes** **(2.89)**	
Cucumber Applied at 2 x 96 g a.i./ha pre bloom application at 10 and 15 day intervals before bloom.	1410 pollen from flowers	317 nectar from flowers	**Yes** **(21.1)**	**Yes (13.2)**	No (0.06)	1173 pollen from flowers	182 nectar from flowers	**Yes** **(21.7)**	**Yes** **(15)**	**Yes** **(1.66)**	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
Sampling occurred early, mid and late bloom 5, 10 and 15 DALA Cucurbits are not registered for foliar applications in Canada (only soil) Pre-bloom application timing scenario represented (for fruiting vegetables) During bloom application timing scenario not represented. Higher rate than vegetables crops. Similar rate to ornamentals.	Total residues c.e. 1299 pollen from flowers	Total residues c.e. 297 nectar from flowers	**Yes** **(23.6)**	**Yes** **(14.5)**	**Yes** **(22.3)**	Total residues c.e. 1049 pollen from flowers	Total residues c.e. 168.2 nectar from flowers	**Yes** **(134)**	**Yes** **(91.4)**	**Yes** **(26.6)**	
Honeydew melon Applied at 1 x 100 g a.i./ha pre bloom application X days before bloom.	39 pollen from bees	16 nectar from bees	**Yes** **(1.1)**	**Yes (0.59)**	No (0.00)	39 pollen from bees	16 nectar from bees	**Yes** **(1.91)**	**Yes** **(1.07)**	No (0.13)	
Sampling occurred 6-15 DALA Cucurbits are not registered for foliar applications in Canada (only soil) Pre-bloom application timing scenario represented (for fruiting vegetables) During bloom	c.e. 33 pollen from bees	c.e. 13.7 nectar from bees	**Yes** **(1.09)**	**Yes** **(0.61)**	**Yes** **(0.98)**	c.e. 33.4 pollen from bees	c.e. 13.7 nectar from bees	**Yes** **(10.9)**	**Yes** **(6.1)**	**Yes** **(1.96)**	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
application timing scenario not represented. Higher rate than vegetables crops. Lower maximum rate than ornamentals. Tunnel conditions. NOTE: Only one sample, therefore, not a true mean.											
Fruiting vegetables											
Tomato Applied at 2 x 96 g a.i./ha <u>pre bloom</u> application at 5 and 10 day intervals before bloom. Sampling occurred early, mid and late bloom 5, 10 and 15 DALA	845 to 1628 pollen from flowers 1.2 Pollen from bees	NA	No (0.01 to 0.02) No (0.00)	**Yes (1.84 to 3.6)** No (0.00)	No (0.00 to 0.01) No (0.00)	675 to 1306 pollen from flowers 0.95 Pollen from bees	NA	No (0.01 to 0.02) No (0.00	**Yes (2.64 to 5.12)** No (0.00)	No (0.15 to 0.30) No (>0.00)	**Tomatoes from Crop Group 8: Fruiting vegetables** *Registered at 2 x 26.25 g ai/ha at 7 day intervals, or 1 x 52.5 g ai/ha, (maximum seasonal rate of 52.5 g ai/ha)* **Potentially Relevant for Other Labelled Crop(s):** **Potato from Crop Group 1: Root and Tuber vegetables** *Registered at 2 x 26 g ai/ha, at 7-10 day intervals (maximum seasonal rate of 52 g ai/ha)* **Field peppers from Crop group 8: Fruiting vegetables** *Registered at 2 x 70 g ai/ha, at 7 day intervals (maximum seasonal rate of 140 g ai/ha)* **Outdoor Ornamentals** *Registered at 2 x 75 g ai/ha, at 14 day intervals (maximum seasonal rate of 150 g ai/ha)*
Tomatoes are a registered use for foliar applications. Pre-bloom application timing scenario represented (for fruiting vegetables) During bloom application timing scenario not represented. Higher rate than vegetables crops.	<u>c.e.</u> 723 to 1394 pollen from flowers 1.03 Pollen from bees	NA	No (0.01 to 0.02) No (0.00	**Yes (1.89 to 3.64)** No (0.00)	**Yes (1.45 to 2.79)** No (0.00)	<u>c.e.</u> 578 to 1118 pollen from flowers 0.81 Pollen from bees	NA	No (0.06 to 0.12) No (0.00)	**Yes (15.1 to 29)** No (0.02)	**Yes (2.31 to 4.47)** No (0.00)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
Similar rate to ornamentals. Residues from California (11703 ppb) were excluded because of possible contamination. Clothianidin contributed to total residues	Total residues c.e. 1523 to 2918	NA	No (0.02 to 0.03)	**Yes (3.97 to 7.61)**	**Yes 3.05 to 5.84)**	Total residues c.e. 1169 to 2269	N/A	No (0.13 to 0.25)	**Yes (30.5 to 59.2)**	**Yes (4.68 to 9.1)**	
Berries and Bushberries											
Strawberry Applied at 3 x 70.62 g ai/ha with 10 day intervals, pre-bloom. Applications were 25, 15 and 5 days before bloom. Strawberries are registered use for foliar applications. Sampling generally occurred 5 or 6 days after last application. During bloom application timing scenario not represented. Higher rate than berry crops.	1202 to 7473 Pollen from flowers	212 to 647 Nectar from flowers	**Yes (14 to 43)**	**Yes (9.4 to 37)**	No (0.04 to 0.13)	174 to 6716 Pollen from flowers	128 to 381 Nectar from flowers	**Yes (15.3 to 45)**	**Yes (8 to 48)**	**Yes (1 to 4.5)**	**Low growing berries from Crop Group 13-07G** *Registered at 2 x 52.5-70 g ai/ha, at 7 day intervals (maximum seasonal rate of 140 g ai/ha)* **Caneberry from Crop Group 13-07A** *Registered at 2 x 52.5-70 g ai/ha, at 7 day intervals (maximum seasonal rate of 140 g ai/ha)* **Ornamentals** *Registered at 2 x 75 g ai/ha, at 14 day intervals (maximum seasonal rate of 150 g ai/ha)*
	c.e. 1029 to 6397 Pollen from flowers	c.e. 181 to 554 Nectar from flowers	**Yes (14 to 44)**	**Yes (9.6 to 37.8)**	**Yes (14 to 49.7)**	c.e. 149 to 5749 Pollen from flowers	c.e. 110 to 326 Nectar from flowers	**Yes (87 to 259)**	**Yes (46 to 274)**	**Yes (15.3 to 66.5)**	
Cranberry Applied at 3 x 70 g a.i./ha pre bloom application at 5, 12 and 19 day intervals before bloom.	53.4 to 2227 pollen from flowers	350 to 2353 nectar from flowers	**Yes (23 to 156)**	**Yes (11 to 80)**	No (0.05 to 0.37)	44 to 1366 pollen from flowers	176 to 1156 nectar from flowers	**Yes (21 to 138)**	**Yes (10 to 71)**	**Yes (1.4 to 9.2)**	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
Sampling occurred early, mid and late bloom 5, 10 and 15 DALA Cranberries are registered use for foliar applications. Pre-bloom application timing scenario represented. During bloom application timing scenario not represented. Higher rate than berry crops. Cranberries are typically grown in bog soils, and therefore the growing conditions are unique to cranberries. Cranberry is a perennial vine plant and some of the berries (e.g. blueberries and caneberries) flower on old wood. The woody nature of cranberries would be similar to other berries, but the perennial nature of cranberries is different than bush berries.	c.e. 47.3 to 1906 pollen from flowers	c.e. 256 to 2014 nectar from flowers	**Yes (20 to 160)**	**Yes (9.9 to 82)**	**Yes (17 to 138)**	c.e. 38 to 1169 pollen from flowers	c.e. 151 to 989 nectar from flowers	**Yes (120 to 785)**	**Yes (58 to 407)**	**Yes (22 to 137)**	
	Total residues c.e. 45.5 to 1932	Total residues c.e. 210 to 2107	**Yes (16.7 to 167)**	**Yes (8 to 85.2)**	**Yes (14 to 144)**	Total residues c.e. 38 to 1185	Total residues c.e. 160.5 to 1056.7	**Yes (130 to 857)**	**Yes (63 to 442)**	**Yes (10.8 to 144)**	
Beans and soybeans											
Soybean Applied at 2 x 70.63 g ai/ha pre-bloom with 7 day intervals. Last application was 5 days	25.8 to 68.2 Anther	0.78 to 3.6 Nectar from bees	No (0.05 to 0.24)	No (0.08 to 0.26)	0.00	15.3 to 56.8 Anther	0.46 to 2.36 Nectar from bees	No (0.06 to 0.28)	No (0.09 to 0.36)	No (0.01 to 0.03)	**Soybeans and shelled beans from Crop Group 6: Legume vegetables** *Registered at 3 x 25.4 g ai/ha, at 7 day intervals (maximum seasonal rate of*

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
before bloom. Soybean is a registered crop During bloom application timing scenario not represented. Higher rate than soybean and bean crops.		Total Up to 10.8 Flower 602	**Total** **0.72** **Flower** **72**	**Total** **0.49** **Flower** **37**	Total 0.10 **Flower** **4.7**		Total Up to 9.5 Flower 536	**Total** **1.1** **Flower** **64**	Total 0.77 **Flower** **33**	Total 0.09 **Flower** **4**	*76.2 g ai/ha)*
	c.e. 22 to 58.4 Anther	c.e. 0.67 to 3.1 Nectar from bees Total Up to 10.8 Flower 515	No (0.05 to 0.25) **Total** **0.86** **Yes** **Flower** **41**	No (0.08 to 0.27) **Total** **0.56** **Yes** **Flower** **209**	No (0.09 to 0.32) **Total** **0.84** **Yes** **Flower** **35**	c.e. 13 to 48.6 Anther	c.e. 0.39 to 2.0 Nectar from bees Total Up to 9.5 Flower 459	**Yes** 0.31 to **2** **Total** **7.5** **Flower** **364**	**Yes** 0.49 to **2** **Total** **4.9** **Flower** **187**	No (0.10 to 0.5) **Total** **1.5** **Flower** **63**	
Other crops											
Cotton Applied at 2 x 71 g a.i./ha pre bloom application at 5 day intervals; last application target 12 days before flower. Same treatment for two consecutive years. Sampling occurred 9-14 DALA Cotton is not grown in Canada.	Y1 46.1 Y2 351 pollen from flowers	Y1 6.85 Y2 46.2 Nectar from flowers	**Y1** **Yes** **(0.46)** **Y2** **Yes** **(3.1)**	Y1 No (0.32) **Y2** **Yes** **(2.24)**	Y1 No (0.00) Y2 No (0.01)	Y1 24.2 Y2 205 pollen from flowers	Y1 4.41 Y2 20.9 Nectar from flowers	Y1 No (0.53) **Y2** **Yes** **(2.49)**	Y1 No (0.35) **Y2** **Yes** **(2)**	Y1 No (0.04) Y2 No (0.21)	**Potentially Relevant for Other Crop(s):** **Potato from Crop Group 1: Root and Tuber vegetables** *Registered at 2 x 26 g ai/ha, at 7-10 day intervals (maximum seasonal rate of 52 g ai/ha)* **Field peppers from Crop Group 8: Fruiting vegetables**
	c.e. Y1 39.5	c.e. Y1 5.86	**Y1** **Yes** **(0.47)** **Y2**	Y1 No (0.33) **Y2**	**Y1** **Yes** **(0.47)** **Y2**	c.e. Y1 20.7	c.e. Y1 3.77	**Y1** **Yes** **(2.99)** **Y2**	**Y1** **Yes** **(1.97)** **Y2**	Y1 No (0.59) **Y2**	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Pre-bloom application timing scenario represented. During bloom application timing scenario not represented. Similar rate to fruiting vegetables and berries. Lower rate than ornamentals. Since flowers only last a few days, there is potential for loss of residues from spent flowers, and thus the residues may not be a conservative estimate.	Y2 300 pollen from flowers	Y2 39.5 Nectar from flowers	**Yes** **(3.14)**	**Yes** **(2.29)**	**Yes** **(3.23)**	Y2 175 pollen from flowers	Y2 17.8 nectar from flowers	**Yes** **(14.1)**	**Yes** **(11.3)**	**Yes** **(3.07)**	*Registered at 2 x 70 g ai/ha, at 7 day intervals (maximum seasonal rate of 140 g ai/ha)* **Outdoor Ornamentals** *Registered at 2 x 75 g ai/ha, at 14 day intervals (maximum seasonal rate of 150 g ai/ha)*
Phacelia Applied at 1 x 5 g a.i./ha during bloom. Sampling occurred 7 and 27 DALA. Tunnel conditions. Low application rate could represent drift from foliar use.	28 Pollen from hive	NA	No (0.00)	No (0.06)	No (0.00)	22 Pollen from hive	NA	No (0.00)	No (0.09)	No (0.01)	Potentially relevant for drift.

CG = crop group, DALA = days after last application, DAP = days after planting, EEC = estimated environmental concentration, RQ = risk quotient, Y = year

Bold values indicate that acute LOC (RQ ≥0.4 acute and 1.0 chronic) is exceeded.

[1] Acute RQ = Acute estimated daily dose (EDD)/acute toxicity endpoint

Acute EDD = nectar dose [nectar consumption rate (mg/day) x maximum nectar residue (µg/kg)/ 1.0 x 10^6] + pollen dose [pollen consumption rate (mg/day) x maximum pollen residue (µg/kg)/1.0 x 10^6]

[2] Chronic RQ = Chronic estimated daily dose (EDD)/acute toxicity endpoint

Chronic EDD = nectar dose [nectar consumption rate (mg/day) x maximum nectar residue (µg/kg)/ 1.0 x 10^6] + pollen dose

Daily consumption rate used for adult worker bees foraging for nectar: 292 mg/day nectar; 0.041 mg/day pollen; 292 mg/day total

Daily consumption rate used for adult nurse bees: 140 mg/day nectar; 9.6 mg/day pollen; 149.6 mg/day total

Daily consumption rate used for bee larvae: 120 mg/day nectar; 3.6 mg/day pollen; 124 mg/day total

Note, for thiamethoxam RA: adult acute oral **LD50 = 0.0044 µg a.i./bee for TGAI;** bee larvae acute **7-day LD_{50} = 0.78 µg a.i./larva/day for TGAI**

Note, for thiamethoxam RA: adult chronic oral **NOED = 0.00245 µg a.i./bee for TGAI;** bee larvae chronic **22-day NOED = 0.0157 µg a.i./larva/day for TGAI**

Note, for clothianidin equivalents RA: adult acute oral **LD50 = 0.00368 µg a.i./bee for TGAI;** bee larvae acute **7-day LD_{50} = >0.0018 µg a.i./larva/day**

Note, for clothianidin equivalents RA: adult chronic **NOED = 0.000368 µg a.i./bee/day;** bee larvae chronic **NOED = 0.0009 µg a.i./larva/day**
NOTE: residues are adjusted for molar ratio of thiamethoxam to clothianidin (0.856), and added to clothianidin in cases whereby clothianidin residues are high enough to contribute to the risk profile.
[2] Standardized maximum value either ½ LOD or ½ LOQ or ½ LOD +LOQ

Tier II refined level risk assessment

Table 4 Foliar Application: Colony Level Risk to *Apis* and non-*Apis* bees Based on Mean Residues of clothianidin equivalents (c.e.) (table spans multiple pages)

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Bee bread***	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**		
Orchard crops											
Cherry Applied at 2 x 96 g a.i./ha, post-bloom 7 and 14 days before fruit harvest, Year 1 (Y1). Y1: 324, 304 and 314 DALA Y2: 321, 306 and 315 DALA	Y1: 37.1 pollen from flowers Y2: 157 pollen from flowers	Y1: 0.63 nectar from flowers Y2: 0.75 nectar from flowers	Range (Y1) 18.1 (Y2) 71.6	**Sandrock 2014[+] LOEC (6.6)** **Straub 2016[+] LOEC (6.3 ppb)** **Williams 2015[+] LOEC (4.5)**	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014[+] LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4)	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Cherry is a registered crop. Post bloom study application is consistent with application timing for pear and apple and cherry (for post bloom only). Single study rate is consistent with maximum post bloom pear and apple rate. Single study rate is higher than cherry rate. Pre-bloom application timing scenario not represented for apple or cherry.	**CG 12: Cherry (Stone fruit)(for post bloom)** *Registered at 2 x 40 g a.i./ha, at 7 day intervals (maximum seasonal rate 80 g a.i./ha) (can apply anytime)* **Potentially Relevant for Other Labelled Crop(s):** **CG 12: Pome fruit (pear and oriental pear)** *Registered at 2 x 79-96 g a.i./ha, at 10 day intervals (maximum seasonal rate 192 g a.i./ha) (post-bloom)* **CG 12: Pome fruit (apple and crabapple) (for post bloom)** *Registered at 2 x 96 g a.i./ha, at 10 day intervals (maximum seasonal rate 192 g a.i./ha) (post-bloom)* *NOTE: pome fruit is also registered for pre-bloom application at one application of 40-79 g ai/ha.*

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Bee bread***	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**		
								LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
Peach Applied at 2 x 96 g a.i./ha, post-bloom 7 and 14 days before fruit harvest, Year 1 (Y1). Y1: 297, 300 and 168 DALA Y2: 266, 284 and 249 DALA	Y1: 29.1 pollen from flowers Y2: 92.5 pollen from flowers	Y1: <LOQ nectar from flowers Y2: 0.70 nectar from flowers	Range (Y1) 13.6 (Y2) 42.8	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)** **Williams 2015+ LOEC (4.5)**	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29)	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05)	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Peach is not a registered crop, however stone fruits are registered. Post bloom study application is consistent with application timing for pear and apple and cherry (for post bloom only). Single study rate is consistent with maximum post bloom pear and apple rate. Single study rate is higher than cherry rate. Pre-bloom application timing scenario not represented for apple or cherry.	**Potentially Relevant for Other Stone fruit labelled Crop(s):** **CG 12: Cherry (Stone fruit)(for post bloom)** *Registered at 2 x 40 g a.i./ha, at 7 day intervals (maximum seasonal rate 80 g a.i./ha) (can apply anytime)* **Potentially Relevant for Other Labelled Crop(s):** **CG 11: Pome fruit (pear and oriental pear)** *Registered at 2 x 79-96 g a.i./ha, at 10 day intervals (maximum seasonal rate 192 g a.i./ha) (post-bloom)* **CG 12: Pome fruit (apple and**

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Bee bread***	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**		
					NOEC (19)			Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			**crabapple) (for post bloom)** *Registered at 2 x 96 g a.i./ha, at 10 day intervals (maximum seasonal rate 192 g a.i./ha) (post-bloom)* *NOTE: pome fruit is also registered for pre-bloom application at one application of 40-79 g ai/ha.* **Outdoor Ornamentals** *Registered at 2 x 75 g ai/ha, at 14 day intervals (maximum seasonal rate of 150 g ai/ha)*
Peach Applied at 1 x 62.5 g a.i./ha, pre-bloom 15 or 6 days before bloom Several sampling events between 10 and 23 days after application.	<LOQ (4.28 ppb) pollen from flowers	<LOQ (4.28 ppb) nectar from flowers	6.8	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) **Williams 2015+ LOEC (4.5)**	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19)	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) **Stanley 2015 & 2016 LOEC (2.05)**	**Fauser-Misslin 2014 LOEC (4.9)** Elston 2013 LOEC (8.56)	Peach is not a registered crop, however stonefruits are registered. Pre- bloom study application is consistent with application timing for pre bloom apple and pre-bloom cherry. Not as relevant for pear post bloom, or post bloom apple. Single study rate is lower than maximum pre bloom apple rate (but within range) Pre-bloom application timing scenario not represented for pear.	**Potentially Relevant for Other Stone fruit labelled Crop(s):** **CG 12: Cherry (Stone fruit)(for pre bloom)** *Registered at 2 x 40 g a.i./ha, at 7 day intervals (maximum seasonal rate 80 g a.i./ha) (can be applied anytime)* **Potentially Relevant for Other Labelled Crop(s):** **CG 12: Pome fruit (pear and oriental pear)** *Registered at 2 x 79-96 g a.i./ha, at 10 day intervals (maximum seasonal rate 192 g a.i./ha) (post-*

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
					2016 CLO CFS LOEC (29) NOEC (19)			**Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			*bloom)* **CG 12: Pome fruit (apple and crabapple) (for post bloom)** *Registered at 2 x 96 g a.i./ha, at 10 day intervals (maximum seasonal rate 192 g a.i./ha) (post-bloom)* *NOTE: pome fruit is also registered for pre-bloom application at one application of 40-79 g ai/ha.* **Outdoor Ornamentals** *Registered at 2 x 75 g ai/ha, at 14 day intervals (maximum seasonal rate of 150 g ai/ha)*
Plum Applied at 2 x 96 g a.i./ha, post-bloom 7 and 14 days before fruit harvest, Year 1 (Y1). Y1: 268, 287 and 286/195 DALA Y2: 234 and 231 DALA	Y1: 94.2 pollen from flowers Y2: 22.4 pollen from flowers	Y1: 2.41 nectar from flowers Y2: 0.29 nectar from flowers	Range (Y1) 45.3 (Y2) 11.7	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)** **Williams 2015+ LOEC**	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) **Stanley 2015 &**	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Plum is not a registered crop, however stonefruits are registered. Post bloom study application is consistent with application timing for pear and apple and cherry (for post bloom only). Single study rate is consistent with maximum post bloom pear and apple rate.	**Potentially Relevant for Other Stone fruit labelled Crop(s):** **CG 12: Cherry (Stone fruit)(for post bloom)** *Registered at 2 x 40 g a.i./ha, at 7 day intervals (maximum seasonal rate 80 g a.i./ha) (can be applied anytime)* **Potentially Relevant for Other Labelled Crop(s):**

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
				(4.5)	CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)			**2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) **Moffat 2016 LOEC (2.14)**		Single study rate is higher than cherry rate. Pre-bloom application timing scenario not represented for apple or cherry.	**CG 12: Pome fruit (pear and oriental pear)** *Registered at 2 x 79-96 g a.i./ha, at 10 day intervals (maximum seasonal rate 192 g a.i./ha) (post-bloom)* **CG 12: Pome fruit (apple and crabapple) (for post bloom)** *Registered at 2 x 96 g a.i./ha, at 10 day intervals (maximum seasonal rate 192 g a.i./ha) (post-bloom)* *NOTE: pome fruit is also registered for pre-bloom application at one application of 40-79 g ai/ha.*
Apple Applied at 1 x 96.41 g ai/ha pre-bloom. Three sampling events after last application ranging from 5 to 13 DAA).	1364 to 1712	37.7 to 486	656 to 1317	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)**	**2014 TMX CFS LOEC (34) NOEC (25.3)** **2016 TMX CFS LOEC (69.6)**	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)**	**Fauser-Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC**	Stanley and Raine 2017 NOEC (8.56) **Stanley and Raine 2015**	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Apple is a registered crop. Pre-bloom study application is consistent with application timing for pear and apple and cherry. Single study rate is above pre bloom pome and stone fruit rate.	**CG 12: Pome fruit (apple and crabapple)(for pre bloom)** *Registered at 2 x 96 g a.i./ha, at 10 day intervals (maximum seasonal rate 192 g a.i./ha) (post-bloom)* *NOTE: pome fruit is also registered for pre-bloom application at one application of 40-79 g ai/ha.*

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
				Williams 2015[+] LOEC (4.5)	**NOEC (34.8)** **2014 CLO CFS LOEC (35.6) NOEC (19)** **2016 CLO CFS LOEC (29) NOEC (19)**	**Williams 2015 LOEC (4.5)**	**(8.56)**	**LOEC (8.56)** **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** **Laycock 2014 NOEC (13.4) LOEC (39)** **Mommaerts 2010 NOEC (85.6)** **Sandrock 2014[+] LOEC (2.9)** **Moffat 2016 LOEC (2.14)**		During bloom timing is not represented for stone fruit.	**Potentially Relevant for Other Stone fruit labelled Crop(s):** **CG 12: Cherry (Stone fruit)(for post bloom)** *Registered at 2 x 40 g a.i./ha, at 7 day intervals (maximum seasonal rate 80 g a.i./ha) (can be applied anytime)*

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Bee bread***	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**		
Cucurbits											
Pumpkin Applied at 1 or 2 x 96 g a.i./ha during bloom Study conducted for 2 consecutive years. 7-10 DALA	1 app 2010 13.1 2 apps 2009 **81.5** 2 apps 2010 21.57 pollen from flowers	1 app 2010 1.37 2 apps 2009 **7.02** 2 apps 2010 3.68 nectar from flowers	1 app 2010 7.5 2 apps 2009 45 2 apps 2010 13	**Sandrock 2014^{+} LOEC (6.6)** **Straub 2016^{+} LOEC (6.3 ppb)** **Williams 2015^{+} LOEC (4.5)**	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014^{+} LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) **Sandrock 2014^{+} LOEC**	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Cucurbits are not a registered use for foliar applications. During-bloom application timing scenario represented (for vegetable crops) Higher rate than vegetables crops Maximum residues were from two years of application which is a relevant use scenario.	**Potentially Relevant for Other Labelled Crop(s):** **Potato from Crop Group 1: Root and Tuber vegetables** *Registered at 2 x 26 g ai/ha, at 7-10 day intervals (maximum seasonal rate of 52 g ai/ha)* **Field peppers from Crop group 8: Fruiting vegetables** *Registered at 2 x 70 g ai/ha, at 7 day intervals (maximum seasonal rate of 140 g ai/ha)* **Outdoor Ornamentals** *Registered at 2 x 75 g ai/ha, at 14 day intervals (maximum seasonal rate of 150 g ai/ha)*

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								(2.9) **Moffat 2016 LOEC (2.14)**			
Cucumber Applied at 2 x 96 g a.i./ha pre bloom application at 10 and 15 day intervals before bloom. Sampling occurred early, mid and late bloom 5, 10 and 15 DALA	1004 pollen from flowers	156 nectar from flowers	Range 627 (using total residues)	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)** **Williams 2015+ LOEC (4.5)**	**2014 TMX CFS LOEC (34) NOEC (25.3)** **2016 TMX CFS LOEC (69.6) NOEC (34.8)** **2014 CLO CFS LOEC (35.6) NOEC (19)** **2016 CLO CFS LOEC (29) NOEC (19)**	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Stanley and Raine 2017 NOEC (8.56) **Stanley and Raine 2015 LOEC (8.56)** **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** **Laycock 2014 NOEC (13.4) LOEC (39)** **Mommaerts 2010 NOEC (85.6)**	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Cucumber (Cucurbits) are not a registered use for foliar applications. Pre-bloom application timing scenario represented (for fruiting vegetables) During bloom application timing scenario not represented. Higher rate than vegetables crops. Similar rate to ornamentals.	
Total Cucumber residues	1049 pollen from flowers	168.2 nectar from flowers									

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Bee bread***	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**		
								Sandrock 2014⁺ LOEC (2.9) **Moffat 2016 LOEC (2.14)**			
Honeydew melon Applied at 1 x 100 g a.i./ha pre bloom application X days before bloom. Sampling occurred 6-15 DALA Tunnel conditions. NOTE: Only one sample, therefore, not a true mean.	33.4 pollen from bees	13.7 nectar from bees	30.4	**Sandrock 2014⁺ LOEC (6.6)** **Straub 2016⁺ LOEC (6.3 ppb)** **Williams 2015⁺ LOEC (4.5)**	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014⁺ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Stanley and Raine 2017 NOEC (8.56) **Stanley and Raine 2015 LOEC (8.56)** **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39)	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Honeydew melons (Cucurbits) are not a registered use for foliar applications. Pre-bloom application timing scenario represented (for fruiting vegetables) During bloom application timing scenario not represented. Higher rate than vegetables crops. Lower maximum rate than ornamentals.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								Mommaerts 2010 NOEC (85.6) **Sandrock 2014+ LOEC (2.9)** **Moffat 2016 LOEC (2.14)**			
Tomato Applied at 2 x 96 g a.i./ha pre bloom application at 5 and 10 day intervals before bloom. Sampling occurred early, mid and late bloom 5, 10 and 15 DALA	578 to 1118 pollen from flowers 0.81 Pollen from bees	NA	Range 525 to 1021 (using total residue) (excluding 4083 ppb) Bee collected 4.2	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)** **Williams 2015+ LOEC (4.5)**	NA	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	NA	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Tomatoes are a registered use for foliar applications. Pre-bloom application timing scenario represented (for fruiting vegetables) During bloom application timing scenario not represented. Higher rate than vegetables crops. Similar rate to ornamentals. Residues from California (11703 ppb) were excluded because of possible contamination. One site contained pollen collected from bees.	**Tomatoes from Crop Group 8: Fruiting vegetables** *Registered at 2 x 26.25 g ai/ha at 7 day intervals, or 1 x 52.5 g ai/ha, (maximum seasonal rate of 52.5 g ai/ha)* **Potentially Relevant for Other Labelled Crop(s):** **Potato from Crop Group 1: Root and Tuber vegetables** *Registered at 2 x 26 g ai/ha, at 7-10 day intervals (maximum seasonal rate of 52 g ai/ha)* **Field peppers from Crop group 8: Fruiting vegetables** *Registered at 2 x 70 g ai/ha, at 7 day intervals (maximum seasonal rate of 140 g ai/ha)* **Outdoor Ornamentals**
Total tomato residues	1169 to 2269	N/A		No risk from honey bee collected pollen		No risk from honey bee collected pollen	No risk from honey bee collected pollen		No risk from honey bee collected pollen		

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
											Registered at 2 x 75 g ai/ha, at 14 day intervals (maximum seasonal rate of 150 g ai/ha)
Berries and Bushberries											
Strawberry Applied at 3 x 70.62 g ai/ha with 10 day intervals, pre-bloom. Applications were 25, 15 and 5 days before bloom. Sampling generally occurred 5 o6 days after last application.	149 to 5749	110 to 326	190 to 2956	**Sandrock 2014⁺ LOEC (6.6)** **Straub 2016⁺ LOEC (6.3 ppb)** **Williams 2015⁺ LOEC (4.5)**	**2014 TMX CFS LOEC (34) NOEC (25.3)** **2016 TMX CFS LOEC (69.6) NOEC (34.8)** **2014 CLO CFS LOEC (35.6) NOEC (19)** **2016 CLO CFS LOEC (29) NOEC (19)**	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014⁺ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Stanley and Raine 2017 NOEC (8.56) **Stanley and Raine 2015 LOEC (8.56)** **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** **Laycock 2014 NOEC (13.4) LOEC (39)** **Mommaerts 2010 NOEC (85.6)**	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Strawberry is a registered crop During bloom application timing scenario not represented. Higher rate than berry crops.	Potential risk from nectar, pollen and bee bread. Uncertainty with bee bread assessment. **Low growing berries from Crop Group 13-07G** *Registered at 2 x 52.5-70 g ai/ha, at 7 day intervals (maximum seasonal rate of 140 g ai/ha)* **Caneberry from Crop Group 13-07A** *Registered at 2 x 52.5-70 g ai/ha, at 7 day intervals (maximum seasonal rate of 140 g ai/ha)*

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Bee bread***	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**		
								Sandrock 2014⁺ LOEC (2.9) **Moffat 2016 LOEC (2.14)**			
Cranberry Applied at 3 x 70 g a.i./ha pre bloom application at 5, 12 and 19 day intervals before bloom. Sampling occurred early, mid and late bloom 5, 10 and 15 DALA	38 to 1169 pollen from flowers	151 to 989 nectar from flowers	Range 301 to 1721 (using total residue)	**Sandrock 2014⁺ LOEC (6.6)** **Straub 2016⁺ LOEC (6.3 ppb)** **Williams 2015⁺ LOEC (4.5)**	**2014 TMX CFS LOEC (34) NOEC (25.3)** **2016 TMX CFS LOEC (69.6) NOEC (34.8)** **2014 CLO CFS LOEC (35.6) NOEC (19)** **2016 CLO CFS LOEC (29) NOEC (19)**	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014⁺ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Stanley and Raine 2017 NOEC (8.56) **Stanley and Raine 2015 LOEC (8.56)** **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** **Laycock 2014 NOEC (13.4) LOEC (39)**	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Cranberries are registered for foliar applications (low growing berries). Pre-bloom application timing scenario represented. During bloom application timing scenario not represented. Higher rate than berry crops. Cranberries are typically grown in bog soils, and therefore the growing conditions are unique to cranberries. The residues may be a conservative estimate. Cranberry is a perennial vine plant and some of the berries (e.g. blueberries and caneberries) flower on old wood. The woody nature of cranberries would be similar to other berries, but the perennial nature of cranberries is different than bush berries.	
Total cranberry residues	269.6 to 1185	160.5 to 1056.7									

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								Mommaerts 2010 NOEC (85.6) **Sandrock 2014⁺ LOEC (2.9)** **Moffat 2016 LOEC (2.14)**			
Beans and soybeans											
Soybean Applied at 2 x 70.63 g ai/ha pre-bloom with 7 day intervals. Last application was 5 days before bloom.	13 to 48.6 Anther	459 Flower 0.39 to 2.0 Nectar from bees Total Up to 9.5	7.4 to 28 Using flower for nectar, bee bread would be 207 ppb	**Sandrock 2014⁺ LOEC (6.6)** **Straub 2016⁺ LOEC (6.3 ppb)** **Williams 2015⁺ LOEC (4.5)**	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014⁺ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Stanley and Raine 2017 NOEC (8.56) **Stanley and Raine 2015 LOEC (8.56)** **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)**	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Soybean is a registered crop During bloom application timing scenario not represented. Higher rate than soybean and bean crops.	**Soybeans and shelled beans from Crop Group 6: Legume vegetables** *Registered at 3 x 25.4 g ai/ha, at 7 day intervals (maximum seasonal rate of 76.2 g ai/ha)*

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
					(19) Risk from flowers			**Laycock 2014 NOEC (13.4) LOEC (39)** **Mommaerts 2010 NOEC (85.6)** **Sandrock 2014⁺ LOEC (2.9)** **Moffat 2016 LOEC (2.14)** No risk from bee nectar			
Other crops											
Cotton Applied at 2 x 71 g a.i./ha pre bloom application at 5 day intervals; last application target 12 days before flower. Same treatment for two consecutive years. Sampling occurred 9-	Y1 20.7 Y2 175 pollen from flowers	Y1 3.77 Y2 17.8 nectar from flowers	Range (Y1) 14.7 (Y2) 99	**Sandrock 2014⁺ LOEC (6.6)** **Straub 2016⁺ LOEC (6.3 ppb)** **Williams 2015⁺**	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8)	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC**	**Fauser-Misslin 2014⁺ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Stanley and Raine 2017 NOEC (8.56) **Stanley and Raine 2015 LOEC (8.56)** **Stanley 2015 &**	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Cotton is not grown in Canada. Pre-bloom application timing scenario represented. During bloom application timing scenario not represented. Similar rate to fruiting vegetables and berries.	**Potentially Relevant for Other Crop(s):** **Potato from Crop Group 1: Root and Tuber vegetables** *Registered at 2 x 26 g ai/ha, at 7-10 day intervals (maximum seasonal rate of 52 g ai/ha)* **Field peppers from Crop Group 8: Fruiting vegetables** *Registered at 2 x 70 g ai/ha, at 7*

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Bee bread***	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**		
14 DALA				**LOEC (4.5)**	2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	**(4.5)**		**2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) **Sandrock 2014⁺ LOEC (2.9)** **Moffat 2016 LOEC (2.14)**		Lower rate than ornamentals. Range of residues considered. Since flowers only last a few days, there is potential for loss of residues from spent flowers, and thus the residues may not be a conservative. estimate	*day intervals (maximum seasonal rate of 140 g ai/ha)* **Outdoor Ornamentals** *Registered at 2 x 75 g ai/ha, at 14 day intervals (maximum seasonal rate of 150 g ai/ha)*
Phacelia Applied at 1 x 5 g a.i./ha during bloom. Sampling occurred 7 and 27 DALA. Tunnel conditions.	18.8 Pollen from hive	NA	8.5	**Sandrock 2014⁺ LOEC (6.6)** **Straub 2016⁺ LOEC (6.3 ppb)**	NA	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)**	**Fauser-Misslin 2014⁺ LOEC (4.9)** **Elston 2013 LOEC**	NA	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Low application rate could represent drift from foliar use.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
				Williams 2015+ LOEC (4.5)		**Williams 2015 LOEC (4.5)**	**(8.56)**				

CFS = colony feeding study, CG = crop group, CLO = clothianidin, DALA = days after last application, DAP = days after planting, EEC = estimated environmental concentration, RQ = risk quotient, TMX = thiamethoxam, Y = year

Bold values indicate that acute LOC (RQ ≥1.0) is exceeded.

NOTE: residues are adjusted for molar ratio of thiamethoxam to clothianidin (0.856)

NOTE: for thiamethoxam CFS from registrant, endpoints were also compared to thiamethoxam residues (see mean residues from Tier I refined level assessment)

[1]Chronic RQ = Chronic estimated daily dose (EDD)/acute toxicity endpoint

Chronic EDD = nectar dose [nectar consumption rate (mg/day) x maximum nectar residue (µg/kg)/ 1.0 x 10^6] + pollen dose [pollen consumption rate (mg/day) x maximum pollen residue (µg/kg)/1.0 x 10^6]

Daily consumption rate used for adult worker bees foraging for nectar: 292 mg/day nectar; 0.041 mg/day pollen; 292 mg/day total

Daily consumption rate used for adult nurse bees: 140 mg/day nectar; 9.6 mg/day pollen; 149.6 mg/day total

Daily consumption rate used for bee larvae: 120 mg/day nectar; 3.6 mg/day pollen; 124 mg/day total

Details on endpoints including strength and limitations can be found in Appendix X

***Bee bread is calculated based on molar adjusted thiamethoxam pollen and nectar.**

[2]Standardized maximum value either ½ LOD or ½ LOQ or ½ LOD +LOQ

\+ These studies were conducted with both thiamethoxam and clothianidin

Appendix VII Pollinator Risk Assessment for Soil Application of Thiamethoxam

Tier I Default Assessment for Soil Applications

Table 1 RQ (risk quotient) for oral exposure from thiamethoxam and clothianidin equivalents

Chemical	Application rate (EEC)	Koch and Weiber (adjustment factor)	Exposure (EEC)	Toxicity endpoint	RQs (EEC/ toxicity endpoint)	LOC exceeded?
	kg ai/ha	µg ai/bee per kg ai/ha	µg ai/bee	µg ai/bee		
Thiamethoxam* **adults (acute)**	0.0485	0.292 x Briggs EEC (0.005)	0.002	LC50: 0.0044	0.45	yes
	0.150	0.292 x Briggs EEC (0.016)	0.005	LC50: 0.0044	1.1	yes
Thiamethoxam* **adults (chronic)**	0.0485	0.292 x Briggs EEC (0.005)	0.002	NOED: 0.00245	0.82	no
	0.150	0.292 x Briggs EEC (0.016)	0.005	NOED: 0.00245	2.0	yes
Thiamethoxam* **brood**	0.0485	0.124 x Briggs EEC (0.005)	0.001	LC50: 0.78	0.001	no
	0.150	0.124 x Briggs EEC (0.016)	0.002	LC50: 0.78	0.002	no
Thiamethoxam* **brood**	0.025	0.124 x Briggs EEC (0.005)	0.001	NOED: 0.0157	0.06	no
	0.150	0.124 x Briggs EEC (0.016)	0.002	NOED: 0.0157	0.13	no
clothianidin equivalents ** **adults (acute)**	0.0415	0.292 x Briggs EEC (0.005) (x 0.856)	0.0013	LC50: 0.00368	0.35	No
	0.128	0.292 x Briggs EEC (0.016) (x 0.856)	0.004	LC50: 0.00368	1.1	yes
clothianidin equivalents** **adults (chronic)**	0.0415	0.292 x Briggs EEC (0.005) (x 0.856)	0.0013	NOEC: 0.000368	3.5	yes
	0.128	0.292 x Briggs EEC (0.016) (x 0.856)	0.004	NOEC: 0.000368	11	yes
clothianidin equivalents** **brood**	0.0415	0.124 x Briggs EEC (0.005) (x 0.856)	0.0005	LC50: >0.0018	<0.28	no
				NOEL: 0.0009	0.56	no
	0.128	0.124 x Briggs EEC (0.016) (x 0.856)	0.0017	LC50: >0.0018	<0.94	yes
				NOEL: 0.0009	1.9	yes

*Exposure (for adults)= (0.292 µg a.i./bee/1kg a.i./ha x Briggs EEC at 0.150 kg a.i./ha (=0.016); exposure (for brood)= (0.124 µg a.i./bee/1kg a.i./ha x Briggs EEC at 0.150 kg a.i./ha (=0.016)
**Exposure (based on c.e.)= application rate (kg ai/ha)(x 0.856) x consumption factor (29 µg ai/bee per kg ai/ha for adults and 12.15 µg ai/bee per kg ai/ha for brood);
Note: LOC for bee is set at 0.4 for acute endpoints and 1 for chronic endpoints.
Lowest endpoint chosen from either thiamethoxam converted to c.e. or from clothianidin.

Tier I refined level risk assessment

Table 2 Soil Application: Acute and Chronic Dietary Risk to Different Bee Castes Based on Maximum and Mean Residues of Thiamethoxam (ppb) and also clothianidin equivalents (c.e.)

Sampled Crop & considerations	EEC - Maximum residue value in ppb / Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC – Mean residue value in ppb / Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Cucurbits											
Cucumber Applied at 1 x 192.8 g a.i./ha Study conducted for 2 consecutive years. One sampling event, at 53 - 54, 43 - 44 and 59 - 60 days after application in coarse, medium and fine soils, respectively. Cucurbits are registered use for soil applications. Rate is higher than registered rate. Applicable bloom and sampling time.	8.22 Pollen from flowers	11.5 Nectar from flowers	**Yes** **(0.76)**	No (0.38)	No (0.00)	5.66 Pollen from flowers	9 Nectar from flowers	**Yes** **(1.07)**	No (0.54)	No (0.07)	**CG 9: Cucurbit** *Registered at 1 x 88 - 150 g a.i./ha, in furrow before bloom* **Potentially Relevant for Other Labelled Crop(s):** **Potato from Crop Group 1: Root and Tuber vegetables** *Registered at 1 x 38 – 140 g ai/ha in furrow before bloom* **Greenhouse Ornamentals** *Registered at 200 to 300 g a.i./ha (greenhouse) before bloom*
	7.04 Pollen from flowers	9.8 Nectar from flowers	**Yes** **(0.78)**	No (0.39)	**Yes** **(0.67)**	4.84 Pollen from flowers	7.70 Nectar from flowers	**Yes** **(6.11)**	**Yes** **(3.06)**	**Yes** **(1.05)**	
Pumpkin Transplant water at 96 g ai/ha followed by drip irrigation 3 weeks later at 96 g ai/ha Sampling was initiated 5 weeks (35 days) after transplant; samples were collected for a period of 7 - 10 days.	69.2 Pollen from flowers	15.1 Nectar from flowers	**Yes** **(1.00)**	**Yes** **(0.63)**	No (0.00)	57.5 Pollen from flowers	10.7 Nectar from flowers	**Yes** **(1.28)**	No (0.84)	No (0.09)	
	53.8	12.9	**Yes** **(1.02)**	**Yes** **(0.63)**	**Yes** **(0.97)**	49.2	9.16	**Yes** **(7.27)**	**Yes** **(4.77)**	**Yes** **(1.42)**	

Sampled Crop & considerations	EEC - Maximum residue value in ppb / Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC – Mean residue value in ppb / Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
Cucurbits are registered use for soil applications. Rate is within rate for cucurbits. Rate is lower than other crops (except potato). Applicable bloom and sampling time.	Pollen from flowers	Nectar from flowers				Pollen from flowers	Nectar from flowers				
Pumpkin Drip irrigation at 2 rates (140 g ai/ha and 192.81 g ai/ha) in 3 different soil types (loamy sand, sand and clay loam). Sampling ranged from 37 to 69 days after application. Samples from nectar, pollen and whole flowers. Cucurbits are registered use for soil applications. Rate is within rate for cucurbits (for lower rate). Rate is higher than other crops (except potato). Applicable bloom and sampling time. There did not appear to be a trend	Range of soils 140 g ai/ha 1.42 (clay) to 8.35 (loamy) 192.8 g ai/ha 2.29 (clay) to 17 (sand) Pollen from flowers	Range of soils 140 g ai/ha 1.34 (clay) to 22 (sand) 192.8 g ai/ha 1.66 (clay) to 14 (loamy sand) Nectar from flowers	**Yes** 140 g ai/ha 0.11 to **1.75** 192.8 g ai/ha 0.13 to **1.15**	**Yes** 140 g ai/ha **0.42** to **0.86** 192.8 g ai/ha 0.13 to **0.60**	No 140 g ai/ha 0 192.8 g ai/ha 0	Range of soils 140 g ai/ha 1.06 (clay) to 4.5 (loamy) 192.8 g ai/ha 1.84 (clay) to 10 (sand) Pollen from flowers	Range of soils 140 g ai/ha 1.08 (clay) to 9.52 (sand) 192.8 g ai/ha 1.61 (clay) to 9.6 (loamy sand) Nectar from flowers	**Yes** 140 g ai/ha (0.13 to **1.13)** 192.8 g ai/ha (0.19 to **1.14**)	No 140 g ai/ha (0.07 to 0.56) 192.8 g ai/ha (0.10 to 0.59)	No 140 g ai/ha (0.01 to 0.07) 192.8 g ai/ha (0.01 to 0.08)	

Sampled Crop & considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC – Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
with rate. Samples were taken at different times in the different studies which could also account for differences in residues.	Range of soil types and rates 1.2 to 14.6 Pollen from flowers	Range of soil types and rates 1.15 to 18.9 Nectar from flowers	**Yes** (0.09 to **1.50**)	**Yes** (0.05 to **0.76**)	**Yes** (0.08 to **1.29**)	Range of soil types and rates 0.91 to 8.56 Pollen from flowers	Range of soil types and rates 0.92 to 8.2 Nectar from flowers	**Yes** (0.73 to **6.51**)	**Yes** (0.37 to **3.34**)	**Yes** (0.13 to **1.13**)	
Summer squash Drip irrigation at 1 rate (1 x 192.81 g ai/ha) in 3 different soil types (loamy sand, sand and clay loam). Sampling ranged from 35 to 51 days after application. Samples from nectar, pollen and whole flowers.	Range of soils 2.81 to 27.5 Pollen from flowers	Range of soils 3.3 to 32.4 Nectar from flowers	**Yes** (0.26 to **2.57**)	**Yes** (0.13 to **1.3)**	No (0 to 0.01)	Range of soils 2.36 to 18.73 Pollen from flowers	Range of soils 2.9 to 31.93 Nectar from flowers	**Yes** (0.35 to **3.81**)	**Yes** (0.17 to **1.9**)	No (0.02 to 0.25)	
Cucurbits are registered use for soil applications. Rate is higher than rate for cucurbits. Rate is higher than other crops (except potato). Applicable bloom and sampling time.	2.4 to 23.5 Pollen from flowers	2.8 to 27.7 Nectar from flowers	**Yes** (0.22 to **2.2)**	**Yes** (0.11 to **1.12)**	**Yes** (0.19 to **1.89)**	2.0 to 16 Pollen from flowers	2.5 to 27 Nectar from flowers	**Yes** (0.22 to **2.2)**	**Yes** (0.11 to **1.12)**	**Yes** (0.19 to **1.89)**	

Sampled Crop & considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC – Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
Muskmelon Drip irrigation at 1 rate (1 x 192.81 g ai/ha) in 3 different soil types (loamy sand, sand and clay loam). Sampling ranged from 35 to 51 days after application. Cucurbits are registered use for soil applications. Rate is higher than rate for cucurbits.	Range of soils* 7.56 to 193 (754 total residues) Pollen in plants	Range of soils 5.8 to 61.5 Nectar in plants	**Yes** **(0.46** to **4.88)**	Yes (0.24 to **2.84)**	No (0 to 0.01)	Range of soils* 4.92 to 66.8 (310 total residues) Pollen in plants	Range of soils 5.5 to 29.4 Nectar in plants	Yes (0.66 to **3.51)**	Yes (0.33 to **1.94)**	No (0.04 to 0.24)	
Rate is higher than other crops (except potato). Applicable bloom and sampling time.	6.45 to 165 Pollen from flowers	4.96 to 52.6 Nectar from flowers	**Yes** (0.39 to **4.18**)	**Yes** (0.21 to **2.43**)	**Yes** (0.34 to **3.84**)	4.2 to 56.7 Pollen from flowers	4.7 to 25 Nectar from flowers	**Yes** (**3.73** to **19.8**)	**Yes** (**1.9** to **10.99**)	**Yes** (0.64 to **3.56**)	
*There is high variability of residues in pollen at different sampling times. *Note: Thiamethoxam contributed to majority of total residues for nectar.*	**Total residues** 7.54 to 754 Pollen from flowers	**Total residues** 4.96 to 52.6 Nectar from flowers	**Yes** (0.39 to **4.2**)	**Yes** (0.21 to **3.97**)	**Yes** (0.35 to **5.01**)	**Total residues** 4.92 to 310 Pollen from flowers	**Total residues** 4.7 to 25 Nectar from flowers	**Yes** (**3.73** to **19.9**)	**Yes** (**1.92** to **17.6**)	**Yes** (0.65 to **4.57**)	

Sampled Crop & considerations	EEC - Maximum residue value in ppb / Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC – Mean residue value in ppb / Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
Melon Granular soil application, at transplant (1 x 39.6 g a.i./ha or 1 x 66 g a.i./ha) Two sampling events, at 35 and 49 - 51 days after application Cucurbits are registered use for soil applications. Rate is lower than rate for cucurbits. Rate is lower than other crops (except potato). Applicable bloom and sampling time.	No pollen collected. In anthers: 3	6.3 Nectar from flowers	**Yes** **(0.42)**	No (0.21)	No (0.00)	No pollen collected. In anthers: 3	3.73 Nectar from flowers	No (0.29)	No (0.19)	No (0.02)	
	No pollen collected. In anthers: 2.57	5.39 Nectar from flowers	**Yes** **(0.43)**	No (0.21)	No (0.36)	No pollen collected. In anthers: 2.57	3.19 Nectar from flowers	**Yes** **(2.53)**	**Yes** **(1.28)**	No (0.44)	
Fruiting vegetables											
Pepper Soil application, at planting (1 x 192.81 g a.i./ha) Different soils tested. Sampling occurred in early bloom, mid-bloom and late bloom (53 to 74 DALA) Fruiting vegetables are registered use for soil applications. Rate is higher than registered fruiting vegetable rate, and other crops (except ornamentals). Conservative for crops without nectar. Applicable bloom and sampling time.	46 to 181 Pollen from flowers	29 to 47.5 Nectar from flowers	**Yes** **(1.92 to 1.91)**	**Yes** **(1.02 to 3.15)**	No (0.00 to 0.01)	41.5 to 84.1 Pollen from flowers	20.7 Nectar from flowers	**Yes** **(2.47)**	**Yes** **(1.35 to 1.51)**	No (0.18)	**Crop group 8-09 (except cucurbits): Fruiting vegetables** *Registered at 1 x –90 - 150 g a.i./ha In-furrow as transplant water before bloom* **Potentially Relevant for Other Labelled Crop(s):** **Potato from Crop Group 1: Root and Tuber vegetables** *Registered at 1 x 38 – 140 g ai/ha in furrow before bloom* **Greenhouse Ornamentals**
	39.3 to 155 Pollen from flowers	24.8 to 40.7 Nectar from flowers	**Yes** **(1.97 to 3.23)**	**Yes** **(1.05 to 1.95)**	**Yes** **(1.73 to 3.02)**	35.5 to 72.0 Pollen from flowers	17.7 Nectar from flowers	**Yes** **(14.1 to 14.1)**	**Yes** **(7.66 to 8.16)**	**Yes** **(2.5 to 2.65)**	
	Total pepper residues 164 to 268	**Total pepper residues** 57.2 To 1384	**Yes** **(4.5 to 21)**	**Yes** **(2.6 to 13.8)**	**Yes** **(4.1 to 20.6)**	**Total pepper residues** 76.2 to 237	**Total pepper residues** 36.6	**Yes** **(29 to 29)**	**Yes** **(15.9 to 20.1)**	**Yes** **(5.2 to 5.8)**	

Sampled Crop & considerations	EEC - Maximum residue value in ppb / Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC – Mean residue value in ppb / Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
Tomato Chemigation in tomato (1 x 193 g a.i./ha). Same treatment for two consecutive years.	49.8 Flower only	N/A	No (0.00)	No (0.11)	No (0.00)	45.7 Flower only	N/A	No (0.00)	No (0.18)	No (0.01)	*Registered at 200 to 300 g a.i./ha (greenhouse) before bloom*
Sampling in the second year, at 34 -73 days after the last application. Fruiting vegetables are registered use for soil applications.	42.6 Flower only	N/A	No (0.00)	No (0.11)	No (0.09)	31.9 Flower only	N/A	No (0.00)	No (0.83)	No (0.13)	
Rate is higher than registered fruiting vegetable rate, and other crops (except ornamentals). Whole flower may be conservative matrix. Not conservative for crops with nectar. Applicable bloom and sampling time.	**Total tomato residues** 147	N/A	No (0.02)	No (0.37)	No (0.28)	**Total tomato residues** 141	N/A	No (0.02)	**Yes** **(3.7)**	No (0.56)	
Tomato In-furrow applications in Kansas (1 x 140 g ai/ha or 1 x 192.81 g ai/ha) Soil drench applications in Illinois (1 x 140 g ai/ha or 1 x 192.81 g ai/ha) Soil drip applications in California (1 x 140 g ai/ha or 1 x 192.81 g ai/ha)	Total residues 140 g ai/ha Range of soils 157 (drip) to 252 (in-furrow)	n/a	**Yes** Total residues 140 g ai/ha Range of soils **0.41** (drip) to	**Yes** Total residues 140 g ai/ha Range of soils 0 (drip and in-furrow)	No Total residues 140 g ai/ha Range of soils 0 (drip and in-furrow)	Total residues 140 g ai/ha Range of soils 118 (drip) to 200 (in-furrow)	n/a	No Total residues 140 g ai/ha Range of soils 0 (drip) to	No Total residues 140 g ai/ha Range of soils 0.46 (drip) to	No Total residues 140 g ai/ha Range of soils 0.01 (drip) to	

Sampled Crop & considerations	EEC - Maximum residue value in ppb / Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC – Mean residue value in ppb / Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
Fruiting vegetables are registered use for soil applications. Rate is higher than registered fruiting vegetable rate, and other crops (except ornamentals). Not conservative for crops with nectar. Applicable bloom and sampling time.	192.8 g ai/ha Range of soils 56 (drench) to 306 (in-furrow) Pollen from flowers		**0.66** (in-furrow) 192.8 g ai/ha Range of soils 0 (drench and in-furrow)	192.8 g ai/ha Range of soils 0.15 (drench) to **0.8** (in-furrow)	192.8 g ai/ha Range of soils 0 (drench) and in-furrow)	192.8 g ai/ha Range of soils 53 (drench) to 220 (in-furrow) Pollen from flowers		0 (in-furrow) 192.8 g ai/ha Range of soils 0 (drench) to 0 (in-furrow)	0.78 (in-furrow) 192.8 g ai/ha Range of soils 0.21 (drench) to 0.86 (in-furrow)	0.05 (in-furrow) 192.8 g ai/ha Range of soils 0.01 (drench) to 0.05 (in-furrow)	
	Total residues Range of soils and application rates and types 56 to 306 Pollen from flowers	N/A	No (0.0)	**Yes** (0.15 to **0.80**)	**Yes** (0.11 to **0.61**)	Total residues Range of soils and application rates 53 to 220 Pollen from flowers	N/A	No (0 to 0.02)	**Yes** (**1.38** to **5.74**)	No (0.21 to 0.88)	

Sampled Crop & considerations	EEC - Maximum residue value in ppb / Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC – Mean residue value in ppb / Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
Low growing berry crops											
Strawberry Drip irrigation at planting (1 x 144.61 or 210.75 g ai/ha). Application was made at 3 sites (2 in Florida and one in California). One site in Florida was applied in November (1) and the other site (2) was applied in October of 2016. Application in California was made in April. Berry crops are registered use for soil applications.	Range of soils and rates (no trend, therefore overall values considered) 89 to 1930* Pollen from flowers	Range of soils and rates (no trend, therefore overall values considered) 45 to 188* Nectar from flowers	**Yes (3.57 to 14.9)**	**Yes (1.94 to 12.19)**	No (0.01 to 0.04)	Range of soils and rates (no trend, therefore overall values considered) 54 to 1293* Pollen from flowers	Range of soils and rates (no trend, therefore overall values considered) 21 to 93* Nectar from flowers	**Yes (2.5 to 11)**	**Yes (1.41 to 10.4)**	**Yes** (0.7 to **1)**	**Low growing berries from Crop Group 13-07G** *Registered at 1 x 140 g a.i./ha soil drench before bloom*
High rate is higher than registered berry rate, and other crops (except ornamentals). Low rate is similar to berry rate. Applicable bloom and sampling time. *It is noted that control pollen from the California site contained residues at 111, 33 and 808 ppb at sampling day 55, 69 and 83, respectively; and control nectar from the Florida site contained residues at <LOD and 275 ppb at sampling day 55 and 62, respectively.	Range of soils and application rates 76 to 1652* Pollen from flowers	Range of soils and application rates 38.5 to 161* Nectar from flowers	**Yes (3.06 to 12.8)**	**Yes (1.66 to 10.4)**	**Yes (2.7 to 14)**	Range of soils and application rates 46 to 1107 Pollen from flowers	Range of soils and application rates 18 to 79.6 Nectar from flowers	**Yes (14 to 63)**	**Yes (8 to 59)**	**Yes (2.6 to 15)**	

Sampled Crop & considerations	EEC - Maximum residue value in ppb / Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC – Mean residue value in ppb / Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Trees/Orchard crops											
Orange Soil drench at 1 x 96, 145, 193, 288 or 623 g a.i./ha. Application timings: 120, 75 and 45 days prior to bloom (DPB).	96 g ai/ha 97.6 (Y2)	96 g ai/ha 3.61 (Y2)	No (0.24)	No (0.33)	No (0.00)	96 g ai/ha 36.4 (Y2)	96 g ai/ha 1.71 (Y2)	No (0.20)	No (0.24)	No (0.02)	**Potentially Relevant for Other Labelled Crop(s):** **Greenhouse Ornamentals**
One sampling event during flowering; corresponds to 71 - 119, 44 - 70 and 28 - 37 days after application for application timings of 120, 75 and 45 DPB, respectively.	96 g ai/ha 83.6 (Y2)	96 g ai/ha 3.09 (Y2)	No (0.25)	No (0.34)	No (0.37)	96 g ai/ha 31.2 (Y2)	96 g ai/ha 1.46 (Y2)	**Yes (1.16)**	**Yes (1.37)**	No (0.32)	*Registered at 200 to 300 g a.i./ha (greenhouse) before bloom*
Oranges are not grown in Canada. May represent woody species such as some berry plants and ornamentals.	145 g ai/ha 89	145 g ai/ha 14	**Yes (0.93)**	**Yes (0.64)**	No (0.00)	145 g ai/ha 36.1	145 g ai/ha 8.09	No (0.96)	No (0.6)	No (0.07)	
145 to 288 g ai/ha rates are relevant for berry and ornamental crops.	145 g ai/ha 76.2	145 g ai/ha 12.0	**Yes (0.95)**	**Yes (0.66)**	**Yes (0.95)**	145 g ai/ha 30.9	145 g ai/ha 6.93	**Yes (5.5)**	**Yes (3.44)**	**Yes (1.05)**	
	193 g ai/ha 25.3 (Y2)	193 g ai/ha 9.11 (Y1)	**Yes (0.60)**	No (0.35)	No (0.00)	193 g ai/ha 19.7 (Y2)	193 g ai/ha 5.48 (Y1)	No (0.65)	No (0.39)	No (0.05)	
	193 g ai/ha 21.7	193 g ai/ha 7.80	**Yes (0.62)**	No (0.35)	**Yes (0.56)**	193 g ai/ha 16.9	193 g ai/ha 4.69	**Yes (3.72)**	**Yes (2.23)**	No (0.69)	

Sampled Crop & considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC – Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
	(Y2)	(Y1)				(Y2)	(Y1)				
	288 g ai/ha 62.1 (Y2)	288 g ai/ha 31.3 (Y1)	**Yes** **(2.08)**	**Yes** **(1.13)**	No (0.01)	288 g ai/ha 32.8 (Y1)	288 g ai/ha 17.4 (Y1)	**Yes** **(2.07)**	**Yes** **(1.12)**	No (0.14)	
	288 g ai/ha 53.2 (Y2)	288 g ai/ha 26.8 (Y1)	**Yes** **(2.13)**	**Yes** **(1.16)**	**Yes** **(1.89)**	288 g ai/ha 28.1 (Y1)	288 g ai/ha 14.9 (Y1)	**Yes** **(11.83)**	**Yes** **(6.4)**	**Yes** **(2.26)**	
	623 g ai/ha 116 (Y1) Pollen from flowers	623 g ai/ha 35.3 (Y2) Nectar from flowers	**Yes** **(2.34)**	**Yes** **(1.38)**	No (0.01)	623 g ai/ha 91.3 (Y1) Pollen from flowers	623 g ai/ha 26.6 (Y2) Nectar from flowers	**Yes** **(3.17)**	**Yes** **(1.88)**	No (0.22)	
	623 g ai/ha 99.3 (Y1) Pollen from flowers	623 g ai/ha 30.2 (Y2) Nectar from flowers	**Yes** **(2.40)**	**Yes** **(1.41)**	**Yes** **(2.21)**	623 g ai/ha 78.2 (Y1) Pollen from flowers	623 g ai/ha 22.8 (Y2) Nectar from flowers	**Yes** **(18.1)**	**Yes** **(10.7)**	**Yes** **(3.35)**	
Orange Soil drench at 1 x 96, 193, 625 g a.i./ha.	Not collected	96 g ai/ha 4.31	No (0.29)	No (0.14)	No (0.00)	Navel does not produce pollen	96 g ai/ha Not calculated	Not calculated			

Sampled Crop & considerations	EEC - Maximum residue value in ppb / Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC – Mean residue value in ppb / Mean residue value in c.e. ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
One sampling event during flowering; corresponds to 117 - 126, 88 - 91 and 46 - 51 days after application for application timings of 150, 90 and 45 DPB, respectively. Oranges are not grown in Canada. May represent woody species such as some berry plants and ornamentals. 193 g ai/ha rate is most relevant for berry crops. Rate range outside of registered rate for ornamentals. Not conservative for plants with pollen exposure.		96 g ai/ha 3.69	No (0.29)	No (0.14)	No (0.25)		96 g ai/ha Not calculated				
		193 g ai/ha 6.91	**Yes** **(0.46)**	No (0.22)	No (0.00)		193 g ai/ha Not calculated				
		193 g ai/ha 5.91	**Yes** **(0.47)**	No (0.22)	No (0.39)		193 g ai/ha Not calculated				
		625 g ai/ha 30.5 Nectar from flowers	**Yes** **(2.02)**	**Yes** **(0.97)**	No (0.00)		625 g ai/ha 30.5 Not calculated				
		625 g ai/ha 26.1 Nectar from flowers	**Yes** **(2.07)**	**Yes** **(0.99)**	**Yes** **(1.74)**		625 g ai/ha 26.1 Not calculated				

CG = crop group, DALA = days after last application, DAP = days after planting, EEC = estimated environmental concentration, RQ = risk quotient, Y = year

NOTE: residues are adjusted for molar ratio of thiamethoxam to clothianidin (0.856)

Bold values indicate that acute LOC (RQ ≥0.4 acute and 1.0 chronic) is exceeded.

[1] Acute RQ = Acute estimated daily dose (EDD)/acute toxicity endpoint

Acute EDD = nectar dose [nectar consumption rate (mg/day) x maximum nectar residue (µg/kg)/ 1.0 x 106] + pollen dose [pollen consumption rate (mg/day) x maximum pollen residue (µg/kg)/1.0 x 106]

[2] Chronic RQ = Chronic estimated daily dose (EDD)/acute toxicity endpoint

Chronic EDD = nectar dose [nectar consumption rate (mg/day) x maximum nectar residue (µg/kg)/ 1.0 x 106] + pollen dose

Daily consumption rate used for adult worker bees foraging for nectar: 292 mg/day nectar; 0.041 mg/day pollen; 292 mg/day total

Daily consumption rate used for adult nurse bees: 140 mg/day nectar; 9.6 mg/day pollen; 149.6 mg/day total

Daily consumption rate used for bee larvae: 120 mg/day nectar; 3.6 mg/day pollen; 124 mg/day total

Note, for thiamethoxam RA: adult acute oral **LD50 = 0.0044 µg a.i./bee for TGAI;** bee larvae acute **7-day LD_{50} = 0.78 µg a.i./larva/day for TGAI**
Note, for thiamethoxam RA: adult chronic oral **NOED = 0.00245 µg a.i./bee for TGAI;** bee larvae chronic **22-day NOED = 0.0157 µg a.i./larva/day for TGAI**
Note, for clothianidin equivalents RA: adult acute oral **LD50 = 0.00368 µg a.i./bee for TGAI;** bee larvae acute **7-day LD_{50} = >0.0018 µg a.i./larva/day**
Note, for clothianidin equivalents RA: adult chronic **NOED = 0.000368 µg a.i./bee/day;** bee larvae chronic **NOED = 0.0009 µg a.i./larva/day**
NOTE: residues are adjusted for molar ratio of thiamethoxam to clothianidin (0.856), and added to clothianidin in cases whereby clothianidin residues are high enough to contribute to the risk profile.
[2] Standardized maximum value either ½ LOD or ½ LOQ or ½ LOD +LOQ

Tier II refined level risk assessment

Table 3 Soil Application: Colony Level Risk to *Apis* and non-*Apis* bees Based on Mean Residues of clothianidin equivalents (c.e.)

Sampled Crop	EEC - mean molar adjusted residue value in c.e. ppb			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
Cucurbits											
Cucumber Applied at 1 x 192.8 g a.i./ha Study conducted for 2 consecutive years. One sampling event, at 53 - 54, 43 - 44 and 59 - 60 days after application in coarse, medium and fine soils, respectively.	4.84 Pollen from flowers	7.70 Nectar from flowers	10.8	Sandrock 2014[+] LOEC (6.6) Straub 2016[+] LOEC (6.3 ppb) **Williams 2015[+]** **LOEC** **(4.5)**	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	**Sandrock 2014** **LOEC** **(6.6)** **Straub 2016** **LOEC** **(6.3 ppb)** **Williams 2015** **LOEC** **(4.5)**	Fauser-Misslin 2014[+] LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) **Stanley 2015 & 2016** **LOEC** **(2.05)** **Baron 2017** **LOEC** **(2.05)** Laycock 2014 NOEC (13.4) LOEC	**Fauser-Misslin 2014** **LOEC** **(4.9)** **Elston 2013** **LOEC** **(8.56)**	Cucurbits are registered use for soil applications. Rate is higher than registered rate. Applicable bloom and sampling time.	**CG 9: Cucurbit** *Registered at 1 x 88 - 150 g a.i./ha, in furrow before bloom* **Potentially Relevant for Other Labelled Crop(s):** **Potato from Crop Group 1: Root and Tuber vegetables** *Registered at 1 x 38 – 140 g ai/ha in furrow before bloom* **Greenhouse Ornamentals** *Registered at 200 to 300 g a.i./ha (greenhouse) before bloom*

Sampled Crop	EEC - mean molar adjusted residue value in c.e. ppb			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								(39) Mommaerts 2010 NOEC (85.6) **Sandrock 2014+ LOEC (2.9)** **Moffat 2016 LOEC (2.14)**			
Pumpkin Transplant water at 96 g ai/ha followed by drip irrigation 3 weeks later at 96 g ai/ha Sampling was initiated 5 weeks (35 days) after transplant; samples were collected for a period of 7 - 10 days.	49.2 Pollen from flowers	9.16 Nectar from flowers	33	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)** **Williams 2015+ LOEC (4.5)**	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Stanley and Raine 2017 NOEC (8.56) **Stanley and Raine 2015 LOEC (8.56)** **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)**	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Cucurbits are registered use for soil applications. Rate is within rate for cucurbits. Rate is lower than other crops (except potato). Applicable bloom and sampling time.	

Sampled Crop	EEC - mean molar adjusted residue value in c.e. ppb			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
					(19)			Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) **Sandrock 2014+ LOEC (2.9)** **Moffat 2016 LOEC (2.14)**			
Pumpkin Drip irrigation at 2 rates (140 g ai/ha and 192.81 g ai/ha) in 3 different soil types (loamy sand, sand and clay loam). Sampling ranged from 37 to 69 days after application. Samples from nectar, pollen and whole flowers.	Range of soils 140 g ai/ha 0.907 (clay) to 3.85 (loamy) 192.8 g ai/ha 1.58 (clay) to 8.56	Range of soils 140 g ai/ha 0.92 (clay) to 8.15 (sand) 192.8 g ai/ha 1.38 (clay) to	Range of soils 140 g ai/ha 1.44 (clay) to 10.9 (sand) 192.8 g ai/ha 2.26 (clay) to	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)** **Williams 2015+ LOEC (4.5)** No risk from lower rate (140 g/ha) or clay at 192 g	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19)	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)** No risk from clay at 140g/ha and 192 g/ha	**Fauser-Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC (8.56)** No risk from lower rate (140 g/ha) or clay at 192 g ai/ha	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) **Stanley 2015 & 2016 LOEC (2.05)**	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)** No risk from clay at 140g/ha and 192 g/ha	Cucurbits are registered use for soil applications. Rate is within rate for cucurbits (for lower rate). Rate is higher than other crops (except potato). Applicable bloom and sampling time. There did not appear to be a trend with rate. Samples were taken at	

Sampled Crop	EEC - mean molar adjusted residue value in c.e. ppb			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
	(sand) Pollen from flowers	8.2 (loamy sand) Nectar from flowers	13 loamy sand)	ai/ha	2016 CLO CFS LOEC (29) NOEC (19)			**Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) **Sandrock 2014+ LOEC (2.9)** **Moffat 2016 LOEC (2.14)**		different times in the different studies which could also account for differences in residues.	
Summer squash Drip irrigation at 1 rate (1 x 192.81 g ai/ha) in 3 different soil types (loamy sand, sand and clay loam). Sampling ranged from 35 to 51 days after application. -	Range of soils 2.0 to 16 Pollen from flowers	Range of soils 2.5 to 27.3 Nectar from flowers	Range of soils 3.7 to 37.9	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)** **Williams 2015+ LOEC (4.5)**	2014 TMX CFS LOEC (34) **NOEC (25.3)** 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC (8.56)** No risk at lower range	Stanley and Raine 2017 NOEC (8.56) **Stanley and Raine 2015 LOEC (8.56)** **Stanley 2015 &**	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)** No risk at lower range	Cucurbits are registered use for soil applications. Rate is higher than rate for cucurbits. Rate is higher than other crops (except potato). Applicable bloom and sampling time.	

Sampled Crop	EEC - mean molar adjusted residue value in c.e. ppb			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
Samples from nectar, pollen and whole flowers.				No risk at lower range	CFS LOEC (35.6) **NOEC (19)** 2016 CLO CFS LOEC (29) **NOEC (19)**	No risk at lower range		**2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) **Sandrock 2014+ LOEC (2.9)** **Moffat 2016 LOEC (2.14)** No risk at lower range			
Muskmelon Drip irrigation at 1 rate (1 x 192.81 g ai/ha) in 3 different soil types	Range of soils* 4.2 to	Range of soils 4.7 to 25.2	Range of soils 7.2 to 54	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+**	2014 TMX CFS LOEC (34) NOEC (25.3)	**Sandrock 2014 LOEC (6.6)** **Straub 2016**	**Fauser-Misslin 2014+ LOEC (4.9)**	Stanley and Raine 2017 NOEC (8.56)	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013**	Cucurbits are registered use for soil applications. Rate is higher than rate for cucurbits.	

Sampled Crop	EEC - mean molar adjusted residue value in c.e. ppb			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
(loamy sand, sand and clay loam). Sampling ranged from 35 to 51 days after application.	57.2	Nectar in plants		**LOEC (6.3 ppb)** **Williams 2015+ LOEC (4.5)** No risk at lower range	2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) **NOEC (19)** 2016 CLO CFS LOEC (29) **NOEC (19)**	**LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Elston 2013 LOEC (8.56)**	**Stanley and Raine 2015 LOEC (8.56)** **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) **Sandrock 2014+ LOEC (2.9)** **Moffat 2016 LOEC (2.14)** No risk at lower range	**LOEC (8.56)**	Rate is higher than other crops (except potato). Applicable bloom and sampling time. *Given the high variability of residues in pollen at different sampling times, there is some uncertainty in these values in the risk assessment.	

Sampled Crop	EEC - mean molar adjusted residue value in c.e. ppb			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
	(310 total residues) Pollen in plants		(144 to 168 considering total residues)		n/a			n/a			
Melon Granular soil application, at transplant (1 x 39.6 g a.i./ha or 1 x 66 g a.i./ha) Two sampling events, at 35 and 49 - 51 days after application	No pollen collected. In anthers: 2.57	3.19 Nectar from flowers	4.7	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) 2016 TMX CFS LOEC (69.6) 2014 CLO CFS LOEC (35.6) 2016 CLO CFS LOEC (29)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) **Williams 2015 LOEC (4.5)**	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6)	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Cucurbits are registered use for soil applications. Rate is lower than rate for cucurbits. Rate is lower than other crops (except potato). Applicable bloom and sampling time.	

Sampled Crop	EEC - mean molar adjusted residue value in c.e. ppb			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								Sandrock 2014⁺ LOEC (2.9) **Moffat 2016 LOEC (2.14)**			
Fruiting vegetables											
Pepper Soil application, at planting (1 x 192.81 g a.i./ha) Sampling occurred in early bloom, mid-bloom and late bloom (53 to 74 DALA)	Range 35.5 to 72.0 Pollen from flowers	17.7 Nectar from flowers	Range 35.9 to 52	**Sandrock 2014⁺ LOEC (6.6)** **Straub 2016⁺ LOEC (6.3 ppb)** **Williams 2015⁺ LOEC (4.5)**	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014⁺ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Stanley and Raine 2017 NOEC (8.56) **Stanley and Raine 2015 LOEC (8.56)** **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39)	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Fruiting vegetables are registered use for soil applications. Rate is higher than registered fruiting vegetable rate, and other crops (except ornamentals). Conservative for crops without nectar. Applicable bloom and sampling time.	**Crop group 8-09 (except cucurbits): Fruiting vegetables** *Registered at 1 x – 90 - 150 g a.i./ha In-furrow as transplant water before bloom* **Potentially Relevant for Other Labelled Crop(s):** **Potato from Crop Group 1: Root and Tuber vegetables** *Registered at 1 x 38 – 140 g ai/ha in furrow before bloom* **Greenhouse Ornamentals** *Registered at 200 to 300 g a.i./ha (greenhouse) before bloom*

Sampled Crop	EEC - mean molar adjusted residue value in c.e. ppb			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								Mommaerts 2010 NOEC (85.6) **Sandrock 2014+ LOEC (2.9)** **Moffat 2016 LOEC (2.14)**			
Total pepper residues	Range 76.2 to 237	36.6	Range 75 to 148	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)** **Williams 2015+ LOEC (4.5)**	**2014 TMX CFS LOEC (34) NOEC (25.3)** 2016 TMX CFS LOEC (69.6) **NOEC (34.8)** **2014 CLO CFS LOEC (35.6) NOEC (19)** **2016 CLO CFS LOEC (29) NOEC (19)**		**Fauser-Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	**Stanley and Raine 2017 NOEC (8.56)** **Stanley and Raine 2015 LOEC (8.56)** **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** Laycock 2014 NOEC	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**		

Sampled Crop	EEC - mean molar adjusted residue value in c.e. ppb			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								(13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) **Sandrock 2014+ LOEC (2.9)** **Moffat 2016 LOEC (2.14)**			
Tomato Chemigation in tomato (1 x 193 g a.i./ha). Same treatment for two consecutive years. Sampling in the second year, at 34 -73 days after the last application.	39.1 Flower only	N/A	17.6	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)** **Williams 2015+ LOEC (4.5)**	N/A	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	N/A	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Fruiting vegetables are registered use for soil applications. Rate is higher than registered fruiting vegetable rate, and other crops (except ornamentals). Whole flower may be conservative matrix. Not conservative for crops with nectar. Applicable bloom and sampling time.	
Total tomato residues	141	N/A	63								
Tomato	Total residues	N/A	Total residues	**Sandrock**	N/A	**Sandrock**	**Fauser-**	N/A	**Fauser-Misslin**	Fruiting vegetables are	

Sampled Crop	EEC - mean molar adjusted residue value in c.e. ppb			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Bee bread***	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**		
In-furrow applications in Kansas (1 x 140 g ai/ha or 1 x 192.81 g ai/ha) Soil drench applications in Illinois (1 x 140 g ai/ha or 1 x 192.81 g ai/ha) Soil drip applications in California (1 x 140 g ai/ha or 1 x 192.81 g ai/ha)	140 g ai/ha Range of soils 118 to 200 192.8 g ai/ha Range of soils 53 to 220 Pollen from flowers		140 g ai/ha Range of soils 45.5 to 77 192.8 g ai/ha Range of soils 20 to 85	**2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)** **Williams 2015+ LOEC (4.5)**		**2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC (8.56)**		**2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	registered use for soil applications. Rate is higher than registered fruiting vegetable rate, and other crops (except ornamentals). Not conservative for crops with nectar. Applicable bloom and sampling time.	
Low growing berry crops											
Strawberry Drip irrigation at planting (1 x 144.61 or 210.75 g ai/ha). Application was made at 3 sites (2 in Florida and one in California). One site in Florida was applied in November (1) and the other site (2) was applied in October of 2016. Application in California was made in April.	Range of soils and rates (no trend, therefore overall values considered) 46 to 1107* Pollen from flowers	Range of soils and rates (no trend, therefore overall values considered) 17.9 to 79.6* Nectar from flowers	Range of soils and rates 40.9 to 588*	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)** **Williams 2015+ LOEC (4.5)**	**2014 TMX CFS LOEC (34) NOEC (25.3)** **2016 TMX CFS LOEC (69.6) NOEC (34.8)** **2014 CLO CFS LOEC (35.6) NOEC (19)** **2016 CLO CFS LOEC (29)**	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	**Stanley and Raine 2017 NOEC (8.56)** **Stanley and Raine 2015 LOEC (8.56)** **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)**	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Berry crops are registered use for soil applications. High rate is higher than registered berry rate, and other crops (except ornamentals). Low rate is similar to berry rate. Applicable bloom and sampling time. Applications in Canada are permitted for post-renovation. *It is noted that control pollen from the California site contained residues at 111, 33	**Low growing berries from Crop Group 13-07G** *Registered at 1 x 140 g a.i./ha soil drench before bloom*

Sampled Crop	EEC - mean molar adjusted residue value in c.e. ppb			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
					NOEC (19)			**Laycock 2014 NOEC (13.4) LOEC (39)** Mommaerts 2010 NOEC (85.6) **Sandrock 2014+ LOEC (2.9)** **Moffat 2016 LOEC (2.14)**		and 808 ppb at sampling day 55, 69 and 83, respectively; and control nectar from the Florida site contained residues at <LOD and 275 ppb at sampling day 55 and 62, respectively.	
Trees/Orchard crops											
Orange Soil drench at 1 x 96, 145, 193, 288 or 623 g a.i./ha. Application timings: 120, 75 and 45 days prior to bloom (DPB). One sampling event during flowering; corresponds to 71 - 119, 44 - 70 and 28 - 37 days after application for application	96 g ai/ha 31.2 (Y2) 145 g ai/ha 30.9 193 g ai/ha 16.9	96 g ai/ha 1.46 (Y2) 145 g ai/ha 6.93 193 g ai/ha 4.69	Range 16 22 13 29 98	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)** **Williams 2015+ LOEC (4.5)**	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Stanley and Raine 2017 NOEC (8.56) **Stanley and Raine 2015 LOEC (8.56)** **Stanley 2015 & 2016 LOEC (2.05)**	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Oranges are not grown in Canada. May represent woody species such as some berry plants and ornamentals. 145 to 288 g ai/ha rates are relevant for berry and ornamental crops.	**Greenhouse Ornamentals** *Registered at 200 to 300 g a.i./ha (greenhouse) before bloom*

Sampled Crop	EEC - mean molar adjusted residue value in c.e. ppb			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
timings of 120, 75 and 45 DPB, respectively.	(Y2) 288 g ai/ha 28.1 (Y1) 623 g ai/ha 78.2 (Y1) Pollen from flowers	(Y1) 288 g ai/ha 14.9 (Y1) 623 g ai/ha 22.8 (Y2) Nectar from flowers			(19) 2016 CLO CFS LOEC (29) NOEC (19)			**Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) **Sandrock 2014+ LOEC (2.9)** **Moffat 2016 LOEC (2.14)** Less risk at 145 g/ha			
Orange Soil drench at 1 x 96, 193, 625 g a.i./ha. One sampling event during flowering; corresponds to 117 - 126, 88 - 91 and 46 - 51 days after application for application	Navel does not produce pollen	96 g ai/ha Not calculated 193 g ai/ha Not calculated 625 g ai/ha		N/A	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC	N/A	N/A	Stanley and Raine 2017 NOEC (8.56) **Stanley and Raine 2015 LOEC**	N/A	N/A	

Sampled Crop	EEC - mean molar adjusted residue value in c.e. ppb			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
timings of 150, 90 and 45 DPB, respectively.		26.1 Not calculated			(34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)			**(8.56)** **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) **Sandrock 2014[+] LOEC (2.9)** **Moffat 2016 LOEC (2.14)**			

CFS = colony feeding study, CG = crop group, CLO = clothianidin, DALA = days after last application, DAP = days after planting, EEC = estimated environmental concentration, RQ = risk quotient, TMX = thiamethoxam, Y = year

Bold values indicate that acute LOC (RQ ≥1.0) is exceeded.

NOTE: residues are adjusted for molar ratio of thiamethoxam to clothianidin (0.856)

NOTE: for thiamethoxam CFS from registrant, endpoints were also compared to thiamethoxam residues (see mean residues from Tier I refined level assessment)

[1] Chronic RQ = Chronic estimated daily dose (EDD)/acute toxicity endpoint

Chronic EDD = nectar dose [nectar consumption rate (mg/day) x maximum nectar residue (µg/kg)/ 1.0 x 10^6] + pollen dose [pollen consumption rate (mg/day) x maximum pollen residue (µg/kg)/1.0 x 10^6]

Daily consumption rate used for adult worker bees foraging for nectar: 292 mg/day nectar; 0.041 mg/day pollen; 292 mg/day total

Daily consumption rate used for adult nurse bees: 140 mg/day nectar; 9.6 mg/day pollen; 149.6 mg/day total
Daily consumption rate used for bee larvae: 120 mg/day nectar; 3.6 mg/day pollen; 124 mg/day total
Details on endpoints including strength and limitations can be found in Appendix X

* **Bee bread is calculated based on molar adjusted thiamethoxam pollen and nectar.**

2 Standardized maximum value either ½ LOD or ½ LOQ or ½ LOD +LOQ

+ These studies were conducted with both thiamethoxam and clothianidin

Appendix VIII Pollinator Risk Assessment for Seed Treatment of Thiamethoxam

Tier I screening level risk assessment

Table 1 RQ (risk quotient) for oral exposure from thiamethoxam and clothianidin equivalents

Chemical	Application rate (EEC)	Exposure (EEC)	Toxicity endpoint	RQs (EEC/ toxicity endpoint)	LOC exceeded?
	kg ai/ha	µg ai/bee	µg ai/bee		
Thiamethoxam * **adults (acute)**	0.0076	0.29	LC50: 0.0044	65	yes
	0.118	0.29	LC50: 0.0044	65	yes
Thiamethoxam* **adults (chronic)**	0.0076	0.29	NOED: 0.00245	118	yes
	0.118	0.29	NOED: 0.00245	118	yes
Thiamethoxam * **brood**	0.0076	0.12	LC50: 0.78	0.15	no
	0.118	0.12	LC50: 0.78	0.15	no
	0.0076	0.12	NOED: 0.0157	7.6	yes
	0.118	0.12	NOED: 0.0157	7.6	yes
clothianidin equivalents ** **adults (acute)**	0.0065	0.25	LC50: 0.00368	68	yes
	0.101	0.25	LC50: 0.00368	68	yes
clothianidin equivalents** **adults (chronic)**	0.0065	0.25	NOEC: 0.000368	679	yes
	0.101	0.25	NOEC: 0.000368	679	yes
clothianidin equivalents** **brood**	0.0065	0.10	LC50: >0.0018	<56	yes
	0.101	0.10	LC50: >0.0018	<56	yes
	0.0065	0.10	NOEL: 0.0009	111	yes
	0.101	0.10	NOEL: 0.0009	111	yes

* Adult dose from oral exposure (µg a.i./bee) = 1 µg a.i./bee x 0.292 g/day = 0.29 µg a.i./bee; Brood dose from oral exposure (µg a.i./bee) = 1 µg a.i./bee x 0.124 g/day = 0.12 µg a.i./bee
** Exposure (based on c.e.)= application rate (kg ai/ha)(x 0.856) x consumption factor
Note: LOC for bee is set at 0.4 for acute endpoints and 1 for chronic endpoints.
Lowest endpoint chosen from either thiamethoxam converted to c.e. or from clothianidin.

Tier I refined level risk assessment

Table 2 Seed Treatment Application: Acute and Chronic Dietary Risk to Different Bee Castes Based on Maximum and Mean Residues of Thiamethoxam (ppb) and also clothianidin equivalents (c.e.)

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Oil seed crops											
Canola Canola treated at 403 g a.i./100 kg seed (reported); 0.0081 - 0.022 mg a.i./seed (calculated) and 26 - 29 g a.i./ha Sampling occurred 53 days to 86 days after sowing. Rate is in range of registered rate. Applicable bloom and sampling time. Hive pollen may be less conservative than plant pollen and no nectar collected.	1.04 Pollen from hives	N/A	No (0.00)	No (0.00)	No (0.00)	0.68 Pollen from hives	N/A	No (0.00)	No (0.01)	No (>0.00)	**Canola from CG 20: Oilseed (canola/rapeseed and mustard)** *Registered at 200 - 404 g a.i./100 kg seed* *0.0046 - 0.022 mg a.i./seed* *8 - 32 g a.i./ha* **Mustard** *Registered at 200 - 404 mg a.i./100 kg seed* *0.0054 - 0.024 mg a.i./seed* *9 - 45 mg a.i./ha* **Potentially Relevant for Other Labelled Crop(s):** **Sugar beets from Crop group 1 (root and tuber vegetables)** *Registered at 30 - 60 g a.i./ 100,000 seeds 0.3 - 0.6 mg a.i./seed 20 - 59 g a.i./ha*
	0.89 Pollen from hives	N/A	No (0.00)	No (0.00)	No (0.00)	0.58 Pollen from hives	N/A	No (0.00)	No (0.02)	No (0.00)	
Canola Canola treated at 404 g a.i./100 kg seed (reported); 0.0081 - 0.022 mg a.i./seed (calculated) and 32 g a.i./ha (calculated). Same treatment for two consecutive years and sampling after each year. Rate is in range of registered rate.	7.7 (Y1) Pollen from flowers	2.5 (Y1) Nectar from flowers	No (0.17)	No (0.10)	No (0.00)	5.5 (Y1) Pollen from flowers	1.8 (Y1) Nectar from flowers	No (0.21)	No (0.12)	No (0.02)	
	6.59	2.14	No	No	No	4.71	1.54	**Yes**	No	No	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
Applicable bloom and sampling time.	(Y1) Pollen from flowers	(Y1) Nectar from flowers	(0.17)	(0.10)	(0.16)	(Y1) Pollen from flowers	(Y1) Nectar from flowers	**(1.22)**	(0.71)	(0.22)	
Canola As above, except that untreated canola seeds were sown in Year 2 (i.e. treatment in Year 1 but no treatment in Year 2). Sampled in Year 2. **Results reflect carryover** from Year 1 seed treatment. Rate is in range of registered rate. Applicable bloom and sampling time.	<LOD (0.22)	<LOD (0.22)	No (0.01)	No (0.01)	No (0.00)	<LOD (0.22)	<LOD (0.22)	No (0.03)	No (0.01)	No (0.00)	
	<LOD (0.19)	<LOD (0.19)	No (0.02)	No (0.01)	No (0.01)	<LOD (0.188)	<LOD (0.188)	No (0.15)	No (0.08)	No (0.03)	
Canola Canola treated at 404 g a.i./100 kg seed (reported); 0.0081 - 0.022 mg a.i./seed (calculated); 32 g a.i./ha (calculated). **Potato in furrow treatment at 140 g a.i./ha the previous year. Therefore residues are not representative (from canola treatment).** One sampling event during peak canola flowering, 41 days to 56 days after sowing Rate is in range of registered rate. Applicable bloom and sampling time.	45 (Plot T467) Pollen from flowers	15 (Plot T467) Nectar from flowers	**Yes** **(1)**	**Yes** **(0.58)**	No (0.00)	45 (Plot T467) Pollen from flowers	13.3 (Plot T467) Nectar from flowers	**Yes** **(1.59)**	No (0.94)	No (0.11)	
	38.5 (Plot T467) Pollen from flowers	12.8 (Plot T467) Nectar from flowers	**Yes** **(1.02)**	**Yes** **(0.59)**	**Yes** **(0.93)**	38.5 (Plot T467) Pollen from flowers	11.4 (Plot T467) Nectar from flowers	**Yes** **(9.05)**	**Yes** **(5.34)**	**Yes** **(1.67)**	
Canola As above, except that untreated canola seeds were sown; **results reflect only carryover from previous potato use.** Canola is registered for seed treatment. Rate is in range of registered rate.	44.7 (Plot T470) No pollen from T467 for comparison	3.45 (Plot T467) Nectar from flowers	No (0.23)	No (0.21)	No (0.00)	35.3 (Plot T470) No pollen from T467 for comparison	3.29 (Plot T467) Nectar from flowers	No (0.39)	No (0.33)	No (0.03)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
Applicable bloom and sampling time.	Pollen from flowers					Pollen from flowers					
	38.3 (Plot T470) No pollen from T467 for comparison Pollen from flowers	2.95 (Plot T467) Nectar from flowers	No (0.23)	No (0.21)	No (0.27)	30.2 (Plot T470) No pollen from T467 for comparison Pollen from flowers	2.82 (Plot T467) Nectar from flowers	**Yes** **(2.24)**	**Yes** **(1.86)**	No (0.05)	
Rapeseed Oilseed rape sown in the fall and treated at 4.2 g a.i./kg seed (reported); 0.02 mg a.i./seed (reported); 12.6 g a.i./ha (calculated). Previous spring barley seed treatment in spring of same year (0.03 mg a.i./seed, 77 g a.i./ha). There were three sampling events, at 201, 207 and 209 days after sowing. Rapeseed is registered for seed treatment. Rate is in range of registered rate. Applicable bloom and sampling time. Hive pollen and nectar may be less conservative than plant pollen and nectar.	6 Pollen from bees	4.6 Nectar from bees	No (0.31)	No (0.16)	No (0.00)	4.1 Pollen from bees	4.01 Nectar from bees	No (0.48)	No (0.25)	No (0.03)	**Rapeseed from CG 20: Oilseed (canola/rapeseed and mustard)** *Registered at 200 - 404 g a.i./100 kg seed* *0.0046 - 0.022 mg a.i./seed* *8 - 32 g a.i./ha* **Mustard** *Registered at 200 - 404 mg a.i./100 kg seed* *0.0054 - 0.024 mg a.i./seed* *9 - 45 mg a.i./ha* **Potentially Relevant for Other Labelled Crop(s):** **Sugar beets from Crop group 1 (root and tuber vegetables)** *Registered at 30 - 60 g a.i./ 100,000 seeds 0.3 - 0.6 mg a.i./seed 20 - 59 g a.i./ha*
	5.14 Pollen from bees	3.94 Nectar from bees	No (0.31)	No (0.16)	No (0.27)	3.51 Pollen from bees	3.43 Nectar from bees	**Yes** **(2.72)**	**Yes** **(1.4)**	No (0.47)	
Rapeseed Oilseed rape sown in the fall and treated at 420 g a.i./100 kg seed (reported); 0.019 mg a.i./seed (reported); 21 g	4 Pollen from	4 Nectar from	No (0.27)	No (0.14	No (0.00)	2.89 Pollen from	3.11 Nectar from	No (0.37)	No (0.19)	No (0.02)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
a.i./ha (calculated). No previous use. Several sampling events. Rate is in range of registered rate. Applicable bloom and sampling time. Hive and bee collected pollen and nectar may be less conservative than plant pollen and nectar.	bees 3 Pollen from hives	bees <LOQ (0.5) Nectar from hives				bees 1.56 Pollen from hives	bees <LOQ (0.5) Nectar from hives				
	3.42 Pollen from bees 2.57 Pollen from hives	3.42 Nectar from bees <LOQ (0.43) Nectar from hives	No (0.27) No (0.14	No (0.23)	No	2.47 Pollen from bees 1.34 Pollen from hives	2.66 Nectar from bees <LOQ (0.428) Nectar from hives	**Yes (2.11)** No (0.34)	**Yes (1.08)** No (0.20)	No (0.36) No (0.06)	
Rapeseed Oilseed rape sown in the fall and treated at 420 g a.i./100 kg seed (reported); 0.019 mg a.i./seed (reported); 12.6 g a.i./ha (calculated). No previous use. Pollen and nectar were collected at 233, 235, 240, 252, 285, 314, 345 and 377 days after sowing. Rate is in range of registered rate. Applicable bloom and sampling time. Hive pollen and nectar may be less conservative than plant pollen and nectar.	<LOQ (1) Pollen from hives	<LOQ (0.5) Nectar from hives	No (0.03)	No (0.02)	No (0.00)	<LOQ (1) Pollen from hives	<LOQ (0.5) Nectar from hives	No (0.06)	No (0.03)	No (0.00)	
	<LOQ (0.856) Pollen from hives	<LOQ (0.43) Nectar from hives	No (0.03)	No (0.02)	No (0.03)	<LOQ (0.856) Pollen from hives	<LOQ (0.428) Nectar from hives	No (0.34)	No (0.19)	No (0.06)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Rapeseed Oilseed rape sown in the fall and treated at 420 g a.i./100 kg seed (reported); 0.019 mg a.i./seed (reported); 12.6 g a.i./ha (calculated). No previous use. Several sampling events. Rate is in range of registered rate. Applicable bloom and sampling time. Hive and bee pollen and nectar may be less conservative than plant pollen and nectar. It is noted, that nectar from hive was higher than other samples/ studies.	4 Pollen from bee	4 Nectar from bee	No (0.27)	No (0.14)	No (0.00)	2.22 Pollen from bee	2.23 Nectar from bee	No (0.27)	No (0.14)	No (0.02)	
	2 Pollen from hive	9 Nectar from hive	**Yes** **(0.60)**	No (0.29)	No (0.00)	1.56 Pollen from hive	2.67 Nectar from hive	No (0.32)	No (0.16)	No (0.02)	
	3.42 Pollen from bee	3.42 Nectar from bee	No (0.27)	No (0.14)	No (0.23)	1.90 Pollen from bee	1.91 Nectar from bee	**Yes** **(1.52)**	No (0.78)	No (0.26)	
	1.71 Pollen from hive	7.70 Nectar from hive	**Yes** **(0.61)**	No (0.30)	**Yes** **(0.52)**	1.34 Pollen from hive	2.29 Nectar from hive	**Yes** **(1.82)**	No (0.91)	No (0.31)	
Rapeseed Oilseed rape sown in the fall and treated at 420 g a.i./100 kg seed (reported); 0.0084 - 0.023 mg a.i./seed (calculated); 17.85 g a.i./ha (calculated). No previous use. Rate is in range of registered rate.	<LOQ (1) Pollen from flowers	1.8 Nectar from flowers	No (0.12)	No (0.06)	No (0.00)	<LOQ (1) Pollen from flowers	1.8 Nectar from flowers	No (0.21)	No (0.11)	No (0.01)	
Applicable bloom and sampling time. Hive and bee pollen and nectar may be less conservative than plant pollen and nectar. It is noted, that nectar from hive was higher than other samples/ studies.	<LOQ (0.856) Pollen from flowers	1.54 Nectar from flowers	No (0.12)	No (0.06)	No (0.10)	<LOQ (0.856) Pollen from flowers	1.54 Nectar from flowers	**Yes** **(1.22)**	No (0.61)	No (0.21)	
Corn											

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Corn Corn treated at 315 g a.i./100 kg seed (reported); 0.39 - 1.05 mg a.i./seed (calculated); 88.2 g a.i./ha (calculated). Same treatment for three consecutive years, with sampling after each year of treatment.	1 Pollen from bees (Y1) Y2 & Y3 <LOQ	N/A	No (0.00)	No (0.00)	No (0.00)	1 Pollen from bees (Y1) Y2 & Y3 <LOQ	N/A	No (0.00)	No (0.00)	No (0.00)	**Corn from Crop group 15: Cereal grains** *Registered at 50 - 500 g a.i./100 kg seed* *0.125 - 1.25 mg a.i./seed* *5.3 - 118 g a.i./ha* **Potentially Relevant for Other Labelled Crop(s):** **Potato** *Registered at 1.9 - 5.86 g a.i./100 kg seed* *91 - 117 g a.i./ha* **Sugar beets from Crop group 1 (root and tuber vegetables)** *Registered at 30 - 60 g a.i./ 100,000 seeds 0.3 - 0.6 mg a.i./seed 20 - 59 g a.i./ha*
One sampling event each year, at 71 - 81 days after sowing. Corn is registered for seed treatment. Rate is in range of registered rate. Applicable bloom and sampling time. Hive pollen may be less conservative than plant pollen. Seed size, lack of nectar production, and rate (on a per hectare basis) are relevant for potato seed piece.	0.856 Pollen from bees (Y1) Y2 & Y3 <LOQ	N/A	No (0.00)	No (0.00)	No (0.00)	0.856 Pollen from bees (Y1) Y2 & Y3 <LOQ	N/A	No (0.00)	No (0.02)	No (0.00)	
Corn Corn treated at 3.15 g a.i./kg seed (reported); 0.85 mg a.i./seed (reported); 88.2 g a.i./ha (calculated). Same treatment for two consecutive years, with sampling after each year of treatment. Sampling at 71 - 75 days after sowing. Rate is in range of registered rate. Applicable bloom and sampling time.	4 (Y1) 2 (Y2) Pollen from bees 2 (Y1)	N/A	No (0.00)	No (0.01)	No (0.00)	3.3 (Y1) 1.67 (Y2) Pollen from bees 2 (Y1)	N/A	No (0.00)	No (0.01)	No (0.00)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Hive and bee pollen may be less conservative than plant pollen. Seed size, lack of nectar production, and rate (on a per hectare basis) are relevant for potato seed piece.	1 (Y2) Pollen from hives					0.58 (Y2) Pollen from hives					
	3.42 (Y1) 1.71 (Y2) Pollen from bees 1.71 (Y1) 0.856 (Y2) Pollen from hives	N/A	No (0.00)	No (0.01)	No (0.01)	2.8 (Y1) 1.43 (Y2) Pollen from bees 1.71 (Y1) 0.496 (Y2) Pollen from hives	N/A	No (0.00)	No (0.04)	No (0.01)	
Corn Corn treated at 315 g a.i./100 kg seed (reported); 0.85 mg a.i./seed (reported); 88.2 g a.i./ha (calculated). Same treatment for two consecutive years, with sampling after each year of treatment. Sampling at 71 - 74 days after sowing.	12 (Y1) 2 (Y2) Pollen from bee 4	N/A	No (0.00)	No (0.03)	No (0.00)	8.33 (Y1) 1.17 (Y2) Pollen from bee	N/A	No (0.00)	No (0.03)	No (0.00)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
Rate is in range of registered rate. Applicable bloom and sampling time. **Pollen from bees may also reflect foraging on other crops.** Seed size, lack of nectar production, and rate (on a per hectare basis) are relevant for potato seed piece.	(Y1) Not collected (Y2) Pollen from hive					1.83 (Y1) Not collected (Y2) Pollen from hive					
	10.3 (Y1) 1.71 (Y2) Pollen from bee 3.42 (Y1) Not collected (Y2) Pollen from hive	N/A	No (0.00)	No (0.03)	No (0.02)	7.13 (Y1) 1.00 (Y2) Pollen from bee 1.57 (Y1) Not collected (Y2) Pollen from hive	N/A	No (0.00)	No (0.19)	No (0.03)	
	Total corn residues 17.3	N/A	No (0.00)	No (0.05)	No (0.03)	**Total corn residues** 12.5	N/A	No (0.00)	No (0.33)	No (0.05)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Corn Corn treated at 315 g a.i./100 kg seed (reported); 0.91 mg a.i./seed (reported); 88.2 g a.i./ha (calculated). Same treatment for two consecutive years, with sampling after each year of treatment. Sampling at 73 - 75 and 66 - 68 days after sowing (Years 1 and 2, respectively). Rate is in range of registered rate. Applicable bloom and sampling time. *Bee pollen was higher than plant pollen.	2 (Y1) 3 (Y2) Pollen from plant 12 (Y1) 8 (Y2) Pollen from bee	N/A	No (Y1 pollen from bee) (0.00)	No (Y1 pollen from bee) (0.03)	No (Y1 pollen from bee) (0.00)	1.44 (Y1) 2.2 (Y2) Pollen from plant 7.89 (Y1) 4.75 (Y2) Pollen from bee	N/A	No (Y1 pollen from bee) (0.00)	No (Y1 pollen from bee) (0.02)	No (Y1 pollen from bee) (0.00)	
Seed size, lack of nectar production, and rate (on a per hectare basis) are relevant for potato seed piece.	1.71 (Y1) 2.57 (Y2) Pollen from plant 10.3 (Y1) 6.84 (Y2)	N/A	No (Y1 pollen from bee) (0.00)	No (Y1 pollen from bee) (0.03)	No (Y1 pollen from bee) (0.02)	1.23 (Y1) 1.88 (Y2) Pollen from plant 6.75 (Y1) 4.07 (Y2)	N/A	No (Y1 pollen from bee) (0.00)	No (Y1 pollen from bee) (0.18)	No (Y1 pollen from bee) (0.03)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
	Pollen from bee					Pollen from bee					
Corn Corn treated at 0.63 mg a.i./seed (reported); 52.5 - 63 g a.i./ha (calculated). No previous use.	<LOQ (1) Pollen from plants	N/A	No (0.00)	No (0.00)	No (0.00)	<LOQ (1) Pollen from plants	N/A	No (0.00)	No (0.00)	No (0.00)	
Sampling at 66 - 84 days after sowing. Rate is in range of registered rate. Applicable bloom and sampling time. Seed size, lack of nectar production, and rate (on a per hectare basis) are relevant for potato seed piece.	<LOQ (0.856) Pollen from plants	N/A	No (0.00)	No (0.00)	No (0.00)	<LOQ (0.856) Pollen from plants	N/A	No (0.00)	No (0.02)	No (0.00)	
Corn Corn treated at 2.21 g a.i./100 kg seed (reported); 0.28 - 0.74 mg a.i./seed (calculated); 69.3 g a.i./ha (calculated). No previous use.	<LOQ (1) Pollen from plants	N/A	No (0.00)	No (0.00)	No (0.00)	<LOQ (1) Pollen from plants	N/A	No (0.00)	No (0.00)	No (0.00)	
Sampled 75 days after sowing. Rate is lower than registered rate on per 100 kg basis. Applicable bloom and sampling time. Seed size, lack of nectar production, and rate (on a per hectare basis) are relevant for potato seed piece.	<LOQ (0.856) Pollen from plants	N/A	No (0.00)	No (0.00)	No (0.00)	<LOQ (0.856) Pollen from plants	N/A	No (0.00)	No (0.02)	No (0.00)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Corn Corn treated at 2.21 g a.i./100 kg seed (reported); 0.28 - 0.74 mg a.i./seed (calculated); 69.3 g a.i./ha (calculated). No previous use.	<LOQ (1) Pollen from plants	N/A	No (0.00)	No (0.00)	No (0.00)	<LOQ (1) Pollen from plants	N/A	No (0.00)	No (0.00)	No (0.00)	
Sampled 74 days after sowing. Corn is registered for seed treatment. Rate is lower than registered rate on per 100 kg basis. Applicable bloom and sampling time. Seed size, lack of nectar production, and rate (on a per hectare basis) are relevant for potato seed piece.	<LOQ (0.856) Pollen from plants	N/A	No (0.00)	No (0.00)	No (0.00)	<LOQ (0.856) Pollen from plants	N/A	No (0.00)	No (0.02)	No (0.00)	
Corn Corn treated at 315 g a.i./100 kg seed (reported); 0.39 - 1.05 mg a.i./seed (calculated); 94.5 - 126 g a.i./ha (calculated). No previous use.	<LOQ (1) Pollen from plants	N/A	No (0.00)	No (0.00)	No (0.00)	<LOQ (1) Pollen from plants	N/A	No (0.00)	No (0.00)	No (0.00)	
Sampled 87 days after sowing. Rate is within registered rate. Applicable bloom and sampling time. Seed size, lack of nectar production, and rate (on a per hectare basis) are relevant for potato seed piece.	<LOQ (0.856) Pollen from plants	N/A	No (0.00)	No (0.00)	No (0.00)	<LOQ (0.856) Pollen from plants	N/A	No (0.00)	No (0.02)	No (0.00)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
Corn Corn treated at 0.63 mg a.i./seed (reported); 69.3 g a.i./ha (calculated). No previous use. Sampled 78 days after sowing.	<LOQ (1) Pollen from plants and bees	N/A	No (0.00)	No (0.00)	No (0.00)	<LOQ (1) Pollen from plants and bees	N/A	No (0.00)	No (0.00)	No (0.00)	
Rate is within registered rate. Applicable bloom and sampling time. Seed size, lack of nectar production, and rate (on a per hectare basis) are relevant for potato seed piece.	<LOQ (0.856) Pollen from plants and bees	N/A	No (0.00)	No (0.00)	No (0.00)	<LOQ (0.856) Pollen from plants and bees	N/A	No (0.00)	No (0.02)	No (0.00)	
Cucurbits											
Pumpkin Pumpkin treated at 0.75 mg a.i./seed (reported); 4.5 g a.i./ha (reported). No previous use. Sampled 35 days after sowing	<LOD (0.2) Pollen from plants	<LOD (0.2) Nectar from plants	No (0.01)	No (0.01)	No (0.00)	<LOD (0.2) Pollen from plants	<LOD (0.2) Nectar from plants	No (0.02)	No (0.01)	No (0.00)	**Cucurbits Crop group 9 (*imported seeds only*)** *Registered at 0.25 - 75 mg a.i./seed* *0.56 - 21 g a.i./ha* **Potentially Relevant for Other Labelled Crop(s):**
Cucurbits are not registered for seed treatment in Canada. However, seeds can be imported. Rate is at maximum registered rate (per seed basis) and within range for per hectare basis. Applicable bloom and sampling time.	<LOD (0.17) Pollen from plants	<LOD (0.17) Nectar from plants	No (0.01)	No (0.01)	No (0.01)	<LOD (0.171) Pollen from plants	<LOD (0.171) Nectar from plants	No (0.14)	No (0.07)	No (0.02)	**Sugar beets from Crop group 1 (root and tuber vegetables)** *Registered at 30 - 60 g a.i./ 100,000 seeds 0.3 - 0.6 mg a.i./seed 20 - 59 g a.i./ha*

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Cereal Grains											
Sorghum Sorghum treated at 0.107 mg a.i./seed (reported); 21.4 - 26.8 g a.i./ha (calculated). No previous use. Sampling at 72 - 83 days after sowing.	<LOQ (1) Pollen from plants	N/A	No (0.00)	No (0.00)	No (0.00)	<LOQ (1) Pollen from plants	N/A	No (0.00)	No (0.00)	No (0.00)	**Sorghum from Crop group 15: Cereal grains (Wheat, barley, rye, triticale, buckwheat, millet and sorghum)** *Registered at 10.6 - 30 g a.i./100 kg seed* *0.003 - 0.014 mg a.i./seed* *0.55 - 63 g a.i./ha* **Potentially Relevant for Other Labelled Crop(s):** **Oats from Crop group 15: Cereal grains***Registered at 10.6 g a.i./100 kg seed* *0.0032 - 0.0048 mg a.i./seed* *5.7 - 12 g a.i./ha* **Sugar beets from Crop group 1 (root and tuber vegetables)** *Registered at 30 - 60 g a.i./ 100,000 seeds 0.3 - 0.6 mg a.i./seed 20 - 59 g a.i./ha*
Sorghum is registered for seed treatment. Above registered rate (per seed basis) and within range for per hectare basis. Applicable bloom and sampling time.	<LOQ (0.856) Pollen from plants	N/A	No (0.00)	No (0.00)	No (0.00)	<LOQ (0.856) Pollen from plants	N/A	No (0.00)	No (0.02)	No (0.00)	
Legume vegetables											
Soybean Soybean treated at 0.0756 mg a.i./seed (reported); 47.08 g a.i./ha (calculated). No previous use. Three sampling events early, mid and late bloom, 45-70 days after sowing. Soybean is registered for seed treatment.	3.38 Anther	5.43 Nectar from bees	No (0.36)	No (0.18)	No (0.00)	2 Anther	2.74 Nectar from bees	No (0.33)	No (0.16)	No (0.02)	**Soybean from Crop group 6: Legume vegetables** *Registered at 30 - 50 g a.i./100 kg seed* *0.045 - 0.076 mg a.i./seed* *17 - 64 g a.i./ha* **Potentially Relevant for Other Labelled Crop(s):** **Chickpeas, lentils, lupins, dry peas, faba beans**
	2.89	4.65 Nectar from bees	No (0.37)	No (0.18)	No (0.32)	1.71	2.34 Nectar from bees	**Yes** **(1.86)**	No (0.93)	No (0.32)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Within registered rate (per seed and per hectare basis). Applicable bloom and sampling time. Below maximum rate for chickpeas and other beans.	Anther					Anther					**(Crop group 6)** *Registered at 10 - 30 g a.i./100 kg seed* *0.003 - 0.3 mg a.i./seed 4.5 - 112 g a.i./ha* **Other beans and peas (Crop group 6)** *30 - 50 g a.i./100 kg seed* *0.02 - 0.17 mg a.i./seed 9.6 - 150 g a.i./ha*
Sunflower (oilseed crop group)											
Sunflower Sunflower treated at 42 g a.i./150,000 seeds (reported); 0.28 mg a.i./seed (reported); 17.7 g a.i./ha (calculated). No previous use. Sampled 78 - 81 days after sowing. Sunflowers are not registered for seed treatment in Canada. However, seeds can be imported. Rate is in range for registered rate (per seed basis) and within range for per hectare basis. Applicable bloom and sampling time.	<LOQ (1) Pollen from bees	<LOQ (1) Nectar from hives	No (0.07)	No (0.03)	No (0.00)	<LOQ (1) Pollen from bees	<LOQ (1) Nectar from hives	No (0.12)	No (0.06)	No (0.01)	**Sunflower** *Registered at 0.25 mg a.i./seed* *4.8 - 28 g a.i./ha* **Potentially Relevant for Other Labelled Crop(s):** **Sugar beets from Crop group 1 (root and tuber vegetables)** *Registered at 30 - 60 g a.i./ 100,000 seeds 0.3 - 0.6 mg a.i./seed 20 - 59 g a.i./ha*
	<LOQ (0.856) Pollen from bees	<LOQ (0.856) Nectar from hives	No (0.07)	No (0.03)	No (0.06)	<LOQ (0.856) Pollen from bees	<LOQ (0.856) Nectar from hives	No (0.68)	No (0.35)	No (0.12)	
Sunflower Sunflower treated at 350 g a.i./100 kg seed (reported); 0.18 - 0.80 mg a.i./seed (calculated); 22.82 g a.i./ha (calculated). No previous use.	3.2 Pollen from flowers	N/A	No (0.00)	No (0.01)	No (0.00)	3.2 Pollen from flowers	N/A	No (0.00)	No (0.01)	No (0.00)	
	2.74 Pollen from	N/A	No (0.00)	No (0.01)	No (0.01)	2.74 Pollen from	N/A	No (0.00)	No (0.07)	No (0.01)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Sampled 71 - 73 days after sowing. Sunflowers are not registered for seed treatment in Canada. However, seeds can be imported. Rate is below registered rate (per seed basis) and within range for per hectare basis. Applicable bloom and sampling time.	flowers					flowers					
Sunflower Sunflower treated at 210 g a.i./100 kg seed (reported); 0.11 - 0.48 mg a.i./seed (calculated); 8.19 g a.i./ha (calculated). No previous use. - Pollen collected from flowers and from bees. Nectar collected from bees and from hives. Sampled 60 - 68 days after sowing. Sunflowers are not registered for seed treatment in Canada. However, seeds can be imported. Rate is in range for registered rate (per seed basis) and within range for per hectare basis. Applicable bloom and sampling time.	<LOQ (1) Pollen from plants and bees	<LOQ (1) Nectar from plants and bees	No (0.07)	No (0.03)	No (0.00)	<LOQ (1) Pollen from plants and bees	<LOQ (1) Nectar from plants and bees	No (0.12)	No (0.06)	No (0..01)	
	<LOQ (0.856) Pollen from plants and bees	<LOQ (0.856) Nectar from plants and bees	No (0.07)	No (0.03)	No (0.06)	<LOQ (0.856) Pollen from plants and bees	<LOQ (0.856) Nectar from plants and bees	No (0.68)	No (0.35)	No (0.12)	
Sunflower Sunflower treated at 500 g a.i./100 kg seed (reported) ; 0.26 - 1.14 mg a.i./seed (calculated); 37.5 g a.i./ha (calculated). No previous use.	1.1 Pollen from bees	<LOQ (1) Nectar from bees	No (0.07)	No (0.03)	No (0.00)	1.1 Pollen from bees	<LOQ (1) Nectar from bees	No (0.12)	No (0.06)	No (0.01)	
	0.94	<LOQ (0.856)	No (0.07)	No (0.04)	No (0.06)	0.942	<LOQ (0.856)	No (0.68)	No (0.35)	No (0.12)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Sampled 72 - 83 days after sowing. Sunflowers are not registered for seed treatment in Canada. However, seeds can be imported. Rate is in range for registered rate (per seed basis) and above rate for per hectare basis. Applicable bloom and sampling time.	Pollen from bees	Nectar from bees				Pollen from bees	Nectar from bees				
Sunflower Sunflower treated at 350 g a.i./100 kg seed (reported); 0.18 - 0.80 mg a.i./seed (calculated); 17.5 - 24.5 g a.i./ha (calculated). No previous use. Sampled 77 days after sowing. Sunflowers are not registered for seed treatment in Canada. However, seeds can be imported. Rate is in range for registered rate (per seed basis and per hectare basis). Applicable bloom and sampling time.	3.2 Pollen from flowers	<LOQ (1)	No (0.07)	No (0.04)	No (0.00)	3.0 Pollen from flowers	<LOQ (1) Not clear	No (0.12)	No (0.07)	No (0.01)	
	2.74 Pollen from flowers	<LOQ (0.856)	No (0.07)	No (0.04)	No (0.06)	2.57 Pollen from flowers	<LOQ (0.856) Not clear	No (0.68)	No (0.39)	No (0.12)	
Sunflower As above, except that untreated sunflower seeds were sown the following year. Results reflect **carryover** from Year 1 seed treatment. Sunflowers are not registered for seed treatment in Canada. However, seeds can be imported.	Not collected	<LOQ (1)	No (0.07)	No (0.03)	No (0.00)	Not collected	<LOQ (1)	No (0.12)	No (0.06)	No (0.01)	
	Not collected	<LOQ (0.856)	No (0.07)	No (0.03)	No (0.00)	Not collected	<LOQ (0.856)	No (0.68)	No (0.33)	No (0.11)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Rate is in range for registered rate (per seed basis and per hectare basis). Applicable bloom and sampling time.											
Cotton											
Cotton Cotton treated at 42 g a.i./ha (reported); 0.208 - 0.218 mg a.i./seed (calculated). No previous use.	<LOQ (1) Pollen from flowers	<LOQ (1) Nectar from flowers	No (0.07)	No (0.03)	No (0.00)	<LOQ (1) Pollen from flowers	<LOQ (1) Nectar from flowers	No (0.12)	No (0.06)	No (0.01)	Cotton is not grown in Canada. **Potentially Relevant for Other Labelled Crop(s):** **Sugar beets from Crop group 1 (root and tuber vegetables)** *Registered at 30 - 60 g a.i./ 100,000 seeds 0.3 - 0.6 mg a.i./seed 20 - 59 g a.i./ha*
Sampled 83 - 98 days after sowing. Cotton is not grown in Canada. May be relevant for sugar beets based on seed size and rate (on a per hectare basis) and below rate on a per seed basis.	<LOQ (0.856) Pollen from flowers	<LOQ (0.856) Nectar from flowers	No (0.07)	No (0.03)	No (0.06)	<LOQ (0.856) Pollen from flowers	<LOQ (0.856) Nectar from flowers	No (0.68)	No (0.35)	No (0.12)	
Cotton Cotton treated at 0.375 mg a.i./seed (reported); 33 - 134 g a.i./ha). No previous use.	<LOD (0.5) Pollen from flower	1.16 Nectar from flower	No (0.08)	No (0.04)	No (0.00)	<LOD (0.5) Pollen from flower	0.72 Nectar from flower	No (0.09)	No (0.04)	No (0.01)	
Nectar from extrafloral nectaries also sampled. Range of soil types. Sampling 83 - 86 days after sowing.	<LOD (0.428) Pollen from flower	0.99 Nectar from flower	No (0.03)	No (0.02)	No (0.03)	<LOD (0.428) Pollen from flower	0.616 Nectar from flower	No (0.49)	No (0.25)	No (0.08)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Cotton is not grown in Canada. May be relevant for sugar beets based on seed size and rate (on a per hectare and per seed basis).											
Rotational crops											
Sunflower Spring barley treated at 70 g a.i./ 100 kg seed (reported); 0.021 - 0.035 mg a.i./seed (calculated); 77 g a.i./ha (calculated). No previous use. Untreated sunflower planted as rotational crop in the same growing season. Sampled 156 days after treated barley seeds were sown.	1.5 Pollen from flower	<LOQ (1) Nectar from flower	No (0.07)	No (0.04)	No (0.00)	1.33 Pollen from flower	<LOQ (1) Nectar from flower	No (0.12)	No (0.06)	No (0.01)	General carry over for seed treatment crops.
	1.28 Pollen from flower	<LOQ (0.856) Nectar from flower	No (0.07)	No (0.04)	No (0.06)	1.14 Pollen from flower	<LOQ (0.856) Nectar from flower	No (0.68)	No (0.36)	No (0.12)	
Sunflower Spring barley treated at 70 g a.i./100 kg seed (reported); 0.021 - 0.035 mg a.i./seed (calculated); 94.5 g a.i./ha (calculated). No previous use. Untreated sunflower planted as rotational crop in the same growing season. Sampling 152 days after treated barley seeds were sown.	<LOQ (1) Pollen from flower	<LOQ (1) Nectar from flower	No (0.07)	No (0.03)	No (0.00)	<LOQ (1) Pollen from flower	<LOQ (1) Nectar from flower	No (0.12)	No (0.06)	No (0.00)	
	<LOQ (0.856) Pollen from flower	<LOQ (0.856) Nectar from flower	No (0.07)	No (0.03)	No (0.06)	<LOQ (0.856) Pollen from flower	<LOQ (0.856) Nectar from flower	No (0.68)	No (0.35)	No (0.12)	
Corn Spring barley treated at 70 g a.i./100 kg seed (reported); 0.021 - 0.035 mg a.i./seed (calculated); 77 g a.i./ha	<LOQ (1) Pollen from flower	N/A	No (0.00)	No (0.00)	No (0.00)	<LOQ (1) Pollen from flower	N/A	No (0.00)	No (0.01)	No (0.00)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
(calculated). No previous use. Untreated corn planted as rotational crop in the same growing season. Samples collected 169 days after treated barley seeds were sown.	<LOQ (0.856) Pollen from flower	N/A	No (0.00)	No (0.00)	No (0.00)	<LOQ (0.856) Pollen from flower	N/A	No (0.00)	No (0.02)	No (0.00)	
Corn Spring barley treated at 70 g a.i./100 kg seed (reported); 0.021 - 0.035 mg a.i./seed (calculated); 94.5 g a.i./ha (calculated). No previous use. Untreated corn planted as rotational crop in the same growing season. Samples collected 146 days after treated barley seeds were sown.	<LOQ (1) Pollen from flower	N/A	No (0.00)	No (0.00)	No (0.00)	<LOQ (1) Pollen from flower	N/A	No (0.00)	No (0.01)	No (0.00)	
	<LOQ (0.856) Pollen from flower	N/A	No (0.00)	No (0.00)	No (0.00)	<LOQ (0.856) Pollen from flower	N/A	No (0.00)	No (0.02)	No (0.00)	
Sunflower Corn treated at 315 g a.i./100 kg seed (reported); 0.39 - 1.05 mg a.i./seed (calculated); 94.5 - 126 g a.i./ha (calculated). No previous use. Untreated sunflower planted as a rotational crop the following year. Samples collected 454 days after treated corn seeds were sown.	No results	<LOD (1)	No (0.07)	No (0.03)	No (0.00)	No results	<LOD (1)	No (0.12)	No (0.06)	No (0.00)	
	No results	<LOD (0.856)	No (0.07)	No (0.03)	No (0.06)	No results	<LOD (0.856)	No (0.68)	No (0.33)	No (0.11)	
Alfalfa & phacelia & rapeseed Corn sown in the spring, treated at 220.5 g a.i./100 kg seed (reported); 0.28 - 0.74 mg a.i./seed (calculated); 61.74 g a.i./ha (calculated). Winter barley sown in the fall, treated at 70 g a.i./ 100 kg	Alfalfa 51 (*uncertain*) Pollen from bees	Alfalfa 6 Nectar from bees	No (0.40)	No (0.30)	No (0.00)	Alfalfa 51 (*uncertain*) Pollen from bees	Alfalfa 0.29 Nectar from bees	No (0.04)	No (0.22)	No (0.01)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	
seed (reported); 0.021 - 0.035 mg a.i./seed (calculated); 77 g a.i./ha (calculated). Untreated alfalfa, phacelia or rapeseed planted as a rotational crop the following year. Pollen and nectar collected from bees, 294 - 296 (alfalfa), 284 - 288 (phacelia) and 256 - 261 (rapeseed) days after treated winter barley was sown.	Alfalfa 43.7 (*uncertain*) Pollen from bees	Alfalfa 5.14 Nectar from bees	**Yes** **(0.41)**	No (0.31)	**Yes** **(0.43)**	Alfalfa 43.6 (*uncertain*) Pollen from bees	Alfalfa 0.248 Nectar from bees	No (0.20)	**Yes** **(1.23)**	No (0.21)	
	Phacelia 10 Pollen from bees	Phacelia <LOQ (0.5) Nectar from bees	No (0.03)	No (0.04)	No (0.00)	Phacelia 3.17 Pollen from bees	Phacelia <LOQ (0.5) Nectar from bees	No (0.06)	No (0.04)	No (0.00)	
	Phacelia 8.56 Pollen from bees	Phacelia <LOQ (0.428) Nectar from bees	No (0.03)	No (0.04)	No (0.05)	Phacelia 2.71 Pollen from bees	Phacelia <LOQ (0.428) Nectar from bees	No (0.34)	No (0.23)	No (0.07)	
	Rapeseed 1 Pollen from bees	Rapeseed 1.6 Nectar from bees	No (0.11)	No (0.05)	No (0.00)	Rapeseed 1 Pollen from bees	Rapeseed 0.81 Nectar from bees	No (0.10)	No (0.05)	No (0.01)	
	Rapeseed 0.856 Pollen from bees	Rapeseed 1.37 Nectar from bees	No (0.11)	No (0.05)	No (0.09)	Rapeseed 0.856 Pollen from bees	Rapeseed 0.693 Nectar from bees	No (0.55)	No (0.29)	No (0.10)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
Alfalfa & phacelia & rapeseed Corn sown in the spring, treated at 220.5 g a.i./ 100 kg seed (reported); 0.28 - 0.74 mg a.i./seed (calculated); 61.74 g a.i./ha (calculated). Winter barley sown in the fall, treated at 70 g a.i./ 100 kg seed (reported); 0.021 - 0.035 mg a.i./seed (calculated); 77 g a.i./ha (calculated). Untreated alfalfa, Phacelia or rapeseed planted as a rotational crop the following year. - Pollen and nectar collected from bees, 246 - 250 (alfalfa), 241 - 245 (phacelia) and 208 - 214 (rapeseed) days after treated winter barley was sown.	Alfalfa <LOQ (1) Pollen from bees	Alfalfa <LOQ (0.5) Nectar from bees	No (0.03)	No (0.02)	No (0.00)	Alfalfa <LOQ (1) Pollen from bees	Alfalfa <LOQ (0.5) Nectar from bees	No (0.06)	No (0.03)	No (0.00)	
	Alfalfa <LOQ (0.856) Pollen from bees	Alfalfa <LOQ (0.428) Nectar from bees	No (0.03)	No (0.02)	No (0.03)	Alfalfa <LOQ (0.856) Pollen from bees	Alfalfa <LOQ (0.428) Nectar from bees	No (0.34)	No (0.19)	No (0.06)	
	Phacelia 1 Pollen from bees	Phacelia 1.4 Nectar from bees	No (0.09)	No (0.05)	No (0.00)	Phacelia 1 Pollen from bees	Phacelia 1.4 Nectar from bees	No (0.17)	No (0.08)	No (0.01)	
	Phacelia 0.856 Pollen from bees	Phacelia 1.20 Nectar from bees	No (0.10)	No (0.05)	No (0.08)	Phacelia 0.856 Pollen from bees	Phacelia 1.20 Nectar from bees	No (0.95)	No (0.48)	No (0.16)	
	Rapeseed 8 Pollen from bees	Rapeseed 5.2 Nectar from bees	No (0.35)	No (0.18)	No (0.00)	Rapeseed 6 Pollen from bees	Rapeseed 3.39 Nectar from bees	No (0.40)	No (0.22)	No (0.03)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
	Rapeseed 6.85 Pollen from bees	Rapeseed 4.45 Nectar from bees	No (0.35)	No (0.19)	No (0.31)	Rapeseed 5.14 Pollen from bees	Rapeseed 2.90 Nectar from bees	**Yes** **(2.30)**	**Yes** **(1.24)**	No (0.41)	
Alfalfa & phacelia & rapeseed Corn sown in the spring, treated at 220.5 g a.i./ 100 kg seed (reported); 0.28 - 0.74 mg a.i./seed (calculated); 80.36 g a.i./ha (reported). Winter barley sown in the fall, treated at 70 g a.i./ 100 kg seed (reported); 0.021 - 0.035 mg a.i./seed (calculated); 73.04 g a.i./ha (reported). Untreated alfalfa, Phaelia or rapeseed planted as a rotational crop the following year. - Pollen and nectar collected from bees, 231 - 235 (alfalfa) and 225 - 229 (phacelia) after treated winter barley was sown.	Alfalfa Sample too small Pollen from bees	Alfalfa 2.2 Nectar from bees	No (0.15)	No (0.07)	No (0.00)	Alfalfa Sample too small Pollen from bees	Alfalfa 2.2 Nectar from bees	No (0.26)	No (0.13)	No (0.02)	
	Alfalfa Sample too small Pollen from bees	Alfalfa 1.88 Nectar from bees	No (0.15)	No (0.07)	No (0.13)	Alfalfa Sample too small Pollen from bees	Alfalfa 1.88 Nectar from bees	**Yes** **(1.49)**	No (0.72)	No (0.25)	
	Phacelia <LOQ (1) Pollen from bees	Phacelia <LOQ (0.5) Nectar from bees	No (0.03)	No (0.02)	No (0.00)	Phacelia <LOQ (1) Pollen from bees	Phacelia <LOQ (0.5) Nectar from bees	No (0.06)	No (0.03)	No (0.00)	
	Phacelia <LOQ (0.856)	Phacelia <LOQ (0.428)	No (0.03)	No (0.02)	No (0.03)	Phacelia <LOQ	Phacelia <LOQ (0.428)	No (0.34)	No (0.19)	No (0.06)	

Sampled Crop & Considerations	EEC - Maximum residue value in ppb Maximum residue value in c.e. ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - Mean residue value in ppb Mean residue value in c.e. ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	
	Pollen from bees	Nectar from bees				(0.856) Pollen from bees	Nectar from bees				
	Rapeseed No sample	Rapeseed No sample	-	-	-	Rapeseed No sample	Rapeseed No sample	-	-	-	

CG = crop group, DALA = days after last application, DAP = days after planting, EEC = estimated environmental concentration, RQ = risk quotient, Y = year

NOTE: residues are adjusted for molar ratio of thiamethoxam to clothianidin (0.856)

Bold values indicate that acute LOC (RQ ≥0.4 acute and 1.0 chronic) is exceeded.

[1] Acute RQ = Acute estimated daily dose (EDD)/acute toxicity endpoint

Acute EDD = nectar dose [nectar consumption rate (mg/day) x maximum nectar residue (µg/kg)/ 1.0 x 10^6] + pollen dose [pollen consumption rate (mg/day) x maximum pollen residue (µg/kg)/1.0 x 10^6]

[1] Chronic RQ = Chronic estimated daily dose (EDD)/acute toxicity endpoint

Chronic EDD = nectar dose [nectar consumption rate (mg/day) x maximum nectar residue (µg/kg)/ 1.0 x 10^6] + pollen dose

Daily consumption rate used for adult worker bees foraging for nectar: 292 mg/day nectar; 0.041 mg/day pollen; 292 mg/day total

Daily consumption rate used for adult nurse bees: 140 mg/day nectar; 9.6 mg/day pollen; 149.6 mg/day total

Daily consumption rate used for bee larvae: 120 mg/day nectar; 3.6 mg/day pollen; 124 mg/day total

Note, for thiamethoxam RA: adult acute oral **LD50 = 0.0044 µg a.i./bee for TGAI;** bee larvae acute **7-day LD_{50} = 0.78 µg a.i./larva/day for TGAI**

Note, for thiamethoxam RA: adult chronic oral **NOED = 0.00245 µg a.i./bee for TGAI;** bee larvae chronic **22-day NOED = 0.0157 µg a.i./larva/day for TGAI**

Note, for clothianidin equivalents RA: adult acute oral **LD50 = 0.00368 µg a.i./bee for TGAI;** bee larvae acute **7-day LD_{50} = >0.0018 µg a.i./larva/day**

Note, for clothianidin equivalents RA: adult chronic **NOED = 0.000368 µg a.i./bee/day;** bee larvae chronic **NOED = 0.0009 µg a.i./larva/day**

NOTE: residues are adjusted for molar ratio of thiamethoxam to clothianidin (0.856), and added to clothianidin in cases whereby clothianidin residues are high enough to contribute to the risk profile.

[2] Standardized maximum value either ½ LOD or ½ LOQ or ½ LOD +LOQ

Tier II Refined Assessment for Seed Treatment Applications

Table 3 Seed Treatment: Colony Level Risk to *Apis* and non-*Apis* bees Based on Mean Residues of clothianidin equivalents (c.e.)

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
Canola and rapeseed (oilseed)											
Canola Canola treated at 403 g a.i./100 kg seed (reported); 0.0081 - 0.022 mg a.i./seed (calculated) and 26 - 29 g a.i./ha Sampling occurred 53 days to 86 days after sowing.	0.58 Pollen from hives	N/A	0.33	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Canola is registered for seed treatment. Rate is in range of registered rate. Applicable bloom and sampling time. Hive pollen may be less conservative than plant pollen and no nectar collected. May be relevant for sugar beet seed size.	**Canola from CG 20: Oilseed (canola/rapeseed and mustard)** *Registered at 200 - 404 g a.i./100 kg seed* *0.0046 - 0.022 mg a.i./seed 8 - 32 g a.i./ha* **Mustard** *Registered at 200 - 404 mg a.i./100 kg seed* *0.0054 - 0.024 mg a.i./seed 9 - 45 mg a.i./ha* **Potentially Relevant for Other Labelled Crop(s):** **Sugar beets from Crop group 1 (root and tuber vegetables)** *Registered at 30 - 60 g a.i./ 100,000 seeds 0.3 - 0.6 mg a.i./seed 20 - 59 g a.i./ha*

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								(85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
Canola Canola treated at 404 g a.i./100 kg seed (reported); 0.0081 - 0.022 mg a.i./seed (calculated) and 32 g a.i./ha (calculated). Same treatment for two consecutive years and sampling after each year.	4.71 (Y1) Pollen from flowers	1.54 (Y1) Nectar from flowers	4.4	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) **Williams 2015+ LOEC (4.5)**	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4)	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Canola is registered for seed treatment. Rate is in range of registered rate. Applicable bloom and sampling time. May be relevant for sugar beet seed size.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
Canola As above, except that untreated canola seeds were sown in Year 2 (i.e. treatment in Year 1 but no treatment in Year 2). Sampled in Year 2. Results reflect **carryover** from Year 1 seed treatment.	<LOD (0.188)	<LOD (0.188)	0.28	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05)	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Canola is registered for seed treatment. Rate is in range of registered rate. Applicable bloom and sampling time. May be relevant for sugar beet seed size.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
					CFS LOEC (29) NOEC (19)			Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
Canola Canola treated at 404 g a.i./100 kg seed (reported); 0.0081 - 0.022 mg a.i./seed (calculated); 32 g a.i./ha (calculated). **Potato in furrow treatment at 140 g a.i./ha the previous year. Therefore residues are not representative (from canola treatment).** One sampling event during peak canola flowering, 41 days to 56 days after sowing	38.5 (Plot T467) Pollen from flowers	11.4 (Plot T467) Nectar from flowers	34.7	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)** **Williams 2015+ LOEC (4.5)**	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Stanley and Raine 2017 NOEC (8.56) **Stanley and Raine 2015 LOEC (8.56)** **Stanley 2015 & 2016 LOEC**	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Canola is registered for seed treatment. Rate is in range of registered rate. Applicable bloom and sampling time. May be relevant for sugar beet seed size.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
					(35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)			**(2.05)** **Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) **Sandrock 2014+ LOEC (2.9)** **Moffat 2016 LOEC (2.14)**			
Canola As above, except that untreated canola seeds were sown; **results reflect only carryover from previous potato use.**	30.2 (Plot T470) No pollen from T467 for comparison	2.82 (Plot T467) Nectar from flowers	21.6	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)**	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6)	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)**	**Fauser-Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Canola is registered for seed treatment. Rate is in range of registered rate. Applicable bloom and sampling time.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Bee bread***	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**		
	Pollen from flowers			**Williams 2015[+] LOEC (4.5)**	NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	**Williams 2015 LOEC (4.5)**		(8.56) **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014[+] LOEC (2.9) **Moffat 2016 LOEC (2.14)**		May be relevant for sugar beet seed size.	
Rapeseed Oilseed rape sown in the fall and treated at 4.2 g a.i./kg seed (reported); 0.02 mg a.i./seed (reported); 12.6 g a.i./ha	3.51 Pollen from bees	3.43 Nectar from bees	5.5	Sandrock 2014[+] LOEC (6.6)	2014 TMX CFS LOEC (34) NOEC (25.3)	Sandrock 2014 LOEC (6.6)	Fauser-Misslin 2014[+] LOEC (4.9)	Stanley and Raine 2017 NOEC (8.56)	**Fauser-Misslin 2014 LOEC (4.9)**	Rapeseed is registered for seed treatment. Rate is in range of registered rate.	**Rapeseed from CG 20: Oilseed (canola/rapeseed and mustard)** *Registered at 200 - 404 g*

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
(calculated). Previous spring barley seed treatment in spring of same year (0.03 mg a.i./seed, 77 g a.i./ha). There were three sampling events, at 201, 207 and 209 days after sowing.				Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	Straub 2016 LOEC (6.3 ppb) **Williams 2015** **LOEC** **(4.5)**	Elston 2013 LOEC (8.56)	Stanley and Raine 2015 LOEC (8.56) **Stanley 2015 & 2016** **LOEC** **(2.05)** **Baron 2017** **LOEC** **(2.05)** Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) **Sandrock 2014+** **LOEC** **(2.9)** **Moffat 2016** **LOEC** **(2.14)**	Elston 2013 LOEC (8.56)	Applicable bloom and sampling time. Hive pollen and nectar may be less conservative than plant pollen and nectar. May be relevant for sugar beet seed size.	*a.i./100 kg seed* *0.0046 - 0.022 mg a.i./seed 8 - 32 g a.i./ha* **Mustard** *Registered at 200 - 404 mg a.i./100 kg seed* *0.0054 - 0.024 mg a.i./seed 9 - 45 mg a.i./ha* **Potentially Relevant for Other Labelled Crop(s):** **Sugar beets from Crop group 1 (root and tuber vegetables)** *Registered at 30 - 60 g a.i./ 100,000 seeds 0.3 - 0.6 mg a.i./seed 20 - 59 g a.i./ha*

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
Rapeseed Oilseed rape sown in the fall and treated at 420 g a.i./100 kg seed (reported); 0.019 mg a.i./seed (reported); 21 g a.i./ha (calculated). No previous use. Several sampling events.	2.47 Pollen from bees 1.34 Pollen from hives	2.66 Nectar from bees <LOQ (0.428) Nectar from hives	4.3	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9)	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Rapeseed is registered for seed treatment. Rate is in range of registered rate. Applicable bloom and sampling time. Hive and bee collected pollen and nectar may be less conservative than plant pollen and nectar. May be relevant for sugar beet seed size.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								Moffat 2016 LOEC (2.14)			
Rapeseed Oilseed rape sown in the fall and treated at 420 g a.i./100 kg seed (reported); 0.019 mg a.i./seed (reported); 12.6 g a.i./ha (calculated). No previous use. Pollen and nectar were collected at 233, 235, 240, 252, 285, 314, 345 and 377 days after sowing.	<LOQ (0.856) Pollen from hives	<LOQ (0.428) Nectar from hives	1.3	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6)	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Rapeseed is registered for seed treatment. Rate is in range of registered rate. Applicable bloom and sampling time. Hive pollen and nectar may be less conservative than plant pollen and nectar. May be relevant for sugar beet seed size.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
Rapeseed Oilseed rape sown in the fall and treated at 420 g a.i./100 kg seed (reported); 0.019 mg a.i./seed (reported); 12.6 g a.i./ha (calculated). No previous use. Several sampling events.	1.90 Pollen from bee 1.34 Pollen from hive	1.91 Nectar from bee 2.29 Nectar from hive	3.6	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39)	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Rapeseed is registered for seed treatment. Rate is in range of registered rate. Applicable bloom and sampling time. Hive and bee pollen and nectar may be less conservative than plant pollen and nectar. It is noted, that nectar from hive was higher than other samples/ studies. May be relevant for sugar beet seed size.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) **Moffat 2016 LOEC (2.14)**			
Rapeseed Oilseed rape sown in the fall and treated at 420 g a.i./100 kg seed (reported); 0.0084 - 0.023 mg a.i./seed (calculated); 17.85 g a.i./ha (calculated). No previous use.	<LOQ (0.856) Pollen from flowers	1.54 Nectar from flowers	2	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Rapeseed is registered for seed treatment. Rate is in range of registered rate. Applicable bloom and sampling time. Hive and bee pollen and nectar may be less conservative than plant pollen and nectar. It is noted, that nectar from hive was higher than other samples/ studies. May be relevant for sugar beet seed size.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
					(19)			NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
Corn											
Corn Corn treated at 315 g a.i./100 kg seed (reported); 0.39 - 1.05 mg a.i./seed (calculated); 88.2 g a.i./ha (calculated). Same treatment for three consecutive years, with sampling after each year of treatment. One sampling event each year, at 71 - 81 days after sowing.	0.856 Pollen from bees (Y1) Y2 & Y3 <LOQ	N/A	0.39	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	N/A	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	N/A	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Corn is registered for seed treatment. Rate is in range of registered rate. Applicable bloom and sampling time. Hive pollen may be less conservative than plant pollen. Seed size, lack of nectar	**Corn from Crop group 15: Cereal grains** *Registered at 50 - 500 g a.i./100 kg seed* *0.125 - 1.25 mg a.i./seed* *5.3 - 118 g a.i./ha* **Potentially Relevant for Other Labelled Crop(s):** **Potato** *Registered at 1.9 - 5.86 g a.i./100 kg seed* *91 - 117 g a.i./ha*

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
										production, and rate (on a per hectare basis) are relevant for potato seed piece. May be relevant for sugar beet based on rate.	**Sugar beets from Crop group 1 (root and tuber vegetables)** *Registered at 30 - 60 g a.i./ 100,000 seeds 0.3 - 0.6 mg a.i./seed 20 - 59 g a.i./ha*
Corn Corn treated at 3.15 g a.i./kg seed (reported); 0.85 mg a.i./seed (reported); 88.2 g a.i./ha (calculated). Same treatment for two consecutive years, with sampling after each year of treatment. Sampling at 71 - 75 days after sowing.	2.8 (Y1) 1.43 (Y2) Pollen from bees 1.71 (Y1) 0.496 (Y2) Pollen from hives	N/A	2.2	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	N/A	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	N/A	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Corn is registered for seed treatment. Rate is in range of registered rate. Applicable bloom and sampling time. Hive and bee pollen may be less conservative than plant pollen. Seed size, lack of nectar production, and rate (on a per hectare basis) are relevant for potato seed piece. May be relevant for sugar beet based on rate.	
Corn Corn treated at 315 g a.i./100 kg seed (reported); 0.85 mg a.i./seed (reported); 88.2 g a.i./ha (calculated). Same treatment for two consecutive years, with sampling after each year of treatment.	7.13 (Y1) 1.00 (Y2) Pollen from	N/A	6.1	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)**	N/A	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb)	**Fauser-Misslin 2014+ LOEC (4.9)** Elston 2013 LOEC	N/A	**Fauser-Misslin 2014 LOEC (4.9)** Elston 2013 LOEC	Corn is registered for seed treatment. Rate is in range of registered rate. Applicable bloom and sampling time.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
Sampling at 71 - 74 days after sowing.	bee 1.57 (Y1) Not collected (Y2) Pollen from hive			**Williams 2015+ LOEC (4.5)**		**Williams 2015 LOEC (4.5)**	(8.56)		(8.56)	Hive and bee pollen may be less conservative than plant pollen. Seed size, lack of nectar production, and rate (on a per hectare basis) are relevant for potato seed piece.	
Total corn residues	12.5	N/A		**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)** **Williams 2015+ LOEC (4.5)**	N/A	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)** **Williams 2015+ LOEC (4.5)**	**Fauser-Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	N/A	**Fauser-Misslin 2014+ LOEC (4.9)** Elston 2013 LOEC (8.56)	May be relevant for sugar beet based on rate.	
Corn Corn treated at 315 g a.i./100 kg seed (reported); 0.91 mg a.i./seed (reported); 88.2 g a.i./ha (calculated). Same treatment for two consecutive years, with sampling after each year of treatment.	1.23 (Y1) 1.88 (Y2) Pollen from plant	N/A	0.88 (Y1) 1.5 (Y2) Pollen from plant	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)** **Williams**	N/A	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams	**Fauser-Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	N/A	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Corn is registered for seed treatment. Rate is in range of registered rate. Applicable bloom and sampling time. *Bee pollen was higher	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
Sampling at 73 - 75 and 66 - 68 days after sowing (Years 1 and 2, respectively). **Pollen from bees may also reflect foraging on other crops.**	6.75 (Y1) 4.07 (Y2) Pollen from bee		3.9 (Y1) 2.6 (Y2) Pollen from bee	**2015+ LOEC (4.5)** No risk from plant pollen		2015+ LOEC (4.5)				than plant pollen. Seed size, lack of nectar production, and rate (on a per hectare basis) are relevant for potato seed piece. May be relevant for sugar beet based on rate.	
Corn Corn treated at 0.63 mg a.i./seed (reported); 52.5 - 63 g a.i./ha (calculated). No previous use. Sampling at 66 - 84 days after sowing.	<LOQ (0.856) Pollen from plants	N/A	0.39	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	N/A	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	N/A	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Corn is registered for seed treatment. Rate is in range of registered rate. Applicable bloom and sampling time. Seed size, lack of nectar production, and rate (on a per hectare basis) are relevant for potato seed piece. May be relevant for sugar beet based on rate.	
Corn Corn treated at 2.21 g a.i./100 kg seed (reported); 0.28 - 0.74 mg a.i./seed (calculated); 69.3 g a.i./ha (calculated). No previous use. Sampled 75 days after sowing.	<LOQ (0.856) Pollen from plants	N/A	0.39	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams	N/A	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	N/A	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Corn is registered for seed treatment. Rate is lower than registered rate on per 100 kg basis. Applicable bloom and sampling time.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
				2015+ LOEC (4.5)		Williams 2015+ LOEC (4.5)				Seed size, lack of nectar production, and rate (on a per hectare basis) are relevant for potato seed piece. May be relevant for sugar beet based on rate.	
Corn Corn treated at 2.21 g a.i./100 kg seed (reported); 0.28 - 0.74 mg a.i./seed (calculated); 69.3 g a.i./ha (calculated). No previous use. Sampled 74 days after sowing.	<LOQ (0.856) Pollen from plants	N/A	0.39	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	N/A	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	N/A	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Corn is registered for seed treatment. Rate is lower than registered rate on per 100 kg basis. Applicable bloom and sampling time. Seed size, lack of nectar production, and rate (on a per hectare basis) are relevant for potato seed piece. May be relevant for sugar beet based on rate.	
Corn Corn treated at 315 g a.i./100 kg seed (reported); 0.39 - 1.05 mg a.i./seed (calculated); 94.5 - 126 g a.i./ha (calculated). No previous use. Sampled 87 days after	<LOQ (0.856) Pollen from plants	N/A	0.39	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams	N/A	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	N/A	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Corn is registered for seed treatment. Rate is within registered rate. Applicable bloom and sampling time.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
sowing.				2015+ LOEC (4.5)		Williams 2015+ LOEC (4.5)				Seed size, lack of nectar production, and rate (on a per hectare basis) are relevant for potato seed piece. May be relevant for sugar beet based on rate.	
Corn Corn treated at 0.63 mg a.i./seed (reported); 69.3 g a.i./ha (calculated). No previous use. Sampled 78 days after sowing.	<LOQ (0.856) Pollen from plants and bees	N/A	0.39	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	N/A	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	N/A	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Corn is registered for seed treatment. Rate is within registered rate. Applicable bloom and sampling time. Seed size, lack of nectar production, and rate (on a per hectare basis) are relevant for potato seed piece. May be relevant for sugar beet based on rate.	
Cucurbits											
Pumpkin Pumpkin treated at 0.75 mg a.i./seed (reported); 4.5 g a.i./ha (reported). No previous use. Sampled 35 days after sowing	<LOD (0.171) Pollen from plants	<LOD (0.171) Nectar from plants	0.27	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Cucurbits are not registered for seed treatment in Canada. However, seeds can be imported. Rate is at maximum registered rate (per seed basis) and within range for per hectare basis.	**Cucurbits Crop group 9 (*imported seeds only*)** *Registered at 0.25 - 75 mg a.i./seed* *0.56 - 21 g a.i./ha* **Potentially Relevant for Other Labelled Crop(s):**

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
				2015+ LOEC (4.5)	NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	Williams 2015 LOEC (4.5)		(8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)		Applicable bloom and sampling time. Maybe be relevant for sugar beet based on seed size and rate.	**Sugar beets from Crop group 1 (root and tuber vegetables)** *Registered at 30 - 60 g a.i./ 100,000 seeds 0.3 - 0.6 mg a.i./seed 20 - 59 g a.i./ha*
Cereal Grains											
Sorghum Sorghum treated at 0.107 mg a.i./seed (reported);	<LOQ (0.856)	N/A	0.39	Sandrock 2014+ LOEC	2014 TMX CFS LOEC (34)	Sandrock 2014 LOEC	Fauser-Misslin 2014+	Stanley and Raine 2017	Fauser-Misslin 2014	Sorghum is registered for seed treatment.	**Sorghum from Crop group 15: Cereal grains (Wheat, barley, rye, triticale, buckwheat,**

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Bee bread***	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**		
21.4 - 26.8 g a.i./ha (calculated). No previous use. Sampling at 72 - 83 days after sowing.	Pollen from plants			(6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	(6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	LOEC (4.9) Elston 2013 LOEC (8.56)	NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016	LOEC (4.9) Elston 2013 LOEC (8.56)	Above registered rate (per seed basis) and within range for per hectare basis. Applicable bloom and sampling time. Maybe be relevant for sugar beet based on seed size and rate.	**millet and sorghum)** *Registered at 10.6 - 30 g a.i./100 kg seed* *0.003 - 0.014 mg a.i./seed 0.55 - 63 g a.i./ha* **Potentially Relevant for Other Labelled Crop(s):** **Oats from Crop group 15: Cereal grains** *Registered at 10.6 g a.i./100 kg seed* *0.0032 - 0.0048 mg a.i./seed* *5.7 - 12 g a.i./ha* **Sugar beets from Crop group 1 (root and tuber vegetables)** *Registered at 30 - 60 g a.i./ 100,000 seeds 0.3 - 0.6 mg a.i./seed 20 - 59 g a.i./ha*

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								LOEC (2.14)			
Legume vegetables											
Soybean Soybean treated at 0.0756 mg a.i./seed (reported); 47.08 g a.i./ha (calculated). No previous use. Three sampling events early, mid and late bloom, 45-70 days after sowing.	1.71 Anther	2.34 Nectar from bees	1.1	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6)	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Soybean is registered for seed treatment. Within registered rate (per seed and per hectare basis). Applicable bloom and sampling time. Below maximum rate for chickpeas and other beans.	**Soybean from Crop group 6: Legume vegetables** *Registered at 30 - 50 g a.i./100 kg seed* *0.045 - 0.076 mg a.i./seed 17 - 64 g a.i./ha* **Potentially Relevant for Other Labelled Crop(s):** **Chickpeas, lentils, lupins, dry peas, faba beans (Crop group 6)** *Registered at 10 - 30 g a.i./100 kg seed* *0.003 - 0.3 mg a.i./seed 4.5 - 112 g a.i./ha* **Other beans and peas (Crop group 6)** *30 - 50 g a.i./100 kg seed* *0.02 - 0.17 mg a.i./seed 9.6 - 150 g a.i./ha*

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								Sandrock 2014+ LOEC (2.9) **Moffat 2016 LOEC (2.14)**			
Sunflower											
Sunflower Sunflower treated at 42 g a.i./150,000 seeds (reported); 0.28 mg a.i./seed (reported); 17.7 g a.i./ha (calculated). No previous use. Sampled 78 - 81 days after sowing.	<LOQ (0.856) Pollen from bees	<LOQ (0.856) Nectar from hives	1.3	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Sunflowers are not registered for seed treatment in Canada. However, seeds can be imported. Rate is in range for registered rate (per seed basis) and within range for per hectare basis. Applicable bloom and sampling time. Potentially relevant for sugar beets based on rate.	**Sunflower** *Registered at 0.25 mg a.i./seed* *4.8 - 28 g a.i./ha* **Potentially Relevant for Other Labelled Crop(s):** **Sugar beets from Crop group 1 (root and tuber vegetables)** *Registered at 30 - 60 g a.i./ 100,000 seeds 0.3 - 0.6 mg a.i./seed 20 - 59 g a.i./ha*

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								(39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
Sunflower Sunflower treated at 350 g a.i./100 kg seed (reported); 0.18 - 0.80 mg a.i./seed (calculated); 22.82 g a.i./ha (calculated). No previous use. Sampled 71 - 73 days after sowing.	2.74 Pollen from flowers	N/A	1.2	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05)	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Sunflowers are not registered for seed treatment in Canada. However, seeds can be imported. Rate is below registered rate (per seed basis) and within range for per hectare basis. Applicable bloom and sampling time. Potentially relevant for sugar beets based on rate.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
					LOEC (29) NOEC (19)			Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
Sunflower Sunflower treated at 210 g a.i./100 kg seed (reported); 0.11 - 0.48 mg a.i./seed (calculated); 8.19 g a.i./ha (calculated). No previous use. - Pollen collected from flowers and from bees. Nectar collected from bees and from hives. Sampled 60 - 68 days after sowing.	<LOQ (0.856) Pollen from plants and bees	<LOQ (0.856) Nectar from plants and bees	1.3	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05)	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Sunflowers are not registered for seed treatment in Canada. However, seeds can be imported. Rate is in range for registered rate (per seed basis) and within range for per hectare basis. Applicable bloom and sampling time. Potentially relevant for sugar beets based on rate.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
					NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)			Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
Sunflower Sunflower treated at 500 g a.i./100 kg seed (reported) ; 0.26 - 1.14 mg a.i./seed (calculated); 37.5 g a.i./ha (calculated). No previous use. Sampled 72 - 83 days after	0.942 Pollen from bees	<LOQ (0.856) Nectar from bees	1.3	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Sunflowers are not registered for seed treatment in Canada. However, seeds can be imported. Rate is in range for registered rate (per seed basis) and above rate for per hectare basis.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
sowing.				2015+ LOEC (4.5)	NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	Williams 2015 LOEC (4.5)		(8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)		Applicable bloom and sampling time. Potentially relevant for sugar beets based on rate.	
Sunflower Sunflower treated at 350 g a.i./100 kg seed (reported); 0.18 - 0.80 mg a.i./seed (calculated); 17.5 - 24.5 g	2.57 Pollen from flowers	<LOQ (0.856)	2.57	Sandrock 2014+ LOEC (6.6)	2014 TMX CFS LOEC (34) NOEC (25.3)	Sandrock 2014 LOEC (6.6)	Fauser-Misslin 2014+ LOEC (4.9)	Stanley and Raine 2017 NOEC (8.56)	Fauser-Misslin 2014 LOEC (4.9)	Sunflowers are not registered for seed treatment in Canada. However, seeds can be imported.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
a.i./ha (calculated). No previous use. Sampled 77 days after sowing.				Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Elston 2013 LOEC (8.56)	Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)	Elston 2013 LOEC (8.56)	Rate is in range for registered rate (per seed basis and per hectare basis). Applicable bloom and sampling time. Potentially relevant for sugar beets based on rate.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
Sunflower As above, except that untreated sunflower seeds were sown the following year. Results reflect **carryover** from Year 1 seed treatment.	Not collected	<LOQ (0.856)	0.96	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9)	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Sunflowers are not registered for seed treatment in Canada. However, seeds can be imported. Rate is in range for registered rate (per seed basis and per hectare basis). Applicable bloom and sampling time. Potentially relevant for sugar beets based on rate.	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								Moffat 2016 LOEC (2.14)			
Cotton											
Cotton Cotton treated at 42 g a.i./ha (reported); 0.208 - 0.218 mg a.i./seed (calculated). No previous use. Sampled 83 - 98 days after sowing.	<LOQ (0.856) Pollen from flowers	<LOQ (0.856) Nectar from flowers	1.5	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Cotton is not grown in Canada. May be relevant for sugar beets based on seed size and rate (on a per hectare basis) and below rate on a per seed basis.	Cotton is not grown in Canada. **Potentially Relevant for Other Labelled Crop(s):** **Sugar beets from Crop group 1 (root and tuber vegetables)** *Registered at 30 - 60 g a.i./ 100,000 seeds 0.3 - 0.6 mg a.i./seed 20 - 59 g a.i./ha*

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
Cotton Cotton treated at 0.375 mg a.i./seed (reported); 33 - 134 g a.i./ha). No previous use. Nectar from extrafloral nectaries also sampled. Range of soil types. Sampling 83 - 86 days after sowing.	<LOD (0.428) Pollen from flower	0.616 Nectar from flower	0.88	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4)	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Cotton is not grown in Canada. May be relevant for sugar beets based on seed size and rate (on a per hectare and per seed basis).	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
Rotational crops											
Sunflower Spring barley treated at 70 g a.i./ 100 kg seed (reported); 0.021 - 0.035 mg a.i./seed (calculated); 77 g a.i./ha (calculated). No previous use. Untreated sunflower planted as rotational crop in the same growing season. Sampled 156 days after treated barley seeds were sown.	1.14 Pollen from flower	<LOQ (0.856) Nectar from flower	1.9	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05)	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Relevant for carry over for a number of crops.	General carry over for seed treatment crops.

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
					(19) 2016 CLO CFS LOEC (29) NOEC (19)			Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
Sunflower Spring barley treated at 70 g a.i./100 kg seed (reported); 0.021 - 0.035 mg a.i./seed (calculated); 94.5 g a.i./ha (calculated). No previous use. Untreated sunflower planted as rotational crop in the same growing season. Sampling 152 days after	<LOQ (0.856) Pollen from flower	<LOQ (0.856) Nectar from flower	1.3	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56)	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)		

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
treated barley seeds were sown.				(4.5)	2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	LOEC (4.5)		Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
Corn Spring barley treated at 70 g a.i./100 kg seed (reported); 0.021 - 0.035 mg a.i./seed (calculated); 77 g a.i./ha (calculated). No previous use. Untreated	<LOQ (0.856) Pollen from flower	N/A	0.39	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX	Sandrock 2014 LOEC (6.6) Straub 2016	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013	Stanley and Raine 2017 NOEC (8.56) Stanley and	Fauser-Misslin 2014 LOEC (4.9) Elston 2013		

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Bee bread***	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**		
corn planted as rotational crop in the same growing season. Samples collected 169 days after treated barley seeds were sown.				(6.3 ppb) Williams 2015+ LOEC (4.5)	CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	LOEC (8.56)	Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)	LOEC (8.56)		
Corn	<LOQ (0.856)	N/A	0.39	Sandrock 2014+	2014 TMX CFS	Sandrock 2014	Fauser-Misslin 2014+	Stanley and Raine	Fauser-Misslin 2014		

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
Spring barley treated at 70 g a.i./100 kg seed (reported); 0.021 - 0.035 mg a.i./seed (calculated); 94.5 g a.i./ha (calculated). No previous use. Untreated corn planted as rotational crop in the same growing season. Samples collected 146 days after treated barley seeds were sown.	Pollen from flower			LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	LOEC (4.9) Elston 2013 LOEC (8.56)	2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat	LOEC (4.9) Elston 2013 LOEC (8.56)		

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								2016 LOEC (2.14)			
Sunflower Corn treated at 315 g a.i./100 kg seed (reported); 0.39 - 1.05 mg a.i./seed (calculated); 94.5 - 126 g a.i./ha (calculated). No previous use. Untreated sunflower planted as a rotational crop the following year. Samples collected 454 days after treated corn seeds were sown.	No results	<LOD (0.856)	0.39	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)		

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
Alfalfa & phacelia & rapeseed Corn sown in the spring, treated at 220.5 g a.i./100 kg seed (reported); 0.28 - 0.74 mg a.i./seed (calculated); 61.74 g a.i./ha (calculated). Winter barley sown in the fall, treated at 70 g a.i./ 100 kg seed (reported); 0.021 - 0.035 mg a.i./seed (calculated); 77 g a.i./ha (calculated). Untreated alfalfa, phacelia or rapeseed planted as a rotational crop the following year. Pollen and nectar collected from bees, 294 - 296 (alfalfa), 284 - 288 (phacelia) and 256 - 261 (rapeseed) days after treated winter barley was sown.	Alfalfa 43.6 (*uncertain*) Pollen from bees	Alfalfa 0.248 Nectar from bees	60.8	**Sandrock 2014+ LOEC (6.6)** **Straub 2016+ LOEC (6.3 ppb)** **Williams 2015+ LOEC (4.5)**	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	**Sandrock 2014 LOEC (6.6)** **Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	**Fauser-Misslin 2014+ LOEC (4.9)** **Elston 2013 LOEC (8.56)**	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts	**Fauser-Misslin 2014 LOEC (4.9)** **Elston 2013 LOEC (8.56)**		

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
	Phacelia 2.71 Pollen from bees	Phacelia <LOQ (0.428) Nectar from bees	1.7	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)		

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
					(19)			NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
Alfalfa & phacelia & rapeseed Corn sown in the spring, treated at 220.5 g a.i./ 100 kg seed (reported); 0.28 - 0.74 mg a.i./seed (calculated); 61.74 g a.i./ha (calculated). Winter barley sown in the fall, treated at 70 g a.i./ 100 kg seed (reported); 0.021 - 0.035 mg a.i./seed (calculated); 77 g a.i./ha (calculated). Untreated alfalfa, Phacelia or rapeseed planted as a rotational crop the following year. - Pollen and nectar	Alfalfa <LOQ (0.856) Pollen from bees	Alfalfa <LOQ (0.428) Nectar from bees	0.87	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5) Fauser-Misslin 2014+ LOEC (4.9)	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)		

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
collected from bees, 246 - 250 (alfalfa), 241 - 245 (phacelia) and 208 - 214 (rapeseed) days after treated winter barley was sown.					2016 CLO CFS LOEC (29) NOEC (19)	Elston 2013 LOEC (8.56)		LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
	Phacelia 0.856 Pollen from bees	Phacelia 1.20 Nectar from bees	Phacelia 1.73								
	Rapeseed 5.14	Rapeseed 2.90	7.5	Sandrock 2014+ LOEC (6.6)	2014 TMX CFS LOEC (34) NOEC (25.3)	**Sandrock 2014 LOEC (6.6)**	Fauser-Misslin 2014+ LOEC (4.9)	Stanley and Raine 2017 NOEC (8.56)	**Fauser-Misslin 2014 LOEC (4.9)**		

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Bee bread***	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**	**Pollen (ppb)**	**Nectar (ppb)**	**Bee bread (ppb)**		
	Pollen from bees	Nectar from bees		Straub 2016[+] LOEC (6.3 ppb) **Williams 2015[+] LOEC (4.5)**	2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	**Straub 2016 LOEC (6.3 ppb)** **Williams 2015 LOEC (4.5)**	Elston 2013 LOEC (8.56)	Stanley and Raine 2015 LOEC (8.56) **Stanley 2015 & 2016 LOEC (2.05)** **Baron 2017 LOEC (2.05)** Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) **Sandrock 2014[+] LOEC (2.9)** **Moffat 2016 LOEC (2.14)**	Elston 2013 LOEC (8.56)		

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
Alfalfa & phacelia & rapeseed Corn sown in the spring, treated at 220.5 g a.i./ 100 kg seed (reported); 0.28 - 0.74 mg a.i./seed (calculated); 80.36 g a.i./ha (reported). Winter barley sown in the fall, treated at 70 g a.i./ 100 kg seed (reported); 0.021 - 0.035 mg a.i./seed (calculated); 73.04 g a.i./ha (reported). Untreated alfalfa, Phaelia or rapeseed planted as a rotational crop the following year. - Pollen and nectar collected from bees, 231 - 235 (alfalfa) and 225 - 229 (phacelia) after treated winter barley was sown.	Alfalfa Sample too small Pollen from bees	Alfalfa 1.88 Nectar from bees	2.52	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC (85.6) Sandrock 2014+ LOEC	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)		

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								(2.9) Moffat 2016 LOEC (2.14)			
	Phacelia <LOQ (0.856) Pollen from bees	Phacelia <LOQ (0.428) Nectar from bees	0.89	Sandrock 2014+ LOEC (6.6) Straub 2016+ LOEC (6.3 ppb) Williams 2015+ LOEC (4.5)	2014 TMX CFS LOEC (34) NOEC (25.3) 2016 TMX CFS LOEC (69.6) NOEC (34.8) 2014 CLO CFS LOEC (35.6) NOEC (19) 2016 CLO CFS LOEC (29) NOEC (19)	Sandrock 2014 LOEC (6.6) Straub 2016 LOEC (6.3 ppb) Williams 2015 LOEC (4.5)	Fauser-Misslin 2014+ LOEC (4.9) Elston 2013 LOEC (8.56)	Stanley and Raine 2017 NOEC (8.56) Stanley and Raine 2015 LOEC (8.56) Stanley 2015 & 2016 LOEC (2.05) Baron 2017 LOEC (2.05) Laycock 2014 NOEC (13.4) LOEC (39) Mommaerts 2010 NOEC	Fauser-Misslin 2014 LOEC (4.9) Elston 2013 LOEC (8.56)	

Sampled Crop	EEC - mean molar adjusted residue value in ppb (c.e.)			Potential risk to *Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Potential risk to non-*Apis* bees from pollen, bee bread or nectar? All endpoints in terms of c.e. ppb. Bolded values exceed residues.			Considerations	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread*	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)	Pollen (ppb)	Nectar (ppb)	Bee bread (ppb)		
								(85.6) Sandrock 2014+ LOEC (2.9) Moffat 2016 LOEC (2.14)			
	Rapeseed No sample	Rapeseed No sample		-	-	-	-	-	-		

CFS = colony feeding study, CG = crop group, CLO = clothianidin, DALA = days after last application, DAP = days after planting, EEC = estimated environmental concentration, RQ = risk quotient, TMX = thiamethoxam, Y = year

Bold values indicate that acute LOC (RQ ≥1.0) is exceeded.

NOTE: residues are adjusted for molar ratio of thiamethoxam to clothianidin (0.856)

NOTE: for thiamethoxam CFS from registrant, endpoints were also compared to thiamethoxam residues (see mean residues from Tier I refined level assessment)

[1]Chronic RQ = Chronic estimated daily dose (EDD)/acute toxicity endpoint

Chronic EDD = nectar dose [nectar consumption rate (mg/day) x maximum nectar residue (µg/kg)/ 1.0 x 10^6] + pollen dose [pollen consumption rate (mg/day) x maximum pollen residue (µg/kg)/1.0 x 10^6]

Daily consumption rate used for adult worker bees foraging for nectar: 292 mg/day nectar; 0.041 mg/day pollen; 292 mg/day total

Daily consumption rate used for adult nurse bees: 140 mg/day nectar; 9.6 mg/day pollen; 149.6 mg/day total

Daily consumption rate used for bee larvae: 120 mg/day nectar; 3.6 mg/day pollen; 124 mg/day total

Details on endpoints including strength and limitations can be found in Appendix X

***Bee bread is calculated based on molar adjusted thiamethoxam pollen and nectar.**

[2]Standardized maximum value either ½ LOD or ½ LOQ or ½ LOD +LOQ

\+ These studies were conducted with both thiamethoxam and clothianidin

Appendix IX 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[3]; Nicolson, 2009[4]). 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)[5].

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[6], Seeley 1995[7], Kühnholz and Seeley 1997, Schmaranzer, 2000[8]). 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)[9]; it is noted that 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., 201010),

3 Kühnholz, S. and T.D. Seeley. 1997. The control of water collection in honey bee colonies. Behavioral Ecology and Sociobiology. 41: 407 – 422.
4 Nicolson SW, 2009. Water homeostasis in bees, with the emphasis on sociality. Journal of Experimental Biology. 212: 429-434; doi: 10.1242/jeb.022343
5 EFSA. 2014. Guidance on risk assessment on bees. https://www.efsa.europa.eu/en/efsajournal/pub/3295, accessed on 2017, August, 2.
6 Gary, N.E., P.C. Witherell, K. Lorenzen. 1978. Distribution of Honey bees During Water Collection. Journal of Apicultural Research. 18, 26-29.
7 Seeley, T. 1995. The Wisdom of the Hive: the Social Physiology of Honey Bee Colonies. Harvard University Press, Cambridge, MA. 295 pp.
8 Schmaranzer, S. 2000. Thermoregulation of water collecting honey bees (Apis mellifera). Journal ofInsect Physiology. 46, 1187-1194.
9 Free JB and Spencer-Booth Y, 1958. Observations on the temperature regulation and food consumption of honeybees (Apis mellifera). Journal of Experimental Biology, 35, 93-937.
10 Becher MA, Hildenbrandt H, Hemelrijk CK and Moritz RFA, 2010. Brood temperature, task division and colony survival in honeybees: A model. Ecological Modelling, 221, 769-776.

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)[11] that was authored by EPA, PMRA and CDPR 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)[12]. 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.

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

[11] 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 August 3, 2017

[12] 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, August 26, 1924. Accessed online: http://digitool.library.colostate.edu///exlibris/dtl/d3_1/apache_media/L2V4bGlicmlzL2R0bC9kM18xL2FwYWNoZV9tZWRpYS84MDcxNw==.pdf

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[13]). 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).

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 U.S.A.; 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

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

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 U.S.A. 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 detections and limited data, 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 honeybees 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

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**
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

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 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
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

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
2548876	2014	British Columbia, Manitoba, Ontario, Quebec, Nova Scotia	Puddles	Agricultural	Thiamethoxam	0.0008	1.2953	6.87	5	10	50
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

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, Manitoba	Pond, creek, marsh, water from a bucket	Agricultural	Imidacloprid	0.0011	**0.0018**	0.018	7	23	30
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

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
						LC-MS: 1	0.131	3.8	4	42	10
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

* 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 analysed. 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
Imidacloprid	SO+ST	rotational	-	-	-	88	12	2	-	-	2513416

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		
		crop Maize*									
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 rape	408.65	-	-	-	-	-	11136.94	9941.9	2766425
Thiamethoxam	ST	winter	14.64	-	-	-	-	-	273.6	248.84	2766426

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		
		oilseed rape									
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 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 X Risk Conclusion Summary

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: Crop Subgroups 1B and 1C (includes all of CG1 except sugar beet) Representative commodities: carrot, radish, sugarbeet, potato, sweet potato	FO	**CG1: No timing restrictions. Not when bees are visiting treatment area.** **Products:** 28407 28408 **Current Label Statements:** 28408, 28407: 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* 28408, 28407: Use Directions-crop specific (potato): *This product is highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply Actara 25WG Insecticide/Actara 240SC Insecticide or allow it to drift onto blooming crops or weeds if bees are visiting treated areas. After an Actara 25WG Insecticide application, wait at least 5 days before placing the beehives in the treated*	**Attractive to**: HB, BB, SB Potato: BB, SB **Agronomic considerations**: **CG1 excluding Potato and Sweet Potato:** 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. **CG1 Potato and sweet potato:** 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: N^2 (Y potato and sweet potato) C: N^2 (Y potato and sweet potato) **CG1 excluding Potato and Sweet Potato:** **Minimal potential for exposure as harvested before bloom.**	**CG1 excluding potato and sweet potato:** **Minimal potential for risk as harvested before bloom.** **CG1 Potato and sweet potato:** Tiered Framework (sweet potato and potato): *Apis* and non-*Apis* bees: T1SL: Y Residues: No potato or sweet potato residues. Considered residues from cucurbit, fruiting vegetable, cotton, mostly pre-bloom foliar (one pumpkin during bloom; rest pre-bloom). T1R: Y T2 CFS: nectar-Y (sweet potato only; potato has no nectar); pollen-Y Non-*Apis* T2 CFS Nectar – Y; pollen – Y. T2 Tunnel: NA T3: NA Incidents : None **Overall:** **Potential for risk from**	**CG1 excluding Potato and Sweet Potato:** **None** **CG1 Potato and Sweet Potato:** **No Crop Specific residues at relevant rates and timing for foliar application to potato or sweet potato.** Considered residues from other crops including cucurbits, fruiting vegetables, cotton. Application timing was mainly pre-bloom foliar. **T2 Tunnel; T3 field; Incidents:** None **Bloom time shorter than CFS exposure durations** Potato/sweet potato bloom time (2-3 weeks) shorter than CFS exposure duration (6 weeks nectar; 5-7 weeks pollen). **Risk may be overestimated**. **Effects endpoints**: Limitations and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	**CG1 excluding Potato and Sweet Potato:** **Maintain use considering negligible exposure as harvested before bloom.** **No additional risk management.** **Label update:** **Add to the bee toxicity section under:** Environmental Hazards/ Environmental Precautions: *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.* **CG1 Potato and Sweet Potato only:** **Remove during-bloom use based on potential for risk. Maintain pre-bloom use considering low pollinator exposure. Maintain post-bloom use as negligible risk.** **Under:** Use Directions- crop specific (potato and sweet potato): **Add** (allows pre-bloom and post-bloom application only): *Do not apply treatment between*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		field. 28408: Use Directions-crop specific (Root Vegetables CG1B and 1C; Celeriac): *This product is highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply Actara 25WG Insecticide or allow it to drift onto blooming crops or weeds if bees are foraging in/or adjacent to the treatment area. If bees are foraging in the ground cover and it contains any blooming plants or weeds, always remove flowers before making an application. This may be accomplished by mowing, disking, mulching, flailing, or applying a labeled herbicide. After an Actara 25WG Insecticide application, wait at least 5 days before placing the beehives in the treated field.*	**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. **CG1 Potato and Sweet Potato:** **Potential for exposure through pre-bloom and during bloom foliar application.** **Annual crops; no exposure through 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.	**during-bloom and pre-bloom foliar application.** **Annual crops; no risk post-bloom.** **Consider Pollinator Exposure: Low to Moderate; considered Low.**		*50% row closure and petal fall. Do not make more than one application per year prior to 50% row closure.* **Add to the bee toxicity section under:** Environmental Hazards/ Environmental Precautions: *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.*
From Crop group 1 Root and Tuber Vegetables: Potato	SO (potato)	**CG1 (potato only): Soil application at seeding, in-furrow.** **Products:** 28407 (potato) **Current Label Statements:** No specific use directions for potato soil treatment.	**Attractive to**: 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	Tiered Framework (potato): *Apis* and non-*Apis* bees: T1SL: Y Residues: No potato residues. Considered surrogate residues from cucurbit, fruiting vegetable, small berry pre-bloom soil	**CG1 Potato:** **No Crop Specific residues at relevant rates and timing for soil application to potato.** Considered residues from other crops including cucurbits, fruiting vegetables, small berry pre-bloom soil treatments.	**Maintain use considering low pollinator exposure.** **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
		28407: 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*	little pollen, which is not considered attractive to most bees. Sweet potato produces nectar and pollen. **Exposure potential**: O: Y C: N **Potential for exposure from potato (pollen) from soil treatment.** **Pollinator Exposure (pollen/nectar): Low**. Potato 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.].	treatments. T1R: Y T2 CFS: nectar-N (potato has no nectar); pollen-Y Non-*Apis* T2 CFS : nectar – Y; pollen – Y. T2 Tunnel: NA T3: NA Incidents : None **Overall:** **Potential for risk from pollen from at-plant soil application (potato has only pollen).** **Consider Pollinator Exposure: Low**.	**T2 Tunnel; T3 field; Incidents:** None **Bloom time shorter than CFS exposure durations** Potato/sweet potato bloom time (2-3 weeks) shorter than CFS exposure duration (6 weeks nectar; 5-7 weeks pollen). **Risk may be overestimated**. **Effects endpoints**: Limitations and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	
From Crop group 1 Root and Tuber Vegetables: Potato	ST (potato seed piece)	**CG1 (potato only): Planting treated seed pieces.** **Products:** 28407 31024 **Current Label Statements:** 28407: 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*	**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	Tiered Framework (potato): *Apis* and non-*Apis* bees: T1SL: Y Residues: No potato specific residues for seed piece treatments. For potato, extrapolation from other available crops is not considered appropriate. T1R: Y T2 CFS: nectar-N; pollen-N	**No crop specific residues at relevant rates for potato seed piece treatment**. For potato, extrapolation from other available treated seed crops is not considered appropriate. There may be differences in residues between potato seed piece treatment and other treated seeds. It is noted that with other crops, residues from seed treatments are lower than residues from other types of treatment (soil or foliar) and the application on a g ai/ha basis is	**Maintain use considering low pollinator exposure.** **No additional risk management.** **Label update:** May update label language to include the following: Environmental Precautions: **Add:** *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
		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 31024: Environmental Hazards: *Toxic to bees, beneficial arthropods and aquatic organisms. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications.*	C: N **Potential for exposure from potato (pollen) from seed piece treatment.** **Pollinator Exposure (pollen/nectar): 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.	Non-*Apis* T2 CFS : nectar – N (for pumpkin, sunflower, cotton), (some residues for canola, rapeseed exceed based on soil residues before planting); pollen – N (for rapeseed, cucurbit, sorghum, soybean, sunflower and cotton) (some residues for canola and corn exceed based on soil residues before planting). T2 Tunnel: NA T3: NA Incidents : None **Overall:** **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.**	generally lower for seed treatments. It may be expected that potato residues from seed piece treatment would be lower than residues resulting from potato foliar or soil treatment. However, there is a lack of confidence in this assumption given that the application rate on the basis of g ai/ha is similar between potato seed piece treatment (117 g ai/ha) and potato soil treatment (140 g ai/ha). **T2 Tunnel; T3 field; Incidents:** None **Bloom time shorter than CFS exposure durations** Potato bloom time (2-3 weeks) shorter than CFS exposure duration (6 weeks nectar; 5-7 weeks pollen). **Risk may be overestimated**. **Effects endpoints**: Limitations and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	*is expected.* Example: Where states the following, the additional sentence may be added: *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: Sugarbeet	ST (sugarbeet)	**CG1 (sugarbeet only): Planting treated seed.** **Products:** 27045 31024 **Current Label Statements:** 31024: Environmental	**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.** **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

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		Hazards: *Toxic to bees, beneficial arthropods and aquatic organisms. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications.* 27045 (label includes corn and soybean, therefore more extensive): Environmental Precautions: *Thiamethoxam is toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications. 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. 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 or soybean 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*	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. CG1 seeds typically have low dust levels and may be pelletized for certain crops within the crop group; sugarbeet seeds are pelletized. Certain planting equipment can increase emission of pesticide containing dust, but is not typically used when planting seeds from this CG.			include the following: Environmental Precautions: **Add:** *When used according to label directions minimal exposure or risk is expected.* Example: Where states the following, the additional sentence may be added: *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
		contact honey bee colonies. Use Restrictions: *Additionally, all treated corn and soybean seed for sale or use in Canada must be labeled with the following information: Thiamethoxam 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.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 or soybean 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.*				
Crop Group 4: Leafy Vegetables (except brassica vegetables) Representative commodities:	FO	**CG4: No timing restrictions. Not when bees are visiting treatment area.** **Products:** 28408 **Current Label Statements:**	**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.** **Label update:**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
celery, head lettuce, leaf lettuce, spinach		28408: 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* 28408: Use Directions-crop specific (Leafy Vegetables CG4): *This product is highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply Actara 25WG Insecticide or allow it to drift onto blooming crops or weeds if bees are foraging in/or adjacent to the treatment area. If bees are foraging in the ground cover and it contains any blooming plants or weeds, always remove flowers before making an application. This may be accomplished by mowing, disking, mulching, flailing, or applying a labeled herbicide. After an Actara 25WG Insecticide application, wait at least 5 days before placing the beehives in the treated field.*	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.			**Add to the bee toxicity section under:** Environmental Hazards/ Environmental Precautions: *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
Crop Group 4: Leafy Vegetables (except brassica vegetables) Representative commodities: celery, head lettuce, leaf lettuce, spinach	SO	**CG4: Soil application at seeding or transplant.** **Products:** 28407 30900 **Current Label Statements:** 28407: 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*. 30900: Environmental Precautions: *Toxic to bees. This product is systemic and bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from soil applications*.	**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.**
5: Brassica (Cole) Leafy Vegetables Representative commodities: broccoli or cauliflower, cabbage,	SO	**CG5: Soil application at seeding or transplant.** **Products:** 28407 30900 **Current Label Statements:**	**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
mustard green		28407: 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.* 30900: Environmental Precautions: *Toxic to bees. This product is systemic and bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from soil applications.*	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.			
From CG6: Legume Vegetables: **Soybeans; Dried Shelled Beans (Phaseolus spp., Lupinus spp., Vigna spp., dry fava beans, dry lablab beans, chickpeas)**	FO Soybean; Dried Shelled Beans (*Phaseolus* spp., *Lupinus* spp., *Vigna* spp., dry fava beans, dry lablab beans and chickpeas)	**CG6: No timing restrictions. Not when bees are visiting treatment area.** **Products:** 30404 **Current Label Statements:** 30404: 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*	**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.	Tiered Framework (legumes): *Apis* and non-*Apis*: T1SL: Yes Residues: Soybean, pre-bloom foliar application. Note: nectar from bees, plant anthers and flowers. [Surrogate crops- during bloom- all indicate risk] T1R: Pre-bloom-N, Y considering flowers	**Crop Specific residues and relevant timing (pre-bloom); rates higher than Canadian rates.** Soybean, pre-bloom foliar application. Other crops also considered. Note: Soybean nectar from bees, plant anthers and flowers. HB collected soybean nectar may underestimate exposure; anther and flower soybean residues may overestimate exposure. Rate higher than Canadian rate. **Risk may be overestimated.**	**Remove during-bloom and pre-bloom use based on potential for risk. Maintain post-bloom use as negligible risk.** **Add to the bee toxicity section under:** Environmental Hazards/ Environmental Precautions: *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/pollinato*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		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.	**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 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.	T2 CFS: Nectar- N; Pollen- Y; Flowers-Y Non-*Apis* T2 CFS : nectar – Y; pollen – Y.T2 Tunnel : NA T3 : NA Incidents : None **Overall:** **Potential for risk pre-bloom (pollen exposure) and during bloom.** **Annual crops; no risk post-bloom.** **Consider Pollinator Exposure (pollen/nectar): Varies with legume type- Low/Moderate, High.**	**T2 Tunnel; T3 field; Incidents:** None **Bloom time shorter than CFS exposure durations** Legume bloom time (2-3 weeks) shorter than CFS exposure duration (6 weeks nectar; 5-7 weeks pollen). **Risk may be overestimated**. **Effects endpoints**: Limitations and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	*rs). Follow crop specific directions for application timing.* **Under:** Use Directions- crop specific (SOYBEANS; DRIED SHELLED BEANS (*Phaseolus* spp., *Lupinus* spp., *Vigna* spp., dry fava beans, dry lablab beans and chickpeas): **Add** (allows only post-bloom application): *Do not apply pre-bloom or during bloom (Do not apply until petal fall). Do not apply when bees are present.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
			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.			
6: Legume Vegetables (Succulent or Dried): Soybeans, chickpeahs, lentils, dry peas, faba beans, other beans and peas Representative commodities: bean (*Phaseolus spp*); pea (*Pisum spp*.); and soybean	ST	**CG6 Legume vegetables: Planting treated seed.** **Products:** 27045 27986 28821 30388 **Current Label Statements:** 27045; 27986; 28821; 30388 (label includes corn and soybean, therefore more extensive): Environmental Precautions: *Thiamethoxam is toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications. 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. When using a seed flow lubricant with this treated seed, only a dust*	**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	Tiered Framework (legume): *Apis* and non-*Apis* bees: T1SL: Y Residues: soybean T1R: N T2 CFS: nectar-N; pollen-N Non-*Apis* T2 CFS : nectar – N; pollen - N T2 Tunnel: NA T3: NA 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**	**Crop Specific residues at relevant rates and timing (soybean).** **T2 Tunnel; T3 field:** None **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. 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,	**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*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		reducing fluency agent is permitted. Talc and graphite are not permitted to be used as a seed flow lubricant for corn or soybean 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. Use Restrictions: *Additionally, all treated corn and soybean seed for sale or use in Canada must be labeled with the following information: Thiamethoxam 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.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 or soybean seed treated with this insecticide. Carefully follow use directions for the seed flow lubricant. Do not load or clean planting equipment near*	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. 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.	**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.**	it is not typically used for other legumes. **Bloom time shorter than CFS exposure durations** Legume bloom time (2-3 weeks) shorter than CFS exposure duration (6 weeks nectar; 5-7 weeks pollen). **Risk may be overestimated.** **Effects endpoints**: Limitations and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	*sale or use in Canada must be labeled with the following information:* *Thiamethoxam 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.* *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.* **Additionally, Label update:** May update label language to include the following: Environmental Precautions: **Add:** *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
		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.				Example: Where states the following, the additional sentence may be added: *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.***
8: Fruiting Vegetables Representative commodities: Tomato (standard size and one cultivar of small tomato); Bell pepper and one cultivar of nonbell pepper; one cultivar of small nonbell pepper or one cultivar of small eggplant	FO	**CG8: No timing restrictions. Not when bees are visiting treatment area.** **Products:** 28408 30723 **Current Label Statements:** 28408, 30723: 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* 30723: Environmental Precautions: *Greenhouse uses: Toxic to bees and other beneficial insects. Avoid*	**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: 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.	Tiered Framework (CG8): *Apis* and non-*Apis* bees: T1SL: Y Residues: Tomato pre-bloom (pollen only). Surrogate residues used to consider pre-bloom nectar residues (cucumber, pumpkin, melon, cotton). Surrogate residues for during-bloom foliar-pumpkin [risk identified for during bloom]. T1R: Y T2 CFS: nectar-Y, some cases; pollen-Y Non-*Apis* T2 CFS : nectar – Y; pollen – Y.T2 Tunnel: BB-Application during bloom (before introduction of bees) on tomato resulted in BB mortality and reduced pollination activity. T3: NA Incidents : None.	**Crop Specific residues and relevant timing (pre-bloom); rates higher than Canadian rates.** Tomato, pre-bloom foliar (pollen only from tomato). Other crops considered (pollen and nectar) pre-bloom (cucumber, pumpkin, melon, cotton).Other crops considered (pollen and nectar) during bloom. Rates for pre-bloom studies higher than Canadian rates. **Risk may be overestimated.** **T2 Tunnel:** Application during bloom (before introduction of bees) on tomato resulted in BB mortality and reduced pollination activity. Rate similar to Canadian rate. **Bloom time may be relevant for CFS exposure durations.** CG8 fruiting vegetable bloom time (indeterminate blooming throughout season) may be relevant for CFS exposure duration (6 weeks nectar; 5-7 weeks	**Remove during-bloom and pre-bloom use based on potential for risk. Maintain post-bloom use as negligible risk.** **Add to the bee toxicity section under:** Environmental Hazards/ Environmental Precautions: *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.* **For outdoor uses on CG8 Fruiting Vegetables:** **Under:** Use Directions- crop specific (CG8: Fruiting Vegetables; field pepper): **Add** (allows only post-bloom application):

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		application when bees or other beneficial insects are actively visiting the treatment area. Residues in/on plants or soil may harm bees and other beneficial insects used in greenhouse production. 28408: Use Directions-crop specific (Fruiting vegetable CG8; field pepper): *This product is highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply Actara 25WG Insecticide or allow it to drift onto blooming crops or weeds if bees are foraging in/or adjacent to the treatment area. If bees are foraging in the ground cover and it contains any blooming plants or weeds, always remove flowers before making an application. This may be accomplished by mowing, disking, mulching, flailing, or applying a labeled herbicide. After an Actara 25WG Insecticide application, wait at least 5 days before placing the beehives in the treated field.*		**Overall:** **Potential for risk pre-bloom and during-bloom (pollen and nectar exposure).** **Annual crops; no risk post-bloom.** **Consider Pollinator Exposure (pollen/nectar): Moderate**	pollen). **Effects endpoints**: Limitations and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	*Do not apply pre-bloom or during bloom (Do not apply until petal fall). Do not apply when bees are present.* **For greenhouse uses on CG8 Fruiting Vegetables (Greenhouse peppers):** **Under:** Use Directions- crop specific (CG8: Fruiting Vegetables; Greenhouse peppers): **Add** (the same directions as under Environmental Hazards/ Environmental Precautions)**:** *Greenhouse uses: Toxic to bees and other beneficial insects. Avoid application when bees or other beneficial insects are actively visiting the treatment area. Residues in/on plants or soil may harm bees and other beneficial insects used in greenhouse production.*
8: Fruiting Vegetables Representative commodities: Tomato (standard size and one cultivar of small tomato); Bell pepper and one cultivar of nonbell pepper; one cultivar of small nonbell pepper or one	SO	**CG8: Soil application at seeding or transplant.** **Products:** 28407 28408 30900 **Current Label Statements:** 28408, 28407: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants*	**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.	Tiered Framework (CG8): *Apis* and non-*Apis* bees: T1SL: Y Residues: Tomato (pollen only); pepper. T1R: Y T2 CFS: nectar-Y; pollen-Y	**Crop Specific residues and relevant timing (at planting); some rates higher than Canadian rates.** Tomato at relevant rate (pollen only from tomato). Pepper at higher rate than Canadian rates. There was no relationship between residue levels and soil type or application rates. **T2 Tunnel:** Drip irrigation to tomato at 150 – 200 g	**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
cultivar of small eggplant		*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.* 30900: Environmental Precautions: *Toxic to bees. This product is systemic and bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from soil applications.*	**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.	Non-*Apis* T2 CFS : nectar – Y; pollen – Y. T2 Tunnel: BB-Drip irrigation to tomato at 150 – 200 g ai/ha resulted in BB mortality when applied during bloom (close to hive introduction). Less effects when bees introduced 14 days or more after application. 150 g ai/ha is relevant rate. T3: NA Incidents: None. Overall: **Potential for risk from soil application at seeding/at transplanting (pollen and nectar exposure).** **There is no relationship with soil type or rate.** **Consider Pollinator Exposure (pollen/nectar): Moderate**	a.i./ha resulted in BB mortality when applied during bloom (close to hive introduction). Fewer effects when bees introduced 14 days or more after application. Rate similar to Canadian rate (150 g ai/ha). **Bloom time may be relevant for CFS exposure durations.** CG8 fruiting vegetable bloom time (indeterminate blooming throughout season) may be relevant for CFS exposure duration (6 weeks nectar; 5-7 weeks pollen). **Effects endpoints**: Limitations and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	
9: Cucurbit Vegetables Representative commodities: cucumber, muskmelon, summer squash	SO	**CG9: Soil application at seeding or transplant.** **Products:** 28407 30900 **Current Label Statements:** 28407: Environmental Precautions: *Toxic to bees. This product is systemic and residues from soil may be transported through plants into leaves, pollen and nectar.*	**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	Tiered Framework (CG9): *Apis* and non-*Apis* bees: T1SL: Y Residues: CG9 residues including melon, summer squash, muskmelon, cucumber and pumpkin.. T1R: Y	**Crop Specific residues and relevant rates and timing (at planting):** CG9 residues including melon, summer squash, muskmelon, cucumber, pumpkin. Rates relevant to Canadian rates. **T 3 Field:** No effects on HB observed from application up to 200 g ai/ha to cucurbit. However, indication of lack of	**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
		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. 30900: Environmental Precautions: *Toxic to bees. This product is systemic and bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from soil applications.*	cucurbit crops. Indeterminate blooming. Flowers close in afternoon; bloom lasts only for one day. **Exposure potential**: O: Y C: N (applied pre-bloom) (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.	T2 CFS: **nectar**-Y (squash, muskmelon at higher range of residues; **nectar**-N (melon, pumpkin, cucumber); **pollen**-Y (cucumber, squash, muskmelon, pumpkin, slight for melon) Non-*Apis* CFS: nectar – Y; pollen – Y (except melon and slight for cucumber). T2 Tunnel:NA T3: HB-No effects observed from application up to 200 g ai/ha to cucurbit. Indication of lack of exposure. Incidents: None. **Overall:** **Potential for risk from soil application at seeding/at transplanting (pollen and nectar exposure).** **Consider Pollinator Exposure (pollen/nectar): High**	exposure during study (no pollen collected). In addition, other non-*Apis* bees (BB, SB) are expected to be exposed, such as squash bees which forage and reproduce on cucurbit crops. **Bloom time may be relevant for CFS exposure durations.** CG9 cucurbits bloom time (indeterminate blooming throughout season) may be relevant for CFS exposure duration (6 weeks nectar; 5-7 weeks pollen). **Effects endpoints**: Limitations and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	
9: Cucurbit Vegetables Representative commodities: cucumber, muskmelon, summer squash	ST	**CG9 Cucurbit vegetables: Planting treated seed.** **Products:** 27045 **Current Label Statements:** 27045 (label includes corn and soybean, therefore more extensive): Environmental Precautions: *Thiamethoxam is toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or*	**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	Tiered Framework (CG9): *Apis* and non-*Apis* bees: T1SL: Y Residues: CG9 residues-pumpkin. T1R: N T2 CFS: nectar-N; pollen-N	**Crop Specific residues at relevant rates and timing (pumpkin).** **T2 Tunnel; T3 field; Incidents:** None **Bloom time may be relevant for CFS exposure durations.** CG9 cucurbits bloom time (indeterminate blooming throughout season) may be relevant for CFS exposure	**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: **Add:**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		nectar resulting from seed treatment applications. 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. 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 or soybean 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. Use Restrictions: *Additionally, all treated corn and soybean seed for sale or use in Canada must be labeled with the following information: Thiamethoxam 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*	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 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.	Non-*Apis* CFS: nectar – N; pollen – N. T2 Tunnel: NA T3: NA 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.**	duration (6 weeks nectar; 5-7 weeks pollen). **Effects endpoints**: Limitations and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	*When used according to label directions minimal exposure or risk is expected.* Example: Where states the following, the additional sentence may be added: *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- 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 or soybean 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.				
11: Pome Fruit Representative commodities: apple and pear	FO	**CG11: Apple: Pre and post bloom; Pear: Post bloom. Not during bloom. Not when bees are visiting treatment area.** **Products:** 28408 **Current Label Statements:** 28408: 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*	**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)	Tiered Framework (CG11): *Apis* and non-*Apis* bees: T1SL: Y Residues: CG11 residues-apple (pre-bloom). Surrogate- CG12 residues-cherry, plum, peach (post-bloom). T1R: Y T2 CFS: nectar-N (post-bloom); Y(pre-bloom); pollen-Y (pre- and post-bloom) Non-*Apis* T2 CFS : nectar – Y; pollen – Y.T2 Tunnel: NA T3: HB- Effects to mortality	**Crop Specific residues for orchard crops (CG11 Pome fruit and CG12 stone fruit):** CG11-apple (pre-bloom); rates higher than Canadian rate. Surrogate: CG12-cherry, plum, peach (post-bloom); rates similar to Canadian rates. **T 3 Field:** HB studies with pear and apple. Mortality when applied 1 and 3 days before bloom on pear (at 95 g ai/ha). No effects when applications made >5 days before bloom. No effects from 100 – 200 g ai/ha applied to apple 7 days before bloom. Indication of lack of exposure during study.	**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
		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 28408: Use Directions-crop specific (Apple, crabapple, pear, oriental pear): *Remarks: DO NOT apply Actara 25WG Insecticide During Bloom* *Pollinator Precautions: This product is highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. [*Apple, crabapple*: Do not apply ACTARA 25WG Insecticide after pre-bloom (early pink growth stage) or before post bloom (petal fall growth stage)] [Pear, Oriental pear: Do not apply ACTARA 25WG Insecticide before postbloom (petal fall).] Do not apply Actara 25WG Insecticide or allow it to drift onto blooming crops or weeds if bees are visiting the treated area. This is especially critical if there are adjacent orchards that are blooming (Refer to Recommendations to Avoid Spray Drift for additional information). If bees are foraging in the orchard ground cover and it contains any blooming plants or weeds, always remove flowers before making an application. This may be accomplished by mowing, disking, mulching, flailing, or applying a labeled herbicide. This restriction does not apply to blooming crops (such as	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 medium acreage. Orchards in some locations can cover large areas.	when applied 1 and 3 days before bloom for pear (at 95 g ai/ha). No effects when applications made >5 days before bloom. No effects from 100-200 g ai/ha applied to apple7 days before bloom. Incidents: Potential effects from spray application during bloom to orchard crops. **Overall:** **Potential for risk pre-bloom (nectar and pollen exposure) and post-bloom (pollen (*Apis* and non-*Apis*) and nectar (non-*Apis*) exposure).** **Consider Pollinator Exposure (pollen/nectar): High**	**Incidents:** Potential effects from spray application during bloom to orchard crops. One monitoring study indicated potential effects in peach and plum orchards. **Bloom time shorter than CFS exposure durations** Pome fruit bloom time (2-3 weeks) shorter than CFS exposure duration (6 weeks nectar 5-7 weeks pollen). **Risk may be overestimated**. **Effects endpoints**: Limitations and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		potatoes) that are not attractive to bees. After an Actara 25WG Insecticide application, wait at least 5 days before placing the beehives in the treated field.				
12: Stone Fruit Representative commodities: sweet cherry or tart cherry, peach, and plum or prune plum **Registered:** **Cherries only**	FO (cherries only)	**Cherry: No timing restrictions. Not when bees are visiting treatment area.** **Products:** 28408 **Current Label Statements:** 28408: 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* 28408: Use Directions-crop specific (Cherries, sweet and sour): *Pollinator Precautions: This product is highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply Actara 25WG Insecticide or allow it to drift onto blooming crops or weeds if bees are*	**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 C: Y (Y also if foraging on flowering groundcover in treated area.) **There is potential for exposure.** **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): *Apis* and non-*Apis* bees: T1SL: Y Residues: CG12 residues-cherry, plum, peach (post-bloom). Surrogate-CG11 residues- apple (pre-bloom). T1R: Y T2 CFS: nectar-N (post-bloom); Y(pre-bloom); pollen-Y (pre- and post-bloom) Non-*Apis* T2 CFS : nectar – Y; pollen – Y.T2 Tunnel: NA T3: HB- Studies with peach indicated limited colony effects from pre-bloom applications made 15 days before bloom. Some effects when application was made 6 days before bloom. Incidents: Potential effects from spray application during bloom to orchard crops. One monitoring study indicated potential effects from peach and plum orchards. **Overall:** **Potential for risk pre-bloom (nectar and pollen**	**Crop Specific residues for orchard crops (CG11 Pome fruit and CG12 stone fruit):** CG12-cherry, plum, peach (post-bloom); rates similar to Canadian rates. Surrogate: CG11-apple (pre-bloom); rates higher than Canadian rate. **T 3 Field:** HB studies with peach indicated limited colony effects from pre-bloom applications made 15 days before bloom. Some effects when application was made 6 days before bloom. Indication of lack of exposure during study. **Incidents:** Potential effects from spray application during bloom to orchard crops. One monitoring study indicated potential effects in peach and plum orchards. **Bloom time shorter than CFS exposure durations** Stone fruit bloom time (2-3 weeks) shorter than CFS exposure duration (6 weeks nectar; 5-7 weeks pollen). **Risk may be overestimated**. **Effects endpoints**: Limitations and differences among 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
		foraging in/or adjacent to the treatment area. If bees are foraging in the orchard ground cover and it contains any blooming plants or weeds, always remove flowers before making an application. This may be accomplished by mowing, disking, mulching, flailing, or applying a labeled herbicide. This restriction does not apply to blooming crops (such as potatoes) that are not attractive to bees. After an Actara 25WG Insecticide application, wait at least 5 days before placing the beehives in the treated field.		**exposure) and post-bloom (pollen (*Apis* and non-*Apis*) and nectar (non-*Apis*) exposure).** **Consider Pollinator Exposure (pollen/nectar): High**	CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	
13: Small fruit and berries (certain subgroups only) **Subgroup 13-07A: Caneberry** Representative crop: blackberry or raspberry **Subgroup 13-07B: Bushberry** Representative crop: highbush blueberry **Subgroup 13-07G: Low growing berry** Representative crop: strawberry	FO	**CG13A,B,G: No timing restrictions. Not when bees are visiting treatment area.** **Products:** 28408 **Current Label Statements:** 28408: 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**: 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	Tiered Framework (CG13): *Apis* and non-*Apis* bees: T1SL: Y Residues: CG13 residues-strawberry (pre-bloom) and cranberry (pre-bloom). T1R: Y T2 CFS: nectar- Y(pre-bloom); pollen-Y (pre-bloom) Non-*Apis* T2 CFS : nectar – Y; pollen – Y.T2 Tunnel: NA T3: NA Incidents: None for thiamethoxam. Are clothianidin foliar spray incidents during bloom for strawberry (contrary to label directions).	**Crop Specific residues; rates higher than Canadian rates.** Strawberry (pre-bloom); Cranberry (pre-bloom). **Incidents:** None for thiamethoxam, but there are clothianidin foliar spray incidents for during bloom application to strawberry (contrary to label directions). **Bloom time shorter than CFS exposure durations** Small fruit and berry bloom time (2-3 weeks; may vary with crop) shorter than CFS exposure duration (6 weeks nectar; 5-7 weeks pollen). **Risk may be overestimated**. **Effects endpoints**: Limitations and differences among some CFS endpoints,	**Remove during-bloom and pre-bloom use based on potential for risk. Maintain post-bloom use based on low risk.** **For strawberry: Maintain post-bloom use based on low/moderate exposure.** **For woody berry plants: Maintain post-bloom use with renovation (cutting back old growth) after harvest, which will reduce exposure.** **Add to the bee toxicity section under:** Environmental Hazards/ Environmental Precautions: *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/pollinato*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
			There is potential for exposure. **Pollinator Exposure:** **CG13-07A Caneberry (considered Blackberry/ Raspberry): Pollinator Exposure (pollen/nectar): High:** Blackberry/ raspberry requires 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. **CG13-07G Low Growing Berry: (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: (considering 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	**Overall:** **Potential for risk pre-bloom, during-bloom, post-bloom (pollen and nectar exposure).** **Consider Pollinator Exposure (pollen/nectar): High; for strawberry Moderate.**	particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	*rs). Follow crop specific directions for application timing.* **Under:** Use Directions- crop specific (Caneberries- Crop Sub Group 13-07A; Bushberries- Crop Group 13-07B; Low Growing Berries- Crop Group 13-07G): **Add**: *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 old growth) must occur after harvest and before the next season's bloom.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
			acreage.			
Crop Group 13: Small fruit and berries; Subgroup 13G: Low growing berry Representative crop: strawberry	SO	**CG13 G: Soil drench post renovation only (note: typically applied in spring, pre-bloom).** **Products:** 28408 **Current Label Statements:** 28408: 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.* 28408: Additional Use Direction- crop specific (low growing berry) for soil drench only: *Apply as a soil drench post renovation only.*	**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 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 **Potential for exposure from soil application pre-bloom (pollen and nectar exposure).** **CG13-07G Low Growing Berry excluding strawberry: Pollinator Exposure (pollen/nectar): High:** Typically 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. Low to medium acreage. **CG13-07G Low Growing Berry, Strawberry: Pollinator Exposure (pollen/nectar): Low to Moderate**	Tiered Framework (CG13): *Apis* and non-*Apis* bees: T1SL: Y Residues: CG13 residues-strawberry T1R: Y T2 CFS: nectar- Y; pollen-Y Non-*Apis* T2 CFS : most nectar – Y; most pollen – N.T2 Tunnel: NA T3: NA Incidents: None **Overall:** **Potential for risk from soil application pre-bloom (pollen and nectar exposure).** **Consider Pollinator Exposure (pollen/nectar): High; for strawberry Moderate.**	**Crop Specific residues and relevant rates and timing (pre-bloom).** Strawberry (pre-bloom soil application in spring). **T2 Tunnel; T3 field; Incidents:** None **Bloom time shorter than CFS exposure durations** Small fruit and berry bloom time (2-3 weeks; may vary with crop) shorter than CFS exposure duration (6 weeks nectar; 5-7 weeks pollen). **Risk may be overestimated**. **Effects endpoints**: Limitations and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *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
			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 15: Cereal Grains Representative commodities: corn (fresh sweet corn and dried field corn), barley, wheat	ST	**CG15 Cereals grains: Planting treated seed.** **Products:** 27045 27986 29127 29192 30436 31453 **Current Label Statements:** 29127, 29192, 30436, 31453 (small grained cereals: barley, winter wheat, spring wheat, oats, rye, triticale, buckwheat, millet, sorghum): Environmental Precautions: *Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications.* 27045, 27986 (label includes corn and soybean, therefore more extensive) (small grained cereals: wheat, barley, corn, rye, triticale, buckwheat, millet, sorghum): Environmental Precautions: *Thiamethoxam is toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications. Dust generated during planting of treated seed may be harmful to bees*	**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) 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,	Tiered Framework (cereal grains): *Apis* and non-*Apis* bees: T1SL: Y Residues: corn (pollen) T1R: N T2 CFS: nectar-N; pollen-N Non-*Apis* T2 CFS: nectar – n/a; pollen – Y/N (yes from studies where residues were in soil prior to planting seeds) T2 Tunnel: HB- dust studies; potential for effects. T3: HB- Results were variable. Some higher tier studies indicated some colony effects from corn planting (at sowing) that recovered. No clear effects from exposure during pollen shed. Plant residues were also low in most cases. Long term exposure (from pollen shed) resulted in no colony effects. BB- Some effects to BB from exposure during pollen shed. Incidents : Incidents	**Crop Specific residues at relevant rates and timing (corn; corn has pollen only).** **T2 Tunnel:** HB dust exposure studies; potential for effects. **T3 Field:** HB dust exposure studies; results variable. Some higher tier studies indicated some colony effects from corn planting (at sowing) that recovered. **T3 Field:** HB exposure during pollen shed: No clear effects from short term exposure during pollen shed; residues low in most cases. Long term exposure from pollen shed resulted in no colony effects. BB some effects from exposure during pollen shed. **Incidents**: 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	**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 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. Use restrictions: **Add:** Use restrictions (corn): No additions; Label statements are acceptable for corn. Use restrictions (all other CG15 cereal seeds excluding corn): *Additionally, all treated CG 15 cereal seed (excluding corn) for sale or use in Canada must be labeled with the following information:* *Thiamethoxam is toxic to bees. Dust*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		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. 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 or soybean 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. Use Restrictions: *Additionally, all treated corn and soybean seed for sale or use in Canada must be labeled with the following information: Thiamethoxam 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*	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 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.	associated with corn dust. PMRA has already implemented dust exposure reduction strategies. **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.**	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 other cereals. **Bloom time/pollen shed shorter than CFS exposure durations** Corn pollen shed (2-3 weeks) shorter than CFS exposure duration (6 weeks nectar; 5-7 weeks pollen). **Risk may be overestimated.** **Effects endpoints**: Limitations and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	*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.* *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.* **Additionally, Label update:** May update label language to include the following: Environmental Precautions: **Add:** *When used according to label directions minimal exposure or risk is expected.* Example: Where states the following, the additional sentence may be added:

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		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 or soybean 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.				*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 20: Oilseeds Canola, rapeseed, mustard, importation of treated sunflower seed.	ST	**CG20 Oilseeds (canola, rapeseed, mustard, sunflower only): Planting treated seed.** **Products:** 26637 26638 27045 31454 **Current Label Statements:** 26637, 26638, 31454 Environmental Precautions: *Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications.* 27045 (label includes corn and soybean, therefore more extensive): Environmental Precautions: *Thiamethoxam is toxic to bees. Bees can be exposed to product residues in*	**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 highly attractive to pollinators and a good source of nutrition. **Exposure:** O: Y C: N **Potential for exposure through pollen and nectar.**	Tiered Framework (oilseed grains): *Apis* and non-*Apis* bees: T1SL: Y Residues: CG20 - canola, rapeseed, sunflower T1R: Y (some) T2 CFS: nectar-N; pollen-N for most canola/rapeseed; N for sunflower. Non-*Apis* T2 CFS : nectar – Y/N (yes from studies where residues were in soil prior to planting seeds) T2 Tunnel: HB- Variable results. Most studies indicated no effects. Effects were observed at rates 10x	**Crop Specific residues at relevant rates and timing (canola, rapeseed, sunflower).** **T2 Tunnel:** HB- variable results. Most studies indicated no effects. Effects were observed at rates 10x higher than Canadian rates. **T3 Field:** HB – Overall, no long term colony effects observed at Canadian relevant rates. Some short term mortality observed in some studies. BB/SB- Some potential short term effects observed. **Incidents:** None **Bloom time shorter than CFS exposure durations** Bloom time (2-3 weeks)	**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: **Add:** *When used according to label directions minimal exposure or risk is expected.* Example: Where states the following, the additional sentence may be added: *Bees can be exposed to product residues in flowers, leaves, pollen*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		flowers, leaves, pollen and/or nectar resulting from seed treatment applications. 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. 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 or soybean 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. Use Restrictions: *Additionally, all treated corn and soybean seed for sale or use in Canada must be labeled with the following information:* (similar to above)	**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.	higher than Canadian rates. T3: HB-Overall, no long term colony effects observed at Canadian relevant rates. Some short term mortality observed in some studies. BB/SB- Some potential short term effects observed. 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.**	shorter than CFS exposure duration (6 weeks nectar; 5-7 weeks pollen). **Risk may be overestimated.** **Effects endpoints**: Limitations and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	*and/or nectar resulting from seed treatment applications*. ***When used according to label directions minimal exposure or risk is expected.***
No associated crop group	FO (outdoor and	**Ornamentals: No timing restrictions. Not when bees are visiting treatment area.**	**Attractive to:** HB, BB, SB	Tiered Framework (Ornamentals):	**No Crop Specific residues at relevant rates and timing for foliar application to**	**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
Ornamentals Includes: Outdoor ornamentals; Outdoor nurseries and landscapes; viburnum in outdoor nurseries and landscapes; Greenhouse ornamentals	greenhouse)	**Products:** 30901 30723 28408 **Current Label Statements:** 30901: Environmental Precautions: *Toxic to bees. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* ***DO NOT apply this product during bloom or when bees are present.*** *Greenhouse Use: Toxic to bees and other beneficial insects. Avoid foliar application when bees or other beneficial insects are actively visiting the treatment area. This product is systemic and residues from soil may be transported through plants into leaves, pollen, and nectar. Residues in/on plants or soil may harm bees and other beneficial insects used in greenhouse production.* 30723, 28408: Environmental Hazards: *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*	**Agronomic considerations:** Ornamentals include many plant 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 potential**: O: Y C: Y **There is potential for exposure.** **Many trees, shrubs, plants are perennial crops. For those that are annual crops; no risk post-bloom.** **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. **Not attractive to pollinators:** **Coniferous Evergreens**: **Pollinator**	*Apis* and non-*Apis* bees: T1SL: Y Residues: No ornamental residues. Surrogates- tomato, cucumber, pumpkin, melon, strawberry, cotton, apple, peach, plum. T1R: Y T2 CFS: nectar- Y/N; pollen- Y Non-*Apis* T2 CFS : nectar – Y; pollen – Y.T2 Tunnel: NA T3: NA Incidents: None for thiamethoxam. Are clothianidin foliar spray incidents during bloom for strawberry (contrary to label directions). **Overall:** **Potential for risk pre-bloom, during-boom, post-bloom (pollen and nectar exposure).** **Many trees, shrubs, plants are perennial crops. For those that are annual crops; no risk post-bloom.** **Consider Pollinator Exposure (pollen/nectar): May vary from Low to Moderate to High**	**ornamentals.** Considered surrogate residues from other crops including cucurbits, fruiting vegetables, cotton, strawberry, apple, peach, cherry. Application timing was pre-bloom foliar and post-bloom (plum, peach). The registrant is conducting foliar ornamental residue studies, but they are not yet available (expected fall 2017). **T2 Tunnel; T3 field; Incidents:** None **Bloom time typically shorter than CFS exposure durations, but may be variation in bloom times.** Ornamental bloom time may be (typically 2-3 weeks, some may be longer) shorter than CFS exposure duration (6 weeks nectar; 5-7 weeks pollen). **Risk may be typically overestimated; could be more relevant exposure period depending on specific ornamental**. **Effects endpoints**: Limitations and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	**Uses without pollinator exposure as identified below may be maintained.** Note: Registrants can submit residue data for ornamentals for reconsideration. Removal of use **does not include** the following ornamentals, as they would not result in pollinator exposure. **Coniferous evergreens** (pine, fir, juniper, spruce, arborvitae, hemlock, cypress, yew, live Christmas trees). (as they are not attractive to pollinators). **Greenhouse Uses: 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
		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. 30723: Environmental Hazards: *Greenhouse uses: Toxic to bees and other beneficial insects. Avoid foliar application when bees or other beneficial insects are actively visiting the treatment area. Residues in/on plants or soil may harm bees and other beneficial insects used in greenhouse production.* 30723, 28408: Use directions-crop specific (ornamentals: outdoor ornamentals; outdoor nurseries and landscape; viburnum in outdoor nurseries and landscape (30723 only)): *Pollinator Precautions: This product is highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply [FLAGSHIP] [ACTARA 25WG] Insecticide or allow it to drift onto blooming crops or weeds if bees are foraging in/or adjacent to the treatment area. If bees are foraging in the ground cover and it contains any blooming plants or weeds, always remove flowers before making an application. This may be accomplished by mowing, disking, mulching, flailing, or applying a labeled herbicide. After a [FLAGSHIP] [ACTARA 25WG] Insecticide*	**Exposure (pollen/nectar):** **Negligible:** Coniferous evergreens (pine, fir, juniper, spruce, arborvitae, hemlock, cypress, yew, live Christmas trees). **Note regarding Greenhouse Use:** Exposure to pollinators may occur when greenhouse ornamentals are planted outdoors. Cut flowers will not result in pollinator exposure, as they are not planted outdoors. Additionally, there is potential for exposure to managed pollinators used in greenhouse production. **Additional Notes on Ornamentals:** 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.			

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		application, wait at least 5 days before placing the beehives in the treated field.				
No associated crop group **Ornamentals** Includes: Greenhouse ornamentals	SO (greenhouse)	**Ornamentals: Drench application indoor use only (no timing restriction)** **Products:** 30901 **Current Label Statements:** 30901: Environmental Precautions: *Toxic to bees. Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site. DO NOT apply this product during bloom or when bees are present.* *Greenhouse Use: Toxic to bees and other beneficial insects. Avoid foliar application when bees or other beneficial insects are actively visiting the treatment area. This product is systemic and residues from soil may be transported through plants into leaves, pollen, and nectar. Residues in/on plants or soil may harm bees and other beneficial insects used in greenhouse production.*	**Attractive to:** HB, BB, SB **Agronomic considerations:** Ornamentals include many plant 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 through.** **Exposure is for greenhouse ornamentals that will be planted outdoors and are attractive to pollinators and therefore may result in pollinator exposure.** **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	Tiered Framework (Ornamentals): *Apis* and non-*Apis* bees: T1SL: Y Residues: No ornamental residues. Surrogates- tomato, pepper, cucumber, pumpkin, melon, orange trees. T1R: Y T2 CFS: nectar- Y/N; pollen- Y (except melon) Non-*Apis* CFS : nectar - most pepper, orange, cucumber, summer squash and muskmelon residues, and some melon and pumpkin residues; p – Y (some pumpkin, summer squash and muskmelon residues). Y for pepper and tomato residues, and no from cucumber and melon residues. T2 Tunnel: NA T3: NA Incidents: None **Overall:** **Potential for risk (pollen and nectar exposure).** **Risk is for greenhouse ornamentals that will be planted outdoors and are**	**No Crop Specific residues at relevant rates and timing for soil application to ornamentals.** Considered surrogate residues from other crops including tomato, pepper, cucumber, pumpkin, melon, orange trees. The registrant is conducting soil ornamental residue studies, but they are not yet available (expected fall 2017). **T2 Tunnel; T3 field; Incidents:** None **Bloom time typically shorter than CFS exposure durations, but may be variation in bloom times.** Ornamental bloom time may be (typically 2-3 weeks, some may be longer) shorter than CFS exposure duration (6 weeks nectar; 5-7 weeks pollen). **Risk may be typically overestimated; could be more relevant exposure period depending on specific ornamental**. **Effects endpoints**: Limitations and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis*	**Remove use based on potential for risk.** **Potential risk identified for greenhouse ornamentals that will 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) **Cut flowers** (as they are not planted outside). Note: Registrants can submit residue data for ornamentals for reconsideration.

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
			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. Cut flowers will not result in pollinator exposure, as they are not planted outdoors. Additionally, there is potential for exposure to managed pollinators used 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. **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.	**attractive to pollinators and therefore may result in pollinator exposure.** **Consider Pollinator Exposure (pollen/nectar): May vary from Low to Moderate to High**	and non-*Apis* endpoints considered.	

FOOT NOTES:

Abbreviations and Explanations:
FO = foliar, SO = soil, ST = seed treatment
HB = Honey bees; BB = Bumble bees; SB = Solitary bees
Y = Yes; N = No; N^2 = No, unless grown for seed. Typically not grown for seed in Canada.
O= Oral exposure potential; C= Contact exposure potential

[1]Pollinator Exposure Potential:
The potential of a pesticide treated crop to result in pollinator exposure 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 contacting foraging bees or forage sources utilized by bees).

Multiple factors influence the potential for pollinator exposure including:

- method, timing and equipment used for application (foliar, soil treatment, seed treatment);
- specific pesticide properties (systemic or non-systemic, persistence, formulation),
- agronomic considerations (crop flowers with a nectar and/or pollen source; 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 through the pollen/nectar route 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* (HB) and non-*Apis* (BB, SB) 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 all of the above criteria.

- 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.

[3] Risk characterization includes:
T1SL (Tier 1 Screening Level Assessment)- Considers effects on individual bees in the laboratory compared with default exposure estimates; *Apis* as surrogate; (non-*Apis* T1 effects endpoints suggest similar sensitivity);
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 was considered, including crops rates, and timing.
T1R (Tier 1 Refined Assessment)- Considers effects on individual bees in the laboratory compared with pollen/nectar residue exposure information; *Apis* as surrogate (non-*Apis* T1 effects endpoints suggest similar sensitivity);
T2 CFS (Tier 2 Colony Feeding Study Assessment)- Considers effects on colony compared with pollen/nectar residue exposure information; *Apis* and non-*Apis*;
T2 Tunnel (Tier 2 Tunnel Studies)- Considers effects on colony resulting from exposure through relevant application to crops/flowering plants; bees are confined to treatment site in tent/tunnel; *Apis* and non-*Apis*;
T3 (T3 Field Studies)- Considers effects on colony resulting from exposure through relevant application to crops/flowering plants in the field; bees are free foraging; *Apis* and non-*Apis*;
Incidents- Information from incident reports
Overall- The overall risk characterization is based on consideration of all available information. Considers both *Apis* and non-*Apis* bees. Takes into account considerations and limitations .
Considerations and limitations: The main considerations and limitations include: Residue information relevance; Whether there was supporting Higher Tier information available from Tier II tunnel studies, Tier III field studies; Incidents; Comparison of crop bloom time to CFS exposure durations; Effects endpoints limitations.
Y= Yes; N= No; NA= Not available

[4]Considerations and Limitations included the following:
Residues: Consideration of whether they were relevant for Canadian crops, rates, timing.
Higher Tier Information: Consideration of whether higher tier information from Tier 2 Tunnel studies, Tier 3 Field studies, Incidents was available.
Crop bloom time: Consideration of the crop bloom duration compared to the exposure duration in the Colony Feeding Studies. If crop bloom time is much shorter than CFS exposure duration, risk may be overestimated.
Effects Endpoints Uncertainty: There were uncertainties 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.
Details on CFS effects endpoints are as follows:
***Apis* Pollen-CFS:** A range of effects endpoint values derived from open and closed pollen-CFS were considered for comparison with residues from pollen and/or estimated bee bread residues. Effect parameters measured varied between pollen-CFS studies, making interpretation difficult. 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:
Clothianidin: No effects were detected in the closed pollen-CFS (No effects: 5, 10 and 20 µg/kg); whereas effects were detected in several open pollen-CFS testing either clothianidin alone (Effects at 4.9 µg/kg; exposure was a declining range of 4.9-2.0 µg/kg over 12 weeks), or a mixture of thiamethoxam and lesser amounts of clothianidin (to represent formation of the transformation product) (Effects at 4.5-6.6 µg c.e./kg).
Thiamethoxam: Effects were detected in several open pollen-CFS testing a mixture of thiamethoxam and lesser amounts of clothianidin (to represent formation of the transformation product) (Effects at 4.5-6.6 µg/kg).
***Apis* Nectar-CFS:** Effects endpoint values derived from an open nectar-CFS were considered for comparison with nectar residues. While the nectar-CFS was robust, there was high control colony overwintering loss; therefore, only effects observed prior to overwintering were considered. Effects following overwintering, including potential for recovery, were not considered. The nectar-CFS study was repeated but a final report was not completed in time for this review. Analysis of available summary information from the repeated nectar-CFS, indicates the effects endpoints selected from the first-CFS are conservative.
Specific nectar-CFS endpoints considered were as follows:
Clothianidin: Effects were detected in open nectar-CFS (No effects at 19 µg/kg; Effects at 35.6 µg/kg).
Thiamethoxam: Effects were detected in open nectar-CFS (No effects at 25.3 µg c.e./kg; Effects at 34 µg c.e./kg).
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.
For clothianidin, the range of effects endpoints for *Apis* and non-*Apis* CFS were similar.
For thiamethoxam, the range of effects endpoints for *Apis* and non-*Apis* CFS included some effects endpoints that were more sensitive for non-*Apis* compared to *Apis*.
Specific CFS endpoints considered were as follows:
Thiamethoxam: Non-*Apis* information included closed nectar-CFS (Effects at 2.05 – 85 c.e. µg/kg (thiamethoxam only, with BB) and 2.9 c.e. µg/kg (mixture of thiamethoxam and lesser amounts of clothianidin, with SB- red mason bee); closed nectar plus pollen-CFS (Effects at 4.9 (mixture of thiamethoxam and lesser amounts of clothianidin) – 8.6 c.e.µg/kg (thiamethoxam only)); open nectar-CFS (Effects at 2.1 c.e. µg/kg (thiamethoxam only).
Clothianidin: Non-*Apis* information included open nectar-CFS testing clothianidin alone (No effects at 17 µg/kg; Effects at 39 µg/kg with BB); closed nectar plus pollen-CFS testing a mixture of thiamethoxam and lesser amounts of clothianidin (Effects at 4.9 c.e. µg/kg with BB)
Note: c.e. = clothianidin equivalents [thiamethoxam converted to clothianidin equivalents by multiplying by the molar ratio of clothianidin to thiamethoxam]

Appendix XI Comments on REV2016-03 and Responses

1.1 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

Comment:
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.

PMRA response:
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.

Comment:
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.

PMRA response:
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.

Comment:
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 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.

PMRA response:
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 that further research is required before economic action thresholds can be adopted by the Québec corn and soybean industries.

1.2 Comments on the economic assessment of the value of neonicotinoid seed treatments to corn and soybean.

Comments:
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.

PMRA response:
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 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.

Comment:
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.

PMRA response:
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.

Comment:
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.

PMRA response:
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.

Comment:
Grower groups indicated that there is a need for transparency around the actual cost of neonicotinoid seed treatments applied to corn and soybean seeds.

PMRA response:
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 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.

Comment:
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.

PMRA response:
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.

List of References

A. Registrant Submitted Studies/Information

A.1 Environmental Assessment

A.1.1 Environmental Fate and Effects Assessment

PMRA Document Number	Reference
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
2446870	2006, Monitoring pesticide residues in Lake Naivasha, Kenya, DACO: 8.3.4
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2600072	2015, Thiamethoxam 25WG (A9584C)- Magnitude of residues in or on leaves, flowers, pollen and nectar of cucumber after foliar application- Final Report, DACO: 8.5
2600073	2015, Thiamethoxam 5FS (A95765N)- Magnitude of residues in leaves, flowers, anthers, pollen and nectar of soybean plants grown from treated seed- Final Report, DACO: 8.5
2610249	2015, Thiamethoxam 25WG (A9584C)- Magnitude of residues in pollen, nectar, flowers, and leaves of stone fruit after foliar application with Actara 25WG in California- Final Report, DACO: 8.5
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1983052	2009, Thiamethoxam (CGA293343): A field study with A9807C treated winter oilseed rape seed, investigating effects on honeybees (*Apis* mellifera L.) over four years in Alsace (France) - Final Report, DACO: 9.2.4.3
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2364810	1997, Assessment of side effects of CGA 322704 to the honey bee, *Apis* mellifera L. in the laboratory following the EPPO Guideline No. 170, DACO: 9.2.4.1,9.2.4.2,9.2.4.3
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2364814	2012, Thiamethoxam - Acute Toxicity to Larval Honey Bees (*Apis* mellifera), DACO: 9.2.4.1,9.2.4.2
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2364835	1999, Toxicity of Actara (Thiametoxam) 25% WG to adults of honey bee (*Apis* mellifera) by spray method, DACO: 9.2.4.1,9.2.4.2
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2364843	2008, Thiamethoxam WS (A9567B) - Acute Oral Toxicity Test in Bee (*Apis* mellifera L.), DACO: 9.2.4.2
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2364861	2011, Thiamethoxam FS (A9700B) - Acute oral toxicity test in bee (*Apis* mellifera L.), DACO: 9.2.4.2
2364868	2005, CGA-293343 - Honey Bee Field Investigation of Actara Pre-Bloom Use in Bartlett Pears, DACO: 9.2.4.3
2364874	1996, Testing toxicity to Honeybee - *Apis* mellifera L. (semifield) CGA 293343 WG 25, DACO: 9.2.4.3
2364876	2013, Thiamethoxam - Assessement of Subchronic Effects to the Honey Bee, *Apis* mellifera L., in a 10-Day Laboratory Feeding Test, DACO: 9.2.4.3
2364881	1998, Semi-field test: effects of CGA 293343 WG 25 (A-9584 C) on the Honey bee (*Apis* mellifera L.), DACO: 9.2.4.3
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2364896	2001, Field test: side effects of sunflower grown from seeds dressed with CGA 293343 WS 70 (A-9567 B) on the honey bee (*Apis* mellifera L.) in Spain, DACO: 9.2.4.3
2364898	1999, Impact of CGA 293343 WG 25 (A-9584 C) after one drip irrigation on the bumble bee Bombus terrestris L. under semi-field conditions on tomatoes, DACO: 9.2.4.3
2364900	1999, Impact of CGA 293343 WG 25 (A-9584 C) after one spray application on the bumble bee Bombus terrestris L. under semi-field conditions on tomatoes, DACO: 9.2.4.3
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2364910	2002, Assessment of side effects of CGA293343 WG25 (A9584C) on the Honey Bee (*Apis* mellifera L.) in Apple Orchard following application before flowering (mouse-ear stage) of the crop. Non GLP test in Spain, DACO: 9.2.4.3

PMRA Document Number	Reference
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2364916	2003, Assessment of Side Effects of CGA 293343 WG 25 (A 9584 C) on the Honey Bee (*Apis* mellifera L.) in the Field following Application via Drip Irrigation to Honeydew Melon Plants, DACO: 9.2.4.3
2364919	2001, Semi-Field Test (Tunnel): Side Effects of Sunflower Grown from Seeds Dressed with A-9567 B on the Honey Bee (*Apis* mellifera L.) in Spain, DACO: 9.2.4.3
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2364923	1998, Tunnel test: Effects of sunflowers grown from seeds dressed with A-9567 B on honey bees (*Apis* mellifera L.), DACO: 9.2.4.3
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2364931	2001, Field Test (Non-GLP): Side Effects of Oil-Seed Winter Rape Grown from Seeds Dressed with A9807 C on the Honey Bee (*Apis* mellifera L.), DACO: 9.2.4.3
2364932	2006, Thiamethoxam - A field study with honeybees (*Apis* mellifera L.) to assess the side effects of A9584C following the application on P. tanacetifolia after daily bee-flight in Eastern Germany, DACO: 9.2.4.3
2364936	2013, Two Field Trials to Determine the Effects of HELIX Seed Treatment on Honeybees Foraging on Canola Flowers - Amendment 2, DACO: 9.2.4.3
2364945	2010, Thiamethoxam (CGA293343) - A Field Study with A9700B + A9638A Treated Maize Seed, Investigating Effects on Honeybees (*Apis* mellifera L.) over Four Years in Alsace (France, DACO: 9.2.4.3
2364948	2011, Thiamethoxam WG (A9584C) - A Field Study to Evaluate Effects on the Honeybee (*Apis* mellifera; Hymenoptera, Apidae) in Peach in Italy 2010, DACO: 9.2.4.3
2364950	2011, Thiamethoxam WG (9584C) - A Semi-Field Study to Evaluate Effects on the Honeybee (*Apis* mellifera; Hymenoptera, Apidae) in Melon in Italy 2010, DACO: 9.2.4.3
2364952	2009, Thiamethoxam (CGA293343) - A Field Study with A9700B + A9638A Treated Maize Seed, Investigating Effects on Honeybees (*Apis* mellifera L.) over Four Years in Lorraine (France), DACO: 9.2.4.3
2364957	2010, Thiamethoxam (CGA293343) - A Field Study with A9700B + A9638A Treated Maize Seed, Investigating Effects on Honeybees (*Apis* mellifera L.) over Four Years in Southern France, DACO: 9.2.4.3
2364966	2000, Assessment of side-effects of CGA 293343 WG 25 (A-9584 C) on the honeybee (*Apis* mellifera L.) in pome fruit orchards after application during bee-flight, DACO: 9.2.4.3
2364970	2002, Subchronic toxicity of CGA 293343 and CGA 322704 to Honeybees, DACO: 9.2.4.3
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PMRA Document Number	Reference
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2365005	2010, Thiamethoxam - A semi-field study with maize seeds treated with A9700B and A14304E, investigating residues in guttation liquid in 2009, DACO: 9.9
2365020	2007, Thiamethoxam (CGA293343) and its metabolite (CGA322704) - A residue study with A10590C treated maize seed, investigating residues in crop, soil and honeybee products in Northern France, DACO: 9.9
2365044	2007, Thiamethoxam (CGA293343) and its Metabolite (CGA322704) - A Residue Study with A9700B treated Spring Barley Seed followed by A9807C treated Winter Oil-Seed Rape Seed, investigating Residues in Crop and Honeybee Products in Southern France, DACO: 9.9
2365047	2007, Thiamethoxam (CGA293343) and its Metabolite (CGA322704) - A residue study with A9807C treated winter oil-seed rape seed, investigating residues in crop and honeybee products in Alsace (France), DACO: 9.9
2365051	2007, Thiamethoxam (CGA293343) and its Metabolite (CGA322704) - A residue study with A9807C treated winter oil-seed rape seed, investigating residues in crop and honeybee products in Northern France, DACO: 9.9
2365055	2007, Thiamethoxam (CGA293343) and its Metabolite (CGA322704) - A residue study with A9807C treated winter oil-seed rape seed, investigating residues in crop and honeybee products in Southern France, DACO: 9.9
2365067	2007, Thiamethoxam (CGA293343) and its metabolite (CGA322704) - A residue study with A10590C treated maize seed, investigating residues in Crop, Soil and Honeybee products in Southern France, DACO: 9.9
2365090	2002, Residue Study with Thiamethoxam (CGA 293343) in or on Spring Barley and Sunflower in North of France, DACO: 9.9
2365092	2002, Residue Study with Thiamethoxam (CGA 293343) in or on Spring Barley and Sunflower in South of France, DACO: 9.9
2365094	2002, Residue Study with Thiamethoxam (CGA 293343) in or on Spring Barley and Maize in North of France, DACO: 9.9
2365095	2002, Residue Study with Thiamethoxam (CGA 293343) in or on Spring Barley and Maize in South of France, DACO: 9.9
2365321	2010, Thiamethoxam (CGA293343) - A Semi-Field Study with A9700B + A9638A Treated Maize Seed, Followed By Untreated Flowering Crop(s), Investigating Residues in Crop(s), Soil and Honeybee Products in Alsace (France), in 2009, DACO: 9.9
2365330	2010, Thiamethoxam (CGA293343) - A semi-field study with A9700B + A9638A treated maize seed, followed by untreated flowering crop(s), investigating residues in crop(s), soil and honeybee products in Picardie (France), in 2009, DACO: 9.9
2365332	2010, Thiamethoxam (CGA293343) - A semi-field study with A9700B + A9638A treated maize seed, followed by untreated flowering crop(s), investigating residues in crop(s), soil and honeybee products in Burgundy (France), in 2009, DACO: 9.9
2365336	2010, Thiamethoxam FS (A9700B) - A field study with treated maize seeds, investigating the effects of residues from dust during seeding and residues in guttation liquid, on honeybee colonies in Alsace (France) in 2009, DACO: 9.9
2365341	2011, Thiamethoxam - Determination of Residues of Thiamethoxam and its Metabolites in Sweet Corn and Sorghum Pollen after drilling of seeds treated with A9700B, France 2010, DACO: 9.9

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2365365	2012, Thiamethoxam FS (A9700B) - A Field Study with treated Maize Seeds, Investigating the Effects of Residues from Dust during Drilling, Residues in Guttation Liquid and Flowering Maize, on the Honeybee (*Apis* mellifera L.) in Alsace, France in 2010, DACO: 9.9
2365370	2012, Thiamethoxam FS (A9700B) - A Field Study with treated Maize Seeds, Investigating the Effects of Residues from Dust during Drilling, Residues in Guttation Liquid and Flowering Maize, on the Honeybee (*Apis* mellifera L.) in Lorraine, France in 2010, DACO: 9.9
2365373	2012, Thiamethoxam FS (A9700B) - A Field Study with treated Maize Seeds, Investigating the Effects of Residues from Dust during Drilling, Residues in Guttation Liquid and Flowering Maize, on the Honeybee (*Apis* mellifera L.) in Stade, Germany in 2010, DACO: 9.9
2365392	2000, Honey bee field investigation of mitigation methods for CGA293343 (A-9795 B) use in cucumbers, DACO: 9.9
2365400	2013, Feeding of honey bees (*Apis* mellifera L.) with thiamethoxam (CGA 293343) 1. Testing of return flight ability 2. Feed consumption and exchange (trophallaxis), DACO: 9.9
2365412	2006, Residue Study with Thiamethoxam (CGA 293343) in or on Maize and Sunflower in South of France, DACO: 9.9
2365414	2006, Residue Study with Thiamethoxam (CGA293343) in or on Sunflower in North of France, DACO: 9.9
2365420	2000, Effect of 1 administration of CGA 293343 (A 9795 B) to tomato on the bumblebee Bombus terrestris determined under greenhouse condictions, DACO: 9.9
2365435	2012, Magnitude of the Residues in Leaves and Flowers from Tomato in California, DACO: 9.9
2385909	2011, Thiamethoxam WG (A9584C) - Honeybees (*Apis* mellifera), acute oral toxicity test, DACO: 9.2.4.2
2404303	2013, Thiamethoxam (A9765N) - Magnitude of the Residues in Whole Flowers, Leaves, and Reproductive Organ Tissues (Structures) of Soybean from Plants Grown from Cruiser(R) 5FS-Treated Seed, DACO: 9.9
2459449	2013, Thiamethoxam 75 SG (A9549C) - Magnitude of the Residues in Leaves, Flowers, Pollen, and Nectar of Cucumbers, Representative Commodity of Cucurbit Vegetables, EPA Crop Group 9, in California, DACO: 9.9
2479590	2014, Thiamethoxam FS (A9807F) - A Field Study to Evaluate Side Effects on Red Mason Bees (Osmia bicornis L.) in Winter Oil Seed Rape in Germany (Tubingen, Kraichtal) and France (Alsace), DACO: 9.2.9
2487496	2014, Thiamethoxam - Effects on homing behaviour of honeybees foraging on treated oilseed rape - Final Report Amendment 2, DACO: 9.9
2487497	2014, Thiamethoxam - Effects on bumble bee colonies foraging on treated oilseed rape - Final Report Amendment 2, DACO: 9.9
2499626	2009, Thiamethoxam - Thiamethoxam (CGA293343) - A Field Study with Thiamethoxam (CGA293343) - A Field Study with A9700B + A9638A Treated Maize Seed, Investigating Effects on Honeybees (*Apis* mellifera L.)over Four Years in Lorraine (France) - Final Report, DACO: 9.2.4.3
2529337	2014, Thiamethoxam - Chronic Larval Toxicity Test on the Honey bee (*Apis* mellifera L.) in the Laboratory, DACO: 9.9

PMRA Document Number	Reference
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2544882	2012, Thiamethoxam FS (A9700B) - A Field Study with treated Maize Seeds, Investigating the Effects of Residues from Dust during Drilling, Residues in Guttation Liquid and Flowering Maize, on the Honeybee (*Apis mellifera* L.) in Lorraine, France in 2010, DACO: 9.2.4.3
2544884	2012, Thiamethoxam FS (A9700B) - A Field Study with treated Maize Seeds, Investigating the Effects of Residues from Dust during Drilling, Residues in Guttation Liquid and Flowering Maize, on the Honeybee (*Apis mellifera* L.) in Alsace, France in 2010, DACO: 9.2.4.3
2549385	2012, Thiamethoxam FS (A9700B) - A Field Study with treated Maize Seeds, Investigating the Effects of Residues from Dust during Drilling, Residues in Guttation Liquid and Flowering Maize, on the Honeybee (*Apis* mellifera L.) in Stade, Germany in 2010, DACO: 9.2.4.3
2554231	2015, Thiamethoxam 40 WG (A11963C) and 5FS (A9765N) - Magnitude of Residues in Leaves, Flowers, Pollen, Nectar and Extra Floral Nectar of Cotton Plants After Foliar Application with Centric(R) 40WG in California or After Application as a Seed Treatment with Cruiser(R) 5FS - Final Report, DACO: 9.9
2586559	2015, Thiamethoxam Technical - Honey Bee Brood and Colony Level Effects Following Thiamethoxam Intake via Treated Sucrose Solution in a Field Study in North Carolina - FINAL REPORT, DACO: 9.2.4.3,9.9
2694872	2016, Thiamethoxa/Metalaxyl-M/Fludioxonil FS (A9807F) - A field study to evaluate side effects on red mason bees (Osmia bicornis L.) in winter oil seed rape in Germany (Niefern), DACO: 9.9
2694873	2016, Thiamethoxam/Metalaxyl-M/Fludioxonil FS (A9807F) - A field study to evaluate side effects on red mason bees (Osmia bicornis L.) in winter oil seed rape in Germany (Tubingen), DACO: 9.9
2694874	2016, Thiamethoxam - Assessment of effects on the adult honey bee, *Apis* mellifera L. in a 10 day chronic feeding test under laboratory conditions, DACO: 9.9
2694875	2016, Thiamethoxam - Honey bee (*Apis* mellifera L.) larval toxicity test (repeated exposure through to adult emergence) Final report amendment 1, DACO: 9.9
2702496	2013, Thiamethoxam - Assessment of Subchronic Effects to the Honey Bee, *Apis* mellifera L., in a 10-Day Laboratory Feeding Test, DACO: 9.2.4
2766425	2015, Thiamethoxam FS (A9807F) - A Field Study to Investigate the Effects of Residues in Guttation Fluid on Honeybees (*Apis* mellifera L.) in Winter Oil Seed Rape in Germany (Niefern), DACO: 9.2.4
2766426	2017, Thiamethoxam FS (A9807F) - A Field Study to Investigate the Effects of Residues in Guttation Fluid on Honeybees (*Apis* mellifera L.) in Winter Oil Seed Rape in Germany (Tubingen), DACO: 9.2.4
2766427	2017, Thiamethoxam/Metalaxyl-M/Fludioxonil FS (A9807F) - A Field Study to Evaluate Side Effects on Red Mason Bees (Osmia bicornis L.) in Winter Oil Seed Rape in Germany (Celle), DACO: 9.2.4

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
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-	Alburaki M., Boutin S., Mercier P.-L., Loublier Y., Chagnon M., Derome N. 2015. Neonicotinoid-coated Zea mays seeds indirectly affect honeybee performance and pathogen susceptibility in field trials. Plos One. DACO: 9.2.4.7
-	Alburaki, M., B. Cheaib, L. Quesnel, P.-L. Mercier, M. Chagnon and N. Derome. 2016. Performance of honeybee colonies located in neonicotinoid-treated and untreated cornfields in Quebec. J. Appl. Entomol. doi: 10.1111/jen.12336. DACO: 9.2.4.7
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B.1.2 Water Monitoring Assessment

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B.2 Unpublished Information

B.2.0 Environmental Assessment

B.2.1 Environmental Fate and Effects Assessment

N/A

B.2. 2 Water Monitoring Assessment

PMRA Document Number	Reference
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