Proposed Re-evaluation Decision PRVD2017-23

Clothianidin 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 turf uses for clothianidin and its associated end-use products, specifically to assess the risk to pollinators. This re-evaluation assessed the potential risk to pollinators in light of international updates to the pollinator risk assessment framework, including 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 clothianidin, 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 clothianidin 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 clothianidin 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

Clothianidin is an insecticide that is widely used in Canada on a variety of crops. This document summarizes the potential risks posed by clothianidin 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 clothianidin are sold as sprays to be applied to plants and to bare soil. Clothianidin 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 clothianidin 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 clothianidin (and its

breakdown products) when they visit certain flowers to collect pollen and nectar. Bees may also be accidentally sprayed or collect water containing clothianidin.

Health Canada examined hundreds of laboratory and outdoor field studies with bees from research conducted around the world. These studies examined possible effects on bees from a wide range of situations including:

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

This risk assessment, conducted according to the *Guidance for Assessing Pesticide Risks to Bees*, has determined that there are varying degrees of effects on bees. Some current uses of clothianidin are not expected to affect bees; however, there are some uses of clothianidin 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 Regulatory Decision for Clothianidin for a list of proposed measures to protect pollinators. When clothianidin 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 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 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 clothianidin is applied, and determined that water sources do not pose risks of concern to bees.

Proposed Regulatory Decision for Clothianidin

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

Registered pesticide product labels include specific directions for use. Directions include risk mitigation measures that must be followed by law. As a result of this re-evaluation of clothianidin, 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. Since 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 clothianidin can lead to effects that may impact the survival of bee colonies or solitary bee species.

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

- Foliar application to orchard trees and strawberries, and
- Foliar application to municipal, industrial and residential turf sites.

In order to protect pollinators, **Health Canada is proposing the following change to the conditions of use of clothianidin**:

- Reduce maximum number of foliar applications to cucurbit vegetables to one per season.

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

- Seed treatment of cereal crops.

International Regulatory Context

Clothianidin 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 clothianidin.

Next Steps

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

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

Clothianidin is a second-generation neonicotinoid insecticide. Clothianidin 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 clothianidin, the registrant of the technical grade active ingredient in Canada indicated their continued support for all registered uses of clothianidin in Canada.

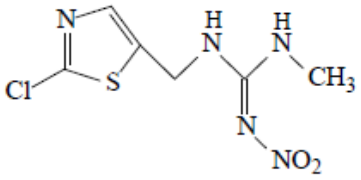
Clothianidin is currently found in 14 end-use products to which pollinators may be exposed. Appendix I lists all clothianidin products that are registered under the *Pest Control Products Act* which may be used as a seed dressing (canola, mustard, rapeseed, corn, wheat, various vegetable crops and potato as a seed piece treatment), foliar spray application (turf, potato, pome fruit, stone fruit, grape, strawberry, and cucurbit vegetable crops), in-furrow (potato) or pre-plant incorporated (sweet potato). Appendix II provides a summary of the use pattern of clothianidin products considered in the pollinator risk assessment.

1.0 The Technical Grade Active Ingredient

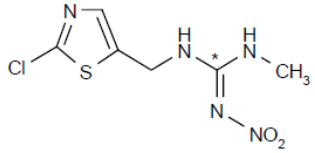
1.1 Identity

Active Substance	Clothianidin
Function	Insecticide
Chemical name	
1. International Union of Pure and Applied Chemistry (IUPAC)	(*E*)-1-(2-chloro-1,3-thiazol-5-ylmethyl)-3-methyl-2- nitroguanidine
2. Chemical Abstract Services (CAS)	[*C*(*E*)]-*N*-[(2-chloro-5-thiazolyl)methyl]-*N*'-methyl-*N*''-nitroguanidine
CAS Number	210880-92-5
Molecular Formula	$C_6H_8ClN_5O_2S$
Molecular Weight	249.68 g/mol

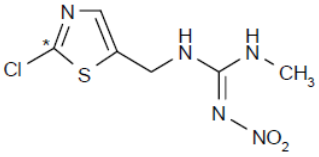
Structural Formula



Position of Radiolabels in Environmental Studies



[Nitroimino-^{14}C] Clothianidin



[Thiazolyl-2-^{14}C] Clothianidin

1.2 Physical and Chemical Properties

Property	Value	Comments[1]
Solubility in water at 20°C	327 mg/L	Very soluble in water.
Vapour pressure	1.3×10^{-10} Pa at 25°C 3.8×10^{-11} Pa at 20°C (extrapolated)	Non-volatile under field conditions.
Henry's law constant	9.8×10^{-16} atm·m^3 / mole at 25°C 2.9×10^{-16} atm·m^3 / mole at 20°C	Non-volatile from water and moist soil surface.
Ultraviolet (UV) / visible spectrum	Maximum of 265.5 nm in acidic and neutral solution, maximum of 246.0 nm in basic solution	Minimal phototransformation expected in the natural environment.
Octanol/water partition coefficient (K_{ow}) at 25°C	log K_{ow} = 0.7	Low potential for bioaccumulation.
Dissociation constant (pK_a) at 20°C	11.09	Under acidic and neutral conditions, clothianidin will be in the undissociated form.

[1] Source: ERC2011-01 and REG2004-06

1.3 Estimated octanol-water partition coefficients for clothianidin transformation products at pH7

Transformation Product	Value	Comments
MNG	log K_{ow} = - 0.8	Low potential for bioaccumulation.
TMG	log K_{ow} = - 1.8	
TZNG	log K_{ow} = 0.9	
TZMU	log K_{ow} = 0.8	

2.0 Pollinator Assessment

2.1 Fate and Behaviour in the Environment

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

- Clothianidin will come in contact with soil when it is applied directly on the ground, sprayed on foliage, or when clothianidin contained in the seed coating moves away from the seed into the surrounding soil. The length of time that clothianidin will persist in soil depends on various factors including soil type. In certain fields, clothianidin may persist long enough to carryover from one growing season to the next. When clothianidin is used for many years, concentrations in soil have been shown to initially increase, then stabilize after approximately 3-5 years.
- Major products formed from the microbial degradation of clothianidin in soil are MNG, TZMU and TZNG. These compounds may also persist in soil. MNG and TZNG have been found in rotational crops.
- Clothianidin can leach through the soil profile and has been detected in groundwater. Some of the soil transformation products may also be mobile.
- Clothianidin may enter the aquatic environment through spray drift or run-off. Clothianidin in water is expected to dissipate relatively quickly if exposed to sunlight. In the absence of sunlight, clothianidin will degrade more slowly. Clothianidin is found in surface water, including puddles which are known sources of drinking water for pollinators.
- Clothianidin 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 clothianidin as a result of this upwards movement or when spray droplets or dust containing clothianidin (produced during the sowing of treated seeds) are deposited directly on open flowers.
- Once inside the plant, clothianidin remains the predominant residue. Major plant metabolites are MG, MNG, TMG and TZMU. MG is reported to be found naturally in plants. MNG and TZNG have also been found in rotational crops. Of these metabolites, only TZNG has been shown to be moderately toxic to bees and is therefore considered to be the most relevant for the pollinator risk assessment.

2.2 Approach to Pollinator Risk Assessment

2.2.1 Background

The pollinator risk assessment followed a tiered framework developed jointly by the PMRA, USEPA and the California Department of Pesticide Regulation CDPR in 2012 with guidance published in 2014 (*Guidance for Assessing Pesticide Risks to Bees*). The tiered risk assessment framework consists of exposure characterization and effects characterization relative to bees, and

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

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

Multiple factors influence pollinator exposure including application type (foliar, soil, seed treatment); specific pesticide properties (systemic, non-systemic, persistence); agronomic considerations (whether crop has pollen/nectar source; harvest relative to bloom; flowering period) (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 management.

Pollinator exposure includes crop pollination requirements, crop attractiveness to *Apis* and non-*Apis* bees, whether it is a major or minor source of pollen and/or nectar, timing of application (pre-, during and post-bloom application), time of harvesting (pre- or post-bloom), crop acreage, etc. (see Appendix IV for criteria for determining pollinator exposure).

An extensive data set (>180 effects and residue studies) from the open literature and registrant were considered for the clothianidin pollinator risk assessment (Appendix V summarizes the available studies). All studies were reviewed for strengths and limitations and considered in the risk assessment in a weight of evidence approach (see Appendix IV for details). The pollinator risk assessment for clothianidin 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 risk assessment considered acute and chronic laboratory endpoints for adult bees and bee brood. There were 46 Tier I studies available for consideration in the risk assessment from the registrant and open literature. Details on the strengths and limitations of these studies can be found in Appendix V. The endpoints in Table1 were considered the most relevant in the Tier I risk assessment.

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

Chemical	Life Stage	Exposure	Endpoint value	Degree of toxicity[1]	Reference
Clothianidin Technical (96.0-99.5%)	Adult	Acute Contact 48-h observation period	LD_{50}: 0.0275 µg a.i./bee	Highly Toxic	PMRA# 2364810
		Acute Oral 48-h observation period	LD_{50}: 0.00368 µg a.i./bee	Highly Toxic	PMRA# 1194190
		Chronic dietary 10-d continuous feeding	NOEC: 7.7 µg/L (actual intake 0.00036 µg a.i./bee/day) LOEC: 15 µg/L (actual intake 0.00072 µg a.i./bee/day)	n/a	PMRA# 2355466
	Brood	Chronic dietary 3-d *in-vitro* feeding; 7-day observation period	LC_{50} > 40 µg a.i./kg diet (actual intake 0.0018 µg a.i./bee/day)	n/a	PMRA# 2355467
		Chronic dietary 4-d *in-vitro* feeding; 12-day observation period	LD_{50} > 0.008 µg a.i./bee/day	n/a	López et al., 2017
		Chronic dietary 3-d *in-vitro* feeding; 22-day observation period	NOEC: 20 µg a.i./kg diet (actual intake 0.0009 µg a.i./bee/day) LOEC: 40 µg a.i./kg diet (actual intake 0.0018 µg a.i./bee/day)	n/a	PMRA# 2355467
TZNG (98.6% TI-435 Metabolite)	Adult	Acute Oral 48-h observation period	LD_{50}: 3.95 µg/bee	Moderately Toxic	PMRA# 1194197

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

2.3.2 Tier I refined assessment – Residues

There were 69 residue studies available for consideration in the risk assessment. Risk estimates based on field residues from all relevant residue studies were considered based on how similar the crop type, application rate and application timing in the study design were in comparison to the registered Canadian use pattern for each crop. Residue information selected for the risk assessment and relevancy to the registered crops is outlined in the refined risk assessment tables for foliar (Appendix VI), soil (Appendix VII) and seed treatment (Appendix VIII) applications. The residue studies used in the risk assessment are summarized in Table 2.

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

Application type	Application Timing	Residue studies
Foliar	Pre-bloom	grape, pumpkin, potato
	During bloom	cotton, turf
	Post-bloom	apple, peach, almond, grape
Soil	At planting	potato, corn, pumpkin, cucumber, melon, squash, orange, rotational crops
Seed treatment	At planting	canola, rapeseed, corn, melon, sweet pepper, soybean, sunflower, cotton

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 20 colony level feeding studies available from the registrant and open literature for consideration in the risk assessment (see Appendix V for details on strengths and limitations for each study). The endpoints in Table 3 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 Clothianidin Risk Assessment

Study type	Matrix which was dosed & length of exposure	Species and caste	Endpoint value[1]	Endpoints affected	Limitations	Reference
Clothianidin colony feeding study (no over-wintering results) Open	Sucrose solution 5 weeks	Honey bee Whole colony	NOAEC: **19 µg a.i./kg** sucrose LOAEC: 35.6 µg a.i./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 exposure from contaminated pollen/bee bread. Only nectar dosing was considered.	PMRA# 2610259
Clothianidin colony feeding study (overwintering results) Open	Sucrose solution 5 weeks	Honey bee Whole colony	Preliminary NOAEC: 19 µg a.i./kg sucrose LOAEC: 29 µg a.i./kg sucrose	Effects to pollen storage and brood were observed in 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.	No study report available.	*Preliminary information 2015/2016 study*
Clothianidin colony feeding study Open	Sucrose solution 11 weeks	Bumble bee *Bombus terrestris* Colony	NOAEC: **17 ppb** LOAEC: 39 ppb	After 11 weeks of verified worker exposure to concentrations of 17 -76 ppb in the sugar syrup, worker movement significantly slowed down and colonies weighed less. After exposure to concentrations of 39 -76 ppb, significantly less brood and males were produced. No treatment	This study has several limitations including a lower level of exposure than expected based on the residue results, unconfirmed queen exposure, a lack of information on the greenhouse foraging crop and datasets that were possibly inappropriately combined from two separate trials in the statistical analysis.	Scholer and Krischik et al., 2014

Study type	Matrix which was dosed & length of exposure	Species and caste	Endpoint value[1]	Endpoints affected	Limitations	Reference
				related effects on female worker or daughter queen production was observed.		
Clothianidin colony feeding study Closed	Pollen 41 days	Honey bee Whole colony	NOAEC: **19.7 µg a.i./kg** LOAEC: not determined	No treatment-related significant effects were noted on mortality, foraging, food collection or storage, comb production, behaviour or population growth.	The treatments in the study were not replicated (only one control and treatment plot were used) therefore no measure of variability was possible for the various parameters being measured and statistical analysis could not be performed on the data.	PMRA# 1194878
Clothianidin colony feeding study Open	Pollen patties 12 weeks	Honey bee Whole colony	NOAEC: not determined LOAEC: 2.0-**4.9 ppb** (exposure was a declining range of 4.9-2.0 µg/kg over 12 weeks)	Significant decline in hygienic behaviour (removal of dead capped brood) and increased absence of queens over time relative to controls. Worker bees that were exposed to clothianidin as larva had a significant (23%) reduction in age to last foraging flight relative to controls and exhibited a different flight pattern (time, duration) relative to controls.	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 of hive provisions by other bee colonies 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 2-5 km radius of the hives was provided to account for foraging exposure outside of the artificial feeders and a palynological (pollen source) analysis	Tsvetkov et al., 2017

Study type	Matrix which was dosed & length of exposure	Species and caste	Endpoint value[1]	Endpoints affected	Limitations	Reference
					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 death is foraging, workers may revert to other tasks within the colony. While supersedure of queens 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.	
Thiamethoxam and clothianidin colony feeding study	Sucrose and pollen patty 9 weeks	Bumble bees Colony (with	NOAEC: not determined LOAEC: **4.9 µg**	Decreased worker production, shorter worker longevity, and decreased sucrose water and pollen	Only one concentration was tested and it combined two active ingredients. Dose verification was not conducted. Bees were maintained in a nest	Fauser-Misslin et al., 2014

Study type	Matrix which was dosed & length of exposure	Species and caste	Endpoint value[1]	Endpoints affected	Limitations	Reference
Closed		parasite)	**c.e./kg** (4 ppb thiamethoxam + 1.5 ppb clothianidin)	collection (only during week 6-9). Less gyne and male production, and queens had a decreased survival when also exposed to a parasite.	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. 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. Bees had a limited alternate food source since this was a closed feeding study.	

[1] Thiamethoxam concentration was converted to clothianidin equivalents (c.e.), if applicable, by multiplying thiamethoxam concentration by 0.856 and adding to the clothianidin concentration [thiamethoxam x 0.856 + clothianidin].

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 clothianidin have been presented previously in the publication Update on Canadian Bee Incident Reports 2012-2016.

Incident reports related to spray applications of clothianidin have been reported in Canada in 2013, 2015 and 2016; all three were associated with the application of Clutch 50 WDG Insecticide to strawberries. In all three cases the application of Clutch occurred when the strawberries were in bloom and the bees were actively foraging. Incident reports related to spray applications have been reported to the USEPA; however, the crop associated with the spray incidents in the United States was cotton, which is not grown in Canada. 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.

The majority of the incident reports available were associated with seed treatments that used clothianidin. Incidents with seed treatments have primarily been associated with dust generated during planting of treated corn and soybean seeds. From 2009 to 2011, a total of four honey bee incidents occurring in Quebec, were reported to Health Canada. Three of the incidents were reported to have occurred around the time of planting and the fourth incident occurred in the month of June. A high number of incident reports associated with corn and soybean planting have since been reported in Canada from 2012 to 2016, predominantly from the corn and soybean growing regions of Ontario. 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. With this mitigation in place for the 2014 planting season, the number of reported incidents during this and subsequent planting periods decreased.

2.5 Pollinator Risk Characterization

2.5.1 Pollinator Risk Assessment Framework

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

Tier I and Tier I refined assessment

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

The Tier I refined risk assessment considers the endpoints from the laboratory toxicity studies in addition to the residues from field studies (also referred to as Tier II residue studies). Therefore, the assessment is still based on individual bees, but is moving from conservative default exposure values to residues measured in the environment, in bee relevant matrices. The residue field studies are typically designed to establish the amount of 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 clothianidin and transformation products sampled from nectar and pollen in different matrices (i.e., hives, plants, bees) following applications with clothianidin were selected from available residue information to refine the Tier I screening level acute and chronic estimated environmental concentrations (EEC). To derive an **acute EEC value** for use in the refined acute oral risk assessment, the maximum residue values in pollen and nectar were selected from relevant residue trials. The maximum value was considered the most relevant for the acute risk assessment as there was considerable spatial and temporal variability in the available residue data. To derive a **chronic EEC value** for use in the refined chronic oral risk assessment, the highest daily mean residue values in pollen and nectar were selected from relevant residue trials. The highest daily mean was considered the most relevant for the chronic risk assessment as bees in the Tier I chronic studies are typically exposed to clothianidin 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 to tunnel studies, the Tier II assessment also considers the effect endpoints from Tier II feeding studies by comparing them to exposure estimates from measured pollen and nectar residues. Complimentary to the tunnel study in which the colony exposure period is limited to a short period, open field feeding studies allow testing of effects over a longer period of time so that potential chronic effects may be investigated.

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

Challenges in characterizing risk using colony feeding studies:

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

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

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

Tier III assessment

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

Overall risk characterization

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

2.5.2 Risk Characterization

The overall pollinator risk characterization for clothianidin 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 clothianidin.

2.5.2.1 Foliar applications

2.5.2.1.1 Tier I screening

The Tier I screening level risk assessment for honey bees (*Apis* bees) using highly conservative estimations of pollen and nectar exposure and conservative effect endpoints from laboratory studies, concludes that all foliar uses of clothianidin and spray drift from foliar uses pose a risk to adult bees and bee larvae from both acute and chronic exposures in bee attractive crops including potato, strawberry, cucurbit vegetables, grapes, orchard crops and certain turf sites. For turf sites containing grass species only (i.e., sod farms and golf courses) there is no exposure of bees to clothianidin due to routine maintenance (mowing, chemical control) to remove flowering weeds and therefore negligible risk to bees is expected.

2.5.2.1.2 Tier I refined

Where measured pollen and nectar residue data were available to refine the screening level exposure values, foliar applications to bee attractive crops that are applied pre-bloom (potato, strawberry, cucurbit vegetables, grapes, orchard crops, turf), during bloom and post-bloom (potato, grapes, orchard crops, turf), result in exposures that pose risks to adult bees and bee larvae. While a potential for risk is indicated for during bloom foliar applications, current label mitigation does not allow foliar applications during bloom or when flowering weeds are present.

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 clothianidin exposure as honey bees on an acute and chronic oral basis but may be less sensitive than honey bees on an acute contact basis. Therefore effect endpoints derived from the Tier I honey bee laboratory studies are considered suitable as a surrogate for non-*Apis* bees 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

The Tier II refined risk assessment considered a full range of effect endpoints from honey bee colony feeding studies compared to measured residues in pollen and/or nectar and estimated residues in bee bread. Results of the Tier II refined risk assessment indicate that foliar applications to bee attractive crops including potato, strawberry, cucurbit vegetables, grapes, orchard crops and certain turf sites pose a risk to bee colonies when clothianidin is applied both pre-bloom and post-bloom (based on residues in pollen and bee bread) and during bloom (based on residues in pollen, nectar and bee bread). As indicated in Tier I refined assessment, while a potential for risk is indicated for during bloom foliar applications, current label mitigation does not allow foliar applications during bloom or when flowering weeds are present. Considering all available residue information for rotational crops, minimal risk is expected to bees foraging on fields that were treated the previous year with a foliar application of clothianidin.

Non-*Apis*

Tier II effects information from colony feeding studies indicates potential effects to non-*Apis* bees from exposure to clothianidin in pollen and nectar at concentrations similar to endpoint concentrations selected from honey bee colony feeding studies. Therefore the results of the Tier II refined risk assessment based on honey bee effect endpoints outlined above for *Apis* bees are considered relevant to non-*Apis* bees.

2.5.2.1.5 Tier II tunnel studies

Apis

No tunnel studies with foliar applications of clothianidin were available for review for *Apis* bees.

Non-*Apis*

For non-*Apis* bees, colony level effects were observed in a Tier II tunnel study where bumble bees colonies were exposed to turf containing flowering white clover treated with a foliar application of clothianidin followed by light irrigation. Bumble bee colonies showed significantly reduced numbers of foragers, increased worker and brood mortality, fewer honey pots, slower growth and did not produce any new queens. In contrast, no adverse colony level effects were detected when colonies were placed on mowed turf that had been treated with a foliar application with clothianidin three weeks prior to mowing. In a separate residue study, mowing was shown to reduce clothianidin residues in nectar from clover blooms sampled at less than 2 weeks after mowing; however, clothianidin residues in the clover nectar were still at a level that would indicate a potential effect when compared to effect endpoints derived from colony feeding studies. Residue levels in pollen were not determined in the clover residue study. The results of these studies indicate a potential risk to non-*Apis* bees from foliar applications to turf when flowering plants are present.

2.5.2.1.6 Tier III field studies

Apis

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

Non-*Apis*

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

2.5.2.1.7 Summary of incident reports

Incident reports related to foliar spray applications of clothianidin in Canada were related to during bloom applications to strawberry when bees were actively foraging. Incident reports related to spray applications on cotton have also been reported to the USEPA. Foliar spray applications made while bees are foraging on crops or nearby plants may result in direct contact exposure and more likely cause bee mortalities.

2.5.2.2 Soil applications

2.5.2.2.1 Tier I screening

The Tier I screening level risk assessment for honey bees (*Apis* bees) using highly conservative estimations of pollen and nectar exposure and conservative effect endpoints from laboratory studies, concludes that all soil uses of clothianidin pose a risk to adult bees and bee larvae from both acute and chronic exposures in bee attractive crops including potato and sweet potato.

2.5.2.2.2 Tier I refined

Where measured pollen and nectar residue data were available to refine the screening level exposure values, soil applications that are applied pre-plant result in exposures that pose risks to adult bees and bee larvae in potato and sweet potato. As potato produces pollen only, no risk was indicated in nectar.

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 clothianidin exposure as honey bees on an acute and chronic oral basis but may be less sensitive than honey bees on an acute contact basis. Therefore effect endpoints derived from the Tier I honey bee laboratory studies are considered suitable as a surrogate for non-*Apis* bees 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

The Tier II risk assessment considered a full range of effect endpoints from honey bee colony feeding studies compared to measured residues in pollen and/or nectar and estimated residues in bee bread. Results of the Tier II refined risk assessment indicate that soil applications of clothianidin pose a risk to bee colonies when applied at-plant (based on residues in pollen and bee bread in potato and surrogate residues in pollen, nectar and bee bread for sweet potato). Considering all available residue information for rotational crops, minimal risk is expected to bees foraging on fields that were treated the previous year with a soil treatment application of clothianidin.

Non-*Apis*

Tier II effects information from colony feeding studies indicates potential effects to non-Apis bees from exposure to clothianidin in pollen and nectar at concentrations similar to endpoint concentrations selected from honey bee colony feeding studies. Therefore the results of the Tier II refined risk assessment based on honey bee effect endpoints outlined above for *Apis* bees are considered relevant to non-*Apis* bees.

2.5.2.2.5 Tier II tunnel studies

Apis

No tunnel studies with soil applications of clothianidin were available for review for *Apis* bees.

Non-*Apis*

No tunnel studies with soil applications of clothianidin were available for review for non-*Apis* bees.

2.5.2.2.6 Tier III field studies

Apis

No field studies with soil applications of clothianidin were available for review for *Apis* bees.

Non-*Apis*

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

2.5.2.2.7 Summary of incident reports

There are no incident reports associated with soil applications of clothianidin.

2.5.2.3 Seed treatment

2.5.2.3.1 Tier I screening

The Tier I screening level risk assessment for honey bees (*Apis* bees) using highly conservative estimations of pollen and nectar exposure and conservative effect endpoints from laboratory studies, concludes that all seed treatment applications of clothianidin pose a risk to adult bees and bee larvae from both acute and chronic exposures in bee attractive crops including certain crops from root and tuber vegetables, bulb vegetables, leafy vegetables, brassica leafy vegetables, fruiting vegetables, cucurbit vegetables, cereals and oilseed crops. In cases where crops are

harvested prior to bloom (including some root and tuber vegetables, bulb vegetables, leafy vegetables and brassica leafy vegetables), negligible risk to bees is expected.

2.5.2.3.2 Tier I refined

Where measured pollen and nectar residue data were available to refine the screening level exposure values, no potential for risk to adult bees or bee larvae was indicated from seed treatment applications at Canadian-relevant rates.

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 clothianidin exposure as honey bees on an acute and chronic oral basis but may be less sensitive than honey bees on an acute contact basis. Therefore effect endpoints derived from the Tier I honey bee laboratory studies are considered suitable as a surrogate for non-*Apis* bees 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

The Tier II risk assessment considered a full range of effect endpoints from honey bee colony feeding studies compared to measured residues in pollen and/or nectar and estimated residues in bee bread. Results of the Tier II refined risk assessment indicate that seed treatment applications of clothianidin in bee attractive crops result in minimal risk to bees at the colony level based on a consistent finding of low residue levels in pollen, nectar and bee bread in studies tested at Canadian relevant application rates. Measured residue information from clothianidin treated seeds at Canadian-relevant application rates and use patterns were below levels where colony-level effects are expected to occur. Considering all available residue information for rotational crops, minimal risk is expected to bees foraging on fields that were treated the previous year with a seed treatment application of clothianidin.

Non-*Apis*

Tier II effects information from colony feeding studies indicates potential effects to non-*Apis* bees from exposure to clothianidin in pollen and nectar at concentrations similar to endpoint concentrations selected from honey bee colony feeding studies. Therefore the results of the Tier II refined risk assessment based on honey bee effect endpoints outlined above for *Apis* bees are considered relevant to non-*Apis* bees.

2.5.2.3.5 Tier II tunnel studies

Apis

A total of seven tunnel studies were reviewed and considered in the risk assessment. All seven were conducted to examine potential effects that may result from seed treatments on honey bees. Five were conducted on summer rape plants and two on sunflower. The rates tested ranged from 0.05 – 0.29 mg a.i./seed over exposure periods that spanned from 3 – 22 days under the tunnels. None of these studies were conducted in North America. No significant effects were noted on foraging, unusual behaviour, colony weight or mortality. One study (PMRA 2355470) conducted in Germany on sunflowers grown from seed treated with 0.29 mg a.i./seed indicated that after a 13 day exposure to blooming flowers, transient effects were noted. These included a short-term increase in foraging behaviour of the treated bees and after only 3 days of exposure, mortality increased but then recovered to levels that were comparable with the control hives. Although clothianidin is not registered as a seed treatment on sunflowers in Canada, this application rate is within the Canadian seed treatment use pattern rate range (0.006 – 1.25 mg a.i./seed). All seed treatment studies were conducted with short exposure duration and a short observation period (up to 22 days). They are not expected to address potential long-term sub-lethal effects that may result from chronic exposure. It is also noted that most of these studies did not have treatment replicates and used small hives. However, each individual study is expected to contribute to a weight of evidence conclusion of the potential effect of clothianidin seed treatments. Overall, the Tier II tunnel studies conducted on honey bees suggest that short-term exposure to flowering seed treated crops has no significant effects on honey bee colonies.

Non-*Apis*

No tunnel studies with seed treatment applications of clothianidin were available for review for non-*Apis* bees.

2.5.2.3.6 Tier III field studies

Apis

A total of nineteen Tier III honey bee field and hive monitoring studies were reviewed and considered in the risk assessment. The studies examined colony level effects following exposure of honey bee colonies to bee attractive crops grown from clothianidin treated seed including canola, oilseed rape, corn/maize and phacelia. The available Tier III field studies indicated no or negligible effects to bee colonies for studies conducted at Canadian-relevant applications rates. These studies examined honey bee colony-level effects on hive weight, bee mortality, brood development, colony strength, foraging activity, bee behaviour or overwinter die-off. Conversely, a potential risk to bees from exposure to dust originating from treated seeds during planting is indicated, as exposure to dust from corn seed planting or simulated dust applications to an attractive flowering crop resulted in adverse effects on adult bee mortality, foraging and a decline in adult bee populations.

Non-*Apis*

A total of nine Tier III field and hive monitoring studies were reviewed and considered in the risk assessment. The studies examined individual and colony level effects following exposure of non-Apis bees to bee attractive crops grown from clothianidin treated seed including oilseed rape and corn. No or negligible short- or long-term colony level effects were observed for non-*Apis* bees in available Tier III field studies conducted at Canadian-relevant rates, which is similar to the findings for *Apis* bees. Significant effects were seen in one seed treatment field study conducted on spring oilseed rape (Rundlöf *et al*., 2015), including significantly lower weight gain, fewer queens, male bees (drones) and worker cocoons in bumble bee colonies and a complete halt to red mason bee nesting; however, in addition to other limitations, this study was conducted at a rate 2.5 times higher than the rate registered in Canada. Therefore, this study is not considered relevant to the Canadian use pattern for seed treatment uses. In another seed treatment field study conducted on corn (Cutler and Dupree, 2014), clothianidin seed treatment had no effect on any bumble bee hive endpoints measured, except the number of workers where significantly fewer workers were removed from hives placed next to conventional fields compared to organic fields. In terms of the most important parameter for bumble bees, queen production (both number and weight), was unaffected by clothianidin treated seed and was actually higher (by >25%) compared to organic. Therefore, it was concluded that exposure during pollen shed from corn grown with treated seed poses low risk to bumble bee colonies.

2.5.2.3.7 Summary of incident reports

The majority of the incident reports for clothianidin are associated with seed treatment applications, primarily 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. Since the introduction of a dust-reducing fluency agent for treated corn and soybean seeds in 2014, the number of incident reports associated with treated corn and soybean seeds in Canada has declined by 70-90%.

2.5.3 Water assessment

In addition to exposure through pollen and nectar, bees may be exposed to clothianidin and its transformation products through contaminated water sources such as surface water, puddles, dew droplet formation on leaves and guttation fluids following foliar, soil and seed treatment applications. The North American *Guidance for Assessing Pesticide Risks to Bees* does not include a method for assessing the potential risk to bees from exposure through water, as it is not 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 nonetheless explored.

A Tier I risk assessment approach similar to that described above for pollen and nectar was followed, using available monitoring data of surface water sources that may be used by bees, as well as residues measured in plant guttation fluid. Based on available relevant surface water monitoring data, the assessment indicated that no risks are expected to bees consuming surface

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

3.0 Value

3.1 Value of Clothianidin

Clothianidin will control a broad spectrum of insect pests on a diverse range of agricultural crops and turfgrass. 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.

Clothanidin 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.

Clothianidin 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 clothianidin and considering the pollinator exposure potential in each crop/crop group, the following risk characterizations are made for each registered use:

Foliar Applications:

(i) For the following crops, negligible risk to bees is expected as there are no flowering plants in turf grown for sod and golf courses:

- **Turf (sod farms and golf courses)**

(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 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 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 in these crop groups (CG):

- **CG1 – Root and Tuber vegetables (potato):** Label currently allows pre-bloom and post-bloom applications. A potential for risk from pre-bloom applications was identified based on full range of effects endpoints and residue levels in pollen from potato studies tested at Canadian-relevant rates, but low pollinator exposure is expected in this crop. There were no tunnel or field studies available for review. There is negligible risk from post-bloom applications as crop is seasonal.
- **CG13D – Small fruit vine climbing (grape):** Label currently allows pre-bloom and post-bloom applications. A potential for risk was identified based on full range of effects endpoints and residue levels in pollen following a single pre-bloom and post-bloom application at Canadian-relevant rate, but only minimal pollinator exposure is expected based on low crop attraction. There were no tunnel or field studies available for review.

(iv) 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:** Risk characterization was based on incident reports from applications during bloom when bees were present, in addition to full range of effects endpoints and residue levels in pollen and nectar from multiple studies in a variety of crops and potential for pollinator exposure in bee attractive crops. A potential for risk is indicated and current label mitigation does not allow applications during bloom in many crops, including bee attractive crops or when flowering weeds are present.
- **CG9 – Cucurbit vegetables:** Label currently allows pre-bloom applications of 2 x 105 g a.i./ha. Risk characterization was based on full range of effects endpoints and residue levels in pollen and nectar following multiple foliar applications in pumpkin at Canadian-relevant rates and the potential for high pollinator exposure. A potential for risk was indicated for multiple applications while no risk was indicated from single applications. No tunnel or field studies were available for review.
- **CG11 – Pome fruit:** Label currently allows post-bloom applications. Risk characterization was based on full range of effects endpoints and residue levels in pollen from orchard crop studies tested at Canadian-relevant rates and considering the potential for high pollinator exposure. No tunnel or field studies were available for review.
- **CG12 – Stone 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 from orchard crop studies tested at Canadian-relevant rates and considering the potential for high pollinator exposure. No tunnel or field studies were available for review.
- **CG13G – Low growing berry (strawberry):** Label currently allows pre-bloom applications. A potential for risk was identified based on full range of effects endpoints and residue levels in pollen and nectar from grape and cucumber studies at various rates and low-moderate pollinator exposure expected in this crop. Pollinator Exposure is low to moderate for strawberry. Most varieties do not require insect pollination, although some varieties do, and pollination services may be used to enhance crop production. Strawberries are a minor source of pollen and nectar for honey bees, bumble bees, solitary bees, and strawberries have low hectarage in Canada.

- Since some cultivars of strawberry are indeterminate bloomers, exposure may extend during the bloom season (although residues are expected to decline with time). No tunnel or field studies were available for review.
- **Turf – municipal, industrial and residential turf sites** where clover or other flowering plants that are attractive to bees are present: Label currently allows pre-bloom and post-bloom applications. Risk characterization was based on full range of effects endpoints and potential residue levels in pollen and nectar and considered higher tier effect studies (tunnel) and potential for high pollinator exposure.

Soil Applications:

(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 crops, 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 in these crops:

- **CG1 – Root and Tuber vegetables (potato and sweet potato):** Label currently allows application at planting. A potential for risk was identified based on full range of effects endpoints and residue levels in pollen from potato and corn studies and pollen and nectar from cucurbit studies tested at Canadian-relevant rates, but low pollinator exposure to these crops is expected. There were no tunnel or field studies available for review.

Seed Treatment Applications:

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

- **CG1 – Root and Tuber vegetables (carrot)**
- **CG3 – Bulb vegetables**
- **CG4 – Leafy vegetables**
- **CG5 – Brassica 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 and/or considering Tier II tunnel and/or Tier III data:

- **CG8 – Fruiting vegetables**: Risk characterization was based on full range of effects endpoints and residue levels in pollen and nectar from a 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 a 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 tested at Canadian-relevant rates and considering higher tier effect studies (tunnel, field) tested at Canadian-relevant rates indicating no or negligible short- or long-term colony effects. No pollinator exposure is expected in wheat because it is not attractive to pollinators.
- **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 tested 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 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 in these crops:

- **CG1 – Root and Tuber Vegetables (potato):** Risk characterization was based on highly conservative screening level risk assessment as no relevant residue information was available; however, 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 crops in Crop Group 15 (CG15). 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 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 clothianidin in various labelled crops

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

Proposed risk mitigation measures are provided where a low, moderate, or high risk potential was identified.

Application Method	**Negligible potential for risk** No use restrictions required; Label improvements*	**Potential for risk + Proposed mitigation**	
		Low-Moderate pollinator exposure	**High pollinator exposure**
Foliar	<u>No exposure:</u> -CG1: Root and Tuber vegetables (post-bloom) (potato only) -Turf: sod farms, golf courses <u>Based on risk assessment:</u> -Rotational crops	**Maintain use (pre-/post-bloom) considering lower pollinator exposure:** -CG1: Root and Tuber vegetables (potato only) -CG13D: Small fruit vine climbing (grape only) **Proposed removal of use:** -CG13G: Low growing berry (strawberry only)	**Proposed removal of use:** -CG11: Pome fruit -CG12: Stone fruit -Turf: municipal, industrial and residential turfgrass sites (as clover or other flowering plants attractive to bees may be present) **Proposed reduction in number of pre-bloom applications from 2 to 1:** -CG9: Cucurbit vegetables
Soil	<u>Based on risk assessment:</u> -Rotational crops	**Maintain use considering lower pollinator exposure:** -CG1: Root and Tuber vegetables (potato and sweet potato only)	No uses with high pollinator exposure potential

Application Method	Negligible potential for risk No use restrictions required; Label improvements*	Potential for risk + Proposed mitigation	
		Low-Moderate pollinator exposure	**High pollinator exposure**
Seed treatment	<u>No exposure (harvested before bloom):</u> -CG1: Root and Tuber vegetables (carrot only) -CG3: Bulb vegetables -CG4: Leafy vegetables -CG5: Brassica leafy vegetables <u>Based on risk assessment:</u> -CG8: Fruiting vegetables -CG9: Cucurbit vegetables -CG15: Cereals -CG 20: Oilseeds -Rotational crops	**Maintain use considering lower pollinator exposure:** -CG1: Root and Tuber vegetables (potato only)	No uses with high pollinator exposure potential with potential for risk

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

4.3 Value Considerations

Clothianidin will control a broad spectrum of insect pests on a diverse range of agricultural crops and turfgrass. 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. Clothianidin can be applied as a seed treatment, soil drench or foliar application which gives growers 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 clothianidin 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 Produwct 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 Clothianidin 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
27445	Technical Grade Active Ingredient	Sumitomo Chemical Company Inc.	Clothianidin Technical Insecticide	Solid	Clothianidin 97.5%
27449	Commercial	Bayer CropScience Inc.	Titan Insecticide	Suspension	Clothianidin 600 g/L
27453		Bayer CropScience Inc.	Poncho 600 FS Seed Treatment Insecticide	Suspension	Clothianidin 600 g/L
27564		Bayer CropScience Inc.	Prosper FL Flowable Insecticide And Fungicide Seed Treatment	Suspension	Clothianidin 120 g/L; carbathiin 56 g/L; thiram 120 g/L; metalaxyl 4g/L
28975		Valent Canada Inc.	Nipsit Inside 600 Insecticide	Suspension	Clothianidin 600g/L
29158		Bayer CropScience Inc.	Prosper T 200 Flowable Insecticide And Fungicide Seed Treatment	Suspension	Clothianidin 142.8g/L; carbathiin 50g/L; trifloxystrobin 7.14g/L; metalaxyl 5.36g/L
29159		Bayer CropScience Inc.	Prosper FX Flowable Insecticide And Fungicide Seed Treatment	Suspension	Clothinidin 285.7 g/L; carbathiin 50 g/L; trifloxystrobin 7.14g/L; metalaxyl 5.36 g/L
29382		Valent Canada Inc.	Clutch 50 WDG Insecticide	Water dispersible granules	Clothianidin 50%
29383		Valent Canada Inc.	Arena 50 WDG Insecticide	Water dispersible granules	Clothianidin 50%
29384		Valent Canada Inc.	Clothianidin Insecticide	Water dispersible granules	Clothianidin 50%
30362		Bayer CropScience Inc.	Emesto Quantum	Suspension	Clothianidin 207g/L; penflufen 66.5 g/L
30363		Bayer CropScience Inc.	Prosper Evergol	Suspension	Clothianidin 290 g/L; trifloxystrobin 7.15g/L; penflufen 10.7g/L; metalaxyl 7.15g/L

Registration number	Marketing Class	Registrant	Product name	Formulation type	Guarantee
30972		Bayer CropScience Inc.	Sepresto 75 WS	Wettable powder	Clothianidin 56.25%; imidacloprid 18.75%
31355		Valent Canada Inc.	Nipsit Suite Canola Seed Protectant	Suspension	Clothianidin 279 g/L; metalaxyl 5.23 g/L; metconazole 1.04 g/L
31357		Valent Canada Inc.	Nipsit Suite Cereals Of Seed Protectant	Suspension	Clothianidin 30.7 g/L; metalaxyl 9.24 g/L; metconazole 4.62 g/L

Appendix II Registered Commercial Class Uses of Clothianidin in Canada as of October 2017 that are subject to this re-evaluation

Use Site Category[1]	Site(s)[2,3]	Pest(s)[3]	Formulation Type	Application Methods and Equipment	Single Application Rate or Rate Range[3]	Maximum Number applications year[3]	Minimum Application Interval (Days)[3]
10	Canola, rapeseed, Carinata, mustard	Flea beetle	Suspension	Commercial seed treatment facility: seed treatment equipment	150 - 406 g a.i./100 kg seed	1	Not applicable
10	Carrot	Carrot rust fly	Wettable powder	Seed not treated in Canada	0.035 - 0.068 g a.i. /1000 seed	1	Not applicable
	Leek, Onion (bulb)	Onion maggot, seedcorn maggot, thrips			0.12 g a.i./1000 seed		
	Onion (bunching)				0.09 g a.i./1000 seed		
	Lettuce	Aphids, leafminer			0.6 g a.i./1000 seed		
	Broccoli, cabbage	Aphids, flea beetle			0.9 g a.i./1000 seed		
	Pepper	Aphids, leafminer, thrips			0.25 g a.i./1000 seed		
	Tomato	Aphids, leafminer, thrips			0.038 g a.i./1000 seed		
	Cucumber, melon, squash	Aphids, thrips			0.75 g a.i./1000 seed		
10	Corn (field, sweet, pop)	Corn rootworm	Suspension	Commercial seed treatment facility: seed treatment equipment	1.25 mg a.i./kernel	1	Not applicable

Use Site Category[1]	Site(s)[2,3]	Pest(s)[3]	Formulation Type	Application Methods and Equipment	Single Application Rate or Rate Range[3]	Maximum Number applications year[3]	Minimum Application Interval (Days)[3]
10	Corn (field, sweet, pop)	Corn flea beetle, black cutworm, seedcorn maggot, wireworm		Commercial seed treatment facility: seed treatment equipment	0.25 - 0.5 mg a.i./kernel		
		White grub (larvae of European chafer, May/ June beetle, Japanese beetle)			0.25 mg a.i./kernel		
10	Wheat	Wireworm	Suspension	On farm and /or commercial seed treatment facility: seed treatment equipment	10 g a.i./100 kg seed	1	Not applicable
10	Potato	Aphids, Colorado potato beetle, leafhoppers, potato flea beetle	Suspension	Ground application: Seed piece treatment equipment	6.2 - 12.48 g a.i./100 kg seed	1	Not applicable
		Wireworm		Ground application: Seed piece treatment – shielded spray system	12.48 g a.i./ 100 kg seed		
13, 14	Potato	Colorado potato beetle, leafhoppers	Suspension	Ground application: In furrow –boom sprayer	1.2 - 2 g a.i./100m of row 132.6 - 223.8 g a.i./ha based upon 90cm row spacing		
		Colorado potato beetle	Water dispersible granule				
		Aphids, Colorado potato beetle, leafhoppers		Ground application: Foliar spray – boom sprayer Aerial application: Rotary or fixed wing	35 - 52.5 g a.i./ha	3	10

Use Site Category[1]	Site(s)[2,3]	Pest(s)[3]	Formulation Type	Application Methods and Equipment	Single Application Rate or Rate Range[3]	Maximum Number applications year[3]	Minimum Application Interval (Days)[3]
14	Crop Group 11: Pome fruit	Oriental fruit moth, codling moth, Brown marmorated stink bug		Ground application: Foliar spray – airblast sprayer	105 - 210 g a.i./ha	2	14
							10
		Aphids, leafhoppers, leafminer			70 - 105 g a.i./ha		
		Pear psylla			140 - 210 g a.i./ha		
		Plum curculio			105 g a.i./ha		
14	Grape	Leafhoppers		Ground application: Foliar spray – over the row sprayer (boom), airblast sprayer	50 - 70 g a.i./ha	1	14
		Grape phyloxera, meallybug			70 - 105 g a.i./ha		
		Thrips			70 g a.i./ha		
		Brown marmorated stink bug			105 g a.i./ha		
14	Strawberry	Lygus bug	Water dispersible granule	Ground application: foliar spray	224 g a.i./ha	1	Not applicable
14	Crop Group 1209: Stone Fruit	Oriental fruit moth	Water dispersible granule	Ground application: Foliar spray – airblast sprayer	105 - 210 g a.i./ha	2	14
							10
		Plum curculio			105 g a.i./ha		
		Aphids, leafhoppers			70 - 105 g a.i./ha		
14	Sweet potato	Larvae of: European Chafer, Japanese Beetle, Masked Chafers, Asiatic Garden Beetle, Oriental Beetle	Water dispersible granule	Ground application: soil spray/drench – incorporated	224 g a.i./ha	1	Not applicable

Use Site Category[1]	Site(s)[2,3]	Pest(s)[3]	Formulation Type	Application Methods and Equipment	Single Application Rate or Rate Range[3]	Maximum Number applications year[3]	Minimum Application Interval (Days)[3]
14	Crop Group 9: Cucurbit vegetables	Cucumber beetle, Squash bug, Tarnished plant bug	Water dispersible granule	Ground application: Foliar spray – boom sprayer	70 g a.i./ha	2	7
		Brown marmorated stink bug			105 g a.i./ha		
30	Turf	European Chafer, Japanese Beetle, Masked Chafers, Asiatic Garden Beetle, Oriental Beetle	Water dispersible granule	Ground application: Foliar spray – boom sprayer	1.25 - 2.5 g a.i./100m^2 125 - 250 g a.i./ha	1	Not applicable
		Hairy chinch bug			1.75 - 2.5 g a.i./100m^2 175 - 250 g a.i./ha		
		Annual bluegrass weevil			2.75 - 3.5 g a.i./100m^2 275 - 350 g a.i./ha		
		Bluegrass billbug			2.25 g a.i./100m^2 225 g a.i./ha		
		European crane fly			2.75 g a.i./100m^2 275 g a.i./ha		

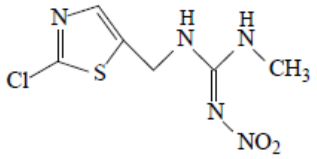
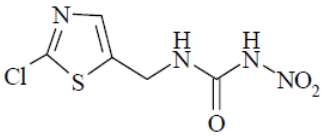
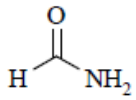
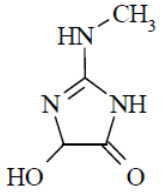
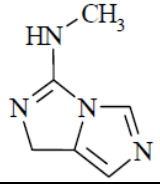
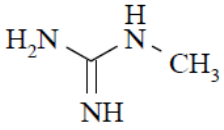
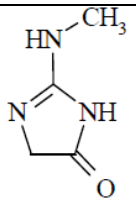
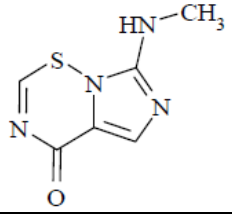
[1] Use Site Category (USC): 5 - Greenhouse Food crops, 6 - Greenhouse Non-food crops, 13 - Terrestrial Feed Crops, 14 - Terrestrial Food Crops, 27 - Ornamentals Outdoors

[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

[3] All information is from the registered labels.

Appendix III Summary of Fate in the Environment

Table 1 Clothianidin and its transformation products formed in the environment

Name	Structure	Matrix: Process (details)
Parent molecule		
Clothianidin		N/A
Transformation products (in alphabetical order)		
CTNU (*N*-(2- Chlorothiazol-5-ylmethyl)-*N'*-nitrourea)		Soil/Water: Hydrolysis (minor at pH 9) Plant: N/A
FA (Formamide)		Soil: N/A Water: Phototransformation in buffer (major, thiazolyl label) Plant: N/A
HMIO (4-Hydroxy-2-methylamino-2-imidazolin-5-one)		Soil: N/A Water: Phototransformation (major, nitroimino radiolabel) Plant: N/A
MAI (3-Methylamino-1*H*imidazo[1,5-*c*]imidazole)		Soil: N/A Water: Phototransformation (minor, nitroimino and thiazolyl radiolabels) Plant: N/A
MG (Methylguanidin)		Soil: N/A Water: Phototransformation (major, nitroimino radiolabel) Plant: Metabolism (major)
MIO (2-Methylamino-2-imidazolin-5-one)		Soil: N/A Water: Phototransformation (minor, nitroimino label) Plant: N/A
MIT (7-Methylamino-4*H*-imidazo[5,1-*b*] [1,2,5]thiadiazin-4-one)		Soil: N/A Water: Phototransformation (major, thiazolyl radiolabel; minor, nitroimino radiolabel) Plant: N/A

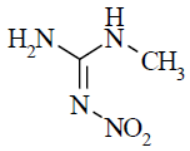
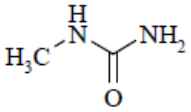
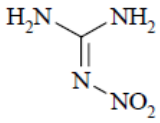
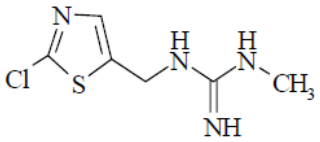
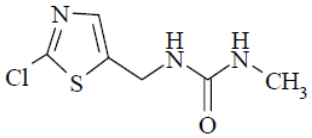
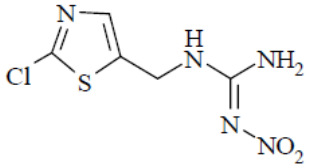
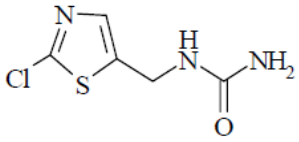
Name	Structure	Matrix: Process (details)
MNG (*N*-Methyl-*N'*-nitroguanidine)		Soil: Phototransformation (minor) Aerobic (minor, probable major) Field (minor) Water: N/A Plant: Metabolism (major)
MU (Methylurea)		Soil: N/A Water: Phototransformation (major, nitroimino radiolabel) Plant: N/A
NTG (Nitroguanidine)		Soil: Aerobic (minor) Water: N/A Plant: Metabolism (minor)
TMG (*N*-(2-chlorothiazol-5-ylmethyl)-*N'*-methylguanidine)		Soil: Field (minor) Water: Phototransformation (minor, nitroimino and thiazolyl radiolabels) Aerobic water/sediment (major, in sediment) Plant: Metabolism (major)
TZMU (*N*-(2-Chlorothiazol-5-ylmethyl)-*N'*-methylurea)		Soil/Water: Hydrolysis (minor at pH 9) Soil: Phototransformation (minor) Aerobic (minor) Field (minor) Water: Phototransformation (major, nitroimino and thiazolyl radiolabels) Aerobic water/sediment (minor) Plant: Metabolism (major)
TZNG (*N*-(2-Chlorothiazol-5-ylmethyl)-*N'*-nitroguanidine)		Soil: Phototransformation (minor) Aerobic (minor, probable major) Field (minor) Water: N/A Plant: Metabolism (minor)
TZU (2-Chlorothiazol-5-ylmethylurea)		Soil: Phototransformation (minor) Water: N/A Plant: Metabolism (minor)

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

Type of study	Test substance	Value	Comments	Reference (PMRA#)[1]
Abiotic transformation				
Hydrolysis	Clothianidin	At 25°C: Stable at pH 5 and pH 7. Minimal hydrolysis at pH 9.	No major or minor transformation products identified at pH 5 and pH 7. Minor transformation products identified at pH 9 were CTNU and TZMU.	1194690
Long term hydrolysis	Clothianidin	At 25°C: Negligible hydrolysis at pH 7 up to 180 days.	No major transformation products were formed. Two unidentified minor transformation products were observed.	1464605, 1636689

Type of study	Test substance	Value	Comments	Reference (PMRA#)[1]
Phototransformation on soil	Clothianidin	$t_{½}$ = 8.2 days (continuous irradiation)	No major transformation products were identified. Minor transformation products were MNG, TZNG, TZMU and TZU.	1194678
Phototransformation in air	Clothianidin	Not required – clothianidin is not volatile		
Biotransformation[1]				
Biotransformation in aerobic soil	Clothianidin	DT_{50}: 144 - 1646 days Representative half-life: 144 - 16100 days	Moderately persistent to persistent. All values were extrapolated beyond the test duration. Four soils were tested (silt loam, silt, loamy sand and sandy loam). - Silt loam: MNG was a major transformation product. Minor transformation products were NTG, TZNG and TZMU. - Silt: MNG and TZNG were considered as probable major transformation products (close to 10% of the applied amount and still increasing). Probable minor transformation products were NTG and TZMU. - Sandy loam and loamy sand: No major transformation products were formed other than CO_2 due to slower degradation. Minor transformation products were MNG, NTG, TZNG and TZMU.	1194671
	Clothianidin	DT_{50}: 542 - 5357 days. Representative half-life: 542 - 5357 days	Persistent. All values were extrapolated beyond the test duration. Six soils were tested (loam, sand, 2 silt loam soils and 2 loamy sand soils). - No major transformation products were formed in any of the test soils. Minor transformation products were TZNG and TZMU.	1194675
	Clothianidin	DT_{50}: 235 days. Representative half-life: 1490 days	Persistent. All values were extrapolated beyond the test duration. Sandy loam soil. - No major transformation products except CO_2 were formed. The only minor transformation product identified was TZNG.	2741626
	Clothianidin	DT_{50}: 258 days. Representative half-life: 317 days	Persistent. All values were extrapolated beyond the test duration. Loamy sand soil. - No major transformation products except CO_2 were formed. No minor transformation products were identified.	2741629

Type of study	Test substance	Value	Comments	Reference (PMRA#)[1]
	Clothianidin	DT_{50}: 1910 days. Representative half-life: $2.2x10^7$ days	Persistent. All values were extrapolated beyond the test duration. Loamy sand soil. - No major transformation products were formed. Minor transformation products included CO_2 and TZNG.	2741625
	Clothianidin	DT_{50}: 11 - 204 days Representative half-life: 139 - 263 days	Non-persistent to persistent. Study was a combined time-dependent soil adsorption, aerobic soil degradation study conducted for 120 days. Four soils were tested (silt loam, 2x sandy loam, clay loam). - Silt loam: TZMU was a major transformation product, plus CO_2. Minor transformation products were TZNG, MNG, TMG, NTG, and TZFA. - Sandy loam #1&2 and clay loam: No major transformation products except CO_2 were formed. Minor transformation products were TZNG, MNG, TZMU, TMG, NTG, and TZFA.	2739670
	MNG	DT_{50}: 71 - 113 days Representative half-life: 82 - 220 days	Moderately persistent. Three soils (sandy loam, silt loam, loam).	1194679
	TZNG	DT_{50}: 53 - 133 days Representative half-life: 91 - 355 days	Moderately persistent. Three soils (sandy loam, silt loam, loam).	1194681
Biotransformation in anaerobic soil	Clothianidin	See biotransformation in anaerobic water/sediment system.		
Mobility[2]				
Adsorption / desorption in soil	Clothianidin	Adsorption K_d = 0.52 - 4.14 Adsorption K_{oc} = 84 - 345	Moderate to high mobility. Five soils. A leaching assessment was previously carried out for clothianidin (ERC2001-01) and included the following information: - GUS[3] of 3.75 - 6.52 (probable leacher) - Most of the Cohen criteria[4] are met	1194682
	Clothianidin	Adsorption K_d = 1.51 – 15.8 Adsorption K_{oc} = 68 - 80	High mobility. Three soils, with two replicates each (loam, silt loam and humic soil).	2741630
	Clothianidin	Adsorption K_d = 0.87 – 7.43 Adsorption K_{oc} = 60 - 293	Moderate to high mobility. Six soils (sandy loam, clay, sand, sandy loam, loam and silt loam).	2741627
	Clothianidin	Adsorption K_d = 0.57 Adsorption K_{oc} = 63.5	Highly mobile. One loamy sand soil	2757917

Type of study	Test substance	Value	Comments	Reference (PMRA#)[1]
	Clothianidin	Time dependant sorption (incubation time up to 99 days): Over the course of the study, the K_{oc} increased by a factor of 2.1 – 3.5.	Sorption of clothianidin increases with residence time in soil.	1194683
		Time dependant sorption (incubation time up to 120 days): Over the course of the study, the K_{oc} increased by a factor of 2.6 – 3.7.	Sorption of clothianidin increases with residence time in soil. Four soils were tested (silt loam, 2x sandy loam, clay loam).	2739670
	MNG	Adsorption K_d = 0.02 - 0.31 Adsorption K_{oc} = 5.2 - 28	Very high mobility. Five soils.	1194684
	TZNG	Adsorption K_d = 0.5 - 4.7 Adsorption K_{oc} = 205 - 432	Moderate mobility. Five soils.	1194685
	TZMU	Adsorption K_d = 0.12 - 1.0 Adsorption K_{oc} = 46 - 96	High to very high mobility. Five soils.	1194686
	TMG	Adsorption K_d = 2.4 - 39 Adsorption K_{oc} = 525 - 6159	Low mobility to immobile. Five soils.	1194687
Column leaching with treated seed	Clothianidin	Treated corn seed planted in soil column: As radioactivity decreased in the treated seed over the course of the 16-week study period, radioactivity increased in the soil (maximum in soil: 76.2% of the applied after 8 weeks) and in plant material (maximum in roots + plant: 6.58% of the applied after 16 weeks and still increasing). Soil DT_{50} was estimated at 165 days. The highest amount of applied radioactivity observed in the leachate was 0.05%. A cumulative 0.17% of the applied radioactivity was leached. Clothianidin was the primary residue in the leachate, accounting for a maximum of 0.055% of the applied radioactivity. TZMU and an unidentified polar product accounted for 0.014% and 0.016% of the applied radioactivity, respectively.		1464604, 1636690
Movement from treated seed	Clothianidin	This study was originally intended to refine the bird and mammal risk assessment, but was thought to provide some information on the fate of clothianidin on treated seeds. Corn seeds were treated at 2.0 mg a.i./seed and were sown according to normal agricultural practices: At the 2-3 leaf stage, 3-45 ppm had moved from the seed to the foliage and 106-630 ppm remained in the seed. In another experiment, it was determined that 5471-6640 ppm of clothianidin is on seeds immediately after treatment when these are treated at 2.0 mg a.i./seed. Considering the difference		1194863

Type of study	Test substance	Value	Comments	Reference (PMRA#)[1]
		between the latter concentration and that recovered in seedlings, it can be assumed that a large proportion of the clothianidin moved from the seed to the soil in the first experiment (interpretation is proposed by the reviewer; not verified in study).		
Field studies				
Field dissipation in site relevant to Canadian conditions: Ontario	TI-435 FS 600 (595 g a.i./L)	One spray application at 600 g a.i./ha on bare ground, incorporated. Based on residues in the total soil profile: DT_{50} = 351 days DT_{90} = 1166 days Representative half-life: 351 days	Persistent. No major transformation products were observed. Minor transformation products were MNG, TZNG, TZMU and TMG (noted that the latter transformation product was not observed in laboratory studies; this is not discussed in the study report or in the original review). Residues of clothianidin are expected to carry-over to the next growing season, as approximately 80% and 31% of residues remained in the soil after 9 months (no measurements at 4 months, which would be the end of one growing season for crops such as canola and corn) and two years, respectively. Residues of clothianidin were not detected below a depth of 30 cm. Transformation products were not detected below 15 cm.	1194854
Field dissipation in site relevant to Canadian conditions: Saskatchewan	TI-435 FS 600 (595 g a.i./L)	One spray application at 243 g a.i./ha on bare ground, incorporated. The DT_{50} and DT_{90} could not be calculated due to limited dissipation.	Persistent. No major transformation products were observed. Minor transformation products were MNG, TZNG and TMG (noted that the latter transformation product was not observed in laboratory studies; this is not discussed in the study report or in the original review). Residues of clothianidin are expected to carry-over to the next growing season, as 91% and 80% of clothianidin residues remained in soil after four months and two years, respectively. Residues of clothianidin were not detected below a depth of 45 cm*. Transformation products were not detected below 15 cm. *While info in REG2004-06 states that clothianidin did not leach below 30 cm, study results indicate that clothianidin was found in the 30-45 cm layer at one sampling event, albeit at low concentrations.	1194855
Field dissipation in site relevant to Canadian	TI-435 FS 600 (595 g a.i./L)	One spray application at 243 g a.i./ha on bare ground, not	Persistent. No major transformation products were observed. Minor transformation	1194853

Type of study	Test substance	Value	Comments	Reference (PMRA#)[1]
conditions: North Dakota		incorporated[5]. Based on residues in the total soil profile: DT_{50} = 2033 days DT_{90} = 6754 days Representative half-life: 2033 days	products were MNG, TZNG and TZMU. Residues of clothianidin are expected to carry-over to the next growing season, as >100% and 47% of clothianidin residues remained in soil after our months and two years, respectively. Residues of clothianidin were not detected below a depth of 45 cm. Transformation products were not detected below 15 cm.	
Field dissipation in site relevant to Canadian conditions: Washington	TI-435 50 WDG (50% a.i.)	One spray application at 225 g a.i./ha on bare ground, not incorporated: DT_{50} = 379 days (slow half-life from a bisphasic dissipation curve; the first-phase half-life was less than a day) DT_{90} = 824 days Representative half-life: 379 days	Persistent. No major transformation products were observed. TZMU was the only minor transformation product. Residues of clothianidin are expected to carry-over to the next growing season, as approximately 39%* and 10% of clothianidin residues remained in soil at the end of the growing season after four months and two years, respectively. No residues of clothianidin were detected below a depth of 45 cm. TZMU was not detected below 15 cm.	1544535
Field dissipation in other sites: Wisconsin	TI-435 FS 600 (595 g a.i./L)	One spray application at 600 g a.i./ha on bare ground, incorporated. Based on residues in the total soil profile: DT_{50} = 408 days DT_{90} = 1355 days Representative half-life: 408 days	Persistent. No major transformation products were observed. Minor transformation products were MNG, TZNG and TZMU. Residues of clothianidin are expected to carry-over to the next growing season, as 89% and 13% of clothianidin residues remained in soil at the end of the growing season (four months) and after two years, respectively. Residues of clothianidin were not detected below a depth of 60 cm. Transformation products were not detected below 45 cm (for TZNG) and 15 cm (for MNG and TZMU).	1194898
Field dissipation in other sites: Ohio	TI-435 FS 600 (595 g a.i./L)	One spray application at 600 g a.i./ha on bare ground, not incorporated[6]. Based on residues in the total soil profile: DT_{50} = 447 days (slow half-life from a bisphasic dissipation curve; the first phase half-life was approximately 13 days)	Persistent. No major transformation products were observed. Minor transformation products were MNG, TZNG and TZMU. Residues of clothianidin are expected to carry-over to the next growing season, as 52% and 14% of clothianidin residues remained in soil after four months and two years, respectively. Residues of clothianidin were not detected below a depth of 30 cm. Transformation products were not	1194899

Type of study	Test substance	Value	Comments	Reference (PMRA#)[1]
		DT_{90} = 1209 days Representative half-life: 447 days	detected below 15 cm.	
Multi-year accumulation study: North America	Not applicable (monitoring study)	50 corn fields in the mid-western United States and 27 canola fields in western Canada were sampled (for soil, pollen and nectar); fields had various years of clothianidin use: Maximum clothianidin residues measured in soil replicates from corn and canola fields were 25.5 and 24.1 ng/g (ppb, dry weight), respectively. Maximum clothianidin residues measured in corn and canola pollen replicates were 11.4 and 17.3 ng/g (ppb, wet weight), respectively; canola pollen samples were however deemed of low quality as they contained fragments of flowers. Clothianidin residues measured in canola nectar replicates reached 2.8 ng/g. The TZNG and TZMU transformation products were detected in corn pollen replicates up to concentrations of 1.0 and 1.3 ng/g, respectively. These transformation products were not detected in canola pollen or nectar. In corn, clothianidin initially built up in soil and did not seem to further accumulate after approximately 4-5 years of previous use. Residues were correlated with the number of years of use; this parameter explained up to 25% of the variability of clothianidin residues in soil when all sites were considered in the analysis and up to 40% when only sites with 5 years of use or less were considered. There was a weak but statistically significant correlation of soil residues with the soil organic matter content; this parameter explained about 16% of the variability. There was no correlation with other soil properties. Clothianidin residues in corn pollen did not appear to be related to the number of years of treatment or to soil concentrations. In canola, residues of clothianidin in soil appeared to increase with more years of treatment, although the relationship was not statistically significant. The canola dataset had a limited range of years of clothianidin use, and interpretation was complicated by the various rotations of clothianidin and thiamethoxam treated seeds. There was no correlation with soil properties or other site specific conditions. Also, clothianidin residues in canola nectar showed no correlation with the number of years of treatment or to soil concentrations.		2465502 and 2555839
Multi-year accumulation study: Europe	TI-435 600 FS (600 g a.i./L)	Field trials were conducted in Germany, in France and in Great Britain (sites relevant to Canadian conditions). Wheat seeds coated with clothianidin were sown in the fall of each year for 7 consecutive years and soil residues were measured: Clothianidin residues in the 0-30 cm soil layer initially increased to then appear to reach a plateau concentration after about 4-5 years. Maximum clothianidin residues measured in the spring during the crop's vegetative stage were 30.2 µg/kg (ppb, dry weight; Germany, crop cycle 4), 40.0 µg/kg (France, crop cycle 5) and 35.1 µg/kg (Great Britain, crop cycle 6). While clothianidin dissipated each year, residues were still remaining in the in the 0-30 cm soil layer at the end of each crop cycle and accumulated over time. Maximum residues measured immediately sowing in the fall were 13.0 µg/kg (Germany,		2465501

Type of study	Test substance	Value	Comments	Reference (PMRA#)[1]
		before sowing for crop cycle 7), 20.7 µg/kg (France, before sowing for crop cycle 6), 20.0 µg/kg (Great Britain, before sowing for crop cycle 6). Clothianidin leached to deeper soil layers at some sites. The maximum clothianidin concentration measured in the 30-40 cm soil layer was 17.5 µg/kg. While clothianidin was detected at some sites in the 40-50 cm soil layers, levels were not quantifiable (between 2 and 5 µg/kg). Residues of TZNG were generally not detected in the 0-30 cm soil layer and were below the level of detection in all samples taken from deeper soil layers. MNG was below the level of detection in all soil samples.	
Field lysimeter	TI-435 200 SC (20% a.i.)	Sprayed on grass from a pome fruit orchard once a year for two years at approx. 160 g a.i./ha; lysimeter placed at depth of 1.3 metres: In the third year of the study, the amount of total radioactive residues in soil and in leachate represented 43-46% and 1.1-1.3% of the applied radioactivity, respectively. Plants were not analyzed. Approximately 55% of the applied radioactivity was attributed to losses due to mineralization. The majority of the total radioactive residues in soil was in the top layers (mainly the 0-10 cm layer); approximately 2% of the applied was found below 30 cm. Residues attributed to clothianidin in the 0-10 cm layer represented 30% of the applied radioactivity and 70% of the radioactivity in soil. MNG and TZNG were the main transformation products found in soil and these were mostly found in the 0-10 cm layer. Clothianidin was not detected in leachate at any of the sampling times. MNG and NTG were detected in the leachate.	1194689
	TI-435 70 WS (70% a.i.)	Applied as a seed treatment at a rate of 100 g a.i./ha the first year (winter barley) and 137.5 g a.i./ha the second year (wheat), lysimeter placed at depth of 1.3 metres: In the third year of the study, the amount of total radioactive residues in soil, leachate and crop represented 59.3%, less than 0.3% and 3.2% of the applied radioactivity, respectively. Approximately 37% of the applied radioactivity was attributed to losses due to mineralization. The majority of the total radioactive residues in soil was in the top layers (mainly in the 0-20 cm layer); less than 2% of the applied was found below 30 cm. Residues attributed to clothianidin in the 0-20 cm layers represented 52% of the applied radioactivity and 87% of the radioactivity in soil. TZNG was the main transformation product found in soil. Clothianidin or TZNG were not detected in leachate over the course of the study.	1194688
Small scale prospective groundwater study (preliminary results)	Arena 50 WDG (50% a.i.)	One broadcast spray application on turf at 450 g a.i./ha (potassium bromide tracer applied at 100 kg/ha), sampled monthly in lysimeters placed at 3, 6, 9 and 12 feet below ground surface and in monitoring wells; to date, sampling was performed up to 15 MMA (months after application): Clothianidin residues in soil-pore water were first observed at 1 MMA (3.21 ppb in a 3-foot lysimeter). Over the course of the 15-month sampling period, clothianidin has been observed sporadically in the 3-, 6-, and 9-foot lysimeters (maximum	2617175

Type of study	Test substance	Value	Comments	Reference (PMRA#)[1]
		residue of 7.51 ppb in a 3-foot lysimeter). To date, no quantifiable residues of clothianidin (LOQ of 1.0 ppb) have been observed in the 12-foot lysimeters and no detectable residues have been determined in groundwater. The first widespread appearance (breakthrough) of the bromide ion tracer in the 3-, 6-, 9-, and 12-foot lysimeters was observed at 3 MAA.		

[1] Classification of the relative persistence of pesticide in soils is based on Goring et al. (1975). The DT_{50} is from the curve that better fits the data; can be from a single first-order exponential function (SFO), double first-order in parallel (DFOP) or indeterminate order rate equation (IORE). The representative half-life is used for modelling and is different from the DT_{50} when the decline is not exponential (i.e. when the decline follows DFOP or IORE), in which case it is a conservative approximation of the first order decline.

[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] Tier II summaries for clothianidin prepared by the registrant state that, at all sites, "the test substance was incorporated to a depth of 5-10 cm to minimize exposure to light, as would be typical for the seed treatment uses" (PMRA#1039671, p. 373). There is however no evidence of incorporation in the study report for the North Dakota and Ohio sites.

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

Type of study	Test substance	Value	Comments	Reference (PMRA#)[1]
Abiotic transformation				
Hydrolysis	Clothianidin	Stable at pH 5 and pH 7. Minimal hydrolysis at pH 9.	No major or minor transformation products identified at pH 5 and pH 7. Minor transformation products identified at pH 9 were CTNU and TZMU.	1194690
Phototransformation in water (sterile buffer)	Clothianidin	$t_{½}$ = 3.1 - 3.4 hours (sterile buffer, continuous irradiation)	Nitroimino radiolabel: Major transformation products were HMIO, MG, MU and TZMU. Minor transformation products were MAI, MIO, MIT, TMG and other unidentified minor products. Thiazolyl radiolabel: Major transformation products were FA, MIT, TZMU and CO_2. Minor transformation products were MAI, TMG and other unidentified minor products.	1194126, 1194152 and 1194206
	TZMU	$t_{½}$ = 24-27 days (continuous irradiation)	Calculated based on results from definitive study with clothianidin. No half-life calculations were carried out for MG and MU, as these are expected to be photostable based on the UV absorption spectra and also because that no decline of these compounds was observed in irradiated samples.	1194126 and 1194152
	HMIO	$t_{½}$ = 9.5 days (continuous irradiation)		
	MIT	$t_{½}$ = 6 days (continuous irradiation)		

Type of study	Test substance	Value	Comments	Reference (PMRA#)[1]
	FA	$t_{½}$ = 10 days (continuous irradiation)		
Phototransformation in water (natural water)	Clothianidin	$t_{½}$ = 25-28 hours (natural sunlight cycle of 9h light:15h dark)	Was considered to provide supplemental information (not a typical data requirement). Minimal transformation in the dark controls suggests that phototransformation is the predominant route of transformation in non-sterile water. Nitroimino radiolabel: Major transformation products were HMIO, MG and MU. Minor transformation products were MAI, MIO, MIT, TMG, TZMU, CO_2 and other unidentified minor products. Thiazolyl radiolabel: Major transformation products were FA, CTCA, MAI, TMG, urea and CO_2. Minor transformation products were MIT, TZMU and other unidentified minor products. Most transformation products were declining at study termination. MG however continued to increase and other products such as MU and TZMU did not show a clear decrease by the end of the study.	1194139 and 1194195
Biotransformation[1]				
Biotransformation in aerobic water	Clothianidin	Pond water, no sediment: DT_{50} > 181 days, extrapolated to 2085 days	Persistent. More than 85% of the parent was remaining at the end of the study. No major transformation products were observed. One unidentified minor transformation product was observed.	1194208
Biotransformation in aerobic water-sediment system	Clothianidin	Pond water-loam sediment system: DT_{50} = 21 - 42 days (water), 486 day (sediment), 61 - 230 days (whole system) Representative half-life: 158 days (water) and 97 days (whole system)	Moderately persistent to persistent in the whole system. TMG was the only major transformation product; found almost entirely in the sediment. TZMU was the only minor transformation product. Whole system half-lives were extrapolated beyond the duration of the study; 60-72% of the parent was remaining at the end of the study (120 days).	2491176

Type of study	Test substance	Value	Comments	Reference (PMRA#)[1]
	Clothianidin	Pond water-loam sediment system: DT_{50} = 9 days (water), 36 days (sediment), 25 days (whole system) Representative half-life: 25 days (water) and 57 days (whole system) Lake water-sandy loam sediment system: DT_{50} = 19 days (water), 98 days (sediment), 52 days (whole system) Representative half-life: 56 days (water) and 131 days (whole system)	Slightly to moderately persistent in the whole system. TMG was the only major transformation product; found in sediment.	1194209
	Clothianidin	River water- coarse textured sediment system: DT_{50} = 23.1 days (water), 59.6 days (sediment), 45.2 days (whole system) Representative half-life: 34.4 days (water), 79.7 days (sediment) and 45.2 days (whole system) Pond water- fine textured sediment system: DT_{50} = 10.9 days (water), 18.5 days (sediment), 25.1 days (whole system) Representative half-life: 16.5 days (water), 18.5 days (sediment) and 25.1 days (whole system)	Slightly persistent in the whole system. TMG was the only major transformation product; found in sediment.	2744380

Type of study	Test substance	Value	Comments	Reference (PMRA#)[1]
Biotransformation in anaerobic water-sediment system	Clothianidin	Pond water-silt loam sediment system under nitrogen: DT_{50} = 5.0 days (water), 25 days (sediment), 19 days (whole system) Representative half-life: 10 days (water) and 19 days (whole system)	Slightly persistent in the whole system. No major transformation products were observed.	1194210
Field studies				
Outdoor freshwater mesocosm study	TI-435 50 WG (49.3% a.i.)	Only the fate component of the study was reviewed at this time. Artificial ponds with 3500-4200 litres of water (1.1 m depth) and a 10 cm layer of natural silt loam / loam sediment were sprayed once at 0.10, 0.32, 1.0, 3.2, and 10 µg a.i./L (nominal; note that the highest test rate would be equivalent to an EEC in 80 cm of water from a direct spray at approximately 80 g a.i./ha, which is much lower than the seasonal rates for clothianidin and also lower than most single application rates): The concentration in the pond water continuously decreased in all test ponds. DT_{50} = 8.9 - 24 days (average of 16.4 days). DT_{90} = 70 - 98 days. At the highest test level, concentrations in the sediment increased until day 28-42 and then decreased. DT_{50} = 46 days. DT_{90} = 153 days. Dissipation rates could not be determined at other test levels. At the highest test level, the whole system DT_{50} = 54 days. DT_{90} = 179 days.	1636641

[1] Classification of the relative persistence of pesticides in water is based on McEwen and Stephenson, 1979. The DT_{50} is from the curve that better fits the data; can be from a single first-order exponential function (SFO), double first-order in parallel (DFOP) or indeterminate order rate equation (IORE). The representative half-life is used for modelling and is different from the DT_{50} when the decline is not exponential (i.e. when the decline follows DFOP or IORE), in which case it is a conservative approximation of the first order decline.

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 (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; *ApisApis* 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.

- ***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 honey bees do not directly consume pollen, but rather consume bee bread, the possibility of estimating residues in bee bread was also considered. Since bee bread is a combination of pollen and honey (Winston 1987), it will be necessary to weight the empirical residues in pollen and nectar (from crops) based on their relative contributions in bee bread. Available information indicates that bee bread is 55% pollen and 45% nectar (based on dry weight). Potential concentrations of 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 honey bees, it is noted that this bee bread estimation may not actually be more realistic, and pollen is likely an adequately conservative estimation of exposure for the pollen/bee bread exposure route. Residue information is available from pollen and nectar collected directly from plants, honey bee collected nectar (from honey stomachs), bee collected pollen (from bee pollen baskets or from pollen traps), hive pollen (bee bread), and hive nectar and honey. In most cases residue levels tend to be lower in hive collected samples (hive pollen/bee bread; hive nectar/honey) as compared to samples collected from bees or from plants (plants tend to be highest). Therefore, the estimate of bee bread residues, which may result in higher residues than either pollen or nectar because of the different water content, does not seem to provide more realistic residue exposure estimates. Information on measured residues suggest that bee bread is typically much lower in residue levels than pollen and/or nectar collected directly from plants or brought back by bees (presumably due to dilution, degradation, processing, etc.), and therefore the estimation of residues in bee bread may not provide a more realistic estimate of exposure in most cases, even though it is a more realistic food source for honey bees. Use of the bee bread estimation may still be helpful if an estimation of exposure through a pollen route is needed in cases where a plant has only nectar and no pollen, or when it is important to consider the contribution of both pollen and nectar to the exposure through the bee bread route. While bee bread estimations are presented in this risk assessment, it is noted that they are likely overly conservative regarding the estimated exposure, and that pollen may be more representative of exposure and also a conservative estimate. In most cases, the risk from bee bread is similar to that of pollen alone.

It is also noted that when using honey bee as a surrogate for non-*Apis* bees, the bee bread exposure route estimate may not be relevant. Most non-*Apis* bees use pollen to create a food 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 honey bee bee bread estimate.

Appendix V Pollinator Study Reviews

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

Test Species	Exposure	Test Substance	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
Honey bee *Apis mellifera carnica* adult	Acute Contact 48-hr observation period	**Clothianidin Technical** (99.2 % CGA322704)	LD_{50}: 0.0275 µg a.i./bee (95% C.I.: 0.0227-0.0340)	Highly Toxic	By 48 hours, mean mortality was 0, 4, 10, 38 and 88% at treatment doses of 0 (control), 0.0016, 0.004, 0.010, 0.025, 0.0625 µg a.i./bee, respectively. The treated bees did not behave differently from the controls at any time during the test.	2364810
Honey bee *Apis mellifera carnica* adult	Acute Contact 48-hr observation period	**Clothianidin Technical** (TI-435 Technical; 96.0% Clothianidin)	LD_{50}:0.0439 µg a.i./bee (95% C.I.: 0.0296-0.0652)	Highly Toxic	By 48 hours, mean mortality was 3.0, 0, 3.0, 10, 43, 93 and 100% at measured treatment doses of 0 (control), 0.00039, 0.0019, 0.0095, 0.046, 0.22 and 1.14 µg a.i./bee, respectively. Sublethal effects, such as partial paralysis/poor coordination (moderate effect) and almost complete paralysis (severe effect) were noted for bees in treatment groups ≥0.0019 µg a.i./bee. These effects were first observed at the 1 hour observation time, and persisted until 48 hours or until bees were dead.	1194190
Bumble bee *Bombus terrestris terrestris* adult	Acute Contact 96-hr observation period	**Clothianidin Technical** (99.2 %)	LD_{50} : 0.1451 µg a.i./bee (95% C.I. 0.1138-0.1958)	n/a	Percent mortality in the treatment groups was 3, 7, 27, 47 and 80% 72 and 96 hours after bees were exposed to clothianidin at 0.0188, 0.0375, 0.075, 0.150 and 0.300 µg a.i./bee (nominal dose), respectively. There was no mortality observed in either the acetone control or wetting agent control groups. Sub-lethal effects including stumbling and knockdown behaviours were observed in all treatment groups, except at 0.0375 µg a.i./bee, over the 96 hour observation period.	2532795
Honey bee *Apis mellifera carnica* adult	Acute Oral 48-hr observation period	**Clothianidin Technical** (99.2 % CGA322704)	LD_{50}: 0.0168 µg a.i./bee (95% C.I.: 0.0139-0.0203)	Highly Toxic	By 48 hours, mean percent mortality was 0, 4.0, 28, 66 and 100% at treatment doses of 0 (control), 0.0015, 0.0044, 0.0114, 0.0222 and 0.0481 µg a.i./bee, respectively. The treated bees did not behave differently from the controls at any time during the test.	2364810

Test Species	Exposure	Test Substance	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
Honey bee *Apis mellifera carnica* adult	Acute Oral 48-hr observation period	**Clothianidin Technical** (TI-435 Technical; 96.0% Clothianidin)	LD_{50}: 0.00368 µg a.i./bee (95% C.I.: 0.00303-0.0045)	Highly Toxic	By 48 hours, mean percent mortality was 0, 3.0, 40, 57, 100, 100 and 100% at measured treatment doses of 0 (control), 0.0009, 0.00253, 0.0062, 0.012, 0.022 and 0.065 µg a.i./bee, respectively. Sublethal effects, such as partial paralysis/poor coordination (moderate effect) and almost complete paralysis (severe effect) were noted for bees in all treatment groups. These effects were first observed at the 1 hour observation time, and persisted until 48 hours or until bees were dead.	1194190
Bumble bee *Bombus terrestris terrestris* adult	Acute Oral 96-hr observation period	**Clothianidin Technical** (99.2 %)	LD_{50}: 0.00199µg a.i./bee (95% C.I.: 0.001657-0.002283)	n/a	Percent mortality in the treatment groups was 34, 90, 100, 100 and 100% 72 and 96 hours after bees were exposed to clothianidin at 0.0017, 0.0036, 0.0040, 0.0080, 0.0196 µg a.i/bee (mean measured dose), respectively. Percent mortality was 3 and 7% in the acetone control and water control groups, respectively. Sub-lethal effects including stumbling and knockdown behaviours were observed in all treatment groups over the 96 hour observation period.	2532795
Honey bee *Apis mellifera* adult	Acute Oral 48-hr observation period	**TMG** (96.0% TI-435 Metabolite TMG)	LD_{50}: > 152 µg a.i./bee (highest dose tested)	Virtually non-toxic	By 48 hrs, mean mortality was 0, 3, 3, 0 and 0% at nominal treatment doses of 0 (control), 0.16, 1.5, 11.5 and 151.7 µg a.i./bee, respectively. Only one bee (0.16 µg a.i./bee treatment group) was observed to be knocked down at 4 hours, and no bees were observed to be knocked down or stumbling at 24 or 48 hours.	1194193
Honey bee *Apis mellifera* adult	Acute Oral 48-hr observation period	**MNG** (99.2% TI-435 Metabolite MNG)	LD_{50}: > 153 µg a.i./bee (highest dose tested)	Virtually non-toxic	By 48 hrs, mean mortality was 0% at nominal treatment doses of 0 (control), 0.18, 1.7, 18 and 153 µg a.i./bee, respectively. There were no sub-lethal effects observed at any observation period for any bees exposed to MNG.	1194194
Honey bee *Apis mellifera* adult	Acute Oral 48-hr observation period	**TZMU** (98.8% TI-435 Metabolite TZMU)	LD_{50}: > 113 µg a.i./bee (highest dose tested)	Virtually non-toxic	By 48 hrs, mean mortality was 0, 10, 0, 0 and 7% at nominal treatment doses of 0 (control), 0.16, 1.6, 16 and 113 µg a.i./bee, respectively. There were no sub-lethal effects of TMZU observed for any bees at 48 hours.	1194196
Honey bee *Apis mellifera* adult	Acute Oral 48-hr observation period	**TZNG** (98.6% TI-435 Metabolite TZNG)	LD_{50}: 3.95 µg a.i./bee (95% C.I.: 3.2-4.9)	Moderately toxic	By 48 hrs, mean mortality was 0, 0, 20, 33, 93, 97 and 93% at nominal treatment doses of 0 (control), 0.89, 2.1, 3.1, 6.3, 16 and 36 µg a.i./bee, respectively. No sub-lethal effects were observed by 48 hours.	1194197
Honey bee	Chronic dietary	**Clothianidin Technical** (CGA	NOEC: 10 µg a.i./L (actual intake	n/a	Bees were fed during 10 days with a sucrose solution containing 0.1, 1 and 10 µg/L of clothianidin in a feeding solution containing	2364970

Test Species	Exposure	Test Substance	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
Apis mellifera mellifera adult	10-d daily feeding: 10 hours with treated food followed by 14 hours with non-treated food	322704)	of 0.2 ng a.i./bee/day)		0.1% (v/v) DMSO, 450 g sucrose/L. Three replicates of 25 bees were kept at 25±1.5°C and 65%±15% RH, in the dark. Bees were fed 10 hours per day with contaminated solution followed by 14 hr per day with non-contaminated food. Water was provided *ad libitum*. Mortality in the control group was 15.4 ±2.9% after the 10 day exposure period. Mortality in the 0.1, 1.0 and 10 µg a.i./L treatment groups was 20.9, 20.5 and 18.2%, respectively (corrected mortality of 6.9, 6.0 and 3.3%, respectively). There was no strong linear dose response relationship since mortality in the 0.1 and 1 µg/L treatment groups were higher than the 10 µg /L treatment group, at test termination. No feeding avoidance was observed when comparing the amount of dose/bee consumed across the treatments. After 10 days of exposure, the total cumulated clothianidin dose ingested by the bees was 0.0180 ± 0.0023, 0.2036 ± 0.0202 and 1.8922 ± 0.2290 ng/bee, respectively. The main deviations in this study include the low test temperature (25±1.5°C instead of 33±2 ºC), lack of positive control to confirm the sensitivity of the test and bees were not fed continuously throughout the 10 day test period with contaminated food.	
Honey bee *Apis mellifera mellifera* adult	Chronic dietary 10-d continuous feeding	**Clothianidin Technical** (99.2%)	NOEC: 7.7 µg a.i./L based on mortality (actual intake of 0.36 ng a.i./bee/day**)** LOEC: 15 µg a.i./L based on mortality (actual intake of 0.72 ng a.i./bee/day)	n/a	Bees were fed continuously and *ad libitum* with a 50% (w/v) sugar solution containing 10, 20, 50 and 100 µg a.i./L. Thirty replicates of 10 bees were tested at each treatment concentration and 60 replicates of 10 bees were tested for the control group. Water was provided *ad libitum*. The temperature during the test was 23.5 - 27.0 °C and the relative humidity was between 56 % and 80%. Mortality in the control group was 12.35% after the 10 day exposure period. Mortality in the 10, 20, 50 and 100 µg a.i./L treatment groups (corresponding to a measured concentration of 7.7, 15, 39 and 80 µg a.i./L) was 13.00%, 24.67%, 50.67% and 89.00% at the final assessment, respectively. The corrected mortality was 0.74 %, 14.06 %, 43.72 % and 87.45% at test termination, respectively. Mean consumption of sugar solution over the 10-day study period was calculated to be 55.1, 47.2, 48.2, 44.8 and 49.1 mg/bee/day	2355466

Test Species	Exposure	Test Substance	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
					(0.00036, 0.00072, 0.00174 and 0.00400 µg a.i./bee/day) in the 0, 7.7, 15, 39, and 80 µg a.i./L treatment groups, respectively. The average food consumption was significantly reduced in the 7.7, 15 and 39 µg a.i./L treatment groups, but not at the highest treatment concentration with percent inhibitions of 14.4, 12.6, 18.7, and 10.9% relative to the control group. Since no dose-response effect could be ascertained, it is unclear whether this effect is actually treatment-related. Therefore, a LOEC for food consumption was not determined and the NOEC for food consumption was considered to be 80 µg a.i./L. Sub-lethal adverse effects such as behavioural abnormalities, were not measured or noted in the study. The main deviations in this study include the low test temperature (25±1.5°C instead of 33±2 °C) and lack of positive control to confirm the sensitivity of the test.	
Honey bee *Apis mellifera carnica* brood	Chronic dietary 3-d *in-vitro* feeding; 22-d observation period	**Clothianidin Technical** (99.5%)	NOEC: 0.68 µg a.i./g diet (feeding rate cannot be determined) LOEC:1.5 µg a.i./g diet (feeding rate cannot be determined), based on pupal mortality, adult emergence, underdeveloped wings EC_{50} (22d): 2.79 µg a.i./g diet (95% CI: 1.94-3.79)	n/a	Larval mortality (D5-D8) was 11.7% in the control and 10.8, 15, 15.8, 15.8 and 24.2% in the 0.33, 0.68, 1.5, 4.4, and 15 µg ai/g diet treatment groups and 100% in the positive treatment group. Pupal (D12 of surviving D8 larvae) mortality was 8.5% in the control and 13.1, 15.7, 32.7, 56.4 and 45.1% in the 0.33, 0.68, 1.5, 4.4, and 15 µg ai/g diet treatment groups. Adult emergence was 80% in the control and 75, 70, 52.5, 24.2 and 15.8% in the 0.33, 0.68, 1.5, 4.4, and 15 µg ai/g diet treatment groups. Food consumption was not measured; therefore dose-based endpoints could not be determined.Sublethal effects on undeveloped wings of emerged adults were observed and were concentration responsive. The percent of emerging adults with undeveloped wings was 2, 5, 14, 38 and 53% among larvae exposed to the 0.33, 0.68, 1.5, 4.4 and 15 µg a.i./g diets, respectively. None of the emerging adults, exposed to the control diet as larvae, exhibited this adverse effect. Adding bees with undeveloped wings with dead bees, the overall cumulative affected bees in the treatment groups at day 21 was 8.3, 16.7, 43.8, 81.3 and 90.6% at 0.33, 0.68, 1.5, 4.4 and 15 µg a.i./g diets, respectively. The study was conducted under conditions different from what are proposed under OECD 237 and the OECD draft guidance document for repeat dose chronic larval study. Such conditions include larval stage (used 2nd instar instead of 1st instar), rearing apparatus (a frame was reared in lab not in hives), amount of	2352303

Test Species	Exposure	Test Substance	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
					feeding, undefined reference chemical and wide range in test temperature.	
Honey bee *Apis mellifera carnica* brood	Chronic dietary 3-d *in-vitro* feeding; 22-d observation period	**Clothianidin Technical** (99.5%)	NOEC: 20 µg a.i./kg diet (nominal feeding rate of 0.9 ng a.i./bee/da.0y), based on adult emergence LOEC: 40 µg a.i./kg diet (nominal feeding rate of 1.8 ng a.i./bee/day), based on adult emergence	n/a	The combined cumulative mortality at the final assessment (across 3 test runs) (day 22) was 17.6, 23.9, 22.7, 28.1 and 33.4% in the control, 5, 10, 20 and 40 µg a.i./kg diet, respectively (corrected mortality was 8.1, 6.3, 13.3 and 19.7%, respectively). The study provides evidence that on an acute basis the LC_{50} is >40 µg a.i./kg (nominal intake of 1.8 ng a.i./bee/day), based on a cumulative larval mortality of <50% by day 7 in all valid test runs. The following points may have affected the study outcome: 1. The test larvae were exposed to the test chemical during part of the larval stage, from D4 to D6, rather than the entire larval stage. As bees were only exposed for 3 days and not 4 days as required by OECD guidelines for larval exposure, the overall effects to bees may have been underestimated. 2. The test larvae were collected from only two hives. This may raise uncertainty of extrapolating the results of this study to other honey bee populations at large. It is recommended that larvae be collected from three different colonies in the OECD draft guidance document.3. During the study, the test temperature varied between 32.7 and 35.6 ^{o}C which is greater than 34.5 ± 0.5^{o}C that is required by OECD 237. There have been concerns on the sensitivity of test temperature to the outcome of the results. Impact of such temperature variation may raise uncertainty in the interpretation of the results.4. The exposure duration for the positive control, dimethoate, was only one day at D4, while the exposure to clothianidin was three days from D4 to D6. In addition, the test concentration was 2x that recommended in the OECD draft guidance for D4. While mortality in the positive control was sufficiently high according to the study protocol, it is not possible to confirm that the test was sufficiently sensitive according to OECD standards. 5. A residue analysis of test concentrations in stock solutions or diet was not performed raising uncertainty into whether nominal test concentrations were reflective of actual exposure.	2355467
Honey bee *Apis mellifera* adult	Residues on alfalfa foliage 24-hr exposure period	**V-10066** (clothianidin 50 % WDG)	24-hr RT_{25} values: 74.1g ai/ha: 111.68 hours	n/a	Sub-lethal symptoms were not observed in the surviving bees. Mortality in the 74.1, 148.3 and 222.4 g a.i./ha treatment groups fell below 25% after 120, 192 and 408 hours, respectively. Control mortality did not exceed 4%. The RT_{25} for V-10066 at 74.1, 148.3 and 222.4 g a.i/ha was calculated as 111.68, 179.51, and 512.39	2352302

Test Species	Exposure	Test Substance	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
			148.3 g ai/ha: 179.51 hours 222.4 g a.i./ha: 512.39 hours		hours, respectively. As the actual foliar residues which bees were exposed to is unknown and aside from the mortality data, it is uncertain whether V-10066 residues were present on the control foliage.	
Honey bee *Apis mellifera* adult	Residues on cotton foliage 24-hr exposure period	**Belay Insecticide** (26.3% w/w clothianidin)	24-hr RT_{25} value (estimated using Probit Analysis): 224 g a.i./ha (2 x 112 g a.i./ha): 11.90 days	n/a	No clothianidin residues were detected in cotton foliage from control plots (LOQ=5.0 ppb, LOD=2.5 ppb). Mean clothianidin leaf residues were highest immediately after the second Belay Insecticide application (mean 14,600 ppb). Mean clothianidin leaf residues declined rapidly and were 501 ppb 28 days after the last application. Residue decline was first-order as shown by an exponential decay plot ($Y = e^{-0.177X}$, R^2 =0.9644) of concentration and time. The foliar residue DT_{50} was 4 days. Bees in the control group at each exposure were normal in behavior. Treated bees showed abnormal behaviors, i.e., stumbling, disorientation, and inability to group. These behaviors were observed in bees at each exposure interval and bees exhibiting such behavior subsequently died. Bee mortality was 100, 100, 99.3, 57.3, 81.3, 20.7, 4.7, 3.3, 20.7 and 9.3% after 1, 2, 3, 4, 5, 8, 13, 16, 21 and 28 days after 2 applications of Belay Insecticide at 112 g a.i./ha, respectively. No bee mortality was observed in the control group. The 24-hr RT_{25} for Belay Insecticide applied to cotton foliage at 2 x 112 g a.i./ha (7 day application interval) was estimated to be 11.9 days using probit analysis.	2465284
Honey bee *Apis mellifera*	Residues on Bees Contact Test 96-hr observation period Oral Test 96-hr observation period	**Clothianidin Technical** (99.5% w/w)	Endpoint not determined	n/a	The purpose of this study was to determine the residue levels of clothianidin and its metabolite TZNG and TZMU in honey bees *(Apis mellifera)* after certain time intervals following oral or contact exposure. Mortality of the bees was also assessed. Percent mortality in the contact test was 0, 3.3, 3.3, 0, 3.3 and 80% in the control, 0.32, 1.6, 8.0, 40 and 200 ng ai/bee test groups, respectively. Behavioural abnormalities including movement coordination problems and/or lethargy were observed in the highest test group only. Percent mortality in the oral test was 0, 3.3, 0, 0, 10 and 90% in the control, 0.26, 0.9, 2.4, 7.0 and 22.2 ng/bee (based on actual uptake rate), respectively. Behavioural abnormalities were observed in the two highest test groups only.	2297706

Test Species	Exposure	Test Substance	Endpoint Value	Degree of Toxicity	Comments	Reference (PMRA#)
					In both the contact and oral test the residues detected in the bees decreased rapidly overtime. By 1 hour post-treatment the residues in the bees ranged from 23 – 47% and ND - 25% of the initial dose for oral and contact exposure, respectively.	
Honey bee *Apis mellifera*	Feed consumption and exchange	**Clothianidin Technical** (99.0% w/w)	NOEC: 100 µg a.i./kg diet based on feed consumption (mean intake of 2.77 ng a.i./bee**)**	n/a	The acute effect of clothianidin spiked sucrose solution on feed consumption and exchange was investigated in the laboratory. Thirty starved honey bees were placed in each of six test cages (Group I) and fed *ad libitum* with a 50% sucrose solution (w/w) containing 1, 10, 25, 50 and 100 µg a.i./kg sucrose solution corresponding to a mean consumption rate of 0.03, 0.33, 0.54, 0.97 and 2.77 ng a.i/bee, in glass tubes. A control group was fed *ad libitum* with untreated 50% sucrose solution (w/w) was also included in each test. In addition, 18 cages were set up with approximately 10 bees/cage without food (Group II). Feeding solutions were coloured with 5 g methylene blue/kg feeding solution to observe the feed exchange between the experimental groups 1 and 2. After ~ 1 hour of feeding inside an incubator (34°C, no light) the ~ 30 bees per cage in Group 1 were split into 3 groups of 10 bees and transferred into a cage with 10 hungry bees from Group 2 (referred to as Group 3). After an additional hour in the incubator the bees were killed with CO_2 and frozen. Honey stomachs were dissected and weighed. The amount of feed and weight of honey stomachs provided data on the feed consumption and trophallaxis. Bees were observed before killing to determine the interaction of the bees especially the trophallaxis. The feeding tests were replicated 2 times. There was no indication that feed consumption and exchange as well as trophallactic interactions of the bees were affected up to the concentration of 100 µg CGA 322704/kg 50% sucrose solution (w/w) (mean consumed amount: 2.77 ng a.i./bee). Limited information on the preparation of the test solutions was provided. Analytical confirmation of test concentrations was not performed. It is uncertain whether the food colouring had any effect on the bees as an uncoloured and untreated control was not tested.	2365431

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

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
***APIS* - Tier I Acute Contact Trials**				
No endpoints determined.	Clothianidin (< 95%) and Poncho 600F (1.25 mg a.i./kernel)	MULTIPLE CONTACT TESTS Test species: *Apis mellifera* Application method: *Contact toxicity* single application of 5 mL was applied in a Potter spray Tower to groups of 20 bees/treatment ; 4-5 concentrations were tested that were 0.00008 – 1% solution, controls were treated with solvent mixture *Contact transfer with corn tassels* corn tassels from plants treated with 1.25 mg a.i./kernel of clothianidin and placed into bioassay chambers were bees were exposed to tassels from Day 1, 2, 3 and 4 of pollen shed; chambers were provisioned with water and ad libitum sugar water Number of bees tested: *Contact toxicity:* 20 bees/treatment *Contact transfer with corn tassels:* 25 bees/treatment; replicated 4 times Caste of bees tested: *Contact toxicity:* adult, >20 day old workers *Contact transfer with corn tassels:* adult, pollen-bearing foragers Observation period: 24 hours after exposure Effect parameters: mortality	**REVIEW:** ***Contact toxicity:*** Mortality data was reported in comparison with other insecticides tested. LC_{50} data was also reported but the concentrations were expressed as percent solution (w/v): LC_{50} = 0.0002% solution **MAJOR UNCERTAINTIES:** It is unclear what the bee sample size or the amount of pollen tassel provided was. **REVIEW:** *Contact transfer with corn tassels:* Mortality was not significantly different for honey bees exposed to pollen tassels grown from treated seed compared to untreated seed. The days after pollen shed had no significance on the results and for all dates and treatments the mean percent mortality remained <10%. **MAJOR UNCERTAINTIES:** Pollen residues were not analyzed for the seed treatment groups. Control pollen was not analyzed for potential contamination. It is unknown if any of the corn tassel pollen was consumed by the bees in this contact transfer study since it was not quantified or reported.	Bailey, J.C., C.D. Scott-Dupree, C.R. Harris, J.Tolman and B.J. Harris. 2005. Contact and oral toxicity to honey bees (*Apis* mellifera L.) of agents registered for use for sweet corn insect control in Ontario, Canada, Apidologie 36: 623-633.
LD_{50}=0.0218 µg a.i./bee)	Clothianidin (>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	**REVIEW:** Acute Contact Topical Endpoint: LD50=0.0218 µg a.i./bee Clothianidin was tested alone. The toxicity reported in this study is similar to those observed in other open literature and registrant studies. Clothianidin demonstrated a similar level of toxicity to imidacloprid and thiamethoxam. **MAJOR UNCERTAINTIES:** The study authors reported that the	Iwasa, T., N. Motoyama, J.T. Ambrose, R.M. Roe. 2004. Mechanism for the Differential Toxicity of Neonicotinoid

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		tested) with a minimum of 30 bees/experiment Caste of bees tested: adult, older workers Observation period: 24 hours Effect parameters: mortality	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.	Insecticides in the Honey Bee, *Apis* Mellifera. Crop Protection. 23: 371-378.
LD_{50}=0.014 µg a.i./bee	Clothianidin 50% WDG	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: LD50=0.014 µg a.i./bee The LD_{50} endpoint values are from the laboratory component of this journal article. By 24 hours percent mortality was 0, 20, 70.7, 90.7 and 100% at doses of 0.005, 0.009, 0.016, 0.029 and 0.052 µg/bee. 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 registrant studies. The toxicity order of the insecticides on honey bees based on acute toxicity experiments conducted under laboratory conditions was clothianidin > thiamethoxam > imidacloprid > cypermethrin. **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}=0.0258 µg a.i./bee (thorax) LD_{50}=0.0365 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	**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	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

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		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	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.	
LD_{50}=0.0350 µg a.i./bee	Clothianidin (99.9%)	CONTACT TOPICAL Test species: *Apis mellifera* Application method: single application of 1µL/bee was applied to thorax; at least five dose rates were tested (with a maximum of 2-fold between doses) (treatment level not reported) Number of bees tested: experiment was repeated 3 times: total amount of bees unknown Caste of bees tested: adult, worker bees Observation period: observations made 1, 4, 24 and 48 hours after exposure Effect parameters: mortality	**REVIEW:** Acute Contact Topical Endpoint: LD_{50}=0.0350 µg a.i./bee (95% C.I. 0.015-0.0607) Clothianidin was also tested in combination with several ergosterol biosynthesis inhibitor (EBI) fungicides: none of which changed the LD_{50} significantly (LD_{50} = 0.0451 + myclobutanil; LD_{50} =0.0312 + propiconazole; LD_{50} = 0.0295 + flusilazole; LD_{50} =0.0287 + tebuconazole). None of the fungicides resulted in any toxic effects when they were tested at the doses used in the study. The toxicity reported in this study for clothianidin is similar to those observed in other open literature and registrant studies. Stumbling, and/or knockdown was observed at 4h in almost all clothianidin treated cages (the doses were selected to assess the mortality rather than the behavioural effects) and the data were not suitable for dose-response approach for assessing increased sublethal toxicity. **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.
LD_{50}: 0.03 µg/bee	Clothianidin (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} = 15.88 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, 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

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
LC_{50}: 0.0000045 µg/µL (4.485 ppm) after 24 hours LC_{50}: 0.0000030 µg/µL (2.967 ppm) after 48 hours LC_{50}:0.00000 27 µg/µL (2.667 ppm) after 72 hours	Dantop 50 WG (clothianidin 50%)	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 1.5, 3.75, 7.5, 15, 37.5 and 75 ppm (ppm= ng/µL); bees were exposed for 3 h Number of bees tested: 10 bees/treatment, experiment was repeated 4 times Caste of bee tested: adult bees, age unknown, unstarved Observation period: bee mortality was assessed at 3, 6, 24, 48 and 72 h after treatment Effects parameter: mortality and behaviour	**REVIEW:** Acute Contact Transfer Endpoints: LC_{50}: 0.0000045 µg/µL (4.485 ppm) after 24 hours, LC_{50}: 0.0000030 µg/µL (2.967 ppm) after 48 hours, LC_{50}:0.00000 27 µg/µL (2.667 ppm) after 72 hours Clothianidin caused total mortality within 24 h at the concentration of 37.5 ppm (half of field concentration) and within 48 h at the concentration of 15 ppm. The product caused statistically significant mortality up to 3.75 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. The highest concentrations of thiamethoxam caused extensive regurgitation in the honey bees. **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.
24 hour: LD_{50}=4.53 and 4.71 ppm for Colony Lig 1 and 3 respectively. LD_{50}=4.08 ppm for Colony Mel 1 48 hour: LD_{50}=3.12 and 4.64 ppm for Colony Lig 1 and 3 respectively. LD_{50}=3.28 ppm for Colony Mel 1	Dantop 50 WG (clothianidin 50%)	CONTACT TRANSFER Test species: *Colony Lig 1 and 3: Apis mellifera lingustica* *Colony Mel 1: Apis mellifera mellifera* strain D 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 1.5, 3.75, 7.5, 15 ppm. Number of bees tested: 10 bees/treatment, experiment was repeated 2-3 times Caste of bees tested: adult, foragers Observation period: observations made	**REVIEW:** Acute Contact Transfer Endpoints: 24 hour: LD50=4.53 and 4.71 ppm for Colony Lig 1 and 3 respectively. LD50=4.08 ppm for Colony Mel 1 48 hour: LD50=3.12 and 4.64 ppm for Colony Lig 1 and 3 respectively. LD50=3.28 ppm for Colony Mel 1 72 hour: LD50=2.96 and 4.29 ppm for Colony Lig 1 and 3 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	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

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
72 hour: LD_{50}=2.96 and 4.29 ppm for Colony Lig 1 and 3 respectively. LD_{50}=3.03 ppm for Colony Mel 1		1, 3, 6, 24, 48 and 72 hours Effect parameters: mortality	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.	
No endpoints determined	Poncho 600F (1.25 mg a.i./kernel) and Dantop 50 WG (clothianidin 50%)	CONTACT TRANSFER Test species: *Apis mellifera* Application method: *Dust treatment:* 0.01 g of Poncho dust was mixed with talc and applied to apple leaves placed on the bottom of a 57.2 cm^2 Plexiglas hoarding cage for bees to walk on for 3 hours; dose tested was 5.12 $\mu g/m^2$ (or based on size of bioassay chamber 0.0293 µg/cage) *Foliar treatment:* 200 µL of Dantop was sprayed to apple leaves placed on the bottom of a Plexiglas hoarding cage for bees to walk on for 3 hours; dose tested was 5.12 $\mu g/m^2$ (0.0293 µg/cage) Number of bees tested: 10 bees/treatment, experiment repeated five times Caste of bees tested: forager bees, age unknown Observation period: observations made every 3, 6, 9, 12, 24, 48 and 72 h Effect parameters: mortality	**REVIEW:** No significant differences were found in the indirect toxicity test between the liquid and the dust formulation. Results showed that even up to the 24th hour, mortality induced by both products were comparable and below 15% when corrected with control data. During the subsequent hours, the number of dead bees increased similarly in both treatments; by 48 h the bees exposed to the dust formulation had about 30% mortality while the foliar contact transfer exposure had approximately 15% mortality and by 72 h, mortality rose to approximately 55% and 40% in the dust and foliar treatments respectively. The 24, 48 and 72 hour percent corrected mortality results were visually estimated from a figure in the article. Comparison with control data was not reported. **MAJOR UNCERTAINTIES:** No control date was available for comparison (however the percent mortality data was corrected with control mortality). No results were presented other than in a graph. The dose tested was calculated by the reviewer.	Sgolastra F, Renzi T, Draghetti S, Medrzycki P, Lodesani M, Maini S and Porrini C. 2012. Effects of neonicotinoid dust from maize seed-dressing on honey bees. Bulletin of Insectology 65(2):273-280.
No endpoint determined.	Clothianidin (not stated)	CONTACT TO EXPOSED BRAIN Test species: *Apis mellifera mellifera* Application method: clothianidin at concentrations of 1-100 nM was bath-applied to honey bee intact brain while submerged in extracellular fluid to simulate environmental exposure of the	**REVIEW:** Kenyon cell exposure to clothianidin evoked a rapid, concentration-dependent depolarization of the resting membrane potential. The depolarization is reversed by the nAChR antagonist d-tubocurarine. Action potential firing occurred during the initial development of the depolarization but not during the plateau phase, reflecting the adaptation in the KCs.	Palmer MJ, Moffat C, Saranzewa N, Harvey J, Wright GA and Connolly CN. 2013. Cholinergic pesticides cause mushroom body

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		Kenyon cells (KCs) in culture, (KCs are the major neuronal component of the mushroom bodies and comprise over 40% of neurons in the honey bee brain) Number of bees tested: 8 bees Caste of bees tested: adult worker bees, age unknown Observation period: immediately after current clamp was applied for approximately 30 seconds Effect parameters: membrane excitability and action potential firing	At 10 nM, clothianidin evoked a significantly larger depolarization than imidacloprid (n = 3-4), consistent with their respective actions as full and partial nAChR agonists. The authors indicated that clothianidin was found to affect KC excitability at concentrations as low as 10 nM, (~ 2.5 ppb clothianidin). Although low concentrations of neonicotinoids transiently increase KC excitability, the data indicates that the predominant effect of exposure will be inhibition of action potential firing, which is expected to significantly impair mushroom body function. **MAJOR UNCERTAINTIES:** Sample size is very small (N=8). It is unknown how exposure to a partially dissected intact honey bee brain can be used in the risk assessment.	neuronal inactivation in honeybees. Nat Commun 4:1634.
***APIS* - Tier I Acute Oral Trials**				
LD_{50} = 0.0269 µg/bee for 48 h LD_{50} = 0.018 µg/bee for 72 h LD_{50} = 0.015 ng/bee for 96 h	Clothianidin (99%)	ACUTE ORAL Test species: *Apis mellifera* (winter bees) Application method: a 2 M sucrose solution was fed to bees *ad libitum* at doses of solvent control, 1, 5, 10, 15, 20, 50, 100 and 200 µg a.i./kg syrup Number of bees tested: 20 bees/treatment, experiment repeated three times Caste of bees tested: winter adult worker bees Observation period: observations made every 24 h Effect parameters: mortality, average daily consumption	**REVIEW:** Acute Oral Endpoints: LD50 = 0.0269 µg/bee for 48 h, LD50 = 0.018 µg/bee for 72 h, LD50 = 0.015 ng/bee for 96 h These results demonstrate a decreasing trend in LD50 values with exposure time. The daily ingested amount per bee is approximately 60 mg of contaminated sugar solution. Therefore, daily ingested doses of clothianidin range from 0.06 to 12 ng a.i./day for the range of applied concentrations. There is a chronic oral and proboscis extension reflex (PER) component of this study that is referred to in the Tier I Chronic Oral *Apis* section of this table. Based on these results, concentrations lower than 20 µg/kg were found to be sublethal, and were used in the chronic toxicity trials section of this study. **MAJOR UNCERTAINTIES:** A negative control was not used in the study (only a solvent control was used). Sucrose treatment concentrations were not analyzed.	Alkassab, A.T. and Kirchner, W.H. 2016. Impacts of chronic sublethal exposure to clothianidin on winter honeybees. Ecotoxicology. DOI 10.1007/s10646-016-1657-3
No endpoints determined.	Poncho 600F (1.25 mg a.i./kernel)	ACUTE ORAL Test species: *Apis mellifera* Application method: pollen from corn tassels was collected from plants treated with 1.25 mg a.i./kernel of	**REVIEW:** For oral toxicity trials, authors reported that there were no significant variations across treatments. **MAJOR UNCERTAINTIES:** Pollen residues were not analyzed for the seed treatment groups. Control pollen was not analyzed for	Bailey, J.C., C.D. Scott-Dupree, C.R. Harris, J.Tolman and B.J. Harris. 2005. Contact and oral

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		clothianidin and placed into bioassay chambers were bees were exposed to tassels from Day 1, 2, 3 and 4 of pollen shed; chambers were provisioned with water and ad libitum sugar water Number of bees tested: 20 bees/treatment; replicated 4 times Caste of bees tested: adult, < 24 h old Observation period: 24 hours after exposure Effect parameters: mortality	potential contamination. It is unknown if any of the corn tassel pollen was consumed by the bees since it was not quantified or reported.	toxicity to honey bees (*Apis* mellifera L.) of agents registered for use for sweet corn insect control in Ontario, Canada, Apidologie 36: 623-633.
No endpoints determined.	Poncho TM (clothianidin 1.25 mg a.i./seed)	ACUTE ORAL Test species: *Apis mellifera* Application method: guttation water was collected from corn plants grown from treated seed, 30 µL of water was provided to individual bees with or without 15% honey Application concentration: residue analysis of guttation water recovered a dose of 23.3 ± 4.2 mg/L Number of bees tested: minimum 12 bees/treatment, unknown if experiment was repeated Caste of bees tested: adult, age unknown Observation period: unknown Effect parameters: time to wing block response (wing paralysis but not actual insect death), dose-response evaluation	**REVIEW:** *Time to wing block:* Estimated from a graph, the average time to wing block was about 4 min for the treated water. No comparison with control was provided. After adding 15% honey to treated water, bees drank more solution and bees offered guttation drops from potted plants of clothianidin resulted in wing block occurring in shorter times than bees offered guttation drops from potted plants of imidacloprid (for imidacloprid all bees (n=63) had irreversible wing block within 2-4 minutes for concentrations > 100 mg/L and 6-15 min at approximate 50 mg/L). Control tests did not result in any mortality or toxicity to bees. *Dose-response evaluation:* for guttation water with 15% honey added, time to reach symptoms (abdomen bending and wing block) occurred within 1 hour for the lowest tested concentration of clothianidin (1.5 mg/L) . Time between abdomen bending and wing block symptoms decreased with increasing concentrations, approaching 0 for concentrations over 100 mg/L. Some symptoms were reversible at low doses (not quantified) at observation periods longer than an hour in length. **MAJOR UNCERTAINTIES:** The authors noted that bees often did not drink when presented with field collected guttation water (thus the addition of 15% honey in their laboratory guttation water experiments). It is unclear from this study whether this reaction is typical for bees and guttation fluid. The level of exposure is unknown since guttation water was collected from field grown plants, and from plants raised in pots in the lab that were planted in individual or in multiples in the same pot. The different planting techniques affect the amount of active ingredient translocated into the leaves.	Girolami, V., L. Mazzon, A. Sqartini, N. Mori, M. Mazaro, A. Di Bernardo, M. Greatti, C. Giorio, A. Tapparo. 2009. Translocation of neonicotinoid insecticides from coated seeds to seedling guttation drops: A novel way of intoxication for bees. Journal of Economic Entomology, 102(5): 1808-1815.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
No endpoints determined.	Clothianidin (not reported)	ACUTE ORAL Test species: *Apis mellifera* and *Bombus terrestris*(with subspecies *dalmatinus, audux, and terrestris)* Application method: doses tested for both species were: 1, 10, 100 nM and 1 μM *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 clothianidin 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 clothianidin for a total of 24 h *Honey bee antennal and mouthpart assays:* Assay 1 – individual honey bees were lightly tapped on the antenna with a solution containing 0.105, 1.05, 10.3, 33.6 ng/bee corresponding to 1, 10, 100 nM and 1 μM of thiamethoxam to elicit proboscis extension reflex (PER) *Electrophysiology experiment:* Electrophysiological recordings were made from taste neurons located in the first 11 sensilla on the honey bee's proboscis and in the first 6 sensilla in 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	Information from this study is also in the section: NON-*APIS* - Tier I Acute Oral Trials **REVIEW:** *Behavioural two-choice assays*: Honey bee The total food consumption of forager honey bees was reduced only when bees fed from solutions containing 100 nM or 1 μM of clothianidin. Bumble bee Bumble bees fed with clothianidin consumed less total food on average than those fed thiamethoxam or the sucrose control at the choice dose of 100 nM and 1 μM *Honey bee antennal and mouthpart assays:* None of the sucrose solutions containing clothianidin affected proboscis extension or retraction. *Electrophysiology experiment:* Stimulation with clothianidin did not elicit spikes from any of the neurons in the galeal sensilla of either bumble bees or honey bees statistically higher than the response to the water control. **MAJOR UNCERTAINTIES:** In general, bumble bees consumed more of the neonicotinoid-laced food than honey bees and were, therefore, exposed to higher pesticide doses. However, bumble bees are also larger in body weight, and the dose is per bee not per weight of the bee. It is unclear how these results can be used in the risk assessment.	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
		mM sucrose. Number of bees tested: *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 Caste of bees tested: *Behavioural two-choice assays:* *Bumble bee:* newly emerged bees *Honey bee:* foragers *Honey bee antennal and mouthpart assays:* foragers *Electrophysiology experiment:* not stated Observation period: *Behavioural two-choice assays*: 24 h *Honey bee antennal and mouthpart assays:* not stated *Electrophysiology experiment:* 2 s Effect parameters: *Behavioural two-choice assays*: mortality, amount of food consumed *Honey bee antennal and mouthpart assays:* proboscis extension reflex (PER), food consumption *Electrophysiology experiment:* taste neuron response		
LD_{50}=0.0049, 0.0047 and 0.0045 µg a.i./bee for 24, 48 and 72 hours: Beehive 1 LD_{50}=0.0039,	Dantop 50 WG (clothianidin 50%)	ACUTE ORAL Test species: *Apis mellifera ligustica* (3 different strains) Application method: 35 µL of sucrose solution was provided for 1 hour in a feeder at doses of 0.0075, 0.015, 0.0375, 0.075, 0.15, 0.375, 0.75, 75 ppm	**REVIEW:** Acute Oral Endpoints: Reviewer calculated mean 48 h LD_{50}= 0.0043 µg a.i./bee. This study showed a slight variability of the LD_{50} values for different strains of bees. Each beehive tested a different strain of bees. The toxicity reported in this study is similar to those observed in other open literature and registrant submitted studies. Mean 48 hour LD_{50} values in this study were 0.0043, 0.101 and 0.003 ng ai/bee for clothianidin,	Laurino D., A. Manino, A. Patetta, M. Ansaldi M. Porporato. 2010. Acute oral toxicity of neonicotinoids on different honey bee strains. Redia;

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
0.0038, 0.00 37 µg a.i./bee for 24, 48 and 72 hours: Beehive 2 LD_{50}=0.0046, 0.0045 and 0.0044 µg a.i./bee for 24, 48 and 72 hours: Beehive 3		Number of bees tested: 10 bees/treatment, experiment was repeated 4 times Caste of bees tested: adult, foragers Observation period: observations made 1, 3, 6, 24, 48 and 72 hours Effect parameters: mortality	imidacloprid and thiamethoxam, respectively. Symptoms of poisoning in the honey bees included 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. 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.	2010.93:99-102.
LD_{50} = 0.0028 µg a.i/bee (0.081 ng/µL) for 24 h LD_{50} = 0.0027 µg a.i/bee (0.077 ng/µL) for 48 h LD_{50} = 0.0026 µg a.i/bee (0.075 ng/µL) for 72 h	Dantop 50 WG (clothianidin 50%)	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 0.0075, 0.0375, 0.075, 0.375, 0.75, 1.5, 3.75, 7.5, 75 ppm Number of bees tested: 10 bees/treatment, experiment was repeated 4 times Caste of bee 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 = 0.0028 µg a.i/bee (0.081 ng/µL) for 24 h, LD50 = 0.0027 µg a.i/bee (0.077 ng/µL) for 48 h, LD50 = 0.0026 µg a.i/bee (0.075 ng/µL) for 72 h Clothianidin caused the death of all the tested honey bees within 3 h from the start of the trial at the field concentration of 75 ppm, and within 72 h at the concentration of 1.5 ppm, 50 times lower. The mortality at the concentration of 1.5 ppm at 1 h from the beginning of the test was greater than that at the 7.5 ppm concentration and the 0.75 ppm concentration caused lower mortality than the 0.375 ppm concentration. The product caused statistically significant mortality up to 0.075 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 clothianidin 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 0.0375 ppm dose (ingested dose (ID) = 0.0033 µg/bee, detected amount (DA) = 0.0008 µg/bee), the 0.375 ppm (ID =	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.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
			0.013 µg/bee, DA = 0.0012 µg/bee), the 0.75 ppm (ID = 0.026 µg/bee, DA = 0.0029 µg/bee), the 7.5 ppm (ID = 0.2623 µg/bee, DA= 0.0054 µg/bee) and the 75 ppm (ID=2.625 µg/bee, DA= 26.6 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. There appears to be a typo in the reported results from the dead bee analysis (table reports a test concentration of 0.09375 ppm; however we have chosen to report this as 0.0375 ppm in the review comments based on consistency with the rest of the article).	
LD_{50}=0.00613 µg a.i./bee: Colony 1 LD_{50}=0.00125 µg a.i./bee: Colony 1a LD_{50}= 0.00279 µg a.i./bee: Colony 2 LD_{50}=0.00483 µg a.i./bee: Colony 3 LD_{50}=0.0025 µg a.i./bee: Colony 5 LD_{50}=0.00216 µg a.i./bee: Colony 6	Dantop 50 WG (clothianidin 50%)	ACUTE ORAL Test species: *Colony 1: Apis mellifera mellifera* *Colony 1a, 2, 3, 5, 6: Apis mellifera lingustica* Application method: 35 µL of 25% sucrose solution was provided for 1 hour in a feeder at doses of 1.5, 0.75, 0.375, 0.15, 0.075, 0.0375, 0.015 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: LD50=0.00613 µg a.i./bee: Colony 1, LD50=0.00125 µg a.i./bee: Colony 1a, LD50= 0.00279 µg a.i./bee: Colony 2, LD50=0.00483 µg a.i./bee: Colony 3, LD50=0.0025 µg a.i./bee: Colony 5, LD50=0.00216 µg a.i./bee: Colony 6 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.	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
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	**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.	du Rand EE, Smit S, Beukes M, Apostolides Z, Pirk CW, Nicolson SW. 2015. Detoxification

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		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	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.	mechanisms of honey bees (*Apis* mellifera) resulting in tolerance of dietary nicotine. 5:11779. DOI: 10.1038/srep11779
LD_{50}= 0.00739 µg a.i./bee	Clothianidin (99.9%)	ACUTE ORAL Test species: *Apis mellifera* Application method: 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:** LD_{50}= 0.00739 µg a.i./bee (95% C.I. 0.000607-0.00903) Clothianidin was tested in combination with several ergosterol biosynthesis inhibitor (EBI) fungicides: none of which increased the toxicity significantly (LD_{50} = 0.00597 µg/bee + myclobutanil; LD_{50}=0.00572 µg/bee + propiconazole; LD_{50} = 0.00441 µg/bee + flusilazole; LD_{50}=0.00389 µg/bee + tebuconazole). None of the fungicides resulted in any toxic effects when they were tested at the doses used in the study. The toxicity reported in this study for clothianidin is similar to those observed in other open literature and registrant studies. Stumbling and/or knockdown was observed at 4 h in almost all imidacloprid-treated cages (the doses were selected to assess the mortality rather than the behavioural effects), and the data were thus not suitable for the analysis of the dose-response approach required for assessing increased sublethal toxicity. **MAJOR UNCERTAINTIES:** No measure of control mortality. The doses used in the study were not reported, however the LD_{50} 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.
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,	**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	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

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		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	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.	neonicotinoids reduces honey bee health near corn crops. Science 356, 1395–1397.
No endpoints determined.	Clothianidin (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 2.5 (10 nM; 0.344 ng/bee/day) and 25 ppb (100 nM; 2.99 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 clothianidin had significantly greater mortality (approximately 40%) in the 25 ppb treatment compared to the 2.5 ppb treatment (approximately 5%). *Sucrose solution consumption:* Within the clothianidin treatment, there was no significant difference in the amount of solution consumed between the 2.5 (mean volume = 0.137 mL/bee/24 hours) and 25 ppb (mean volume = 0.119 mL/bee/day) treatments. *Behaviour:* The 2.5 ppb clothianidin 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 2.5 ppb clothianidin 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 reported, a graph was used for visual estimates of the acute toxicity study but there was no mortality reporting for the behavioural assays.	Williamson, S. M.; Willis, S. J., and Wright, G. A. Exposure to Neonicotinoids Influences the Motor Function of Adult Worker Honeybees Ecotoxicology. 2014 Oct; 23(8):1409-18. doi: 10.1007/s10646-014-1283-x. Epub 2014 Jul 11

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
			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.	
***APIS* - Tier I Chronic Adult Oral Trials**				
10 day LD_{50} = 0.0095 µg/bee 12 day NOEC=10 µg/kg (estimated to be 0.0006 µg/bee/day based on a mean daily sugar consumption rate of 60 mg over 10 days) 12 day LOEC=20 µg/kg (estimated to be 0.0012 µg/bee/day based on a mean daily sugar consumption rate of 60 mg)	Clothianidin (99%)	CHRONIC ADULT ORAL Test species: *Apis mellifera carinca* (winter bees) Application method: *Chronic oral toxicity:* a 2 M sucrose solution was fed to bees *ad libitum* for 12 days at doses of solvent control, 1, 5, 10 and 15 µg a.i./kg syrup *PER:* the same application as above for the chronic oral toxicity, but then bees were fed for an additional 4 days with untreated sucrose and then harnessed and trained for sucrose responsiveness, olfactory learning and habituation of PER assays; the bees were starved for 2h prior to the PER experiments Number of bees tested: *Chronic oral toxicity:* 20 bees/treatment, experiment repeated five times *Sucrose responsiveness:* 26-32 bees/treatment *Olfactory learning:* 29-43 bees/treatment *Habituation of PER:* 18-22 bees/treatment Caste of bees tested: winter adult worker bees Observation period: *Chronic oral toxicity:* observations made after 12 days of exposure *PER assays:* observations made after	**REVIEW:** Chronic Adult Oral Endpoint: LD50 = 0.0095 µg/bee for 10 days *Chronic oral toxicity:* There is an acute oral component of this study that is referred to in the Tier I Acute Oral *Apis* section of this table. Results from that trial indicated that the 1 and 10 µg/kg treatments did not significantly affect survival of winter bees. Based on these results, the concentrations selected for this chronic oral toxicity test were lower than 20 µg/kg and determined to be sublethal. *PER assays:* Numerically, bees exposed to 10 and 15 µg/kg: • Showed partial reductions of sucrose responsiveness (results did not appear to be dose-response and were non-significant). • Showed reduced response (non-significant) to the conditioning stimulus at the 10 and 15 µg/kg doses during the 3rd and 4th, and the 5th and 6th trials respectively. For the other trials, results were similar to control. • Showed lower memory performance 1 and 24 h after treatment when compared to the control, however, the results were non-significant. • A slight decrease in the PER habituation of winter bees after long-term exposure to 15 µg/kg of clothianidin was observed. When comparing these results with the selected Tier I endpoints from registrant and open literature data, it suggests that winter bees may be less sensitive to chronic poisoning when compared to tests conducted on summer bees. This may be due to the physiological differences between summer and winter bees. **MAJOR UNCERTAINTIES:** A negative control was not used in the	Alkassab, A.T. and Kirchner, W.H. 2016. Impacts of chronic sublethal exposure to clothianidin on winter honeybees. Ecotoxicology. DOI 10.1007/s10646-016-1657-3

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		12 days of exposure, 4 days of untreated food exposure Effect parameters: mortality, average daily consumption, PER response, mid-term memory (MTM) and early long-term memory (e-LTM)	study (only a solvent control was used). Sucrose treatment concentrations were not analyzed. Behavioural data from the sublethal trials was not recorded or reported. It is unclear how the PER learning results can be related to field level honey bee exposure in the field.	
LD_{50} > 0.00024 µg a.i./bee/day (estimated to be 5.85 µg/L) NOEL= 0.00024 µg/bee/day (estimated to be 5.85 µg/L)	Clothianidin (99.9%; TGAI)	CHRONIC ADULT ORAL Test species: *Apis mellifera* Application method: spiked sucrose solution was fed *ad libitum* to bees at 41 µL/bee/day for a total of 10 days, doses tested were 0.03, 0.06, 0.12 and 0.24 ng/bee Number of bees tested: 30 bees/treatment, experiment repeated four times Caste of bees tested: adult, young bees Observation period: observations made 10 days after exposure Effect parameters: mortality	**REVIEW:** Chronic Adult Oral Endpoints: LD_{50} > 0.00024 µg a.i./bee/day (estimated to be 5.85 µg/L), NOEL= 0.00024 µg/bee/day (estimated to be 5.85 µg/L) No hyperactivity symptoms were observed in bees exposed to clothianidin. The mortality rate was <1.2% with no significant differences between doses and their respective control group. **MAJOR UNCERTAINTIES:** Uncertainty is expected during the conversion from the test concentration to dose as the consumption rate may be reduced. The authors assumed all bees consumed the same amount: 41 µL/bee/day. The actual amount consumed per bee was not measured in this test, it was estimated from a preliminary trial.	Boily M., B. Sarrasin, C. DeBlois, P. Aras, M. Chagnon. 2013. Acetylcholinesterase in honey bees (*Apis* mellifera) exposed to neonicotinoids, atrazine and glyphosate: Laboratory and field experiments. Environ Sci Pollut Res 20(8):5603-5614.
No endpoints determined.	Clothianidin (not stated)	CHRONIC ADULT ORAL Test species: *Apis mellifera* and *Bombus terrestris* Application method: 50% sucrose solution was provided to bees for 11-12 days *ad libitum* and replenished every 2-4 days; 4 treatments were tested control, 4 ppb clothianidin (Neo), *Nosema ceranae* parasite (Para), 4 ppb of clothianidin and *N. ceranae* (NP); PER assays were conducted after the exposure Number of bees tested: *Honey bee:* 336 in 1st replicate, 288 in 2nd replicate *Bumble bee:* 240 for both replicates Caste of bees tested: *Honey bee:* newly emerged adult bees *Bumble bee:* worker bees, age unknown	**REVIEW:** *Nosema infections:* Parasite screenings of alive and dead bee samples showed that 100% of *Nosema*-inoculated honey bees were infected (0% of control honey bees), whereas only 3% of inoculated bumble bees were infected. Because of the low level of confirmed bumble bee infections, this data has been determined to be INVALID for our review and will not be reported in this DER. *Responsiveness to sucrose stimulus* There were no differences in responsiveness among treatment groups. *Learning* *Honey bee* Learning acquisition was significantly impaired by pesticide exposure while parasite treatment did not have an effect. In the Neo group the proportion of positive responses started to decrease after the 4th trial and was 53% and 72% at the 9th and 10th trial. In the NP group, the proportion of positive responses started to decrease after the 3rd trial reaching 54% by the 10th trial. For non-pesticide-exposed bees (C and	Piiroinen S, Goulson D. 2016 Chronic neonicotinoid pesticide exposure and parasite stress differentially affects learning in honey bees and bumblebees. Proc. R. Soc. B 283: 20160246. http://dx.doi.org/10.1098/rspb.2016.0246

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		Observation period: daily monitoring for 11-12 days of feeding prior to PER assays Effect parameters: measure ability to associate an odour with a sugar reward, memory learning tests, parasite screenings, sugar solution consumption	Para groups), the level of learning remained fairly high throughout the trials being 81% and 68% by the 10th trial for control and parasite groups, respectively. *Bumble bee* Within non-parasite-treated bumble bees, control and pesticide exposed bees had statistically similar rates of learning. *Memory* Honey bees and bumble bees in all treatment groups (C, Neo, Para, and NP) remembered the learned association equally well 2.5 h later in the memory test when compared with the final level of learning after 10 PER trials. *Sugar water consumption/collection* In honey bees, neither pesticide exposure nor parasite treatment affected sugar water consumption, which increased with time. In bumble bees, pesticide-exposed bees had significantly lower sugar water collection than non-exposed bees and sugar water collection increased with time. These results show that clothianidin impairs learning in honey bees, specifically learning acquisition over time. Parasite exposure affected the final level of learning in honey bees when they were presented with an unrewarded PER test. In honey bees, although N. ceranae infection slightly impaired learning, it did not result in more adverse effects in combination with exposure to the pesticide. In bumble bees, chronic clothianidin exposure led to significantly lower sugar water collection. Honey bees and bumble bees in all treatment groups (C, Neo, Para, and NP) remembered the learned association equally well 2.5 h later in the memory test when compared with the final level of learning. **MAJOR UNCERTAINTIES:** Because of the low level of confirmed bumble bee infections, this data has been determined to be INVALID for our review and will not be reported. Approximately 18% of both species failed to complete PER conditioning, either because they died during the PER conditioning, were not sufficiently responsive to US, or showed positive PER to the CS at the 1st trial. Therefore the final sample size for PER assays was 155 honey bees and 151 bumble bees. The age of the bumble bees was not controlled, which could potentially explain some of the differences in sensitivity between the species. It is	

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
			unclear how this closed-feeding, bioassay-style Tier I study can be related to chronic field level bumble bee exposure in the field.	
***APIS* - Tier I Chronic Larvae Trials**				
12-d LD_{50} >32 ng a.i./larva (8 ng a.i./larva/day)	Clothianidin (not stated)	CHRONIC ORAL LARVAE Test species: *Apis mellifera carnica* larvae Application method: honey bee larvae were reared in 48 well plates according to a method described by Aupinel et al., 2005 *Treatments* 1) control + 1% acetone; 2-4) 8, 16 and 32 ng a.i./larva; 5) 100 spores of *Paenibacillus larvae* (strain 233/00) genotype Eric II (American Foulbrood (AFB)); 6-8) 32 ng a.i./larva + 100 spores of *Paenibacillus larvae* (strain 233/00) genotype Eric II *Control* Day 1 = 20 µL of diet/larvae Day 2 = nothing added Day 3, 4, 5 and 6 = 20, 30, 40 and 50 µL of diet/larvae *Clothianidin* Day 1 = 20 µL of diet/larvae Day 2 = nothing added Day 3, 4, 5 and 6 = 20, 30, 40 and 50 µL of diet containing clothianidin/larvae *Bacterial* Day 1 = 10 µL of diet + 10 µL of diet containing spores/larvae Day 2 = nothing added Day 3, 4, 5 and 6 = 20, 30, 40 and 50 µL of diet/larvae *Clothianidin + Bacterial* Day 1 = 10 µL of diet + 10 µL of diet containing spores/larvae	**REVIEW:** Chronic Oral Larvae Endpoint: 12-d LD_{50} >32 ng a.i./larva (8 ng a.i./larva/day) Honey bee larvae reared in the lab and observed for 12 days showed no mortality effects when exposed to 8, 16 or 32 ng a.i./larva. Larval mortality was 45.2% when fed approximately 100 *P. larvae* (American Foulbrood, AFB) spores. After 12 days a significant increase in total hemocyte count (THC) but not differential hemocyte count (DHC) was seen when larvae were fed 32 ng a.i./larva. The opposite effect (an increase in DHC with no effect on THC) was seen in larvae fed AFB spores. By the end of the experiment, mortality was 16.7, 13.9, 45.2 and 63.9% in the control, 32 ng a.i./larva, AFB spores and AFB spores + 32 ng a.i./larva, respectively. Larvae co-exposed to both stressors showed significantly higher mortality and a significant increase in THC and DHC than compared to the effects from a single stressor; this suggests a synergistic effect between clothianidin and a bacterial infection with *P. larvae* (AFB). **MAJOR UNCERTAINTIES:** It is not stated how much of the pesticide was added on Day 3, 4, 5 and 6; just the total dose was reported.The emergence rate of the adults was not recorded on day 22 (as outlined in OECD guidance document for honey bee larval toxicity testing No. 239). The control mortality was slightly over the OECD No. 239 guidance which stated it should be ≤15%. Hemocyte counts (THC and DHC) were taken on 7 day old treated larvae and compared to naïve control larvae that were asymptomatic. According to the author's this created a biased comparison.	López, J. H. et al. Sublethal pesticide doses negatively affect survival and the cellular responses in American foulbrood-infected honeybee larvae. Sci. Rep. 7, 40853; doi: 10.1038/srep40853 (2017).

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		Day 2 = nothing added Day 3, 4, 5 and 6 = 20, 30, 40 and 50 µL of diet containing clothianidin/larvae Number of bees tested: 48 larvae (16 larvae/colony from 3 different colonies) per replicate, each treatment was replicated 3 times = 144 larvae tested per treatment Caste of bees tested: first instar larvae (~5-10 hours old) Observation period: 12 days Effect parameters: mortality, larval weight, cellular immune response as measured by total hemocyte count (THC) on day 7 and differential hemocyte count (DHC) on day 7		
NON-*APIS* - Tier I Acute Contact Trials				
Bombus impatiens: LC_{50}=3.9 µg/kg of bee *Megachile rotundata:* LC_{50}=0.8 µg/kg of bee *Osmia lignaria*: LC_{50}=1.0 µg/kg of bee	Clothianidin >(95%)	CONTACT TOPICAL Test species: *Bombus impatiens*, *Megachile rotundata* and *Osmia lignaria* Application method: potter spray tower was used to administer 5 mL of clothianidin at 4-6 concentrations Number of bees tested: 9-11 bees/treatment, experiment repeated 4-6 times *B impatiens:* 253 bees *M. rotundata:* 297 bees *O. lignaria:* 380 bees Caste of bees tested: *B impatiens:* adult, workers *M. rotundata:* adult, 7 days old (female:male ratio was 2:1) *O. lignaria:* adults, (female: male ratio was 1:1.7) Observation period: observations made	**REVIEW:** Acute Contact Topical Endpoints: These endpoints were converted by the reviewer based on the assumption that density of the test solution is 1 g/ml. Bumble bees were generally more tolerant to the direct contact applications > *O. lignaria* > alfalfa leafcutting bees, although differences in relative toxicities between the three bee species were not consistent. Control mortality did not exceed 10%. **MAJOR UNCERTAINTIES:** Reported results were concentrations expressed as percentage of solution (wt:vol) (x 10^{-3}): *B impatiens:* LC_{50}=0.39 *M. rotundata:* LC_{50}=0.08 *O. lignaria:* LC_{50}=0.10	Scott-Dupree, C.D., L. Conroy, C.R. Harris. 2009. Impact of Currently Used or Potentially Useful Insecticides for Canola Agroecosystems on Bombus impatiens (Hymenoptera: Apidae), Megachile rotundata (Hymenoptera: Megachilidae), and Osmia lignaria (Hymenoptera: Megachilidae). J. Econ. Entomol. 102(1): 177-182

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		48 hours after exposure Effect parameters: mortality		
NON-*APIS* - Tier I Acute Oral Trials				
No endpoints determined.	Clothianidin (not stated)	ACUTE ORAL Test species: *Osmia cornuta* Application method: naïve bees were fed 0.00076 µg a.i./bee 1 hour after they were caught and then incubated for 1 hour before test; in the retention test bees were fed 0.00076 µg a.i./bee immediately after 4 days of training or fed 1 hour before the test on the 5th day Number of bees tested: Four groups of bees were tested: - naive bees without exposure to clothianidin (N=20, naive control) - trained bees without exposure to clothianidin (N=12, trained control) - naive bees treated with clothianidin (N=10, naive treated) - trained bees treated with clothianidin (N=10, trained treated). Caste of bees tested: virgin recently emerged females Observation period: *Naïve:* fed 0.76 ng/bee for 1h, then incubated for 1h before the test *Trained:* fed 0.76 ng/bee immediately after day 4 of training and 1h before the test on the 5th day Effect parameters: - Trajectories as measures of search behavior - Walking speed as a measure of locomotor behaviour	**REVIEW:** *Search behaviour:* Naive pesticide-treated bees spent significantly more time in the wrong quadrant where the local cue was not located compared to the naïve control bees. Naïve control bees spent significantly more time in the quadrants where the local cue was located compared to the naïve treated bees. Trained pesticide- treated bees spent significantly more time in quadrant where local cue was previously located during training than the trained control bees. Trained control bees spent significantly more time in quadrants where the local cue was currently located than compared to the trained treated bees. No significant differences in the amount of time spent being active within each quadrant was seen between the naïve-treated and trained – treated bees. These results suggest that clothianidin interferes with the retrieval of memory for the learned guiding features in the arena, the local cue and the panorama. *Locomotory behaviour:* There was no difference in walking speed (mean distance (in mm)) between control and treated animals, but there was a difference in the straightness of their walks (mean radian) between the trained bees that were treated compared to the trained controls. However this difference did not result in a preference of trained treated animals for any specific quadrant. These results suggest that clothianidin, fed to solitary bees at a concentration of 0.00076 µg/bee, impairs the retrieval of memory necessary for navigating towards a learned location. **MAJOR UNCERTAINTIES:** Additional results were presented in the article but the treated and control data was pooled for the naïve and trained populations; this data is not presented in the table because it is not clear if effects were associated with a clothianidin treatment. It is not stated if the bees were provided pollen during the 5 day training and testing process. Other than during the training process which	Jin, N., Klein, S., Leimig, F., Bischoff, G., Menzel, R. 2015. The neonicotinoid clothianidin interferes with navigation of the solitary bee Osmia cornuta in a laboratory test. J. Exp. Biol. 2015 218: 2821-2825; doi: 10.1242/jeb.123612

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
			happened 3 times a day for four days, it is unclear if the bees were provided with any other food or water source over the course of 4 days in captivity. The methodology and how the local and panoramic cues were moved throughout the testing and training process was not clear.	
			See non-*Apis* and *Apis* information from this study 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
No endpoints determined.	Clothianidin (>99%)	ACUTE ORAL Test species: *Bombus terrestris* Application method: bees fed 1.5 mL/bee/day in 30% sucrose solution for 4 days; tested concentrations 1, 10 and 100 µg/L Number of bees tested: 20 bees/treatment Caste of bees tested: adult, age unknown Observation period: observations made 3, 4 or 5 days after exposure Effect parameters: mortality and feeding rate	**REVIEW:** <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 80% by day 2 and reached 100% by day 3; these data were excluded from the statistical analysis. There was no significant effect of day, but there was a significant effect of dose (0, 1 or 10 µg/L) on consumption. When compared with the control, the total intake of the 1 µg clothiandin/L was not significantly different, but the total intake of the 10 µg clothiandin/L treated sucrose over the 4 days was significantly lower. **MAJOR UNCERTAINTIES:** The discussion of certain results was 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.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
NON-*APIS* - Tier I Chronic Adult Oral Trials				
			See non-*Apis* and *Apis* information from this study in the section: Tier I Chronic Oral Trials *Apis*	Piiroinen S, Goulson D. 2016 Chronic neonicotinoid pesticide exposure and parasite stress differentially affects learning in honey bees and bumblebees. Proc. R. Soc. B 283: 20160246. http://dx.doi.org/10.1098/rspb.2016.0246
No endpoints determined.	Clothianidin (TGAI)	CHRONIC ADULT ORAL Test species: *Osmia bicornis* Application method: Chronic oral exposure to 0.45 ppm in nectar substitute in artificial flowers for entire adult life span (up to ~40 days). Number of bees tested: Caste of bees tested: adults Observation period: regular observations up to ~10 months after exposure Effect parameters: mortality, number of nests, larval conditions, hatching success, sex ratios and body weights of adults, residues	**REVIEW:** Overall, the study documented statistically significant reduction of offspring production and male biased sex ratio in the group receiving clothianidin residues Female body weight*:* No difference between negative control and treatment population. Residue analysis*:* None of the larval food provisions or bees collected from negative control and treatment groups had detectable clothianidin residues. Female longevity*:* Average life spans were the same in the treatment (24.5 ± 7.2 days) and negative control (23.8 ± 6.6 days). Nest Number: Fewer nests were completed in the treatment population (151 nests) compared with the negative control (194 nests), a 22% reduction. Brood cell number: Completed nests contained 43.7% fewer total brood cells (497 cells) compared with the negative control (883 cells) ($p < 0.001$). Offspring development/mortality: Proportion of offspring that completed larval development and/or hatched after hibernation was ~50% lower in the treatment population (423 bees) versus the negative control (808 bees) ($p < 0.001$). Offspring sex ratio: The treatment population exhibited a significantly male-biased sex ratio compared with the negative control ($p < 0.003$). On average, 47.1% of emerged bees in the treatment population were	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

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
			females versus 55.6% in the negative control. Offspring body weight: Parsed out by sex, the emerged offspring body weight did not differ between the treatment group and the negative control group Pollen was not included in the study because light exposure could not be excluded. These concentrations were chosen based on values reported in oilseed rape with thiamethoxam (Pohorecka et al., 2012). Artificial flowers were filled with freshly prepared nectar substitutes and replaced every 3 days. Residue analyses were also performed on leftover larval provisions. **MAJOR UNCERTAINTIES:** *Osmia bicornis* is a European species; however, solitary bees in the Osmia genus are also native to North America. Sensitivity compared to North American species is unknown. There was a lack of replication. Both pollen and nectar food sources may be contaminated with neonicotinoids, whereas this study only considered the nectar exposure route. Conversely, bees in the study had no choice but to consume neonicotinoid-treated nectar whereas in the real world, the diet may be more diverse and contain some food sources without neonicotinoids.	
NON-*APIS* - Tier I Chronic Larvae Trials				
No endpoints determined.	Clothianidin (99.75%)	CHRONIC LARVAE Test species: *Megachile rotundata* Application method: eggs with treated pollen provisions were placed into culture plates. Pollen provisions were injected with 1 µL at doses of 0 (water control), 6, 30 and 300 ppb. The developing larvae were incubated at 29°C. Once most of the larvae had cocooned, they were left at room temperature (24°C) for a week before being placed in a 4°C refrigerator to overwinter. In June 2006, cocoons were incubated at 29°C Number of bees tested: 24 bees/treatment, for each experiment Caste of bees tested: egg/first instar	**REVIEW:** There were no significant treatment effects in the number of hours incubated before emergence and the weight of female *M. rotundata*. The study authors found a significant treatment and initiation date interaction for females in the time to complete spinning a cocoon, which was significantly shorter for control than for high treatment bees on two of the seven initiation days, with no treatment differences on the remaining days. There was an initiation date effect on the time to finish darkening a cocoon with two of the days differing from each other and the rest of the days falling between the two. There were no initiation date effects for the time until emergence or weight for females. For males, the study authors did not find any treatment effects for the time until cocoon completion, the time to darken a cocoon, the time until emergence, and weight. There were significant effects of initiation date on the time until cocoon completion, the time to darken a cocoon, the time until emergence, and weight.	Abbott, V.A., J.L. Nadeau, H.A. Higo, and M.L. Winston. 2008. Lethal and sublethal effects of imidacloprid on Osmia lignaria and clothianidin on Megachile rotundata (Hymenoptera: Megachilidae). Journal of Economic Entomology, 101(3): 784-796.

Endpoint	Test Substance	Study Methodology	Review Comments	Reference
		through to adult Observation period: observations made regularly until emergence Effect parameters: larval development, emergence, adult bee weight, bee mortality, time in days to reach last larval stage, to spin a cocoon, to darken a cocoon, or to emerge from a cocoon	The study authors did not find any effect of the treatment on survival until adulthood. LOAEC=300 ppb, NOAEC=30 ppb **MAJOR UNCERTAINTIES:** Small sample sizes in lab due to difficulty rearing larvae for successful cocoon spinning. Statistical power was low as a result of small sample sizes. Chemical may not have been evenly distributed throughout the injected spiked pollen provision. The health of the solitary bees is unknown. Long-term effects were not investigated in the study. In the "own pollen", male bees in all treatment groups weighed significantly more than control bees. It is noted that this was not a dose response.	

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

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
Tunnel Seed treatment Honey bee	Test crop: summer rape plants Test species: *Apis mellifera* (small colonies, ~5000 bees/hive) Application rate: 42.6 g a.i./ha (1.67 L/100 kg seed; 8.6 g a.i./kg seed; 181,000 seeds are in 1 kg seed = 0.05 mg a.i./seed) Number of hives tested: 1 control plot, 1 treated plot; one hive/tent/plot Exposure period: 5 days (July 2-6, 1998) during bloom Observation period: 5 days Effect parameters: flight and foraging intensity, bee behaviour, bee mortality Residue samples: bees, pollen and nectar from bees (nectar from honey bulbs, pollen from pollen pockets), nectar from flowers, flowers Location: Sweden Year: 1998	**REVIEW:** No treatment related short-term adverse effects were observed in honey bees after hives were exposed for 5 days in tunnels to flowering summer rape plants grown from seeds treated at a rate of 0.05 mg a.i./seed (42.6 g a.i./ha). The treatment exposure levels from the samples were a result of levels found in samples taken during the first week of July 1998, over 2 months after the seed treatment application of TI-435, as follows: forage bees, 0.0014 mg/kg; nectar in bees, 0.0086 mg/kg; nectar from rape flowers, 0.0012 mg/kg and 0.0072 mg/kg (sampled 7/3/98 and 7/2/98, respectively); and rape flowers, 0.0041 mg/kg. There was insufficient sample for residue analysis of the pollen from the bees (pollen baskets/pockets). There were no levels of detection in the control bees (nectar or bees) hived on untreated rape or the control plants (nectar or flowers from untreated rape plants). **MAJOR UNCERTAINTIES:** There was no replication of control or treated groups, raw data were not provided and storage stability studies were not submitted. The residue levels in the nectar taken from the bees (0.0086 mg/kg) is higher than the acute oral NOAEL for honey bees (< 0.007 mg/kg) and this nectar residue is only part of the exposure that	1194868

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
		the bees could be expected to incur while foraging on the seed-treated rape plants.	
Tunnel Seed treatment Honey bee	Test crop: summer rape plants Test species: *Apis mellifera* (small colonies, ~5000 bees/hive) Application rate: 52 g a.i./ha (5 kg seed/ha; 1.67 L/100 kg seed; 10.4 g a.i./kg seed; 181,000 seeds are in 1 kg seed = 0.06 mg a.i./seed) Number of hives tested: 1 control plot, 1 treated plot; one hive/tent/plot Exposure period: 3 days (June 22-24, 1998) Observation period: 3 days (June 22-24, 1998) Effect parameters: flight and foraging intensity, returning forager frequency, bee behaviour, bee mortality Residue samples: bees, pollen and nectar from bees (nectar from honey bulbs, pollen from pollen pockets), nectar from flowers, flowers Location: United Kingdom Year: 1998	**REVIEW:** No treatment related short-term adverse effects were observed in honey bees after hives were exposed for 3 days in tunnels to flowering summer rape plants grown from seeds treated at a rate of 0.06 mg a.i./seed (52 g a.i./ha). Samples from honey bees exposed to the treated rape provided no detectable levels of TI-435. Residues were detected and quantified in treated rape blossoms at 0.0033 mg TI-435/kg (wet weight). There was insufficient sample for residue analysis of the pollen from the bees' pollen baskets (pockets) and nectar from plants and in the bees' honey stomachs (honeybulbs) in bees exposed to the treated rape plants. **MAJOR UNCERTAINTIES:** There was no replication of control or treated groups, raw data were not provided, and storage stability studies were not submitted. The exposure period (3 overcast days with 1 of these days receiving rain) was extremely limited for a small (< 5,000 bees) colony that was moved to the site on 6/22/98 and then removed from the site on 6/25/98.	1194869
Tunnel Seed treatment Honey bee	Test crop: summer rape plants Test species: *Apis mellifera* (small colonies, ~5000 bees/hive) Application rate: 52 g a.i./ha (5 kg seed/ha; 1.67 L/100 kg seed; 10.4 g a.i./kg seed; 181,000 seeds are in 1 kg seed = 0.06 mg a.i./seed) Number of hives tested: 1 control plot, 1 treated plot; one hive/tent/plot Exposure period: 3 days (June 15-18, 1998) Observation period: 3 days (June 15-18, 1998) Effect parameters: bee behaviour, bee mortality Residue samples: bees, pollen and nectar from bees (nectar from honey bulbs, pollen from	**REVIEW:** No treatment related short-term adverse effects were observed in honey bees after hives were exposed for 3 days in tunnels to flowering summer rape plants grown from seeds treated at a rate of 0.06 mg a.i./seed (52 g a.i./ha). Residues were detected and quantified in rape pollen collected by bees at 0.0017 mg TI-435/kg. No detectable residues of TI-435 (<0.0003 mg TI-435/kg) were found in bees, nectar samples from bees or flowers and blossom samples from plants exposed to TI-435 as treated seed. **MAJOR UNCERTAINTIES:** There was no replication of control or treated groups, storage stability studies were not submitted, the exposure/ observation period was short, raw data were not provided for mortality or behavioural effects, and no bees were present in tents on the control plot.	1194870

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
	pollen pockets), nectar from flowers, flowers Location: Northern France Year: 1998		
Tunnel Seed treatment Honey bee	Test crop: summer rape plants Test species: *Apis mellifera* (small colonies, ~2000-3000 bees/hive) Application rate: 28.4 g a.i./ha (5 kg seed/ha; 10.6 g a.i./kg seed; 181,000 seeds are in 1 kg seed = 0.06 mg a.i./seed) Number of hives tested: 1 control plot, 1 treated plot; one hive/tent/plot Exposure period: 17 days (July 4-20, 2000) Observation period: 17 days (between July 4-20, 2000) Effect parameters: foraging intensity, bee behaviour, bee mortality Residue samples: nectar from bees, nectar from flowers, flowers Location: Laccher Hof, Germany Year: 2001	**REVIEW:** No treatment related short-term adverse effects on bee mortality, weight development of hives and foraging were observed in honey bees after hives were exposed for 17 days in tunnels to flowering summer rape plants grown from seeds treated at a rate of 0.06 mg a.i./seed (28.4 g a.i./ha). The treatment exposure levels from the samples were a result of levels found in samples taken during the first week of July, 2000, over 2 months after the seed treatment application of TI-435 FS 600, as follows: nectar from rape flowers: 2.8 µg ai/kg and 3.0 µg ai/kg (sampled 7/6/00 and 7/7/00, respectively). There were no TI-435 levels of detection in the control. The metabolites of TI-435, TZMU and TZNG, were not detected in any of the nectar samples taken. Sampling of pollen from honey bees and from beehives was not feasible because bees could not collect appropriate pollen quantities due to the bad weather. **MAJOR UNCERTAINTIES:** There was no replication of control or treated groups. Residue levels of TI-435 in various components of the hive (e.g. honeycomb wax) should have been determined, given that residues were detected in nectar but bee honey bulbs (stomachs) were not analyzed. These data would yield information on the transfer of residues to the bee hives by foraging bees. It should be noted that with the exception of the residue samples found in the rape nectar, the results from other parameters measured (i.e., bee foraging behavior and the weight development of the beehives) are questionable due to the adverse weather conditions during the sampling period. There appeared to be an unusual amount of rainfall (5.7 inches in July, 2000) during the sampling period which would have restricted normal bee flight and foraging activity. It is also not clear whether or not the colonies used in this study were queen right. From the explanation provided on page 7 of this study, dealing with the hive preparation of the colonies used, it could readily be assumed that the colonies used in this study were queenless. The use of queenless,	1194873

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
		undersized colonies (2,000 - 3,000 worker bees) would have provided additional factors that would make the results from the parameters measured questionable.	
Tunnel Seed treatment Honey bee	Test crop: summer rape plants Test species: *Apis mellifera* (small colonies, ~2000-3000 bees/hive) Application rate: 28.4 g a.i./ha (5 kg seed/ha; 10.6 g a.i./kg seed; 181,000 seeds are in 1 kg seed = 0.06 mg a.i./seed) Number of hives tested: 1 control plot, 1 treated plot; one hive/tent/plot Exposure period: 22 days (June 27 and July 18, 2000) Observation period: 22 days (between June 27 and July 18, 2000) Effect parameters: foraging intensity, bee behaviour, bee mortality Residue samples: nectar from bees, nectar from flowers, flowers Location: Farmland "Hofchen", Germany Year: 2001	**REVIEW:** No treatment related short-term adverse effects on honey bee mortality, weight development of hives and foraging were observed after hives were exposed for 22 days in tunnels to flowering summer rape plants grown from seeds treated at a rate of 0.06 mg a.i./seed (28.4 g a.i./ha). The treatment exposure levels from the samples were a result of levels found in samples taken from 6/30 through 7/18/00 over 2 months after the seed treatment application of TI-435 FS 600, as follows: nectar from rape flowers, 5.4 µg ai/kg and 1.0 µg ai/kg (sampled 6/30/00 and 7/6/00, respectively); and pollen from rape flowers sampled from combs/forage bees, 1.9 to 2.5 µg ai/kg (combs sampled 7/12/00; forage bees sampled on 7/2 and 7/18/00). There were no TI-435 levels of detection in the control. The metabolites of TI-435, TZMU and TZNG, were not detected in any of the nectar or pollen samples taken. Male and female blossoms were sampled from summer rape plants on Day 9 of the sampling period (7/5/00). However, these blossoms were not analyzed since nectar and pollen analysis was considered to be sufficient to detect residues of the test material. **MAJOR UNCERTAINTIES:** There was no replication of control or treated groups. It should be noted that with the exception of the residue samples found in the rape nectar and the residues detected in the pollen sampled, the results from other parameters measured (i.e., bee foraging behavior and the weight development of the beehives) are questionable due to the adverse weather conditions during the sampling period. There appeared to be an unusual amount of rainfall (6.2 inches in July, 2000) during most of the sampling period which would have restricted normal bee flight and foraging activity. It is also not clear whether or not the colonies used in this study were queen right. From the explanation provided on page 8 of this study, dealing with the hive preparation of the colonies used, it could readily be assumed that the colonies used in this study were queenless. The use of queenless, undersized colonies (2,000 - 3,000 workerbees) would have provided	1194874

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
		additional factors that would make the results from the parameters measured questionable.	
Tunnel Seed treatment Honey bee	Test crop: sunflower Test species: *Apis mellifera* (small colonies, ~2000-3000 bees/hive) Test item: TI 435 FS 600 equivalent to Poncho 600 FS (Reg. No. 27453) Application rate: 25.5 g a.i./ha (43.3 g a.i./150,000 seed; 88,500 seeds/ha = 0.29 mg a.i./seed) Number of hives tested: 1 control plot, 1 treated plot; one hive/tent/plot Exposure period: 13 days (August 11 to August 25, 2000) Observation period: 13 days (August 11 to August 25, 2000) Effect parameters: foraging intensity, bee behaviour, bee mortality, colony weight Residue samples: nectar from bees, pollen from bees, blossoms from sunflowers, pollen from blossoms Location: "Laacher Hof", Germany Year: 2001	**REVIEW:** No treatment related adverse effects on honey bee foraging and colony weight were recorded after honey bee hives were exposed for 13 days in tunnels during the flowering period of sunflower grown from seeds treated with clothianidin at a rate of 0.29 mg a.i./seed (22.5 g a.i./ha). Honey bee foraging activity was generally higher in treated sunflower. There was also some indication that adult mortality increased on the third day of the exposure period; however, this effect was transient and mortality decreased to values comparable to those in the control group. Residues of clothianidin and the transformation products TZMU and TZNG were not detected in nectar samples from combs. Residues of clothianidin were detected in pollen samples from both sunflowers and from honey comb at concentrations ranging from 1.2 to 3.1 ug/kg, no residues of the transformation products were detected in pollen samples (LOD=0.3 ug/kg). **MAJOR UNCERTAINTIES:** The treatment and control group were not replicated therefore no measure of variability was possible for the various parameters being measured and statistical analysis could not be performed on the data. As the study was not replicated it is not possible to determine whether any of the parameter effects were significant or part of the natural variability. The number of bees per colony used in the study was low (about 2,000-3000 honey bees per colony). EPPO 170 recommends between 3,000-5,000. It did not indicate whether colonies were queen-right. Assessments were only made for 13 days. No long term or overwintering assessments were made.	2355470
Tunnel Seed treatment Honey bee	Test crop: sunflower Test species: *Apis mellifera* (small colonies, ~2000-3000 bees/hive) Test item: TI 435 FS 600 equivalent to Poncho 600 FS (Reg. No. 27453) Application rate: 25.5 g a.i./ha (43.3 g a.i./150,000 seed; 88,500 seeds/ha = 0.29 mg a.i./seed) Number of hives tested: 1 control plot, 1 treated plot; one hive/tent/plot	**REVIEW:** Honey bees were not adversely affected (adult mortality, foraging activity and colony weight) by exposure for 13 days in tunnels to clothianidin residues in pollen from the comb and in blossoms of sunflowers following the planting of sunflower seeds dressed with clothianidin at a rate of 0.29 mg a.i./seed (22.5 g a.i./ha). Residues of clothianidin and the transformation products TZMU and TZNG were not detected in nectar samples from combs. Residues of clothianidin were detected in pollen samples from both sunflowers and the comb at concentrations ranging from 2.3 and 2.9 µg/kg, no residues	2355471

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
	Exposure period: 13 days (July 25 to August 7, 2000) Observation period: 13 days (July 25 to August 7, 2000) Effect parameters: foraging intensity, bee behaviour, bee mortality, colony weight Residue samples: nectar from bees, pollen from bees, nectar and pollen from comb, pollen from sunflower blossoms Location: "Hofchen", Germany Year: 2001	of the transformation products were detected in pollen samples (LOD = 0.3 µg/kg) following the planting of sunflower seeds dressed with clothianidin (TI 435 FS 600). **MAJOR UNCERTAINTIES:** The treatments in the study were not replicated (only one control and treatment plot were used) therefore no measure of variability was possible for the various parameters being measured and statistical analysis could not be performed on the data.	
Closed feeding Artificially fed hives with treated and untreated pollen from a mixture of plants were placed in tents containing oat plants for 41 days, untreated honey was provided in feeders Honey bee	Test crop: tunnels were placed on untreated oat fields Test species: *Apis mellifera* (small colonies ~ 500 bees/hive) Application rate: 10 – 30 g portions of a pollen mixture from different plants (mainly rosemary but designated as maize pollen) was treated with 5, 10 or 20 µg a.i./kg and fed to hives Number of hives tested: 2 control plots, 3treatment plots; each plot had a tunnel with one 4 frame hive: 5 hives total Exposure period: 41 days Observation period: 41 days Effect parameters: bee mortality, comb cell production, food consumption, honey storage, egg laying, brood success, hive weight, colony strength, number of bees foraging on pollen feeder, honey feeder and tent roof, quantity of honey and pollen collected, bee behaviour, Residue samples: pollen Location: Nordrhein-westfalen, Germany Year: 2001	**REVIEW:** Honey bee hives fed TI-435 treated pollen at nominal concentration of 5,10 or 20 µg a.i./kg (5.4, 10.7 and 19.7 µg a.i./kg measured) did not exhibit treatment-related effects in mortality, foraging activity (including honey and pollen collection), comb production, honey storage behavior, population growth (including egg, larvae, pupae, and adult growth stages) or behavioral anomalies. **MAJOR UNCERTAINTIES:** The treatments in the study were not replicated (only one control and treatment plot were used) therefore no measure of variability was possible for the various parameters being measured and statistical analysis could not be performed on the data.	1194878
Closed feeding Artificially fed hives with maize pollen collected from plants grown from	Test crop: tunnels were placed on untreated oat fields Test species: *Apis mellifera* (small colonies ~ 500 bees/hive) Test item: TI 435 FS 600 equivalent to	**REVIEW:** No lasting colony level effects up to 52 days to honey bees that foraged on and consumed pollen from maize plants that were grown from seeds dressed with Tl 435 FS 600 at the rate of 1 g a.i./1000 kernels. There were no significant differences between control and treatment in comb cell production, honey consumption, hive weight	2355468

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
treated seeds were placed in tents containing oats for 43days, untreated sunflower honey was provided in feeders Honey bee	Poncho 600 FS (Reg. No. 27453) Application rate: pollen was collected from maize plants treated with 1 mg a.i./seed and fed to hives in 8.4 - 34.9 g portions that was replenished every 2-9 days for a period of 43 days; the portions were placed either in a feeder in or outside of the test hives Number of hives tested: 3 control plots, 3treatment plots; each plot had a tunnel with one 4 frame hive: 5 hives total Exposure period: 43 days Observation period: 52 days Effect parameters: bee mortality, comb cell production, food consumption, pollen and honey storage, egg laying, brood success, hive weight, colony strength, foraging intensity, bee behaviour Residue samples: pollen Location: Nordrhein-westfalen, Germany Year: 2001	increase, pollen stores and honey stores, egg deposition, larval abundance, pupal abundance and abundance of adult bees. Pollen consumption was significantly higher in the treatment than in the control, which was explained by the registrant as being due to the different granulation of control and treatment pollen. The treatment pollen was finer than the control pollen and was therefore easier to transport by the bees. Foraging activity at the tunnel roofs, pollen feeder and the honey feeder was comparable in the control and treatment. Mortality in front of the bee hives was comparably low in control and treatment. The number of dead bees found at the tunnel edges, however, was higher in the treatment than in the control. The residue levels of Tl 435 were below the limit of quantitation (LOQ = 1 µg/kg) and those of the transformation products of TZMU and TZNG were below the limit of detection (LOD) in pollen which originated from seeds dressed with Tl 435 FS 600 (LOQ=0.001 mg/kg for Tl 435, TZMU, TZNG and LOD=0.0003 mg/kg for Tl 435, TZMU, TZNG). **MAJOR UNCERTAINTIES:** Due to feeding activity of wasps, ants and earwigs the comb cells of the bee colony of treatment 2c were found completely empty on study day 45. The treatment pollen was more pulverulent than the control pollen and therefore was easier to be transported by the bees. The differences in the granulation of the pollen occurred due to the harvesting conditions. The treatment pollen was harvested during wet and the control pollen during dry weather. These conditions led to a significant difference in the overall amount of pollen collected between the treatment and the control. The colonies were in the tunnel for a period of 43 days which may have caused the colonies to become stressed due to confinement near the end of the experiment. No reference treatment was applied for comparison. The treatments in the study were not replicated (only one control and treatment plot were used) therefore no measure of variability was possible for the various parameters being measured and statistical analysis could not be performed on the data.	
Open feeding Artificially fed small hives with 50% w/v spiked sugar syrup solution for 4 days	Test crop: not applicable, open field Test species: *Apis mellifera* (small colonies, ~5000-10,000 bees/hive) Dose rate: 0 (control), 10 and 20 µg a.i./kg 50% w/v aqueous sucrose solution (measured	**REVIEW:** No treatment related adverse effects on honey bee weight gain of hives, syrup consumption, average number of marked bees arriving at the hive were recorded after hives were placed in open (uncaged) fields and fed a spiked sucrose solution at a nominal concentrations of 10 and 20 µg clothianidin/kg (measured	1194871

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
Honey bee	concentrations 11.8 and 25 µg a.i./kg) Number of hives tested: 1 hive per treatment and control group. The control group was placed on a beet field near Metternich (Field no. 1), the 11.8 µg/kg treatment group was placed on a reaped cereal field near Klein-Vernich (Field no. 2), and the 25.0 µg/kg treatment group was placed on a reaped cereal field near Lommersum (Field no. 3). Exposure period: 4 days Observation period: 4 days (all assessments made between 9 am and 4:15 pm Effect parameters: foraging activity, syrup consumption, mortality, colony weight, behavioural abnormalities Location: Germany Year: 2001	concentrations were 11.8 and 25.0 µg/kg) over a 4 day period. Mortality in the 25.0 µg/kg treatment group was notably higher than mortality in the control group; however, these data were reportedly unreliable because wasps were observed removing dead bees from the study plots. **MAJOR UNCERTAINTIES:** There was no replication of control or treated groups, mortality data were unreliable because wasps were observed removing dead bees from the study plots.	
Open feeding Artificially fed hives with spiked bee bread Honey bee	Test crop: not applicable, open field Test species: marked bees, *Apis mellifera* (~10,000 bees/hive) Test item: TI 435 (99.4% clothianidin) Dose rate: 0 and 0.01 mg/kg (mean measured 8.8 µg/kg) of spiked artificial bee bread diet; on average 166.4 g bee bread/replenishment day was provided for a total of 1.83 kg/hive Number of hives tested: 20 hives: 10 control and 10 treatment hives Exposure period: 3, 6, 12 and 20 days Effect parameters: bee behaviour, overall morphological structure of the food gland, and internal structures of the acini (containing nucleus, cytoplasm, and vacuole) Location: Gent, Belgium Year: 2005	**REVIEW:** Nurse bees fed an exclusive diet of bee bread spiked at a mean measured concentration of 9 µg clothianidin/kg diet (LOQ=10 µg/kg; LOD=3 µg/kg) did not affect the development of hypopharyngeal food glands in larval bees. This study is a companion study to PMRA No. 2355501. **MAJOR UNCERTAINTIES:** This is a non-guideline study that has not been validated. No raw data were provided and neither descriptive nor inferential statistical results were provided in the study report. No analysis was conducted for clothianidin (and its metabolites) residues in the sampled honey bees.	2355500
Open feeding Artificially fed hives with spiked bee bread in open	Test crop: not applicable, open field Test species: *Apis mellifera* (~10,000 bees/hive) Test item: TI 435 (99.4% clothianidin)	**REVIEW:** Dietary treatment of honey bees with bee bread spiked with clothianidin at concentrations of 8.8 µg/kg did not result in transference of measurable residues of clothianidin or its metabolites, TZMU and TZNG (LOD = 0.3 µg/kg), to royal jelly. This is a companion study to	2355501

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
field for 4 weeks Honey bee	Dose rate: 0 and 0.01 mg/kg (mean measured 8.8 µg/kg) of spiked artificial bee bread diet; on average 166.4 g bee bread/replenishment day was provided for a total of 1.83 kg/hive Number of hives tested: 20 hives: 10 control and 10 treatment hives Exposure period: 29 days (bees fed every 3 days) Observation period: 29 days Effect parameters: frame coverage of honey, brood, empty cells, number of royal cells, hive strength, artificial bee bread consumption Residue samples: royal jelly Location: Gent, Belgium Year: 2005	PMRA No. 2355500. **MAJOR UNCERTAINTIES:** This is a non-guideline study. The colony study was not conducted according to GLP standards since it was intended for information purposes only; however, the analytical phase of the study was conducted according to GLP standards and provides some insight into the transfer of residues in bee food within a hive. Weather conditions for the duration of the study companion study including temperature and humidity were not reported. The results on hive condition in this study should not be used quantitatively unless discrepancies in the dataset regarding the number of sectors of each hive are explained. Given that 40% of the control colonies could not be treated with beebread by Day 21 of the 29-day study and that the lack of beebread combined with the use of pollen traps likely starved these control colonies of protein, the study does not provide a meaningful comparison of potential effects of the clothianidin treatment. There was contradictory information in the report as to whether these colonies that lacked bee bread after Day 21 were control or treatment colonies.	
Open feeding Artificially fed bees with 50% w/v spiked sugar solution Honey bee	Test crop: not applicable, open field Test species: *Apis mellifera* (individual pollen forager bees; hive size not stated) Test item: clothianidin technical (99.0% w/w) Dose rate: 0 (control), 10, 25, 50 and 100 µg a.i./kg 50% w/v aqueous sucrose solution Number of hives tested: Exposure period: *ad libitum* <4 hours Observation period: 1 and 24 hours from the time of release Effect parameters: flight return, behaviour, mortality Location: Germany Year: 2000	**REVIEW:** The NOEC and LOEC based on flight return of honey bee pollen foragers fed clothianidin spiked sucrose solution was determined to be 25 and 50 µg a.i./kg, respectively (corresponding to a mean consumption rate of 0.81 and 1.61 ng a.i./bee, respectively). **MAJOR UNCERTAINTIES:** Only pollen foragers were selected for the returning flight study because the study authors suggest that their pollen loads indicate that they are successful foragers and each will usually return hungry with small amounts of supplies in their honey stomach. It is noted that the results from experienced forager bees may not apply to naive worker bees that have not yet experienced their first orientation flight or foraged for pollen or nectar. The study authors indicated that each test was replicated 3 times over a 10 day period. It is noted that replicates should be conducted around the same time period to be considered a true replicate. Limited information on the preparation of the test solutions was provided. Analytical confirmation of test concentrations was not performed. For the flight return test, the bees were fed in the test cages *ad libitum*. The feeding period for each replicate varied between 2 hours 45 minutes to 3 hours 40 minutes. It is not clear what criteria were used to stop feeding the bees or how this	2365431

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
		variation would affect the study results.	
Open feeding Artificially fed bees with 50% w/v spiked sugar solution Honey bee	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./L (9.5, 19.0, 35.6, 71.8 and 140.1 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 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	**REVIEW:** The overall quantitative NOAEC and LOAEC for this study is 20 and 40 µg/L, 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. **MAJOR UNCERTAINTIES:** 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 information on a number of colony health parameters about the long term (however excluding overwintering) exposure to clothianidin at the colony level.	2610259
Open feeding Artificially fed bees with 50% w/v spiked sugar solution Honey bee	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 brood (larvae), capped brood (pupae), and	**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 19 ppb (20 µg/L). The LOAEC appears to be 29 ppb (30 µg/L), based on significant adverse effects on pollen storage that were sustained across multiple CCAs and on brood (both capped and uncapped) prior to overwintering.	Interim and final reports were not available at the time of this review

Study type / Application method / Species	Study Methodology	Review Comments	Reference (PMRA#)
	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	**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.	

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

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
Open field study Seed treatment Honey bee	Test crop: canola Test species: *Apis mellifera* hives Test item: TI-435 (clothianidin – concentration not specified) Application rate: TI-435 at a rate of 6.06 g a.i./kg seed; 181,000 seeds are in 1 kg seed = 0.03 mg a.i./seed (equivalent to 41 g a.i./ha; 6.725 kg seed/ha). Number of hives tested: 1 control field,1 treatment field with 2 hives each in Ontario and Minnesota: 8 hives total Plot size: 1 ha Exposure period: 25-30 days Observation period: 25-30 days Effect parameters: hive weight, bee mortality, foraging activity, amount of sealed brood, framed of adult bees, hive behaviour Residue samples: in-hive nectar and pollen Location: Ontario, Minnesota Year: 2001	**REVIEW:** No significant treatment-related reductions were observed in the parameters that were tested (amount of sealed honey bee brood, mortality, honey yields, foraging, pollen collection) after honey bee hives were exposed in the field for 25-30 days to flowering canola grown from seeds treated with clothianidin at a rate of 0.03 mg a.i./seed (41 g a.i./ha). Residues of TI-435 were detected in-hive pollen and nectar at 7 and 14 days after hive placement. Residues ranged from 0.9-3.7 ppb in nectar and 1.6-3.0 in pollen in the treatment hives. No quantifiable residues of TI-435 were detected in control hives. **MAJOR UNCERTAINTIES:** Results could not be validated as raw data were not provided. Variability could not be assessed. Field exposure to the test substances and bee observation period were too brief (25-30 days) to fully evaluate the impact the exposure levels of clothianidin (and imidacloprid) would have on the bee colonies that were tested. Longer-term effects could not be assessed due to the short time frame of the study (e.g., brood survival), but that the time may have been sufficient to provide information about other parameters (e.g., adult mortality). Residue levels were also measured which provides some information about exposure to bees. These measurements were, however, taken on only two days at 7 and 14 days after hive placement.	1194872
Open field study	Test crop: canola Test species: *Apis mellifera* hives	**REVIEW:** No treatment related adverse effects on bee mortality, worker longevity, brood development, hive weight and honey yields	1464606

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
Seed treatment Honey bee	Test items: Prosper FL (9.49% clothianidin) and Poncho 600 FS (48% clothianidin) Application rate: Mixture of Prosper FL and Poncho 600 FS at a rate of 4.0 g a.i./kg seed; 181,000 seeds are in 1 kg seed = 0.02 mg a.i./seed (equivalent to 32 g a.i./ha; 8.0 kg seed/ha) Number of hives tested: 4 control fields and 4 treatment fields; each had 4 hives: 32 hives total Exposure period: 21 day bloom period Post exposure period: after the exposure period bees were relocated to a monitoring location without extensive bee attractive crops Observation period: extended to after overwintering (130 days from the beginning of exposure) Effect parameters: hive weight, honey yield, bee mortality, worker longevity, brood development, overwintering success (see PMRA No. 1464608) Residue samples: honey, beeswax, bee collected pollen and nectar Location: Guelph, Ontario Year: 2005-2006	were observed when honey bee hives were exposed. In the majority of samples, clothianidin was detected at <LOQ (<0.5 ng/g) in honey, nectar, pollen and beeswax from clothianidin-treated and control colonies. Clothianidin was detected at concentrations of 0.501-0.928 ng/g in honey in 5 of the 28 samples collected from colonies in clothianidin-treated canola fields and was < LOQ (< 0.5 ng/g) in honey (28 samples) collected from colonies in the control canola fields. Clothianidin was detected at concentrations of 0.521-2.24 ng/g in nectar in 9 of 45 samples collected from colonies in clothianidin-treated canola fields and at concentrations of 0.535-0.969 ng/g in 4 of 29 samples collected from colonies in the control canola fields. In pollen, clothianidin concentrations were 0.698-2.59 ng/g in 4 of 19 samples obtained from colonies in clothianidin-treated canola fields and was < LOQ (< 0.5 ng/g) from colonies in the control canola fields. Clothianidin concentrations in beeswax were < LOQ (<0.5 ng/g) collected from colonies in clothianidin-treated and control canola fields. As an addendum to this study, a summary was provided on the assessment of the overwintered colonies (see PMRA No. 1464608) **MAJOR UNCERTAINTIES:** The effect of clothianidin-treated canola on adult mortality in worker and drone bees was considered to be inconclusive from the study. In many cases, mortality in the control bee colonies was relatively high, often greater than that of the clothianidin-treated colonies. The high variability in the number of dead bees may have also reduced the ability to detect statistical differences. In addition, some control hives were contaminated with clothianidin which suggests that bees from the control hives might have foraged on clothianidin-treated fields. Thus, there is uncertainty with the ability to differentiate the clothianidin-treatment effects as clothianidin was detected in nectar from control colonies. Furthermore, there were no raw data provided on bee mortality which limited the interpretation of the reported statistical analyses. While there are uncertainties on the cross contamination of the test chemicals in the control and interpretation of the results, the hive study is generally well-designed and reflects some of the exposure scenario to honey bees in the field.	

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
Open field study Seed treatment Honey bee	Test crop: canola Test species: *Apis mellifera* hives Test items: Prosper FL (9.49% clothianidin) and Poncho 600 FS (48% clothianidin) Application rate: Mixture of Prosper FL and Poncho 600 FS at a rate of 4.0 g a.i./kg seed; 181,000 seeds are in 1 kg seed = 0.02 mg a.i./seed (equivalent to 32 g a.i./ha; 8.0 kg seed/ha) Number of hives tested: 4 control fields and 4 treatment fields; each had 4 hives: 32 hives total Exposure period: 21 day bloom period Post exposure period: after the exposure period bees were relocated to a monitoring location without extensive bee attractive crops Observation period: extended to after overwintering (130 days from the beginning of exposure) Effect parameters: hive weight, honey yield, bee mortality, worker longevity, brood development, overwintering success (see PMRA No. 1464608) Residue samples: honey, beeswax, bee collected pollen and nectar Location: Guelph, Ontario Year: 2006	**REVIEW:** No differences between control and clothianidin-treated colonies were detected in the spring assessment. This is an addendum to the PMRA 1464606 study that includes a summary on the assessment of the overwintered colonies. **MAJOR UNCERTAINTIES:** As no data (raw or summarized) or statistical analyses were provided in the study report, the results of the spring assessment on the status of the overwintered colonies could not be verified. Overall the hive study is generally well-designed and reflects some of the exposure scenario to honey bees in the field.	1464608
Open field study Seed treatment Honey bee	Test crop: canola Test species: *Apis mellifera* hives Test items: Prosper FX Flowable Formulation (285.7 g clothianidin/L, 5.36 g metalaxyl/L, 7.14 g trifloxystrobin/L and 50 g carbathiin/L) Application rate: Prosper FX Flowable at a rate of 4.0 g a.i./ kg seed; 181,000 seeds are in 1 kg seed = 0.02 mg a.i./seed (equivalent to 22.4 g a.i./ha; based on a seeding rate of 5.6 kg seed/ha) Number of hives tested: 5 control fields and 5 treatment fields; each had 4 hives: 40 hives	**REVIEW:** No treatment related effects were detected with respect to honey bee colony weight, honey production, pest incidence, bee mortality, number of adults and sealed brood, pollen collection and overwintering survival after hives were exposed for 2 weeks in the open field to flowering canola plants grown from seeds treated at a rate of 0.02 mg a.i./seed (22.4 g a.i./ha; based on a seeding rate of 5.6 kg seed/ha). Residues of clothianidin and the transformation products MNG, TMG, TZMU and TZNG were not detected in nectar, honey and beeswax samples in the control and treatment sites during and after the 14 day exposure period. Residues of clothianidin were detected in treatment	2357346

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
	total Exposure period: 14 day bloom period Post exposure period: after the exposure period bees were relocated to monitoring location without extensive bee attractive crops Observation period: 84 days 2012; 332 days including post-overwintering 2013 Effect parameters: weight gain, honey production, adult bee mortality, number of adults and sealed brood, queen behavior and condition, determination of presence/absence of queen supercedure or swarm cells, eggs and uncapped larvae, colony health, overwintering success, Residue samples: honey, beeswax, pollen (pollen traps) and nectar (in-hive) Location: Guelph, Ontario Year: 2012-2013	fields in pollen sampled from pollen traps during the 14 day exposure period at mean concentrations ranging from 0.46 to 1.91ppb (maximum 2.33 ppb). Residues were also detected in control site pollen sampled from pollen traps at mean concentrations of 0.38-1.29 ppb (maximum 1.49 ppb) during the second week of exposure. Residues of clothianidin were not detected in pollen sampled after the exposure period. Overall no clear trend was observed in colony survival among control and treatment sites with the residue levels of clothianidin, pollen type and total pollen collected. **MAJOR UNCERTAINTIES:** While the field study is considered to be generally well-designed and no treatment related effects were detected, there is some uncertainty whether treatment related effects can be detected in the current study considering: 1)while clothianidin residues were not detected in any sampled matrices in control sites during the first week of exposure where clothianidin was detected in pollen samples from all 5 treatment sites (mean 0.58-1.15 ppb, n=5/ 5 samples), clothianidin residues were detected in pollen samples in four of five control sites in quantifiable (mean 0.38-1.5 ppb, n=3/5 samples) and trace levels (<LOQ >LOD, LOQ=1.0 ppb, LOD = 0.6 ppb, n=1/5 samples) during the second week of exposure at levels similar to what was detected in the treatment sites (mean 0.46-1.9 ppb , n=5/5 samples) during the same time period; 2)overall maximum residue levels in pollen samples collected during the exposure period were low under the current study design (≤ 2.33 ppb) and were reportedly not detected in other matrices including nectar, honey and beeswax; 3)overwintering loss in Ontario was high at the time of the study (38%) and overwintering loss in the control sites was higher than average (47%) and; 4)results for some parameters were highly variable, which while not unexpected when conducting a field study, limits the ability to detect treatment related differences. The study was meant to represent a worst case exposure scenario for bees; however, due to above average temperatures, drought conditions and subsequent shorter bloom time in addition to a low seeding rate, small test plot size and choice of study location in southern Ontario, the study did not end up representing a worst case-exposure scenario for clothianidin seed treatment use in Canada.	

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
Open field Seed treatment Dust-off exposure Guttation Honey bee	Test crop: maize Test species: *Apis mellifera* hives Test item: Clothianidin FS 600B G (600 g a.i./L) same formulation as Poncho 600 FS in Canada Application rate: Clothianidin FS 600B G at a rate of 0.5 mg a.i./seed (equivalent to 50.6 g a.i./ha; 101,100 seeds/ha) Number of hives tested: 1 control field and 1 treatment field; each field had 6 hives that were placed in the field before planting occurred: 12 hives total Exposure period: 71 days Post exposure period: after the exposure period bees were relocated to monitoring location without extensive bee attractive crops Observation period: 126 days Effect parameters: bee mortality, flight activity, brood development, hive strength, occurrence and duration of guttation, bees collecting guttation fluid Residue samples: guttation fluid, dead honey bees, pollen and nectar from combs (samples not analysed) Location: Aquitaine, France Year: 2009	**REVIEW:** No adverse effects on honey bee colony health and development (colony strength, health, and brood development and food storage) were observed in hives potentially exposed to dust released during drilling of treated maize seeds and to guttating maize. Elevated mortality in the treatment group observed during some of the assessments after drilling could have resulted from clothianidin-containing dust from the seed treatment. Since there were no observations made of bees collecting guttation droplets during the exposure period or otherwise interacting with guttating plants, the likelihood of the elevated mortality resulting from bees consuming guttation liquid is very low. **MAJOR UNCERTAINTIES:** Statistical analysis was not performed. Dust drift was not measured. Residue analysis of sampled matrices was not conducted. Planter differences exist in all four studies completed in the study series (PMRA Nos. 2142805-808. This (amongst other weather and regional differences) could account for variations seen in the dust-off effects between all 4 studies. During part of the experimental duration, maize (and other crops in the surrounding area) would have been flowering. Therefore bees would have been exposed via foraging on nectar and pollen from seed-treated maize and potentially other treated agricultural crops plants as well. Overall in both treatment groups symptoms of chalk brood and Varroa infection or infestation were noticed, which might be a reason for the problems with the development of the colonies. This was not quantified in the trial report (i.e. how and when bee health surveys were conducted, incidence of pests or seasonal timing of pests) The number of plants was not always counted if less than 10 % of the plants displayed guttation.	2142805
Open field Seed treatment Dust-off exposure	Test crop: maize Test species: *Apis mellifera* hives Test item: Clothianidin FS 600B G (600 g a.i./L) same formulation as Poncho 600 FS in Canada	**REVIEW:** No adverse effects on honey bee colony health and development (colony strength, health, and brood development and food storage) were observed in hives potentially exposed to dust released during drilling of treated maize seeds and to guttating maize. Elevated mortality in the treatment group observed during some of the	2142806

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
Guttation Honey bee	Application rate: Clothianidin FS 600B G at a rate of 0.5 mg a.i./seed (equivalent to 54.1 g a.i./ha; 108,200 seeds/ha) Number of hives tested: 1 control field and 1 treatment field; each field had 6 hives that were placed in the field before planting occurred: 12 hives total Exposure period: 45 days Post exposure period: after the exposure period bees were relocated to monitoring location without extensive bee attractive crops Observation period: 85 days Effect parameters: bee mortality, flight activity, brood development, hive strength, occurrence and duration of guttation, bees collecting guttation fluid Residue samples: guttation fluid, dead honey bees, pollen and nectar from combs (samples not analysed) Location: Languedoc-Roussillon, France Year: 2009	assessments after drilling could have resulted from clothianidin-containing dust from the seed treatment. Since there were no observations made of bees collecting guttation droplets during the exposure period or otherwise interacting with guttating plants, the likelihood of the elevated mortality resulting from bees consuming guttation liquid is very low. **MAJOR UNCERTAINTIES:** Statistical analysis was not performed. Dust drift was not measured. Residue analysis of sampled matrices was not conducted. Planter differences exist in all four studies completed in the study series (PMRA Nos. 2142805-808. This (amongst other weather and regional differences) could account for variations seen in the dust-off effects between all 4 studies. The treatment field is immediately surrounded by hedgerows on 3 of the 4 sides; the fourth side is beside a road. Beyond the hedgerows are orchards. No agricultural info on these surrounding fields is provided therefore it is unknown if these orchards were sprayed with any pesticides that could have affected foraging honey bees. The control field is immediately adjacent to an orchard, roads and hedgerows. No agricultural info on these surrounding fields is provided therefore it is unknown if these orchards were sprayed with any pesticides that could have affected foraging honey bees. The control colonies were always assessed earlier in the morning than the treatment colonies, when lower temperatures were prevailing, which leads to lower flight activity and therefore a higher number of bees was found in the hives.	
Open field Seed treatment Dust-off exposure Guttation	Test crop: maize Test species: *Apis mellifera* hives Test item: Clothianidin FS 600B G (600 g a.i./L) same formulation as Poncho 600 FS in Canada Application rate: Clothianidin FS 600B G at a rate of 0.5 mg a.i./seed (equivalent to 51.9 g a.i./ha; 103,800 seeds/ha)	**REVIEW:** No adverse effects on honey bee colony health and development (colony strength, health, and brood development and food storage) were observed in hives potentially exposed to dust released during drilling of treated maize seeds and to guttating maize. Elevated mortality in the treatment group observed during some of the assessments after drilling could have resulted from clothianidin-containing dust from the seed treatment. Since there were no observations made of bees collecting guttation droplets during the	2142807

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
Honey bee	Number of hives tested: 1 control field and 1 treatment field; each field had 6 hives that were placed in the field before planting occurred: 12 hives total Exposure period: 34 days Post exposure period: after the exposure period bees were relocated to monitoring location without extensive bee attractive crops Observation period: 83 days Effect parameters: bee mortality, flight activity, brood development, hive strength, occurrence and duration of guttation, bees collecting guttation fluid Residue samples: guttation fluid, dead honey bees, pollen and nectar from combs (samples not analysed) Location: Champagne, France Year: 2009	exposure period or otherwise interacting with guttating plants, the likelihood of the elevated mortality resulting from bees consuming guttation liquid is very low. **MAJOR UNCERTAINTIES:** Statistical analysis was not performed. Dust drift was not measured. Residue analysis of sampled matrices was not conducted. Planter differences exist in all four studies completed in the study series (PMRA Nos. 2142805-808. This (amongst other weather and regional differences) could account for variations seen in the dust-off effects between all 4 studies. Flight activity in front of the hives of the control plot on days with guttation, no observations were made on 24 May past 8:48AM due to "Maximum flight activity (not further determined)". No further clarification of this term was included in the trial report. The control plot was surrounded by rape fields. The test item treatment plot was surrounded by rape and sugar beet fields. The agricultural practices of these surrounding fields were not included in the trial report. It is unknown if honey bees were foraging on these crops and if they were exposed to treated seed dust-off during planting or if the crops were sprayed during the time of this experiment. Swarming may have occurred between mid of June and the beginning of July. Swarm activity was not observed in the field but hatched queen cells were found in the hives and there were periods in July where little to no larvae and eggs were seen in hives T4 and T6.	
Open field Seed treatment Dust-off exposure Guttation Honey bee	Test crop: maize Test species: *Apis mellifera* hives Test item: Clothianidin FS 600B G (600 g a.i./L) same formulation as Poncho 600 FS in Canada Application rate: Clothianidin FS 600B G at a rate of 0.5 mg a.i./seed (equivalent to 51.6 g a.i./ha; 103,100 seeds/ha) Number of hives tested: 1 control field and 1	**REVIEW:** No adverse effects on honey bee colony health and development (colony strength, health, and brood development and food storage) were observed in hives potentially exposed to dust released during drilling of treated maize seeds and to guttating maize. Elevated mortality in the treatment group observed during some of the assessments after drilling could have resulted from clothianidin-containing dust from the seed treatment. Since there were no observations made of bees collecting guttation droplets during the exposure period or otherwise interacting with guttating plants, the	2142808

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
	treatment field; each field had 6 hives that were placed in the field before planting occurred: 12 hives total Exposure period: 69 days Post exposure period: after the exposure period bees were relocated to monitoring location without extensive bee attractive crops Observation period: 141 days Effect parameters: bee mortality, flight activity, brood development, hive strength, occurrence and duration of guttation, bees collecting guttation fluid Residue samples: guttation fluid, dead honey bees, pollen and nectar from combs (samples not analysed) Location: Alsace, France Year: 2009	likelihood of the elevated mortality resulting from bees consuming guttation liquid is very low. **MAJOR UNCERTAINTIES:** Statistical analysis was not performed. Dust drift was not measured. Residue analysis of sampled matrices was not conducted. Planter differences exist in all four studies completed in the study series (PMRA Nos. 2142805-808. This (amongst other weather and regional differences) could account for variations seen in the dust-off effects between all 4 studies. The agricultural practices of these surrounding fields were not included in the trial report. It is unknown if honey bees were foraging on these crops and if they were exposed to treated seed dust-off during planting or if the crops were sprayed during the time of this experiment. The control plot was surrounded by forest on three sides with a residential area and a young forest plantation nearby. Within a 2 km radius there were rape, rye and wheat fields. The test item treatment plot was adjacent to a coniferous forest, apple and cherry trees and a meadow with flowering plants. Within a 2 km radius there was a rye field.	
Open field Seed treatment Honey bee	Test crop: maize Test species: *Apis mellifera* hives Test item: Clothianidin FS 600B G (600 g a.i./L) same formulation as Poncho 600 FS in Canada Application rate: Clothianidin FS 600B G at a rate of 0.5 mg a.i./seed (equivalent to 15 g a.i./ha; nominal seeding rate of 30,000 seeds/ha) Number of hives tested: 1 control field and 1 treatment field; each field had 6 hives: 12 hives total Exposure period: 11 days Post exposure period: after the exposure	**REVIEW:** Exposure of honey bees to flowering maize grown from seeds treated with Clothianidin FS 600B G at a dressing rate of 0.5 mg a.s./seed had no adverse effect on the honey bee colony health and development (e.g. strength, health, brood development and food storage behavior) during the exposure and in the months following the exposure in 2008 until spring 2009. Furthermore, no test item-related differences between treatment and control in mortality, flight and foraging intensity in the test fields and behavior of the bees during exposure to the maize fields were observed. For residue analysis one sample of pollen from forager bees and one sample of pollen from plants were taken per treatment group. In the test item treatment group, low residue levels of clothianidin were detected in pollen samples from bees and plants (0.003 mg/kg and 0.005 mg/kg).	2355460 2355463

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
	period bees were relocated to monitoring location without extensive bee attractive crops Observation period: 261 days Effect parameters: bee mortality, flight activity, brood development, hive strength, colony weight, bee behaviour, colony health, overwintering success Residue samples: pollen from forager bees (live), pollen from plants Location: Alsace, France Year: 2009	No quantifiable residues of its metabolites TZNG and TZMU were found either in pollen from bees or in the pollen from plants. No residues were detected in any of the control samples. **MAJOR UNCERTAINTIES:** This an interim report of the first year observations. Pollen analysis of pollen collected from pollen traps located at the hive entrances showed that only a small % of the pollen collected by the bees was maize pollen (2%). A very high % of the pollen collected was from white clover (up to 72%). The honey bees were obviously feeding on alternate food sources in this study. It would have been more desirable to have the bees feeding on a higher % of maize pollen in order to determine if there was a treatment related effect from clothianidin. Clothianidin residue levels were low in this study and thus the study may not represent a worst case exposure scenario.	
Open field Seed treatment Honey bee	Test crop: maize Test species: *Apis mellifera* hives Test item: Clothianidin FS 600B G (600 g a.i./L) same formulation as Poncho 600 FS in Canada Application rate: Clothianidin FS 600B G at a rate of 0.5 mg a.i./seed (equivalent to 15 g a.i./ha; nominal seeding rate of 30,000 seeds/ha) Number of hives tested: 1 control field and 1 treatment field; each field had 6 hives: 12 hives total Exposure period: 11 days Post exposure period: after the exposure period bees were relocated to monitoring location without extensive bee attractive crops Observation period: 236 days Effect parameters: bee mortality, flight activity, brood development, hive strength, colony weight bee behaviour, colony health, overwintering success Residue samples: pollen from forager bees	**REVIEW:** Exposure of honey bees to flowering maize grown from seeds treated with Clothianidin FS 600B G at a dressing rate of 0.5 mg a.i./seed had no adverse effect on honey bee health at a colony level, brood development and food storage behavior. Moreover, no test item-related difference between treatment and control in mortality, flight and foraging activity of the bees in the test fields during exposure to the maize fields was observed. Development of colony strength was variable between the different colonies. The mean strength of the control colonies did increase during the exposure period whereas the test item treatment group colonies decreased which could be a treatment effect; however this observation is based on only two data points in time during the exposure period. Some of the colonies, however, showed symptoms of chalk brood which can also have an inhibiting impact on the development of the bee colonies. It was also noted that an increase in mortality one day after set-up was seen across all hives and could be attributed to transportation stress; one colony died during transport. No adverse effects of the treatment to bee behavior were detected. Overwintering success and the colony health and strength after overwintering of the treatment group colonies was not adversely affected by exposure to Clothianidin-seed-treated maize. In the test item treatment group, low residue levels of clothianidin were	2355461 2355464

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
	(live), pollen from plants Location: Languedoc-Roussillon, France Year: 2009	detected in the pollen samples from bees and from plants (0.003 mg/kg), respectively. No residues of its transformation products TZNG and TZMU were found either in pollen from bees or in the pollen from plants. No residues were detected in any of the control samples. **MAJOR UNCERTAINTIES:** Honey bees were foraging on plants other than maize. The sorghum fields flowering near the control field were highly attractive to the honey bees and up to 88% of pollen came from the Poaceae plant family (the family that includes sorghum). The control and treated fields were 2.5 km apart; well within a forager bees flight range whether they were from a hive in the control field or the treated. Clothianidin residue levels were low in this study and thus the study may not represent a worst case exposure scenario. *Paenibacillus* larvae (American foulbrood; AFB) were found in the samples of T6 on all three sampling dates. Honey bee sanitary requirements in Ontario dictate that hives with positive detections of AFB must be destroyed. It is not clear why these hives were not destroyed in this European study after the first detection and instead, were left intact and able to infect other hives.	
Open field Seed treatment Honey bee	Test crop: maize Test species: *Apis mellifera* hives Test item: Clothianidin FS 600B G (600 g a.i./L) same formulation as Poncho 600 FS in Canada Application rate: Clothianidin FS 600B G at a rate of 0.5 mg a.i./seed (equivalent to 15 g a.i./ha; nominal seeding rate of 30,000 seeds/ha) Number of hives tested: 1 control field and 1 treatment field; each field had 6 hives: 12 hives total Exposure period: 11 days Post exposure period: after the exposure period bees were relocated to monitoring location without extensive bee attractive crops Observation period: 261 days	**REVIEW:** Exposure of honey bees to flowering maize grown from seeds treated with Clothianidin FS 600B G at a dressing rate of 0.5 mg a.s./seed had no definitive adverse effect on the honey bee colony health and development (e.g. strength, health, brood development and food storage behavior) during the exposure and in the months following the exposure in 2008 until spring 2009. Furthermore, no colony-level definite test item-related differences between treatment and control in mortality, flight and foraging intensity in the test fields and behavior of the bees during exposure to the maize fields were observed. However, it should be noted that both the pollen identification and the residue analysis results indicate that the level of honey bee exposure was low in this experiment. Overwintering success and the colony health and strength after overwintering of the treatment group colonies was not adversely affected by the exposure to Clothianidin-seed-treated maize.	2355462 2355465

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
	Effect parameters: bee mortality, flight activity, brood development, hive strength, colony weight bee behaviour, colony health, overwintering success Residue samples: pollen from forager bees (live), pollen from plants Location: Champagne, France Year: 2009	For residue analysis one sample of pollen from forager bees and one sample of pollen from plants were taken per treatment group. In the test item treatment group, low residue levels of clothianidin were detected in the pollen samples from plants (0.001 mg/kg), but no residues of its transformation products TZNG and TZMU were detected. No residues were detected in the pollen from plant samples in the control treatment. Since the amount of pollen that could be sampled from bees in both treatment groups was too low; pollen samples from bee pollen loads could not be analysed. **MAJOR UNCERTAINTIES:** Honey bees were foraging on plants other than maize. The study report states in the treated hives "… significant fractions of pollen from *Taraxacum* sp. (dandelion- type up to 97 %), up to 56 % only on DAS2), *Eupatorium* sp. (hemp agrimony-type; up to 25 % only on DAS2), *Sinapsis* sp. (mustard- type; up to 38 % only on DAS3) and *Carduus* sp. (thistle- type; up to 21 %, only on DAS3) were detected". In the control fields "…bees…collected less than 1 % maize pollen. Mainly pollen of *Anthriscus* sp. (chervil- type; up to 89 %), *Helianthus* spp. (sunflower; up to 68 %) and *Taraxacum* sp. (dandelion- type up to 42 %) was detected". Therefore the amount of exposure is very low as confirmed by the pollen identification results. Maize seed was drilled on 6 May. The experimental hives were set-up and the assessments were initiated on 4 August, almost three months later. Traditionally August is not a stressful time of year for honey bee colonies. A more stressful time of year that may have better represented a worst-case scenario, is if the hives were introduced in the spring, closer to the seed drilling date and when colonies are historically trying to ramp up brood production and require a larger input of food resources. Clothianidin residue levels were low in this study and thus the study may not represent a worst case exposure scenario.	
Open field Seed treatment Guttation and effects study	Test crop: winter oilseed rape Test species: *Apis mellifera* hives Test item: Elado flowable concentrate (400 g a.i./L clothianidin; 80 g a.i./L beta-cyfluthrin) Application rate: Elado at a rate of 7.28 g	**REVIEW:** The overall maximum measured concentration of clothianidin within guttation fluid, collected from the treatment plots, was determined during the autumn growth period of the W-OSR crop and accounted for 0.41 mg/L. Clothianidin residues in guttation fluid were generally higher during the autumn growth period as compared to	2355469

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
Honey bee	clothianidin/kg seeds and 1.47 g beta-cyfluthrin/kg seed (equivalent to 29.12 g a.i./ha clothianidin and 5.88 g a.i./ha beta-cyfluthrin; based on a nominal seeding rate of 4.0 kg seeds/ha; 181,000 seeds are in 1 kg seed = 0.04 mg a.i./seed[3]); Control at a rate of 2.10 g beta-cyfluthrin/kg seeds (8.4 g beta-cyfluthrin/ha beta-cyfluthrin; based on a nominal seeding rate of 4.0 kg seeds/ha) Number of hives tested: 3 control fields and 3 treatment fields; each field had 5 hives: 30 hives total Exposure period: 11 weeks Observation period: 11 weeks Effect parameters: frequency and duration of guttation, bee mortality, flight activity, colony strength, colony health, overwintering success Residue samples: guttation fluid sampled in the morning if present up to 52 days from emergence in Autumn 2009 and up to 31 days in Spring 2010. LOQ: 0.01 mg/L (10 ppb) LOD: 0.001 mg/L (1 ppb) Location: Ihinger Hof, Germany Year: 2009	the spring growth period. During the spring growth period, the maximum measured concentration of clothianidin within guttation fluid was 0.02 mg/L. The measured residue levels of the clothianidin metabolites TZNG and TZMU in guttation fluid were within the range of <0.001 mg/L (=LOD) to < 0.01 mg/L (=LOQ). Overall, only a small proportion of bees were observed consuming guttation fluid (3.5%). Guttation fluid from winter oil-seed rape that was seed-treated with clothianidin may have contributed to the mortality of adult bees during certain periods in the spring and fall. However, the amount of dead bees recorded did not result in any measurable colony level effects. **MAJOR UNCERTAINTIES:** Hives were not fed nectar and pollen to discourage foraging off-site. No statistical analysis was conducted on the data.	
Open field Seed treatment Guttation and effects study Honey bee	Test crop: winter barley Test species: *Apis mellifera* hives Test item: Clothianidin + Imidacloprid FS 100 + 175 G (100 g a.i./L clothianidin; 175 g a.i./L imidacloprid) Application rate: Seed sowing rate varied between 183-202 kg seed/ha in the control group and 189-207 kg seed/ha in the treatment group. Application rate on a per seed or per ha basis not reported. Number of hives tested: 5 control plots and 5 treatment plots; each plot had 5 hives: 50 hives	**REVIEW:** Clothianidin and imidacloprid residues in guttation fluid sampled from treated W-BAR plants were higher in the autumn growth period compared to the spring growth period. The overall maximum measured concentration of clothianidin and imidacloprid was 8.511 mg/L and 6.645 mg/L, respectively, during the autumn growth period. During the spring growth period, the maximum measured concentration of clothianidin and imidacloprid within guttation fluid was 0.150 mg/L and 0.068 mg/L, respectively. Guttation fluid, excreted by winter barley, seed treated with Clothianidin + Imidacloprid FS 100 + 175 G, does not have unacceptable effects on honey bee colonies under typical commercial	2355472, 2510478

[3] Amount of summer rape seeds contained in 1 kg of seed calculated from Verified Use Information document (PMRA 2534259).

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
	total Exposure period: 83 days Observation period: 83 days Effect parameters: frequency and duration of guttation, bee mortality, flight activity, colony strength, colony health, overwintering success Residue samples: guttation fluid sampled in the morning every second day and from 16 March 2012 to 17 April 2012 if present up to 28 days from emergence in Autumn 2011 and up to 32 days in Spring 2012. LOQ: 10 ppb LOD: 1 ppb Location: Gießen in Hesse, Germany Year: 2011-2012	use conditions, as there were no adverse acute, short-term or long-term effects on colony strength and -development, brood development, food storage, honey bee behaviour, queen survival, overall hive vitality, colony health, or on overwintering performance. **MAJOR UNCERTAINTIES:** Application rate of actives on a per seed or per ha basis was not reported.	
Seed treatment Guttation and effects	Test crop: winter wheat Test species: *Apis mellifera* Application rate: Seed treatment of winter wheat with Clothianidin & Beta-Cyfluthrin FS 375 + 80 at 50 g clothianidin/100 kg seed (100 g clothianidin/ha based on a seeding rate of 200 kg seeds/ha) or Triadimenol & Imidacloprid & Fuberidazol & Imazalil FS 60 + 70 + 7.2 + 8 at 70 g imidacloprid/100 kg seeds (140 g imidacloprid/ha based on a seeding rate of 200 kg seeds/ha) and untreated winter wheat planted October 2009 in Germany. Study design: Five honey bee colonies were placed at each treatment and control plot (replicated 2 times for a total of 6 study plots) before sowing either adjacent to or up to 0.5 m in the crop. Bees were observed as soon as colonies were set up and every 21 days until the end of October and again in Spring 2010. Effect parameters: bee mortality, flight activity, brood development, hive strength, bee health, overwintering performance, occurrence and duration of guttation, bees collecting	**Residues:** Residues in guttation fluid sampled from treated W-WHT plants were higher in the autumn growth period compared to the spring growth period for all test chemicals. The overall maximum measure concentration of clothianidin and its metabolites TZNG and TZMU was 13.0, 0.32 and 0.49 mg/L, respectively, during the autumn growth period. During the spring growth period, the maximum measured concentration within guttation fluid was 0.15, 0.04 and 0.03 mg/L for clothianidin, TZNG and TZMU, respectively. The overall maximum concentration of imidacloprid and its metabolites 5-Hydroxy and olefin was 6.9, 0.61 and 0.12 mg/L, respectively during the autumn growth period. During the spring growth period the maximum measured concentration within guttation fluid was 0.19, 0.02 and <LOQ for imidacloprid, 5-Hydroxy and olefin, respectively. **Monitoring:** Guttation occurred frequently on W-WHT at 86.4% of observation days in autumn 2009 and 87.9% of observation days in spring 2010. Bees were frequently observed in the study plots. There was overlap between presence of guttation fluid and bee flight activity during morning hours; bee activity in the evening during periods of guttation was not frequent. A moderate proportion of bees were observed taking up guttation fluid (10.5% of bees) predominantly during the springtime (0.5% during the Autumn and 11.9% during springtime).	2355497, 2510486, 2535904

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
	guttation fluid Sampled water matrices: Guttation fluid sampled routinely from winter wheat plants during Autumn from ~19-31 October 2009 and again in Spring 2010 from 23 March 2010 to 26 April 2010. Other sampled matrices: none	**Effects:** No treatment related differences in honey bee mortality, colony development in autumn and spring or overwintering performance were observed between the control and the treatment groups (imidacloprid and clothianidin treatment group, respectively). Study authors reported that weak development in autumn, leading to discarding the colonies or winter losses were a result of high varroa loads and other diseases found in the colonies, together with the very long and cold winter 2009/10. **Limitations:** Low attractiveness of the crop. Combi-product not a registered use therefore effects information of limited value. There is no reporting of the time of day when colony assessments were made.	
Seed treatment Guttation and effects	Test crop: winter barley Test species: *Apis mellifera* Application rate: Seed treatment of winter barley with Clothianidin & Beta-Cyfluthrin FS 375 + 80 at 50 g clothianidin/100 kg seed (100 g clothianidin/ha based on a seeding rate of 200 kg seeds/ha) or Triadimenol & Imidacloprid & Fuberidazol & Imazalil FS 60 + 70 + 7.2 + 8 at 70 g imidacloprid/100 kg seeds (140 g imidacloprid/ha based on a seeding rate of 200 kg seeds/ha) and untreated winter barley planted September 2009 in Germany. Study design: Five honey bee colonies were placed at each treatment and control plot (replicated 2 times for a total of 6 study plots) before sowing either adjacent to or up to 0.5 m in the crop. Bees were observed as soon as colonies were set up and every 21 days until the end of October and again in Spring 2010 from late March until mid-May. Effect parameters: bee mortality, flight activity, brood development, hive strength, bee health, overwintering performance, occurrence and duration of guttation, bees collecting guttation fluid Sampled water matrices: Guttation fluid	**Residues:** Residues in guttation fluid sampled from treated W-BAR plants were higher in the autumn growth period compared to the spring growth period for all test chemicals. The overall maximum measured concentration of clothianidin and its metabolites TZNG and TZMU was 2.3, 0.05 and 0.02 mg/L, respectively, during the autumn growth period. During the spring growth period, the maximum measured concentration within guttation fluid was 0.18 mg/L for clothianidin and <LOQ for both TZNG and TZMU. The overall maximum measured concentration of imidacloprid and its metabolites 5-Hydroxy and olefin was 15.0, 0.64 and 0.05 mg/L, respectively during the autumn growth period. During the spring growth period, the maximum measured concentration within guttation fluid was 0.10 for imidacloprid and <LOQ for 5-Hydroxy and olefin. **Monitoring:** Guttation occurred frequently on W-BAR at 84.2% of observation days in autumn 2009 and 80.7% of observation days in spring 2010. Bees were frequently observed in the study plots. There was overlap between presence of guttation fluid and bee flight activity during morning hours; guttation did not coincide with bee activity in the evening. A moderate proportion of bees were observed taking up guttation fluid (10.6% of bees) predominantly during the springtime (2.6% during the Autumn and 16% during springtime). **Effects:** No treatment related differences in honey bee mortality, colony development in autumn and spring or overwintering performance were observed between the control and the imidacloprid	2355498 2510477 2535882

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
	sampled routinely in the morning from plants during Autumn from ~19-31 October 2009 and again in Spring 2010 from 23 March 2010 to 26 April 2010. For clothianidin, imidacloprid and respective metabolites: LOQ: 10 ppb LOD: 1 ppb Other sampled matrices: none	treatment group. Treatment related effects in the clothianidin treatment group were observed including high bee mortality and poor overwintering survival (see limitations). **Limitations:** Low attractiveness of the crop. Combi-product not a registered use therefore effects information of limited value. There is no reporting of the time of day when colony assessments were made. Methodological deficiencies including higher number of weak colonies at study initiation, higher Varroa infestation level and less favourable ambient conditions during hibernation, may have resulted in experimental biases for the clothianidin treatment group. Initial colony vitality between the control and the imidacloprid treatment groups was comparable.	
Seed treatment Guttation and effects	Test crop: corn Test species: *Apis mellifera* hives Test item: Poncho® (0.50 mg clothianidin/seed) or Poncho Pro® (1.25 mg clothianidin/seed) Application rate: Corn seeds treated with: Poncho® (0.50 mg clothianidin/seed) or Poncho Pro® (1.25 mg clothianidin/seed) planted in 15 sites in the North region (Baumgarteberg): 39.5-44.0 g a.i./ha and 15 sites in the South region (Jennersdorf): 40.0-100.0 g a.i./ha planted Spring 2009 in Austria France. Study design: At each site two small honey bee colonies (~1370-2030 bees/hive) were placed at the border or inside the field after drilling but before emergence. In two of the sites honey bee hives were set up before drilling. Natural water sources were within a distance of 300 m or more in most sites. Water sources were placed in 5 out of the 15 sites in each region. Colonies were relocated to a monitoring site post-exposure. Bees were monitored for up to 141 days total. Effect parameters: bee mortality, flight activity, brood development, hive strength,	**Residues:** The residue levels of clothianidin in bees from Baumgartenberg were between <LOD and 45.5 ppb, and for bees from Jennersdorf between <LOD and 384.9 ppb. The residue levels of clothianidin in guttation water from Baumgartenberg were between <LOQ and 717mg/L, and for guttation water from Jennersdorf between <LOQ and 285 mg/L. The residue levels of TZNG in bees from Baumgartenberg were between <LOD and 31.2 ppb, and for bees from Jennersdorf between <LOD and 39.7 ppb. The residue levels of TZNG in guttation water from Baumgartenberg were between <LOD and 4.0 mg/L, and for guttation water from Jennersdorf between <LOD and 4.9 mg/L. The residue levels of TZMU in bees from Baumgartenberg were between <LOD and 3.3 ppb, and for bees from Jennersdorf between <LOD and 12.4 ppb. The residue levels of TZMU in guttation water from Baumgartenberg were between <LOD and 9.0 mg/L, and for guttation water from Jennersdorf between <LOD and 6.7 mg/L. **Monitoring:** Guttation in corn was a near daily phenomenon and occurred more frequently during the morning than in the evening. Despite an overlap of the presence of guttation liquid and bees foraging, bees were infrequently observed consuming guttation liquid**.** The study demonstrates that exposure to and consumption of guttation fluid by foraging bees is unlikely to happen, or only at a very low rate. **Effects:** no adverse effect at the colony level was observed.	2355499, 2377282

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
	occurrence and duration of guttation, bees collecting guttation fluid Sampled water matrices: guttation fluid sampled daily from corn plants over a 3-6 week period after emergence. LOQ: 0.01 mg/L (10 ppb) LOD: 0.001 mg/L (1 ppb) Other sampled matrices: dead honey bees, pollen and nectar from combs (samples not analysed)	**MAJOR UNCERTAINTIES:** Residues reported in the field phase study report (100- 200 mg/L; 1 mg/L after 3 weeks; 0.1 mg/L after 5 weeks) is not consistent with the analytical phase report. Higher residue values were reported in the latter and are presented here. some of residue samples may have been a mix of guttation, dew and/or rain. Control plots were not included in the study. Various soil types including loamy silt, silty loam, sandy loam, clay loam and silty clay.	
Seed treatment Guttation and effects	Test crop: corn Test species: *Apis mellifera* hives Test item: Poncho Application rate: corn seed treated with Poncho at a rate of 0.5 mg a.i./seed (drilling rate and rate per ha not reported) planted Spring 2009 in Zollikofen, Switzerland in two separate fields Study design: Six large honey bee colonies (about 12, 000 to 20, 000 bees/hive) were placed in a fallow strip adjacent to each of two treatment plots 6-16 days before drilling until 38-46 days after sowing. Bees were observed for about 54 days total. Effect parameters: bee mortality, hive development Sampled water matrices: guttation fluid sampled daily from corn plants in the morning over a 30-47 day period after emergence until 24 June 2009. LOD: 0.10 µg/l (ppb) Other sampled matrices: dead honey bees, pollen from traps and honey from combs	**Residues:** Clothianidin concentrations in guttation fluid varied from 25000 to 39000 µg a.s/L (limit of detection for water 0.10 µg/L). With increasing growth of the corn plants, the clothianidin concentrations in the guttation fluid decreased. **Monitoring:** frequency, duration and overlap of guttation and honey bee activity was not investigated. **Effects:** bee mortality did not increase considerably after sowing and no clothianidin residues were detected in the bees. Bee colonies developed normally during the duration of each trial; however, specific population measurements of the test colonies were not undertaken. **MAJOR UNCERTAINTIES:** Control plots were not included in the study. Specific colony measurements of the test colonies were not undertaken. Soil type not specified. No raw data provided. No statistical analysis was conducted on the data.	2377280
Foliar application Guttation and effects	Test crop: potato Test species: *Apis mellifera* Application rate: Potato plants spray sprayed with Dantop 50WG (50% w/w clothianidin) at a nominal rate 150 g product/ha (75 g a.i./ha	**Residues:** Clothianidin residues were detected in guttation fluid sampled from potato plants in the treatment plot 1 day after a spray application with Dantop 50WG (50% w/w clothianidin) at high levels (1317 µg clothianidin/kg) and declined over a 12 day period (26 µg clothianidin/kg). Clothianidin metabolites TZNG and TZMU were also	2532796

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
	clothianidin) 26 June 2012 in North Yorkshire, UK. Study design: Six honey bee colonies (>10,000 bees/colony) were placed at 1 treatment and 1 control plot 7 days before spray application until 14 days after application. Colonies were then relocated to a monitoring site and observed for 108 days after application. Bees were observed for 115 days total until the start of the overwintering period. Effect parameters: bee mortality, flight activity, brood development, colony weight, hive strength, food storage, bee health, occurrence and duration of guttation, bees collecting guttation fluid Sampled water matrices: Guttation fluid sampled routinely from potato leaves in the morning over a 14 day period after application. LOQ: 1 ppb LOD: 0.3 ppb Other sampled matrices: dead honey bees (samples not analyzed)	detected in guttation fluids at low levels (1-53 µg/kg). **Monitoring:** Despite overlaps of the presence of guttation liquid and bees foraging, bees were not observed consuming guttation liquid. **Effects:** No negative treatment related effects were detected with respect to honey bee colony weight, queen health, pest incidence, bee mortality, bee activity and percent area of pollen, nectar, eggs, larvae, capped cells and adults. **Limitations:** Mortality and foraging activity was higher in the control plot than the treated plot. This may have had an impact on the assessment reported for colony i.e. the number of bees, the brood, the pollen are lower in the control than the treated field. Therefore some treatment related effects might have been hidden. The size of and distance between test plots is considered small for honey bee foraging considering the foraging range of honey bees can be in excess of 10 km.	
Seed treatment Guttation and effects	Test crop: sugar beet Test species: *Apis mellifera* Application rate: Sugar beet pills (seed) treated with Poncho beta + which consists of Poncho beta (clothianidin+beta-cyfluthrin FS 453.3 (400+53.3 g/L)) + Gaucho 70 WS (imidacloprid WS 70 (700 g/kg)) + standard fungicides Hymexazol + TMTD at a nominal rate of 0.6 mg clothianidin/pill + 0.3 mg imidacloprid /pill + 0.08 mg beta-cyfluthrin/pill (equivalent to 78 g clothianidin, 39 g imidacloprid and 10.4 g beta-cyfluthrin/ha; 142,000 pills/ha) and untreated sugar beet pills planted May 2013 in Baden-Württemberg, Germany.	**Residues:** Residue analysis of guttation fluid sampled in sugar beet plots during the exposure period resulted in the detection of clothianidin and its metabolites TZNG and TZMU at concentrations within the range of 153-327, 35-57 and 36-53 µg/kg, respectively and imidacloprid and its metabolites imidacloprid-5-hydroxy and imidacloprid-olefine at concentrations within the range of 18-61, 6.9-16 and 1.9-4.0 µg/kg, respectively. Residues of beta-cyfluthrin were virtually non-detectable in guttation fluids. **Monitoring:** The assessment on honey bee flight activity in the test plots during the exposure period overlapped with the guttation period; however, flight activity was low in the test plots with ≤5 honey bees observed in each test site and no honey bees were observed collecting guttation droplets during the exposure period in both the control and treatment plot.	2510479, 2535883

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
	Study design: Eight honey bee colonies were placed at 1 treatment and 1 control plot shortly after emergence (BBCH 12) until 42 days after emergence. Colonies were then relocated to a monitoring site. Bees were observed for 278 days total from 5 days before emergence until the end of overwintering. Effect parameters: bee mortality, flight activity, brood development, hive strength, bee health, overwintering performance, occurrence and duration of guttation, bees collecting guttation fluid Sampled water matrices: Guttation fluid sampled routinely from beet plants over a 42 day period after emergence (14 June 2013) until 25 July 2013. For clothianidin, imidacloprid and respective metabolites: LOQ: 1 ppb LOD: 0.1 ppb For beta-cyfluthrin LOQ: 10 ppb Other sampled matrices: dead honey bees (samples not analyzed)	**Effects:** No treatment related adverse effects of the potential exposure of the colonies to guttating beets on honey bee colony health and development (mortality, colony strength, health, brood development and food storage) were observed during the exposure and monitoring phase. **Limitations:** Low attractiveness of the crop. Combi-product not a registered use therefore effects information of limited value. There is no reporting of the time of day when colony assessments were made. No statistical analysis performed.	
Seed treatment Guttation and effects	Test crop: sugar beet Test species: *Apis mellifera* Application rate: Sugar beet pills (seed) treated with Poncho beta + which consists of Poncho beta (clothianidin+beta-cyfluthrin FS 453.3 (400+53.3 g/L)) + Gaucho 70 WS (imidacloprid WS 70 (700 g/kg)) + standard fungicides Hymexazol + TMTD at a nominal rate of 0.6 mg clothianidin/pill + 0.3 mg imidacloprid /pill + 0.08 mg beta-cyfluthrin/pill (equivalent to 78 g clothianidin, 39 g imidacloprid and 10.4 g beta-cyfluthrin/ha; 121,000 pills/ha) and untreated sugar beet pills planted May 2013 in Baden-Württemberg, Germany.	**Residues:** Residue analysis of guttation fluid sampled in sugar beet plots during the exposure period resulted in the detection of clothianidin and its metabolites TZNG and TZMU at concentrations within the range of 17-64, 2.9-12 and 3.1-11 µg/kg, respectively and imidacloprid and its metabolites imidacloprid-5-hydroxy and imidacloprid-olefine at concentrations within the range of 2.9-10, 1.2-4.2 and < LOQ-1.3µg/kg, respectively. Residues of beta-cyfluthrin were virtually non-detectable in guttation fluids. **Monitoring:** Guttation occurred infrequently in sugar beets compared to adjacent off-crop areas. Out of the 40 assessment days, guttation was observed on only 3 and 5 days in the cropped area and on 25 and 20 days in the off-crop area in the control and treatment groups, respectively. When guttation was observed, the proportion of guttating plants varied from 2.9 % to 57.1 % in the control group and 3.0% to	2510480, 2535884

Study type / Application method / Species	Study Methodology	Review Comments	PMRA #
	Study design: Eight honey bee colonies were placed at 1 treatment and 1 control plot shortly after emergence (BBCH 12) until 42 days after emergence. Colonies were then relocated to a monitoring site. Bees were observed for 278 days total from 5 days before emergence until the end of overwintering. Effect parameters: bee mortality, flight activity, brood development, hive strength, bee health, overwintering performance, occurrence and duration of guttation, bees collecting guttation fluid Sampled water matrices: Guttation fluid sampled routinely from beet plants over a 42 day period after emergence (15 June 2013) until 26 July 2013. For clothianidin, imidacloprid and respective metabolites: LOQ: 1 ppb LOD: 0.1 ppb For beta-cyfluthrin LOQ: 10 ppb Other sampled matrices: dead honey bees (samples not analyzed)	82.1% in the treatment group. The assessment on honey bee flight activity in the test plots during the exposure period overlapped with the guttation period; however, flight activity was low in the test plots with 77 honey bees observed in each test site and no honey bees were observed collecting guttation droplets during the exposure period in both the control and treatment plot. **Effects:** No treatment related adverse effects of the potential exposure of the colonies to guttating beets on honey bee colony health and development (mortality, colony strength, health, brood development and food storage) were observed during the exposure and monitoring phase. **Limitations:** Low attractiveness of the crop. Combi-product not a registered use therefore effects information of limited value. There is no reporting of the time of day when colony assessments were made. No statistical analysis performed.	

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

Study type / Application method / Species	Study Methodology	Review Comments	Reference
Tier II *Apis* Trials			
Open Feeding Study Individual foragers were trained to a feeder, captured, fed spiked sugar solution, tagged and released away from hives and monitored for up to 3 days after capture Honey bee	Test crop: N/A Test species: *Apis mellifera* Application rate: individual pollen foragers were captured, fed 49 µL of sucrose solution containing 1 µL of either clothianidin (2.5 ng/bee; 25 ppb) or imidacloprid (7.5 or 11.25 ng/bee; 75 or 112.5 ppb) for 90 minutes Number of hives tested: 1 hive (containing >30,000 bees) was used to sample bees; total number of bees tested was 98 in 2011 and 110 in 2012 Exposure period: 90 min Observation period: up to 3 days after capture Effect parameters: number of bees that did not fly, delayed start to flying, return flight to hive, vector flight, homing flight Location: Germany Year: 2011 and 2012	**REVIEW:** Individual foragers were trained to a feeder, captured, fed sugar solution with 7.5 or 11.25 ng imidacloprid/bee, or 2.5 ng clothianidin/bee, tagged and released away from hives and monitored for up to 3 days after capture. Effects noted as follows: Results showed that both imidacloprid treatments significantly increased the number of bees failing to return to the hive, that the bees exposed to the highest imidacloprid treatment (112.5 ppb) had significantly shorter vector flights (although duration was not statistically affected by any treatment) and that the direction and the number of directional changes of these vector flights was significantly different when compared to the control in both the imidacloprid treatments. This suggests the bees were relying on the sun compass more than their current memory stores. Clothianidin results indicated that this treatment resulted in a significant difference in the direction of the bees compared to the control for the vector flights. This also suggests the bees were relying on the sun compass more than their current memory stores. During homing flights, the total flight path had a significantly longer length and increased duration in bees treated with 25 ppb clothianidin. This suggests that activating remote memories and acquiring new information during orientation flights were affected in clothianidin treated bees. **MAJOR UNCERTAINTIES:** Only 1 hive per year was used to sample test bees and the sample size was very low (15-20 bees). The number of test bees in the 11.25 ng/bee imidacloprid treatment is very low since it was only tested in 2011; the higher dose was omitted in 2012. This resulted in a lower number of tested individuals for this dose and an uneven treatment study design. As the imidacloprid doses were notably high compared to currently available Tier I data, it is unclear whether these bees suffered mortality and this was not reported. No description of the surrounding vegetation within a 2-5km radius of the hives was provided to account for foraging exposure outside of the trained feeders. It's not clear if experiments were run on different days (which may have	Fischer J., Müller T., Spatz A.-K., Greggers U., Grünewald B., Menzel R. 2014. Neonicotinoids interfere with specific components of navigation in honeybees.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		led to different environmental and colony conditions that could have affected flight and bee behaviour), or if all of the test bees were collected over the course of one day in 2011 and one day in 2012. The 2011 and 2012 data was pooled despite slightly different hive locations and no mention of any statistical test to determine if pooling data was appropriate. The authors only mentioned that they did not observe any differences in the flight behaviors between the years as a justification for pooling. It was assumed by the reviewer that the bees consumed the entire 1 µL allotment. The reviewer assumed that these colonies were in excellent health prior to the experiment. Nothing was noted by the authors about the quality of the hives prior to the test.	
Open Feeding Study 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% brewers 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	**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 affects 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. In the colony feeding studies observed to date from the registrant, effects on honey storage may have been masked because the bees are exposed through contaminated sucrose. In this study design there appeared to be effects in both pollen storage and honey storage which was not masked from being exposed to contaminated bee bread.	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	Reference
	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		
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	Test crop: surrounding vegetation not stated Test species: honey bee Application rate: 100 g pollen paste (60% honey bee 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	**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. Although significantly lower, sperm viability of 83.5% in treated drones may be sufficient for reproductive output. It is unknown how the results of this study would relate in the field. 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	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.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
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	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 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	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).	

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	viability) was assessed after 14 days in the observation cages Residues: dose verification prior to experimentation Location: Bern, Switzerland Year: April – May 2015		
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 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	**REVIEW:** 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 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	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	Reference
		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.	
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	**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. No description of the surrounding landscape was provided to characterize exposure. 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	Reference
	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 post-grafting. Effect parameters: daily queen flights, presence of queens and developing workers, queen dissections Location: Bern, Switzerland Year: 2013		
Open Feeding Study Individual foragers were trained to a feeder, captured, fed sucrose solution spiked with either clothianidin or imidacloprid, tagged and released away from hives and monitored for up to 48 hours after capture Honey bee	Test crop: N/A Test species: *Apis mellifera* Application rate: trained worker bees were captured a at a training feeder located 7 m away, and were individually exposed to 10 µL of a 2 M sucrose solution containing either 0.00005, 0.0005, 0.001 and 0.002 µg clothianidin/bee or 0.00015, 0.0015, 0.003 and 0.006 µg imidacloprid/bee. They were then kept in isolation for 20 min prior to being released. Bees were monitored with RFID tracking tags for return to the hive for up to 48 hours after exposure. Number of hives tested: 1 nucleus bee hive/year containing 6 mini combs and approximately 2000 bees; maximum of 12 bees/treatment were tested; 8 trials were repeated for clothianidin and 2 trials were	**REVIEW:** This study was conducted during the summer of 2009 and 2010 at a research facility in Germany. Each trial included training foragers to consume contaminated sucrose from feeders located 7 m away from the experimental hives and a subsequent observation period of up to 48 hours. One week was needed to conduct a single test. Bees were labeled with radio frequency identification (RFID) tags to track foraging activity. *Clothianidin:* At 3 hours after exposure, a trend of declining in proportion of bees that returned to the hive and the number of feeder visits was seen with the increase of treatment doses from 0.05 – 2 ng/bee. During 3 hours of exposure to 0.5, 1 and 2 ng/bee, there were significant increases in the time duration of foraging trip, time to feeder, time at feeder, time to hive, and the interval inside the hive between trips. Some of these effects persisted up until 24 hours after wards: increased foraging trip duration, increased time to hive, and interval between foraging trips. Number of feeder visits and time to feeder were not significantly affected 24 hours	Schneider CW, Tautz J, Grünewald B and Fuchs S. 2012. RFID tracking of sublethal effects of two neonicotinoid insecticides on the foraging behavior of *Apis* mellifera. Plos One 7(1):e30023.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	repeated for imidacloprid Exposure period: 20 min Observation period: up to 48 hours after capture Effect parameters: number of feeder visits, length of time for a foraging trip, time to feeder, at feeder, and to hive, interval between foraging trips, time inside the hive Location: Oberursel, Germany Year: 2009 and 2010	after. *Imidacloprid:* At 3 hours after exposure, a trend of declining in proportion of bees that returned to the hive and the number of feeder visits was seen with the increase of treatment doses from 0.15 – 6 ng/bee. At 6 ng/bee, 25% bees returned to the hive and no bees returned to the feeder within 24 hours. During 3 hours of the exposure to 1.5 and 3 ng/bee, there were significant increases in the time duration of foraging trip, time to feeder, time at feeder, time to hive, and the interval inside the hive between trips. The majority of effects were not significantly different after 24 hours except the interval between foraging trips and time to feeder. **MAJOR UNCERTAINTIES:** There were large variations in measured parameters which may be related to the small sample size, particularly for imidacloprid. Two trials was ran for imidacloprid as a means for validation and calibration of the test methods whereas 8 trials were run for clothianidin. No information was provided on other factors that could potentially confound the results, such as husbandry of the colonies, pathogens (Nosema) and parasites (Varroa) and other viral diseases prior to or during the experimental phase.	
Open Feeding Study Hives were fed approximately every 5-10 days for a total of approximately 68 days with spiked sucrose and pollen paste containing 0, 400, 800 or 4000 ppb clothianidin. Honey bee	Test crop: N/A Test species: *Apis mellifera* Application rate: spiked sugar syrup in a feeder and pollen paste made with spiked sucrose with pollen and pollen substitute were fed to hives approximately every 5-10 days for a total of 68 days in the control hives and 126 days in the treated hives; there were 2 control hives and 1 hive/treatment for the 400, 800 and 4000 ppb clothianidin treatments Number of hives tested: 5 hives (10,000 bees each); 1 hive/treatment Exposure period: *Control:* 18 July 2010 - 24 September	**REVIEW:** This study tested concentrations of 400, 800 and 4000 ppb that were well above the documented LC50 and NOEL effect levels. No statistical analyses were conducted because only 1 hive/treatment was tested. Dose-response effects were seen in the number of declining adults and brood and the increase in dead bees and hive failures over the 68 day period. **MAJOR UNCERTAINTIES:** The test concentrations are well above the LC_{50} or NOEL levels for clothianidin. The total per capita intake was reported to be 0.0360 µg/bee, 0.1150 µg/bee and 0.0706 µg/bee for the 400, 800 and 400 ppb clothianidin treatments, respectively. Clothianidin's reported acute contact 48-hr LD50 is 0.0439 µg a.i./bee and acute oral 48-hr LC50 is 0.00368 µg/bee (USEPA). The average total intake per bee is near the acute contact LD50 and at least an order of magnitude higher than the acute oral LC50 for clothianidin. If the	Yamada T, Yamada K and Wada N. 2012. Influence of dinotefuran and clothiandin on a bee colony. Jpn J Clin Ecol 21:10-23.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	2010 (68 days) *400 and 800 ppb:* 49 to 84 days before failure *4000 ppb:* 12 days before failure Observation period: *Control:* 18 July 2010 - 24 September 2010 (68 days) *Treatment:* 18 July 2010 - 21 November 2010 (126 days) Effect parameters: colony assessments including adult and brood counts, consumption of sucrose syrup and pollen paste, number of dead adults Location: Japan Year: 2010	average chemical intake in the colonies that the study authors reported is correct, it should not be surprising that each of these colonies collapsed. No statistical analysis was performed on any of the data by the study authors. This is likely a result of using only one hive/treatment which precludes the ability to quantitatively analyze the data. This study included descriptions of mortality around hive entrances that were not quantitative, it lacked data around other hive endpoints (e.g. honey and pollen storage), and lacked control colony observations after Day 68. Although colonies were able to freely forage, if they did not want (or wanted to supplement) the supplied sugar syrup and pollen paste, the study authors reported that few flowers were in bloom. Therefore, it is unclear whether the observed colony responses were due to toxicity inherent from the test chemical or due to colony starvation due to inadequate forage.	
Open Topical Study Individual foraging bees were captured and 1 µL was applied dorsally to each bee with a dose of 0.545, 1.09, 2.18, 5.45 or 10.9 ng clothianidin/bee and then placed in a holding cage with 67% sucrose solution and water for 3 h prior to being released 500 m away from their home hive. Honey bee	Test crop: hives surrounded by fallow and buckwheat fields and mixed forest Test species: *Apis mellifera* Application rate: foraging bees were captured, marked, and had 1 µL drops applied to dorsal side of thorax containing 0.0005, 0.001, 0.002, 0.005 or 0.011 µg clothianidin/bee (doses were based on 1/40, 1/20, 1/10, ¼, ½ of the LD_{50}=0.022 ng/bee); bees were placed in a holding cage with 67% sucrose solution and water for 3 h prior to being released 500 m away from their home hive Number of hives tested: 6 hives were set up along a path at 1 m intervals on August 17 (4) and September 16 (2); 20 bees/treatment were sampled on 2 October and 20 November Exposure period: 3 hours (topically) Observation period: 1700 seconds (approximately 30 min after release) Effect parameters: number of bees	**REVIEW:** The proportion of successful homing flights was significantly lower among treatments with doses equal or higher than 0.002 µg/bee; no significant differences were observed in the lower doses. **MAJOR UNCERTAINTIES:** The LD_{50} selected for this study is lower (0.0218 µg/bee) than the value (0.0275 µg/bee) that was selected for the Tier I risk assessment. It is unknown if these hives were in prior contact with neonicotinoid contaminates. The timing of the hives being set up (August – September) is late in the year and may have affected the quality of the foragers (i.e. older foragers) collected. The reviewer assumed that these colonies were in excellent health prior to the experiment. Nothing was noted by the authors about the quality of the hives prior to the test.	Matsumoto T. 2013. Reduction in homing flights in the honey bee *Apis* mellifera after a sublethal dose of neonicotinoid insecticides. Bulletin of Insectology 66(1):1-9.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	returning to hive (homing flight) Location: Japan Year: unknown		
Tier III *Apis* Trials			
Field Study Various field studies with different application methods were reviewed for this article. Honey bee, Bumble 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
Field Study Dust applied to	Test crop: *Phacelia tanacetifolia* Test species: *Apis mellifera* hives Application rate: dust was collected from a	**REVIEW:** Significant treatment effects after exposure to 0.25 g a.s./ha of clothianidin dust values were seen on foraging when compared to the control and on mortality levels when compared to the control and when	Pistorius,J., Wehner,A., Kriszan,M.,

Study type / Application method / Species	Study Methodology	Review Comments	Reference
simulate seed treatment application Honey bee	seed treatment facility during packaging of maize treated with Poncho FS (600 g/L clothianidin) and mixed with soil; a target application rate of 600 g dust mixture/ha was applied via a specialized dust applicator attached to a pneumatic seeder. Three treatments: (1) 0.25 g a.s./ha field of 0.4167 ha, (2) 1 g a.s./ha field of 0.4167 ha, and (3) control field of 0.6374 ha Number of colonies tested: 4 colonies/treatment field were placed about 3 m from the edge Exposure period: 7 days Observation period: 11 days (4 days before application and 7 days after) Effect parameters: mortality, foraging activity, behaviour, flight activity, colony condition, pollen analysis Residue analysis: dead bees, bee bread Location: Southern Germany Year: 2012	comparing the pre- to post-exposure values. Significant treatment effects after exposure to 1.0 g a.s./ha were seen on foraging when comparing the pre- to the post-exposure values, on mortality levels when compared to the control and when comparing the pre- to post-exposure values, and by 11 days after application the number of adults bees were significantly lower by 59% when compared to the control hive counts. No treatment-related brood effects were seen. No statistical analysis on changes in the pollen stores over time were conducted but trends showed that the levels fluctuated in all three treatments over time. Clothianidin was not detected in control dead bees or bee bread. Metabolite residues were not detected in any matrix examined. Dead bees had highest clothianidin residues when sampled 1 hour after application and ranged from 30.9 – 33 µg/kg. Bee bread samples had the highest clothianidin residues of 28.0 µg/kg in the 0.25 g a.s./ha treatment and 18.4 µg/kg in the 1..0 g a.s./ha treatment. **MAJOR UNCERTAINTIES:** Dust particles used were limited to only the size classes of <80 µm and 80-160µm, as the authors stated that previous work indicated these sizes may cause greater effects, have higher residue content, are more likely to drift and be more relevant to honey bees (as their sizes may resemble pollen). By limiting all the active substance application to these particle sizes, the experiment may simulate a higher end exposure to bees, and it's relevance to actual field conditions is uncertain. The relevance of the rates chosen (0.25 and 1.0 g a.s./ha) is uncertain compared to actual field conditions. The study authors discussion referred to proposals from EFSA (2013) using worst-case deposition rates off-crop of 0.56% or 5.6% of the application rate for maize sown with and without deflectors, respectively, which would result in a range of high-end exposure rates of 0.112 g a.s./ha – 2.8 g a.s./ha. The actual range of exposures in dust following seed treatments is uncertain and likely to vary considerably with different planting equipment, depths and seed crops. Testing honey bee colonies in August and September may be too late in the season when production begins to wind down (as observed here in brood production after 14DAA) and may have introduced an additional source of uncertainty compared to an earlier (spring) exposure window, which would also be when the vast majority of treated seed crops would be planted in Canada. No information was presented on potential prior exposure history of the hives to pesticides and residues of other pesticides besides clothianidin	Bargen,H., Knabe,S., Klein,O., Frommberger,M., Stahler,M., Heimbach,U.. 2015. Application of predefined doses of neonicotinoid containing dusts in field trials and acute effects on honey bees. Bulletin of Insectology 68 (2): 161-172

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		and its metabolites were not tested for in the analytical sampling. A description of the surrounding forage to help explain if the differences in control foraging numbers or mortality difference in T1 before application were due to unexpected exposure. The mean number of adult bees in each colony at the start of the experiment appeared to be least in controls. The study authors did not indicate whether an attempt was made to block colonies according to their relative strengths prior to field placement, but if control colonies were weaker compared to treatment colonies, than the study design may have masked some potential effects.	
Field Study Hive monitoring Seed treatment Honey bee, Bumble bee	Test crop: winter oilseed rape (OSR) Test species: *Apis mellifera carnica*, *Bombus terrestris dalmatinus* and *Osmia bicornis* Test sites: A control site (C) and treatment site (T) each comprising an area of 65 km^2 of arable land with a diameter of 9 km were used in the study. Test sites were characterized by high OSR cultivation with no other crop providing suitable bee forage during OSR flowering. A minimum 3 km distance between honey bee and bumble bee hive study locations and the border of the test sites was provided. The distance for red mason bees was at least 1.9 km, because of their comparatively shorter foraging flights. Post-exposure sites: *Apis mellifera:* four locations in Erlensee, west-central Germany in an area without any agricultural or horticultural activities *Bombus terrestris:* nature park in Belgium (Park Lieteberg, which belongs to the National Park Hoge Kempen, covering more than 5700 ha consisting mainly of forests, lakes and heath) *Osmia bicornis:* nesting blocks were removed from the study locations and	**REVIEW:** Exposure to clothianidin winter oilseed rape plants grown from seeds treated with Elado® (nominal 10g clothianidin and 2 g β-cyfluthrin/kg seed; 0.0297-0.0663 mg clothianidin a.i./seed) did not adversely affect: honey bee (*Apis mellifera*) colony strength, brood development, honey yield and pathogen infection; bumble bee (*Bombus terrestris*) colony development (hive weight and number of workers) and reproductive output (number of young queens and queen brood cells) or; red mason bee (*Osmia bicornis*) reproductive performance (number of completed nesting holes, cocoons, parasitization rate and overwintering success). Palynological analysis indicated that test bees were exposed to OSR pollen in the treatment sites at varying levels throughout the exposure period. For honey bees, the mean percentage of OSR pollen from pollen traps increased from 35.8±13.5% 15 days after hive placement (DAP) in treated sites to 82.8±8.8% 19-23 DAP. Honey sampled from honey bee hives at the end of the exposure phase (33 DAP) contained on average up to 79.61±7.48% OSR pollen. OSR pollen sampled from bumble bees foraging in treatment sites was low at 32% or less 4-6 DAP but this significantly increased to 95% 15-16 DAP. The mean amount of OSR pollen sampled from red mason bee nesting blocks (DAP 12-13 and 19-20) was overall low in treated sites at 10.6 ± 6.8% or less. At the treatment site, clothianidin residues were measured in bee collected nectar, pollen and honey. Maximum residues of clothianidin from honey bees were 3.6 µg/kg in nectar (mean 1.3±0.9 µg/kg), 3.5 µg/kg in pollen (mean 1.7±0.8 µg/kg) and 2.1 µg/kg in honey (mean 1.35 ± 0.48 µg/kg). Maximum residues of clothianidin in pollen from bumble	Heimbach, F., Russ, A., Schimmer, M., Born, K., 2016. Large-scale monitoring of effects of clothianidin dressed oilseed rape seeds on pollinating insects in Northern Germany: implementation of the monitoring project and its representativeness. Ecotoxicology. 25: 1630-1647. AND Rolke, D., Fuchs, S., Grünewald, B. Z. Gao, W. Blenau. 2016. Large-scale monitoring of effects of clothianidin-dressed oilseed rape seeds

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	transferred to a sheltered place (an agricultural warehouse) to avoid predation or parasitism. Application rate: In autumn 2013, Elado®-dressed OSR seeds (nominal concentration of 10 g clothianidin and 2 g β-cyfluthrin/kg seed) were drilled in study fields within the T site at a rate of 28.8 ± 10 g/ha clothianidin calculated to be 0.0297-0.0663 mg a.i./seed based on a seeding rate of 3.6 ± 1.1 kg seed/ha, 5.92 ± 1.21 g/1000 seeds and an average loading rate of 7.8 ±1.5 g a.i./kg seed. Elado®-free OSR seeds were drilled in study fields within the C site. Number of hives tested: *Apis mellifera:* 8 hives (queen + 10 bee covered combs) were placed in each of 6 study locations in both the T and C sites for a total of 96 hives. *Bombus terrestris*: 10 hives (queen + 40-50 workers) were placed in each of 6 study locations in both the T and C sites for a total of 120 hives. *Osmia bicornis*: 3 nesting shelters with 8 nesting blocks were set up at each of 6 study locations in both the T and C sites for a total of 96 nesting shelters and 1600 nesting holes per study location. *All test species:* At 3 of the study locations hives/nesting blocks were placed directly adjacent to OSR fields and at the other 3 locations placed 400 m distance from OSR fields for *A. mellifera* and *B. terrestris* and 100 m for *O. bicornis* bees at both T and C sites. Honey bee and bumble bee hives were placed at the same study locations each separated by ~ 10-30 m.	bees and red mason bees were 1.3 µg/kg (mean 0.88 ± 0.27 µg/kg) and 1.7 µg/kg (mean 0.88 ± 0.42 µg/kg), respectively. TZMU and TZNG were < LOD or <LOQ in all test sites. No quantifiable residues of clothianidin were found in the control site. **MAJOR UNCERTAINTIES:** No initial measure of the colony size of the test honey bees was provided at the start of exposure. The ratio between the number of bees and the number of bees at 1st assessment was used to adjust for initial differences in the effects parameters. The first assessment was 4-7 days after bees were exposed. Sample size and frequency in the bumble bee and red mason bee studies may not have been sufficient to permit residue detection during the exposure phase. Residues from treated winter oilseed rape may not represent a worst case exposure scenario in comparison to other treated oilseed crops such as spring/summer oilseed rape and canola. Palynological analysis indicated that bees were foraging predominantly on other non-crop species during the exposure period during the first sampling event for honey bees and bumble bees and in all sampling events for red mason bees indicating a low exposure scenario for test bees. No overwintering measures for honey bees or bumble bees. For red mason bees males emerge first before females due to their location in the nesting tubes. Smaller females tend to produce more male offspring and reduce female offspring body size, because smaller females are obtaining less pollen. Also, female age also predicts sex allocation in offspring – older females are less efficient at foraging for pollen and thus produce more males.	on pollinating insects in Northern Germany: effects on honey bees (*Apis mellifera*). Ecotoxicology 25: 1648-1665. AND Sterk, G., Peters, B., Gao, Z., Zumkier, U., 2016. Large-scale monitoring of effects of clothianidin-dressed OSR seeds on pollinating insects in Northern Germany: effects on large earth bumble bees (*Bombus terrestris*). Ecotoxicology.25: 1666-1678. AND Peters, B., Gao, Z. & Zumkier, U., 2016. Large-scale monitoring of effects of clothianidin-dressed oilseed rape seeds on pollinating

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	Exposure period: *Apis mellifera*: 28 days - hives placed in fields from 21 April 2014 (OSR full flowering) to 20 May 2014 (when 40-90% pods reached final size). *Bombus terrestris*: 22 days-hives placed on 24 April 2014 and removed May 2014 at the end of OSR bloom. *Osmia bicornis*: 35 days-cocoons placed on 21 April 2014 (OSR full flowering) and removed 26 May 2014 at the end of OSR flowering Post-exposure period: *Apis mellifera*: 123 days - from 26 May 2014 (34 days after hive placement or DAP) to 26 September 2014 (DAP 157); *Bombus terrestris*: 21 days from May to June 2014 (DAP 43); *Osmia bicornis*-from 26 May 2014-30 March 2015 Observation period: *Apis mellifera*-157 days; *Bombus terrestris*- 43 days; *Osmia bicornis*-343 days Effect parameters: palynological analysis; *Apis mellifera*: colony strength, development, honey production and health; *Bombus terrestris*: colony development; *Osmia bicornis*: reproductive performance Residue analysis: pollen and nectar from tented and free foraging honey bees; pollen from red mason nesting blocks and free foraging bumble bees; honey from free foraging honey bee hives LOQ = 1.0 µg/kg, LOD = 0.3 µg/kg for clothianidin, TZNG and TZMU Location: Germany Year: 2013-2014		insects in Northern Germany: effects on red mason bees (*Osmia bicornis*) Ecotoxicology. 25: 1679-1690. AND Rolke, D., Persigehl, M., Peters, B., Sterk, G., Blenau, W., 2016. Large-scale monitoring of effects of clothianidin-dressed oilseed rape seeds on pollinating insects in northern Germany: residues of clothianidin in pollen, nectar and honey. Ecotoxicology.25: 1691-1701.

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Field Study Seed treatment Honey bee	Test crop: 2010: winter oilseed rape; 2012: spring oilseed rape Test species: *Apis mellifera carnica* and *Apis mellifera caucasica* Application rate: Imidacloprid: Chinook Plus 500 FS 2010: 420 g/L, dose 5 ml/kg seed on winter oilseed rape, Chinook 200 FS 100 g/L on spring oilseed rape, dose 20 ml/kg seeds on pring rape; Thiamethoxam: Cruiser OSR 322FS, 280 g/l dose 11.25 ml/kg seeds on winter oilseed rape and spring rape. Clothianidin: Modesto 480 FS, 400 g/l, dose 12.5 ml/ kg Seeds on pring rape. 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	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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		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. **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.	
Field Study Seed treatment Guttation water exposure Honey bee	Test crop: winter oilseed rape Test species: *Apis mellifera* hives Application rate: *2009:* 1 field planted in Southern Germany with CruiserOSR (0.0185 mg thiamethoxam/seed); 2 fields planted with Elado + TMTD Satec (0.044 mg clothianidin/grain) *2010:* 2 fields planted in Southern Germany with Elado + TMTD Satec + DMM (0.044 mg clothianidin/grain) *2011:* 1 field planted in Northern Germany with CruiserOSR (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	**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	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:

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	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	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.	http://dx.doi.org/10.1093/jee/tov287 summary
Field Study Seed treatment Honey bee, Bumble bee, Solitary bee	Test crop: oilseed rape Test species: *Apis mellifera* hives, *Bombus terrestris* hives, *Osmia bicornis* solitary bees Application rate: 16 fields (8 pairs) were used in the study, 1 field in each of the 8 pairs was planted with Elado (clothianidin 400 g/L; converts to 0.06 mg a.i./seed and β-cyfluthrin 180 g/L); fields were planted from April 6 to May 18, 2013 Number of colonies tested: *Apis mellifera:* 6 hives (mean of 3418 bees)/field for a total of 96 hives *Bombus terrestris:* 6 hives (queen + 50	**REVIEW:** Wild bee density (which includes the number of solitary and bumble bees) was significantly lower in the insecticide-treated fields compared to the control. Larger field sizes and increased flower cover had positive influences on increasing wild bee density. The amount of agricultural land and the type of flower cover (crop vs wild flowers) did not affect density. During the exposure period effects were not seen in honey bee colony strength; in bumble bee colonies there were significant effects with treatment including lower weight gain and fewer cocoons of all castes; and significantly lower numbers of nesting tubes were seen in the *O. bicornis* solitary bee nests. Because of the differences in effects seen across the three species tested, the authors conclude from this study that the use of honey bees as model organism in environmental risk assessments of neonicotinoids may not be suitable for generalizations to other bee species based on methodology and/or biological differences.	Rundlöf M., Andersson G.K.S., Bommarco R., Fries I., Hederström V., Herbertsson L., Jonsson O., Klatt B.K., Pedersen T.R., Yourstone J., Smith H.G. 2015. Seed coating with a neonicotinoid insecticide negatively affects wild bees. Nature

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	workers and brood)/field for a total of 96 hives *Osmia bicornis:*48 nests were tested Exposure and observation period: *Apis mellifera:* 14-28 June to 2-31 July; 18-33 days *Bombus terrestris:* 14-28 June to 7 July-5 August; 23-38 days *Osmia bicornis:* placement during 10-24 June ; nesting tubes collected 36-43 days later and placed in cold storage until October 2013 for assessment Effect parameters: *Foraging activity:* transect surveys of wild bees and flower cover in fields and adjacent borders *Apis mellifera:* number of adults, pollen trap samples *Bombus terrestris:* number of queens and worker/male cocoons, weight of cocoons, larvae and nest structure, number of cells for food storage, pollen from foragers *Osmia bicornis:* proportion of adults that successfully emerged, pollen from brood cells Residue analysis: crop pollen and nectar from the field, flowers and leaves from transects walked for bee survey and field borders *Apis mellifera:* pollen and nectar from foragers *Bombus terrestris:* nectar from foragers Location: Sweden Year: 2013	**MAJOR UNCERTAINTIES:** The control fields contained just the fungicide while the treated fields contained both a neonicotinoid and a pyrethroid along with a fungicide, While the reviewer assumes that direct effects from the pyrethroid are likely low (no detected residues in nectar/pollen and it is not a systemic product), there is uncertainty in discerning the relative impact of the pyrethroid on other environmental factors (for example, indirect effects of beta-cyfluthrin on crop growth and flower density may have impacted the foraging of test bees). The study authors' state that compared to the wild bees, honey bees were not affected. However, the response variables measured between the wild bees and honey bees are not entirely comparable as weight and/or reproductive parameters were measured in the wild bees, whereas numbers of adults were measured in the honey bees studies as an indirect measurement of fitness. This introduces uncertainty in the ability to compare responses between the species. Exposure through pollen to *O. bicornis* cannot be confirmed since none were found nesting in the treated fields (therefore no pollen to collect from provisions).	521, 77–80

Study type / Application method / Species	Study Methodology	Review Comments	Reference
Hive Monitoring Honey bee, bumble bee and *Osmia bicornis* were placed in oilseed rape fields during bloom (from treated seed) in Germany, Hungary and United Kingdom) to examine effects on the colony (reproduction and survival), and also expression of residues. This study assessed interactions between locations, seed treatment and residues. Honey bee, Bumble bee, Solitary bee	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	**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	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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	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	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 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 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 scientist's criticisms indicate that data was omitted from the article. The review of this study is based on submitted data and the article.**	

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	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. 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.		

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	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.		
Field Study Hive monitoring	Test crop: maize Test species: honey bee hives Application rate: maize seed treated with 1.25 mg/kernel of clothianidin (talc was	**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	Krupke CH, Hunt GJ, Eitzer BD, Andino G and Given K. 2012.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
Seed treatment Honey bee	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	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. Previous exposure history of the field used for sampling soil is not provided. The source of the colonies and their prior exposure history is uncertain. The methods to collect the waste talc were not clearly described.	Multiple routes of pesticide exposure for honey bees living near agricultural fields. Plos One 7(1):e29268.
Field Study 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	**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	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 summary

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	levels, pollen collection, hive weight, brood development Residue analysis: alive foragers, trapped pollen, screened corn pollen Location: Quebec, Canada Year: 2013	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. One apiary location was changed in this 2013 study compared to the 2012. 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.	
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	**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:	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	Reference
	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	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	

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		($F_{(1,48)}$=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 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.	
Field Study hive monitoring 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. Honey bee	Test crop: N/A Test species: *Apis mellifera* hives Application rate: 17 frames were constructed with sections of a contaminated brood comb beside control brood comb and placed into experimental hives; various pesticides at different exposure levels were present in the contaminated brood comb Number of hives tested: 3 hives were used to host 28 experimental frames supporting the paired comb blocks Exposure and observation period: pupation recorded on day 12 and 19, adult emergence from brood comb recorded daily from day 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	**REVIEW:** Standard Langstroth frames with the center removed (22x11cm) were implanted with comb blocks of low or high levels of pesticide residues and placed in hives with caged queens. Effects were noted as follows: Delayed development of brood reared on the contaminated comb was observed and total larval mortality increased in both the contaminated and control sections of the comb with the repeated use of the experimental frames. Worker bees lived longer when reared on control comb and adult emergence was delayed when reared on contaminated comb. Only 1/13 brood comb samples contained residue levels for clothianidin, imidacloprid and thiamethoxam with LOD = 20; levels were 35 ng/g, 45 ng/g, and 38 ng/g, respectively. Pesticide residue transfer from contaminated to control was confirmed with chemical analysis over time. **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	Wu JY, Anelli CM, and Sheppard WS. 2011. Sub-lethal Effects of Pesticide Residues in Brood Comb on Worker Honey Bee (*Apis* mellifera) Development and Longevity. PLoS ONE 6(2): e14720.

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		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.	
Tier II Non-*Apis* Trials			
Tunnel Study Foliar application Bumble bee	Test crop: Kentucky bluegrass turf (*Poa pratensis*) with approximately 30% cover of flowering white clover (*Trifolium ripens*) Test species: *Bombus impatiens* Application rate: foliar applications of Arena 50 WDG at a rate of 450 g a.i./ha were made on 14 May 2012, *Experiment 1:* 1 hour after application the plots were watered with sprinkling cans, colonies were placed in the tunnels 2 days after application (16 May) *Experiment 2:* after application on 1 June, the turf was mowed to remove flower clovers and colonies were placed 1 week after mowing on 22 June when new blooms had formed Number of hives tested: small colonies (20 workers + fertilized queen) per treatment and control plots Exposure period: *Experiment 1:* 6 days *Experiment 2:* 2 weeks *Experiment 3:* bee counts were taken daily for 1 week Observation period: *Experiment 1:*after 6 days, colonies were moved to an insecticide free area for 6 weeks before destructively sampled *Experiment 2:* 2 weeks	**REVIEW:** Clothianidin residues of 171 ppb recovered from the nectar of treated blooming clover flowers resulted in significant treatment related effects on bumble bees. A significant reduction in foraging, and an increase in worker mortality was seen after a 5-6 day exposure and after the exposure period, slower colony weight gain and no new queens were produced. These effects were mitigated and not seen when colonies were placed on the treated turf after the flowers were mowed and a second flower growth was exposed. No significant differences were observed in the number of bumble and/or honey bees foraging in the clothianidin-treated or control areas. Residue analysis was not conducted on the second flowering. **MAJOR UNCERTAINTIES:** Adverse effects were not observed when colonies were placed in situ following mowing (3 weeks after treatment), however residues were not measured in clover blooms that came up following mowing, therefore it is not known what potential exposure levels were in the new clover blooms. The study rate for clothianidin is higher than the maximum labeled application rate in Canada (0.35 kg a.i./ha) for bluegrass weevil control. The Canadian label also indicates that the product is not to be applied to flowering crops or weeds if bees are visiting the treatment area and spray drift minimized to reduce harmful effects on bees in habitats close to the application site.	Larson, J.L., C.T. Redmond, and D.A. Potter. 2013. Assessing Insecticide Hazard to Bumble Bees Foraging on Flowering Weeds in Treated Lawns. PLoS ONE, 8(6): e66375

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	Experiment 3: 1 week Effect parameters: number of living and dead bees and brood, queens, honey pots, live adult and queen weight Residue analysis: *Experiment 1:* nectar samples from 100 non-pollinated flowers collected on day 6 after bees were removed Location: Kentucky, USA Year: 2012		
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 pollen patties for 9 weeks (63 days). Bumble bee	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 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	**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 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:** Samples of the food items were taken prior to spiking to ensure that they were free of thiamethoxam and clothianidin (LOD = 0.1 ppb). However, dose verification after adding was not conducted. Bees were maintained in a nest attached to a foraging box for 63 days, this may have cause stress on the bees since the 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.	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 51:450-459.
Closed Feeding Study Micro-colonies were	Test crop: N/A Test species: *Bombus terretris* Application rate: micro-colonies were fed *ad libitum* with 60% sugar water. Four	**REVIEW:** Chronic clothianidin exposure at 1 ppb in sugar water for a total of 33 days did not affect sugar water collection or fecundity (total number of males, eggs, larvae and pupae produced by workers in microcolonies) in bumble bees.	Piiroinen S, Botías C, Nicholls E, Goulson D. 2016. No effect of low-

Study type / Application method / Species	Study Methodology	Review Comments	Reference
artificially fed *ad libitum* with spiked 60% sugar water containing 1 of 4 treatments: (1) control, (2) 1 ppb of clothianidin, (3) parasite *Nosema* or (4) 1 ppb of clothianidin plus *Nosema*; sugar solutions and untreated pollen were replenished every 3 days for a total of 33 days. Bumble bee	treatments were tested: control, pesticide where 1 ppb of clothianidin was in sugar water, parasite where *Nosema ceranae* spores, or pesticide + parasite where 1 ppb of clothianidin was fed in addition to *N. ceranae* spores. Sugar solution and untreated pollen was replenished every 3 days for a total of 33 days. Number of hives tested: 60 micro-colonies (8 adult worker bees) for each treatment Exposure and observation period: 33 days Effect parameters: mortality, production of males, at the end of the exposure period the number of eggs, larvae, pupae, males was counted, a subset of alive and dead workers were screened for *Nosema* infection Location: presumed to be in UK Year: not stated	**MAJOR UNCERTAINTIES:** It was presumed by the reviewer that the exposure and observation period was 33 days (based on the raw data supplementary data). Only 1 bee belonging to the parasite treatment group was infected with *N. ceranae*. No spores were detected under the microscope. Therefore the *N. ceranae* data does not provide value to the pollinator risk assessment since the infectious nature of the particular strain of *N. ceranae* used in this experiment was never validated in bumble bees – it was extracted from honey bees and verified in honey bees as well.	level chronic neonicotinoid exposure on bumblebee learning and fecundity. PeerJ 4:e1808; DOI 10.7717/peerj.1808
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.	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	**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	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.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
Solitary bee	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	offspring sex ratio was significant; however, it is unclear if 47% compared to 55% females would result in a significant effect in the field.	
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 the study, a 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	Test crop: there were 5 different test locations: 1. Wester Ross (the Highlands) a pristine wilderness/enriched grassland habitat 2. University of Dundee Botanic Garden 3. Aberfeldy, near a livestock farming area 4. Perthshire and Fife, an intensively arable landscape Test species: *Bombus terrestris audax* Application rate: sugar syrup was presumed to be fed *ad libitum* for 5 weeks spiked with 2.5 ppb of imidacloprid, clothianidin or thiamethoxam Number of hives tested: 75 colonies were placed at 5 different locations; colonies produced a total of 5884 bees, 5365 brood and 727 queens Exposure and observation period: reviewer assumed 35 days (5 weeks) Effect parameters: nest mass, number of live bees, brood cells and queens at the end of the experiment, weight, cast of bees and male and female proportions at the end of the experiment, queen size estimate (Number of bees >535 mg in size was determined to be a queen)	**REVIEW:** In this study, the authors compared all three EU-suspended neonicotinoids, imidaclorpid, thiamethoxam and clothianidin, 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, and significantly reduced the number of brood cells at the end of the 5 week exposure period by 70% compared to the control. • The change in nest mass was significantly lower in the thiamethoxam fed hives after a 5 week exposure period by 10% compared to the control. • The proportion of females was significantly lower in the thiamethoxam fed hives by 49% compared to the control at the end of the 5 week exposure period. *Clothianidin* • Clothianidin fed to the hive in sucrose solution (presumed *ad libitum*) at a dose of 2.5 ppb significantly increased the number of queens produced by 266% by the end of the 5 week exposure period	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. DOI: 10.1038/srep24764

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link function (proportion females) was used. Bumble bee	Location: Scotland, UK Year: 2015	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 thiamthoxam 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.	
Open Feeding Study Hives were fed 3 times a week for a total of 77 days with 50% sugar syrup spiked with either imidacloprid or	Test crop: unknown, trial conducted in a greenhouse but the crop growing was not stated Test species: *Bombus impatiens* Application rate: hives were fed 50% sugar syrup solution that was contaminated with 0, 10, 20, 50, 100 ppb of either imidacloprid or clothianidin; solution was	**REVIEW:** *Imidacloprid:* *Queen and brood effects:* Queen effects were noted in queens after 6 and 11 weeks of exposure to 50-100 and 20-100 ppb respectively. Exposure levels are uncertain since no queens were ever observed in the flight box with feeders and the levels of recovered imidacloprid residues from syrup stored in wax cells was lower than target doses. Total brood (alive and dead) was	Scholer, J and V. Krischik. 2014. Chronic Exposure of Imidacloprid and Clothianidin Reduce Queen Survival, Forgaing, and Nectar Storing

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clothianidin at rates of 0, 10, 20, 50, 100 ppb; supplemental pollen collected from honey bee pollen traps was combined with a sugar supplement to create a paste that was provided weekly. Bumble bee	replenished 3 times a week for a total of 11 weeks (77 days); supplemental pollen collected from honey bee pollen traps was combined with a sugar supplement to create a paste that was provided weekly Number of hives tested: 162 hives (queen + 30-50 workers) were constructed in two attached cages, one for foraging and one for colony development that had a see-through lid; for each dose for both imidacloprid and clothianidin, 8 hives were tested (except for 0 ppb clothianidin where 9 hives were tested; the whole experiment was repeated twice Exposure and observation period: *Imidacloprid:* 1st trial July 6 to September 15, 2011 and 2nd trial September 14 to November 23, 2011 *Clothianidin:* 1st trial January 18 to March 30, 2012 and 2nd trial March 12 to May 25, 2012 Effect parameters: queen status, worker and queen movement (colony was in a box with a see-through plastic lid), syrup consumption, colony weight, number of wax pots and amount of syrup they contained, adult bee and brood counts of alive and dead, forager weight over time Residue analysis: dose verification of sugar syrup and pollen paste, sugar syrup from wax pots Location: Minnesota, USA Year: 2011-2012	significantly reduced at 50 and 100 ppb treatments and by week 11, the amount of alive brood was significantly reduced at 20-100 ppb when compared to control. No treatment-related effects were noted on daughter queens. *Worker bee and colony effects:* Worker bee movement significantly slowed down at the 20 and 50 ppb treatment and at all treatments, less males were produced. No treatment-related effects were seen in the number of female workers produced, or bee weight. By week 11, colony weight was significantly reduced in all treatments. *Residues and food consumption:* Dose verification confirmed that exposure levels were actually 0, 14, 16, 71 and 127 ppb instead of 0, 10, 20, 50 and 100 ppb. Sugar consumption was significantly lower in all treatments in weeks 2, 6 and 8; but significantly higher in the 0 and 10 ppb treatments in week 4. The weight of the syrup and the number of wax pots added was significantly reduced in the 50 and 100 ppb. *Clothianidin:* *Queen and brood effects:* Queen effects were noted in queens after 6 and 11 weeks of exposure to 50-100 and 20-100 ppb respectively. Exposure levels are uncertain since no queens were ever observed in the flight box with feeders and the levels of recovered clothianidin residues from syrup stored in wax cells was lower than target doses. Total brood (alive and dead) was significantly reduced at 50 and 100 ppb treatments and by week 11, the amount of alive brood was significantly reduced at 50-100 ppb when compared to control. No treatment-related effects were noted on daughter queens but a decreasing trend was seen. *Worker bee and colony effects:* Worker bee movement significantly slowed down at the 20 and 50 ppb treatment, at 50 and 100 ppb, less males were produced and at 20 ppb, bee weight was significantly lower. No treatment-related effects were seen in the number of female workers produced. By week 11, colony weight was significantly reduced in 20-100 ppb. *Residues and food consumption:* Dose verification confirmed that exposure levels were actually 0, 9, 17,	in Colonies of Bombus terrestris. Published: March 18, 2014 http://dx.doi.org/10.1371/journal.pone.0091573

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		39 and 76 ppb instead of 0, 10, 20, 50 and 100 ppb. Sugar consumption was significantly lower in all treatments in weeks 2, 6 and 8; but significantly higher in all treatments in week 4. The weight of the syrup and the number of wax pots added was significantly reduced in all clothianidin treatments. **MAJOR UNCERTAINTIES:** Variability in the measured test solutions was observed. It appears that the results of both trials, which were conducted at two different times, were combined for statistical analysis as well as in the presentation of the data in the figures. Given the variability measured in the test solutions, there is uncertainty in the actual doses received between these two trials, and the appropriateness of combining datasets. The limit of quantification or detection (LOQ/LOD) in the stock or test solutions or the syrup in the wax pots was not reported. The study authors state that the colonies were fed untreated sugar syrup for two weeks prior to the start of the study. The reviewer is uncertain what was removed or what had been added prior to this two weeks. The reviewer is uncertain as to why feed consumption was not evaluated past week 8 for an 11 week study. The 100 ppb treatment was removed from the chronic dose effect on worker behaviour analysis as there were too few bees to quantify movement. The removal of an entire treatment group will affect the overall result analysis. Without the raw data, this data set cannot be re-analyzed properly to include the missing treatment group. The nominal vs measured dose - the differences between these two resulted in a wide exposure range which brings the analysis into question (especially those looking at clothianidin exposure through the wax pots on queen effects where exposure was assumed to be through wax pots only and the recovered residue amount was 0 ppb from the pots for the 50 and 100 ppb nominal treatments). The details on what the bumble bees were foraging on away from the nest are not provided. The reviewer assumed the foraging was contained within the greenhouse on a crop (tomato being the most common) however; there are periods throughout the winter when even a greenhouse crop will not bloom under supplemental light and watering regimes. Trials on clothianidin were conducted during these periods when no bloom is expected in a greenhouse.	

Study type / Application method / Species	Study Methodology	Review Comments	Reference
Tier III Non-*Apis* Trials			
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
Field Study Hive monitoring 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	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)	**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).	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

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(15/07/14 - 2/08/14). Bumble bee	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	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.	
Field Study Seed treatment Bumble bee	Test crop: corn Test species: *Bombus impatiens* 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, 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	**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 of 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 hives 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	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.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	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: 2013	posed a problem for the sites 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.	
Field Study 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	**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*	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.

Study type / Application method / Species	Study Methodology	Review Comments	Reference
	bees/colony *Site C:* 20 colonies; mean of 16 bees/colony Exposure period: *Site A:* 13 April – 2 June (50 days) *Site B:* 13 April – 2 June (50 days) *Site C:* 26 April – 11 June (46 days) Observation period: *Site A:* 60 days *Site B:* 61 days *Site C:* 63 days Effect parameters: foraging activity, forager and nest pollen, colony weight, worker, drone, brood and queen weight was measured at the end of the experiment, nectar and pollen storage cells were measured at the end of the experiment, presence of *Nosema bombi* and/or *Crithidia bombi* in queens at the end of the experiment Residue analysis: nectar and pollen from colonies, nectar and pollen from nearby honey bee colonies, Location: England, UK Year: winter-sown in 2012, experiment in 2013	There were no treatment replicates for treatments in this study. The numbers of colonies within each test site were considered as pseudo replicates for various measurements. *Colony mass over time* There were significant changes in colony mass both between sites and between sites over time. The change in colony mass over time after placement in the field included a significant difference at Site C (imidacloprid mean peak mass=0.885 kg) compared with Sites A (untreated: 1.130 kg) and B (clothianidin=1.119 kg) from week 3 onwards. *Foraging activity over time* There was a significantly different pattern of foraging activity between sites and between sites over time with significant differences between colonies at site C and those at the other two sites in weeks 1-3 after placement on the field. The study author stated that the local climatic conditions (Site C flowered later than Sites A and B) during the foraging and colony mass assessment at each site may in part account for these differences. *Colony structure* Site C (imidacloprid) had significantly lower numbers of single occupancy larvae, drone/worker pupae, maximum brood mass increase and brood nest mass at colony dissection when compared to both Site A (untreated) and B (clothianidin). Site B (clothianidin) had significantly lower numbers of workers and nectar cells when 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); Site B (2.397 in nectar, 0.718 in pollen); Site C (no detects in nectar or pollen)	2013. Evaluation of the FERA study on bumble bees and consideration of its potential impact on the EFSA conclusions on neonicotinoids. EFSA Journal 11(6):3242. AND Goulson, D. 2015. Neonicotinoids impact bumblebee colony fitness in the field; a reanalysis of the UK's Food & Environment Research Agency 2012 experiment. Peer J 3:e854

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

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		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	

Study type / Application method / Species	Study Methodology	Review Comments	Reference
		clothianidin and thiamethoxam in both nectar and pollen. **MAJOR UNCERTAINTIES:** The test seed treatment rates were much lower (more than 4 times lower) than the registered rates in Canada on canola for imidacloprid but not for clothianidin. There was a lack of replication. Significant site effects were identified in the study - there was only one site for each treatment and control. There is no true control in the study. Multiple neonicotinoids were detected in the control colonies. The level of contamination in the control was even greater than that in the imidacloprid treatment in many cases. Colonies placed in site C were significantly smaller than that in Site A and B; and the colonies were placed two weeks later in Site C than in Sites A and B due to the late flowering of test crops in the sites. Such differences at the beginning of the study are expected to confound the comparison on the colony development between sites/treatments. The analytical method for thiamethoxam was not validated. The reliability of reported thiamethoxam residues is questionable. The statistical analysis of the results was debated in the published literature.	
Field Study Hive monitoring Seed treatment		See non-*Apis* and *Apis* information from this and related studies in the section: *Tier III Apis Trials*	Peters, B., Gao, Z. & Zumkier, U., 2016. Large-scale monitoring of effects of clothianidin-dressed oilseed rape seeds on pollinating insects in Northern Germany: effects on red mason bees (*Osmia bicornis*) Ecotoxicology. 25: 1679-1690.
Field Study Seed treatment		See non-*Apis* and *Apis* information from this study in the section: *Tier III Apis Trials*	Rundlöf M., Andersson G.K.S., Bommarco R., Fries I., Hederström V., Herbertsson L.,

Study type / Application method / Species	Study Methodology	Review Comments	Reference
			Jonsson O., Klatt B.K., Pedersen T.R., Yourstone J., Smith H.G. 2015. Seed coating with a neonicotinoid insecticide negatively affects wild bees. Nature 521, 77–80
Field Study Hive monitoring Seed treatment		See non-*Apis* and *Apis* information from this and related studies in the section: *Tier III Apis Trials*	Sterk, G., Peters, B., Gao, Z., Zumkier, U., 2016. Large-scale monitoring of effects of clothianidin-dressed OSR seeds on pollinating insects in Northern Germany: effects on large earth bumble bees (*Bombus terrestris*). Ecotoxicology.25: 1666-1678.
Hive Monitoring Honey bee, bumble bee and *Osmia bicornis* were placed in oilseed rape fields during bloom (from treated seed) in Germany, Hungary and United Kingdom) to		See non-*Apis* and *Apis* information from this study in the section: *Tier III Apis Trials*	Woodcock B.A., Bullock, J.M., Shore, R.F., Heard, M. S, Pereira, M.G, Redhead, J., Ridding, L., Dean, H, Sleep, D., Henrys, P., Peyton, J., Hulmes, S., Humes, L., Saraspataki, M.,

Study type / Application method / Species	Study Methodology	Review Comments	Reference
examine effects on the colony (reproduction and survival), and also expression of residues. This study assessed interactions between locations, seed treatment and residues.			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.

Appendix VI Pollinator Risk Assessment for Foliar Application of Clothianidin

Tier I Default Assessment for Foliar Applications

Table 1 Foliar Application: Acute contact risk to bees based on screening level exposure estimates for clothianidin.

Chemical	Application rate (EEC)	Koch and Weiber (adjustment factor)	Exposure Estimate for Bees*	Toxicity endpoint	RQ**	LOC exceeded?
	kg a.i./ha	µg a.i./bee per kg a.i./ha	µg a.i./bee/day	µg a.i./bee/day		
Clothianidin ***	0.035	2.4	0.084	LD_{50}: 0.0275	3.05	yes
	0.350	2.4	0.84	LD_{50}: 0.0275	30.5	yes

*Exposure estimate for bees= application rate (kg a.i./ha) x adjustment factor
**Exposure estimate for bees/toxicity endpoint
***Toxicity study endpoint based on exposure with TGAI submitted by the registrant. LD_{50} values ranged between 0.0218-0.0439 µg a.i./bee and an assessment using the endpoint range indicates risk as well (RQ = 1.9-38.5)
Note: LOC for bees is set at 0.4.

Table 2 Foliar Application: Acute and chronic dietary risk to bees based on screening level exposure estimates for clothianidin and relevant transformation products.

Chemical	Application rate	Adjustment factor	Exposure Estimate for Bees*	Toxicity endpoint	RQ**	LOC exceeded?
	kg a.i./ha	µg a.i./bee per kg a.i./ha	µg a.i./bee/day	µg a.i./bee/day		
ADULTS (ACUTE)						
Clothianidin	0.035	28.6	1.0	LD_{50}: 0.00368	272	yes
	0.350	28.6	10.0	LD_{50}: 0.00368	2717	yes
TZNG	0.035	28.6	1.0	LD_{50}: 3.95	0.3	no
	0.053	28.6	1.52	LD_{50}: 3.95	0.4	no
	0.350	28.6	10.0	LD_{50}: 3.95	2.5	yes
ADULTS (CHRONIC)						
Clothianidin	0.035	28.6	1.0	NOEL: 0.00036	2778	yes
	0.350	28.6	10.0	NOEL: 0.00036	27778	yes
BROOD (ACUTE)						
Clothianidin	0.035	12.15	0.425	LD_{50} > 0.0018	236	yes
	0.350	12.15	4.25	LD_{50} > 0.0018	2361	yes
BROOD (CHRONIC)						
Clothianidin	0.035	12.15	0.425	NOEL: 0.0009	472	yes
	0.350	12.15	4.25	NOEL: 0.0009	4722	yes

*Exposure estimate for bees= application rate (kg a.i./ha) x adjustment factor (28.6 µg a.i./bee per kg a.i./ha for adults and 12.15 µg a.i./bee per kg a.i./ha for larvae)
**Exposure estimate for bees/toxicity endpoint
Note: LOC for bees is set at 0.4 for acute endpoints and 1.0 for chronic endpoints.

Table 3 Foliar Application: In-field and off-field exposure of clothianidin on plant surfaces after application at the minimum and maximum single application rate.

Foliar Application Method	Drift Deposition Adjustment Factor %	Maximum In-field Single Application Rate (g a.i./ha)	Maximum Off-field Spray Drift (g a.i./ha)	Minimum In-field Single Application Rate (g a.i./ha)	Minimum Off-field Spray Drift (g a.i./ha)
Aerial	26	52.5	13.65	35	9.1
Airblast (Early Season)	74	210	155.4	50	37
Airblast (Late Season)	59	210	123.9	50	29.5
Ground Field Sprayer	11	350	38.5	35	7.10

Table 4 Foliar Application: Acute and chronic risk (contact and/or oral) to bees from spray drift based on screening level exposure clothianidin and relevant transformation products (TZNG)

Bee stage	Exposure	Chemical	Adjustment factor	Exposure estimate for bees* (µg a.i./bee/day)	Endpoint (µg a.i./bee/day)	RQ**	LOC exceeded ?
Aerial Spray (26% drift): 0.0137 kg a.i./ha (maximum off-field spray drift)							
Adult	Acute contact	Clothianidin	2.4	0.0328	LD_{50}: 0.0275	1.2	yes
	Acute oral	Clothianidin	28.6	0.392	LD_{50}: 0.00368	107	yes
		TZNG	28.6	0.392	LD_{50}: 3.95	0.1	no
	Chronic oral	Clothianidin	28.6	0.392	NOEL: 0.00036	1089	yes
Brood	Acute oral	Clothianidin	12.15	0.166	LD_{50} > 0.0018	89	yes
	Chronic oral	Clothianidin	12.15	0.166	NOEL: 0.0009	184	yes
Aerial Spray (26% drift): 0.0091 kg a.i./ha (minimum off-field spray drift)							
Adult	Acute contact	Clothianidin	2.4	0.022	LD_{50}: 0.0275	0.8	yes
	Acute oral	Clothianidin	28.6	0.260	LD_{50}: 0.00368	71	yes
		TZNG	28.6	0.260	LD_{50}: 3.95	0.1	no
	Chronic oral	Clothianidin	28.6	0.260	NOEL: 0.00036	722	yes
Brood	Acute oral	Clothianidin	12.15	0.111	LD_{50} > 0.0018	62	yes
	Chronic oral	Clothianidin	12.15	0.111	NOEL: 0.0009	123	yes
Airblast - early season (74% drift): 0.1554 kg a.i./ha(maximum off-field spray drift)							
Adult	Acute contact	Clothianidin	2.4	0.373	LD_{50}: 0.0275	14	yes
	Acute oral	Clothianidin	28.6	4.44	LD_{50}: 0.00368	1207	yes
		TZNG	28.6	4.44	LD_{50}: 3.95	1.1	yes
	Chronic oral	Clothianidin	28.6	4.44	NOEL: 0.00036	12333	yes
Brood	Acute oral	Clothianidin	12.15	1.89	LD_{50} > 0.0018	1050	yes
	Chronic oral	Clothianidin	12.15	1.89	NOEL: 0.0009	2100	yes
Airblast - early season (74% drift): 0.0370 kg a.i./ha (minimum off-field spray drift)							
Adult	Acute contact	Clothianidin	2.4	0.089	LD_{50}: 0.0275	3.2	yes
	Acute oral	Clothianidin	28.6	1.058	LD_{50}: 0.00368	288	yes

Bee stage	Exposure	Chemical	Adjustment factor	Exposure estimate for bees* (µg a.i./bee/day)	Endpoint (µg a.i./bee/day)	RQ**	LOC exceeded ?
		TZNG	28.6	1.058	LD_{50}: 3.95	0.3	no
	Chronic oral	Clothianidin	28.6	1.058	NOEL: 0.00036	2939	yes
Brood	Acute oral	Clothianidin	12.15	0.450	LD_{50} > 0.0018	250	yes
	Chronic oral	Clothianidin	12.15	0.450	NOEL: 0.0009	500	yes
Airblast - late season (59% drift): 0.1239 kg a.i./ha(maximum off-field spray drift)							
Adult	Acute contact	Clothianidin	2.4	0.297	LD_{50}: 0.0275	11	yes
	Acute oral	Clothianidin	28.6	3.54	LD_{50}: 0.00368	962	yes
		TZNG	28.6	3.54	LD_{50}: 3.95	0.9	yes
	Chronic oral	Clothianidin	28.6	3.54	NOEL: 0.00036	9833	yes
Brood	Acute oral	Clothianidin	12.15	1.51	LD_{50} > 0.0018	839	yes
	Chronic oral	Clothianidin	12.15	1.51	NOEL: 0.0009	1678	yes
Airblast - late season (59% drift): 0.0295 kg a.i./ha(minimum off-field spray drift)							
Adult	Acute contact	Clothianidin	2.4	0.071	LD_{50}: 0.0275	2.6	yes
	Acute oral	Clothianidin	28.6	0.844	LD_{50}: 0.00368	229	yes
		TZNG	28.6	0.844	LD_{50}: 3.95	0.2	no
	Chronic oral	Clothianidin	28.6	0.844	NOEL: 0.00036	2344	yes
Brood	Acute oral	Clothianidin	12.15	0.358	LD_{50} > 0.0018	199	yes
	Chronic oral	Clothianidin	12.15	0.358	NOEL: 0.0009	398	yes
Ground Field Spray (11% drift): 0.0385 kg a.i./ha(maximum off-field spray drift)							
Adult	Acute contact	Clothianidin	2.4	0.092	LD_{50}: 0.0275	3.3	yes
	Acute oral	Clothianidin	28.6	1.10	LD_{50}: 0.00368	299	yes
		TZNG	28.6	1.10	LD_{50}: 3.95	0.3	no
	Chronic oral	Clothianidin	28.6	1.10	NOEL: 0.00036	3056	yes
Brood	Acute oral	Clothianidin	12.15	0.468	LD_{50} > 0.0018	260	yes
	Chronic oral	Clothianidin	12.15	0.468	NOEL: 0.0009	520	yes
Ground Field Spray (11% drift): 0.0071 kg a.i./ha (minimum off-field spray drift)							
Adult	Acute contact	Clothianidin	2.4	0.017	LD_{50}: 0.0275	0.6	yes
	Acute oral	Clothianidin	28.6	0.203	LD_{50}: 0.00368	55	yes
		TZNG	28.6	0.203	LD_{50}: 3.95	0.1	no
	Chronic oral	Clothianidin	28.6	0.203	NOEL: 0.00036	564	yes
Brood	Acute oral	Clothianidin	12.15	0.086	LD_{50} > 0.0018	48	yes
	Chronic oral	Clothianidin	12.15	0.086	NOEL: 0.0009	96	yes

*Exposure estimate for bees= application rate (kg a.i./ha) x adjustment factor (µg a.i./bee per kg a.i./ha)
**Exposure estimate for bees/toxicity endpoint
Note: LOC for bees is set at 0.4 for acute endpoints and 1.0 for chronic endpoints.

Tier I Refined Assessment for Foliar Applications

Table 5 Foliar Application: Acute and Chronic Dietary Risk to Different Bee Castes Based on Maximum and Mean Residues of Clothianidin.

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
Apple Applied at 1 x 210 g a.i./ha, post-bloom 7 days before harvest. Same treatment scenario in each of two years. After each applica-tion sampling occurred the following year: Year 1 (Y1) sampled 218-232 DALA Year 2	**Y1:** 57.4 pollen from flowers	**Y1:** 0.71 nectar from flowers	No (0.057)	No (0.18)	No (0.16)	**Y1:** 31.2 pollen from flowers	**Y1:** 0.61 nectar from flowers	No (0.50)	**Yes** **(1.1)**	No (0.21)	-Single application rate in study consistent with registered maximum single application rate and seasonal rate on apple and other orchard crops. -Post-bloom application timing scenario consistent with labelled use on apple and other orchard crops. -Post-bloom, pre-harvest application timing scenario represented. -Post-bloom, post-harvest application timing scenario is not represented. -Pre-bloom application timing scenario not represented for other orchard	No acute dietary risk to adult bees or bee larvae is indicated following post-bloom foliar applications on apple with pre-harvest application timing. There is a marginal potential for chronic dietary risk to adult nurse bees indicated following a single post-bloom foliar application on apple with pre-harvest application timing. No chronic dietary risk to adult forager bees or bee larvae was indicated.	**CG 11: Pome fruit (apple, pear, crabapple, oriental pear, loquat, mayhaw and quince)** (post bloom application) *Registered at 2 x 70-210 g a.i./ha, at 10-14 day intervals (maximum seasonal rate 210 g a.i./ha) (post-bloom only)* **Potentially Relevant for Other Labelled Crop(s):** **CG 12: Stone fruit (apricot, sweet and**
	Y2: 31.1 pollen from flowers	**Y2:** <LOQ[3] 0.6 nectar from flowers	No (0.048)	No (0.10)	No (0.10)	**Y2:** 12.8 pollen from flowers	**Y2:** <LOQ[3] 0.6 nectar from flowers	No (0.49)	No (0.57)	No (0.13)			

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	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) sampled 231-248 DALA											crops. -Maximum residues from loam soil in Ontario.		**tart cherry, nectarine, peach, plum, prune and plumcot)** (pre-bloom and post-bloom) *Registered at 2 x 70-210 g a.i./ha, at 10-14 day intervals (maximum seasonal rate 210 g a.i./ha) (pre-bloom and post-bloom)*
Peach Applied at 2 x 112 g a.i./ha at intervals of 10-14 days, post bloom, 21-40 days before harvest. Same treatment scenario	**Y1:** 6.19 pollen from flowers	**Y1:** <LOD[3] 0.1[2] nectar from flowers	No (0.008)	No (0.02)	No (0.008)	**Y1**: 5.52 pollen from flowers	**Y1:** <LOD[3] 0.1 nectar from flowers	No (0.08)	No (0.19)	No (0.04)	-Single application rate in study lower than registered rate on peach and other orchard crops. -Seasonal rate in study similar to registered seasonal rate on peach and other orchard crops. -Post-bloom application timing scenario consistent with	No acute dietary risk to adult bees or bee larvae is indicated following post-bloom foliar applications on peach with pre-harvest application timing. No chronic dietary risk to adult bees or bee larvae is indicated	**CG 12: Stone fruit (apricot, sweet and tart cherry, nectarine, peach, plum, prune and plumcot)** (pre-bloom and post-bloom applications) *Registered at 2 x 70-210 g a.i./ha, at 10-*
	Y2: 5.26 pollen from flowers	**Y2:** <LOQ[3] 0.6 nectar from flowers	No (0.048)	No (0.037)	No (0.050)	**Y2:** 2.53 pollen from flowers	**Y2**: <LOQ[3] 0.6 nectar from flowers	No (0.49)	No (0.30)	No (0.09)			

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
in each of two years. After each appli-cation sampling occurred the following year: Year 1 (Y1) sampled 234-277 DALA Year 2 (Y2) sampled 233-281 DALA											labelled use on peach and other orchard crops. -Post-bloom, pre-harvest application timing scenario represented. -Post-bloom, post-harvest application timing scenario is not represented. -Pre-bloom application timing scenario not represented for peach and other stone fruit orchard crops. -Maximum residues from loamy sand soil in California. -A higher clothianidin concentration of 130 ppb was found in peach pollen collected from South Carolina during Year 2. This outlier sample was suggesting either there was contamination	following post-bloom foliar applications on peach with pre-harvest application timing.	*14 day intervals (maximum seasonal rate 210 g a.i./ha) (pre-bloom and post-bloom)* **Potentially Relevant for Other Labelled Crop(s):** **CG 11: Pome fruit (apple, pear, crabapple, oriental pear, loquat, mayhaw and quince)** (post-bloom) *Registered at 2 x 70-210 g a.i./ha, at 10-14 day intervals (maximum seasonal rate 210 g a.i./ha) (post-bloom only)*

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**			
											during the field sample or the analytical sample processing.		
Almond Applied at 2 x 112 g a.i./ha, post-bloom at BBCH growth stage ca. 7.5 and ca. 21 days before harvest. Same treatment scenario in each of two years. Sampling after each year of treatment: Various intervals tested: **1-2 MALA** Year 1 (Y1)	**Y1:** **1-2 mo.** **27*** anther from plant **2.0-2.5 mos.** 13.3 pollen from flowers **3.5 mos.** 14 pollen from flowers **4 mos.** 1.6 pollen from flowers **4-6 mos.**	**Y1:** **1-2 mo.** <LOQ[3] 0.6 nectar from flower **2.0-2.5 mos.** <LOD[3] 0.1 nectar from flowers **3.5 mos.** **1.28*** nectar from flowers **4 mos.** <LOD[3] 0.1 nectar from flowers **4-6 mos.**	No (0.10) using **max values*** from anther and nectar	No (0.12) using **max values*** from anther and nectar	No (0.14) using **max values*** from anther and nectar	**Y1:** **1-2 mo.** **18.7*** anther from plant **2.0-2.5 mos.** 11.5 pollen from flowers **3.5 mos.** 13.4 pollen from flowers **4 mos.** 1.16 pollen from flowers **6 mos.**	**Y1:** **1-2 mo.** <LOQ[3] **0.6*** nectar from flower **2.0-2.5 mos.** <LOD[3] 0.1 nectar from flowers **3.5 mos.** <LOQ[3] **0.6*** nectar from flower **4 mos.** <LOD[3] 0.1 nectar from flowers **6 mos.**	No (0.49) using **max mean values*** from anther and nectar	No (0.73) using **max mean values*** from anther and nectar	No (0.15) using **max mean values*** from anther and nectar	-Single application rate in study lower than registered rate on other orchard crops. -Seasonal rate in study similar to registered seasonal rate on other orchard crops. -Post-bloom application timing scenario consistent with labelled use on other orchard crops. -Post-bloom, pre-harvest application timing scenario represented. -Post-bloom, post-harvest application timing scenario is not represented for orchard crops. -Pre-bloom application timing	No acute dietary risk to adult bees or bee larvae is indicated following post-bloom foliar applications on almond with pre-harvest application timing. There is a marginal potential for chronic dietary risk to adult forager bees indicated following multiple post-bloom foliar applications on almond with pre-harvest application timing. No chronic dietary risk to nurse bees or bee larvae was indicated.	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):** **CG 11: Pome fruit (apple, pear, crabapple, oriental pear, loquat, mayhaw and quince)** (post-bloom) *Registered at 2 x 70-210 g a.i./ha, at 10-14 day intervals (maximum seasonal rate 210 g a.i./ha) (post-bloom only)*

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	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 218-252 DALA Year 2 (Y2)	7.08 pollen from flowers	**1.28*** nectar from flowers				5.3 pollen flowers	<LOD[3] 0.1 nectar flowers				scenario not represented for orchard crops. -Residues in pollen and nectar from Year 2 were generally lower than in Year 1. -Residues in pollen were generally lower with increasing interval time between applications -Anther samples were collected in two test trials as pollen was unavailable for sampling.		**CG 12: Stone fruit (apricot, sweet and tart cherry, nectarine, peach, plum, prune and plumcot)** (pre-bloom and post-bloom applications) *Registered at 2 x 70-210 g a.i./ha, at 10-14 day intervals (maximum seasonal rate 210 g a.i./ha) (pre-bloom and post-bloom)*
sampled 250-251 DALA **2.0-2.5 MALA** Y1: 209-210 Y2: 250-251 **3.5 MALA** Y1: 212-214 DALA Y2: 250-251 **4 MALA** Y1: 197-198 DALA Y2: 195-196 DALA **4-6 MALA** Y1 + Y2: 139-147 DALA	**Y2:** **1-2 mo.** 9.34 anther from plant **2.0-2.5 mos.** **13.8*** pollen from flowers **3.5 mos.** 11.7 pollen from flowers **4 mos.** 1.04 pollen from flowers **4-6**	**Y2:** **1-2 mo.** 1.09 nectar from flower **2.0-2.5 mos.** <LOD[3] 0.1 nectar from flowers **3.5 mos.** <LOQ[3] 0.6 nectar from flowers **4 mos.** <LOD[3] 0.1 nectar from flowers **4-6 mos.**	No (0.16) using **max values*** from anther and nectar	No (0.11) using **max values *** from anther and nectar	No (0.16) using **max values*** from anther and nectar	**Y2:** **1-2 mo.** 4.92 anther from plant **2.0-2.5 mos.** **11*** pollen from flowers **3.5 mos.** 7.8 pollen from flowers **4 mos.** 1.16 pollen from flowers **4-6 mos.**	**Y2:** **1-2 mo.** <LOQ[3] 0.6 nectar from flower **2.0-2.5 mos.** <LOD[3] 0.1 nectar from flowers **3.5 mos.** <LOD[3] 0.1 nectar from flowers **4 mos.** <LOD[3] 0.1 nectar from flowers **4-6 mos.**	**Yes** **(1.1)** using **max mean values*** from anther and nectar	No (0.82) using **max mean values *** from anther and nectar	No (0.22) using **max mean values *** from anther and nectar			

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
	mos. 5.42 pollen from flowers	**2.04*** nectar from flowers				4.82 pollen from flowers	**1.35*** nectar from flowers						
Grape Applied at 1 x 112 g a.i./ha, pre-bloom (BBCH ca. 14) 17-44 DALA	1564 pollen from flowers	n/a	No (0.02)	**Yes (4.1)**	**Yes (3.1)**	1306 pollen from flowers	n/a	No (0.15)	**Yes (35)**	**Yes (5.2)**	-Single and seasonal application rate in study consistent with registered rates for grapes. -Pre-bloom and post-bloom application timing scenario consistent with labelled use on grape. -Residues in pollen were generally higher following pre-bloom applications compared to post-bloom applications. -Risk estimates based on exposure from pollen source only.	There is a potential for acute and chronic dietary risk to adult nurse bees and bee larvae following a single pre-bloom foliar application on grape. No acute or chronic dietary risk to adult forager bees is indicated following a single pre-bloom application on grape. No acute or chronic dietary risk to adult bees or larvae is indicated following a single post-bloom application on grape.	**Grape** (pre-bloom and post-bloom) *Registered at 1 x 50-105 g a.i./ha (maximum seasonal rate 105 g a.i./ha), (pre-bloom and post-bloom)* **Potentially Relevant for Other Labelled Crop(s):** **CG 12: Stone fruit (apricot, sweet and tart cherry, nectarine, peach, plum, prune and plumcot)** (single pre-bloom and post-bloom
Grape Applied at 1 x 112 g a.i./ha, post-bloom (BBCH ca. 71) 325-360 DALA	31.9 pollen from flowers	n/a	No (<0.001)	No (0.08)	No (0.06)	18.1 pollen from flowers	n/a	No (0.002)	No (0.48)	No (0.07)			

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	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 based on exposure through pollen only) *Registered at 2 x 70-210 g a.i./ha, at 10-14 day intervals (maximum seasonal rate 210 g a.i./ha) (pre-bloom and post-bloom)* **Strawberry** (low end estimate pre-bloom and post-bloom) *Registered at 1 x 224 g a.i./ha (pre-bloom and post-bloom)*
Pumpkin Applied at 2 x 105 g a.i./ha at intervals of 2-4	49.1 pollen from flowers	6.51 nectar from flowers	**Yes** **(0.43)**	No (0.38)	**Yes** **(0.53)**	46.3 pollen from flowers	4.86 nectar from flowers	**Yes** **(4.0)**	**Yes** **(3.1)**	No (0.83)	-Single and seasonal application rate in study consistent with registered rates for pumpkin and other cucurbit crops.	There is a potential for acute dietary risk to adult forager bees and bee larvae following pre-bloom foliar applications in	**Crop Group 9: Cucurbit vegetables** (pre-bloom applications) *Registered at*

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
days, pre-bloom 9-28 DALA											-Pre-bloom application timing scenario represented. -First application at BBCH growth stage ca. 21-23(formation of side shoots). A second application at BBCH ca. 51 (inflorescence emergence i.e., right before flowering) -Pollen samples collected 10 DALA in the loam soil site were reported to have contained high amounts of plant filaments which would have led to higher residue concentrations (i.e., 123 ppb max, 108 ppb mean). -Residues not determined in control samples. -Maximum residues from loamy sand in	pumpkin. No acute dietary risk to nurse bees is indicated. There is a potential for chronic dietary risk to adult forager bees following pre-bloom foliar applications in pumpkin. No chronic dietary risk to bee larvae is indicated.	*2 x 70-105 g a.i./ha, 7 days intervals (maximum seasonal rate 210 g a.i./ha) (pre-bloom)* **Potentially Relevant for Other Labelled Crop(s):** **Strawberry** (pre-bloom) *Registered at 1 x 224 g a.i./ha (pre-bloom and post-bloom)*

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
											Ontario		
Pumpkin Applied at 1 x 112 g a.i./ha, pre-bloom 21-53 DALA	3.03 pollen from flowers	1.86 nectar from flowers	No (0.15)	No (0.08)	No (0.13)	1.59 pollen from flowers	0.69 nectar from flowers	No (0.05)	No (0.03)	No (0.05)	-Single application rate in study slightly higher than the registered maximum single application rate of 105 g a.i./ha. -Seasonal rate in study much lower than registered seasonal rate on pumpkin and other cucurbit crops. -Pre-bloom application timing scenario represented. -Application made during leaf development. -Controls were used for method validation and quality control. Residues were determined in some samples: the only detections in control pollen and nectar were 1.16 ppb in pollen from OR site and 0.24 ppb in nectar from CA site.	No acute or chronic dietary risk to adult bees or bee larvae is indicated following a single pre-bloom foliar application on pumpkins at the maximum single application rate. [See risk characterization above for multiple foliar applications on pumpkins.]	**Crop Group 9: Cucurbit vegetables** (single pre-bloom application) *Registered at 2 x 70-105 g a.i./ha, 7 days intervals (maximum seasonal rate 210 g a.i./ha) (pre-bloom)* **Potentially Relevant for Other Labelled Crop(s):** **Grapes** (pre-bloom) *Registered at 1 x 50-105 g a.i./ha (maximum seasonal rate 105 g a.i./ha), (pre-bloom and post-bloom)*

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
Potato Applied at 2 x 75 g a.i./ha at intervals of 7-10 days, pre-bloom 4-18 DALA	clay 732 pollen from flower	n/a	No (0.008)	**Yes** **(1.9)**	**Yes** **(1.5)**	clay 601 pollen from flower	n/a	No (0.07)	**Yes** **(16.0)**	**Yes** **(2.4)**	-Single application rate in study higher than registered single rate on potato. Seasonal rate in study is consistent with registered rate for potato. -Pre-bloom application scenario. -Pollen could not be collected from all locations and at sampling times. - clothianidin in pollen from control: up to 3 ppb in clay, 7 ppb in sandy clay loam and <LOQ in silt loam. - clothianidin in anthers up to 37 ppb. -Maximum residues from clay soil types in Spain which is not a typical soil type in Canadian potato growing regions (sandy to sandy loam type)	There is a potential for acute and chronic dietary risk to adult nurse bees and bee larvae following pre-bloom foliar applications in potato plants. No acute or chronic dietary risk to adult forager bees is indicated.	**Potato** (pre-bloom applications) *Registered at 3 x 35-52.5 g a.i./ha, at minimum of 10 day intervals, (maximum seasonal rate of 157.5 g a.i./ha)*
	sandy clay loam 147 pollen from flower	n/a	No (0.002)	No (0.38)	No (0.29)	sandy clay loam 94.7 pollen from flower	n/a	No (0.01)	**Yes** **(2.5)**	No (0.38)			
	silt loam 130 pollen from flower	n/a	No (0.001)	No (0.34)	No (0.26)	silt loam 110 pollen from flower	n/a	No (0.01)	**Yes** **(2.9)**	No (0.44)			

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
Potato Applied at 1 x 56 g a.i./ha, pre-bloom 9-23 DALA	sandy loam 116 pollen from flower	n/a	No (0.001)	No (0.30)	No (0.23)	sandy loam 76.1 pollen from flower	n/a	No (0.009)	**Yes** **(2.01)**	No (0.30)	-Single application rate is similar to registered single rate on potato. Seasonal rate in study is about 3x lower than registered rate for potato. -Pre-bloom application scenario. -Pollen could not be collected from all locations and all sampling times. -Foliar application at BBCH growth stage 33 in California and between 35-50 in Oregon. - clothianidin in pollen from control: up to 7.2 ppb but generally <LOQ. - clothianidin in anthers: up to 21.8 ppb.	No acute dietary risk to adult bees or bee larvae is indicated following a single pre-bloom foliar application on potato at the maximum single application rate. There is a potential for chronic dietary risk to adult nurse bees following a single pre-boom foliar application in potato at the maximum single application rate. No chronic dietary risk to adult forager bees or bee larvae is indicated. [See risk characterization above for multiple foliar applications on potatoes.]	**Potato** (single pre-bloom application) *Registered at 3 x 35-52.5 g a.i./ha, at minimum of 10 day intervals, (maximum seasonal rate of 157.5 g a.i./ha)*
	loamy sand 33.5 pollen from flower	n/a	No 0.0004)	No (0.09)	No (0.07)	loamy sand 28.1 pollen from flower	n/a	No 0.003)	No (0.75)	No (0.11)			

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	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 2 x 112 g a.i./ha, first application pre-bloom, second applica-tion 7 days after during bloom 1-28 DALA	sandy loam 761* pollen from flowers	loamy sand 182* nectar from flowers	**Yes (14.5)**	**Yes (8.9)**	**Yes (13.7)**	sandy loam 419* pollen from flowers	sandy loam 142 nectar from flowers	**Yes (115)**	**Yes (66)**	**Yes (21)**	-Pre-bloom and at bloom application scenario -No quantifiable residues in control pollen and nectar. - clothianidin in extrafloral nectar after two applications: up to 4163 ppb in leaf nectar and 651 ppb in subbracteal nectar. Even though these concentrations are higher than in floral nectar, they are not further considered for the refined assessment; extrafloral nectaries are unique to cotton, which is not grown in Canada. -Only one sample at some sampling times, explaining why same max and mean concentrations. *the other pollen and nectar replicates had measured	There is a potential for acute and chronic dietary risk to adult bees and bee larvae following pre-bloom and at bloom foliar applications in cotton.	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):** **Turf** (low end estimate) *Registered at 1 x 350 g a.i./ha* **Strawberry** (pre-bloom) *Registered at 1 x 224 g a.i./ha (pre-bloom and post-bloom)* **CG 12: Stone fruit (apricot, sweet and tart cherry, nectarine, peach, plum, prune and plumcot)**
	sandy loam 300 pollen from flowers	sandy loam 142 nectar from flowers	**Yes (11.3)**	**Yes (6.2)**	**Yes (10.1)**	sandy loam 300 pollen from flowers	loamy sand 142 nectar from flowers	**Yes (115)**	**Yes (63)**	**Yes (20)**			
	loamy sand 246 pollen from flowers	loamy sand 79.4 nectar from flowers	**Yes (6.3)**	**Yes (3.7)**	**Yes (5.8)**	loamy sand 130 pollen from flowers	loamy sand 95.8* nectar from flowers	**Yes (115)**	**Yes (59)**	**Yes (19)**			

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
											concentrations of 76.8 and 9.5 ppb respectively and therefore a range of maximum residues were considered. Without considering the maximum concentrations, clothianidin concentrations were slightly higher in the sandy loam plot compared to the loamy sand.		(pre-bloom only) *Registered at 2 x 70-210 g a.i./ha, at 10-14 day intervals (maximum seasonal rate 210 g a.i./ha) (pre-bloom and post-bloom)*
Cotton 1 x 93 g a.i./ha, pre-bloom 6-35 DALA	loamy sand (CA) 1216 pollen from flowers	loamy sand (MO) 11.5 nectar from flowers	**Yes (0.93)**	**Yes (3.6)**	**Yes (3.2)**	loamy sand (CA) 911 pollen from flowers	sandy clay loam (TX) 8.17 nectar from flowers	**Yes (6.7)**	**Yes (27)**	**Yes (4.7)**	-Pre-bloom application scenario. -Single application was made pre-bloom, right before the onset of flowering (petals visible, buds still closed or beginning to open)	There is a potential for acute and chronic dietary risk to adult bees and bee larvae following a single pre-bloom foliar application in cotton.	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):** **Grape** (pre-bloom) *Registered at 1 x 50-105 g a.i./ha (maximum seasonal rate 105 g a.i./ha),*

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	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 and post-bloom) **CG 12: Stone fruit (apricot, sweet and tart cherry, nectarine, peach, plum, prune and plumcot)** (low end estimate pre-bloom only) *Registered at 2 x 70-210 g a.i./ha, at 10-14 day intervals (maximum seasonal rate 210 g a.i./ha) (pre-bloom and post-bloom)*
Turf 1 x 450 g a.i./ha, during bloom, sampling 8 DALA	n/a	319 nectar from clover flowers	**Yes** **(25)**	**Yes** **(12)**	**Yes** **(21)**	n/a	171 nectar from clover flowers	**Yes** **(139)**	**Yes** **(67)**	**Yes** **(23)**	-Single application rate is higher than single registered rate. -1 hour after application plots were lightly irrigated -Insecticides not	There is a potential for acute and chronic dietary risk to adult bees and bee larvae following a single foliar application in turf containing	**Turf** *Registered at 1 x 350 g a.i./ha*

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
											detected in control plots	flowering clover during bloom.	
Turf 1 x 450 g a.i./ha, during bloom, sampling 1 DALA	n/a	4475 nectar from clover flowers	**Yes (355)**	**Yes (170)**	**Yes (298)**	n/a	2992 nectar from clover flowers	**Yes (2427)**	**Yes (1164)**	**Yes (399)**	-Single application rate is higher than single registered rate. -Plots were treated and then lightly irrigated	.	
Turf 1 x 450 g a.i./ha, during bloom, mowed and then sampling on new blooms 10-13 DALA	n/a	18 nectar from clover flowers	**Yes (1.4)**	**Yes (0.68)**	**Yes (1.2)**	n/a	18 nectar from clover flowers	**Yes (14.6)**	**Yes (7)**	**Yes (2.4)**	-Single application rate is higher than single registered rate. -Plots were treated, lightly irrigated and then mowed to remove all blooms. -Residue samples from clover flowers produced after mowing. -Insufficient information in study report to determine the maximum residue value in nectar. Residue value presented for acute risk assessment is the maximum mean value for nectar.	There is a potential for acute and chronic dietary risk to adult bees and bee larvae following a single pre-bloom foliar application in turf containing flowering clover.	

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

[1] **Bold** values indicate that acute LOC (RQ ≥0.4) is exceeded.

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]; 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: adult acute oral LD50 = 0.00368 µg a.i./bee for TGAI; bee larvae 7-day LD_{50} = 0.0018 µg a.i./larva/day for TGAI

[2] **Bold** values indicate that chronic LOC (RQ ≥1.0) is exceeded.

Chronic RQ = Chronic estimated daily dose (EDD)/chronic toxicity endpoint; Chronic EDD = nectar dose [nectar consumption rate (mg/day) x highest mean nectar residue (µg/kg)/ 1.0 x 10^6] + pollen dose [pollen consumption rate (mg/day) x highest mean 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; Note: 10-d NOEL = 0.00036 µg a.i./bee/day for adult worker bees for TGAI; bee larvae 22-d NOEL = 0.0009 µg a.i./larva/day for TGAI

[3]Standardized maximum value ½ LOD or ½ LOQ or ½ LOD +LOQ

Table 6 Foliar Application: Acute Dietary Risk to Different Bee Castes Based on Maximum Residues of Clothianidin Transformation Products.

Compound	Test Crop	Matrix	EEC-maximum residue value	Did the Acute RQ[1] exceed LOC (0.4)? (RQ)		Risk Characterization
				Nectar forager	Nurse bee	
TZNG	Apple	pollen	0.6	No (<0.0001)	No (<0.0001)	No acute dietary risk to adult bees is indicated from TZNG following foliar applications with clothianidin.
		nectar	0.15			
	Peach	pollen	1.71	No (<0.0001)	No (<0.0001)	
		nectar	0.125			
	Almond	pollen	8.19	No (<0.0001)	No (<0.0001)	
		nectar	0.1			
	Grape	pollen	90.7	No (<0.0001)	No (0.0002)	
		nectar	n/a			
	Pumpkin	pollen	7.5	No (0.0002)	No (0.0001)	
		nectar	2.37			
	Potato	pollen	210	No (<0.0001)	No (0.0005)	
		nectar	n/a			
	Cotton	pollen	87.9	No (0.0046)	No (0.0024)	
		nectar	62.7			

EEC = estimated environmental concentration, RQ = risk quotient

Bold values indicate that acute LOC (RQ ≥0.4) 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]; 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: adult acute oral LD50 = 3.95 µg a.i./bee for TGAI

Tier II Refined Assessment for Foliar Applications

Table 7 Foliar Application: Chronic Risk Assessment for Honey Bee Hives Based On a Comparison of Measured Clothianidin Residues and Colony Feeding Study Effects Values.

Sampled Crop	EEC - highest mean residue value in ppb[a]			Potential risk from pollen, bee bread or nectar?[b,c]			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
Apple Applied at 1 x 210 g a.i./ha, post-bloom 7 days before harvest, Year 1 (Y1). Same treatment scenario in each of two years. After each application sampling occurred the following year: Year 1 (Y1) sampled 218-232 DALA Year 2 (Y2) sampled 231-248	**Y1:** 31.2 pollen from flowers	**Y1:** 0.61 nectar from flowers	14.7	**Yes**	No	**Yes**	Single application rate in study consistent with registered maximum single application rate and seasonal rate on apple and other orchard crops. Post-bloom application timing scenario consistent with labelled use on apple and other orchard crops. Post-bloom, pre-harvest application timing scenario represented. Post-bloom, post-harvest application timing scenario is not represented. Pre-bloom application timing scenario not represented for other orchard crops.	**Yes** When applied post-bloom in apple with pre-harvest application timing. Potential for risk from pollen and bee bread exposure. No risk to bees indicated from nectar exposure.	**CG 11: Pome fruit (apple, pear, crabapple, oriental pear, loquat, mayhaw and quince)** (post bloom application) *Registered at 2 x 70-210 g a.i./ha, at 10-14 day intervals (maximum seasonal rate 210 g a.i./ha) (post-bloom only)* **Potentially Relevant for Other Labelled Crop(s):** **CG 12: Stone fruit (apricot, sweet and tart cherry, nectarine, peach, plum, prune and plumcot)** (pre-bloom and
	Y2: 12.8 pollen from flowers	**Y2:** <LOQ[1] 0.6 nectar from flowers	6.4	**Yes**	No	**Yes**			

Sampled Crop	EEC - highest mean residue value in ppb[a]			Potential risk from pollen, bee bread or nectar?[b,c]			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
DALA							Maximum residues from loam soil in Ontario.		post-bloom) *Registered at 2 x 70-210 g a.i./ha, at 10-14 day intervals (maximum seasonal rate 210 g a.i./ha) (pre-bloom and post-bloom)*
Peach Applied at 2 x 112 g a.i./ha at intervals of 10-14 days, post bloom, 21-40 days before harvest. Same treatment scenario in each of two years. After each application sampling occurred the following year:	**Y1:** 5.52 pollen from flowers	**Y1:** <LOD[1] 0.1 nectar from flowers	2.6	**Yes**	No	No	Single application rate in study lower than registered rate on peach and other orchard crops. Seasonal rate in study similar to registered seasonal rate on peach and other orchard crops. Post-bloom application timing scenario consistent with labelled use on peach and other orchard crops. Post-bloom, pre-harvest application timing scenario represented. Post-bloom, post-	**Yes** When applied post-bloom in apple with pre-harvest application timing. Potential for risk from pollen exposure. No risk to bees indicated from nectar or bee bread exposure.	**CG 12: Stone fruit (apricot, sweet and tart cherry, nectarine, peach, plum, prune and plumcot)** (pre-bloom and post-bloom applications only) *Registered at 2 x 70-210 g a.i./ha, at 10-14 day intervals (maximum seasonal rate 210 g a.i./ha) (pre-bloom and post-bloom)* **Potentially Relevant for Other Labelled Crop(s):**
	Y2: 2.53 pollen from flowers	**Y2:** <LOQ[1] 0.6 nectar from flowers	1.8	No	No	No			

Sampled Crop	EEC - highest mean residue value in ppb[a]			Potential risk from pollen, bee bread or nectar?[b,c]			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Bee bread**	**Pollen**	**Nectar**	**Bee bread**			
Year 1 (Y1) sampled 234-277 DALA Year 2 (Y2) sampled 233-281 DALA							harvest application timing scenario is not represented. Pre-bloom application timing scenario not represented for peach and other stone fruit orchard crops. Maximum residues from loamy sand soil in California. A higher clothianidin concentration of 130 ppb was found in peach pollen collected from South Carolina during Year 2. This outlier sample was suggesting either there was contamination during the field sample or the analytical sample processing.		**CG 11: Pome fruit (apple, pear, crabapple, oriental pear, loquat, mayhaw and quince)** (post-bloom) *Registered at 2 x 70-210 g a.i./ha, at 10-14 day intervals (maximum seasonal rate 210 g a.i./ha) (post-bloom)*
Almond Applied at 2 x 112 g a.i./ha, post-bloom at BBCH growth stage ca. 7.5 and	**Y1:** **1-2 mo.** **18.7*** anther from plant **2.0-2.5**	**Y1:** **1-2 mo.** <LOQ[1] **0.6*** nectar from flower **2.0-2.5**	9.1 using **max mean values*** from anther and nectar	**Yes**	No	**Yes**	Single application rate in study lower than registered rate on other orchard crops. Seasonal rate in study similar to registered seasonal rate on other orchard crops.	**Yes** When applied post-bloom in almond with pre-harvest application timing. Potential for risk	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):** **CG 11: Pome fruit (apple,**

Sampled Crop	EEC - highest mean residue value in ppb[a]			Potential risk from pollen, bee bread or nectar?[b,c]			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Bee bread**	**Pollen**	**Nectar**	**Bee bread**			
ca. 21 days before harvest. Same treatment scenario in each of two years. Sampling after each year of treatment: Various monthly intervals tested (mos.) **1-2 MALA** Year 1 (Y1) sampled 218-252 DALA Year 2 (Y2) sampled 250-251 DALA **2.0-2.5 MALA** Y1: 209-210 Y2: 250-251	**mos.** 11.5 pollen from flowers **3.5 mos.** 13.4 pollen from flowers **4 mos.** 1.16 pollen from flowers **4-6 mos.** 5.3 pollen flowers	**mos.** <LOD[1] 0.1 nectar from flowers **3.5 mos.** <LOQ[1] **0.6*** nectar from flower **4 mos.** <LOD[1] 0.1 nectar from flowers **4-6 mos.** <LOD[1] 0.1 nectar flowers					Post-bloom application timing scenario consistent with labelled use on other orchard crops. Post-bloom, pre-harvest application timing scenario represented. Post-bloom, post-harvest application timing scenario is not represented for orchard crops. Pre-bloom application timing scenario not represented for orchard crops. Residues in pollen and nectar from Year 2 were generally lower than in Year 1. Residues in pollen were generally lower with increasing interval time between applications Anther samples were collected in two test trials as pollen was unavailable for sampling.	from pollen and bee bread exposure only. No risk to bees indicated from nectar exposure.	**pear, crabapple, oriental pear, loquat, mayhaw and quince)** (post-bloom) *Registered at 2 x 70-210 g a.i./ha, at 10-14 day intervals (maximum seasonal rate 210 g a.i./ha) (post-bloom only)* **CG 12: Stone fruit (apricot, sweet and tart cherry, nectarine, peach, plum, prune and plumcot)** (pre-bloom and post-bloom applications) *Registered at 2 x 70-210 g a.i./ha, at 10-14 day intervals (maximum seasonal rate 210 g a.i./ha) (pre-bloom and post-bloom)*
	Y2: **1-2 mo.** 4.92 anther from plant **2.5 mos.** **11*** pollen from	**Y2:** **1-2 mo.** <LOQ[1] 0.6 nectar from flower **2.5 mos.** <LOD[1] 0.1 nectar from	6.5 using **max mean values*** from anther and nectar	**Yes**	No	**Yes**			

Sampled Crop	EEC - highest mean residue value in ppb[a]			Potential risk from pollen, bee bread or nectar?[b,c]			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
3.5 MALA Y1: 212-214 DALA Y2: 250-251 **4 MALA** Y1: 197-198 DALA Y2: 195-196 DALA **4-6 MALA** Y1 + Y2: 139-147 DALA	flowers **3.5 mos.** 7.8 pollen from flowers **4 mos.** 1.16 pollen from flowers **6 mos.** 4.82 pollen from flowers	flowers **3.5 mos.** <LOD[1] 0.1 nectar from flowers **4 mos.** <LOD[1] 0.1 nectar from flowers **6 mos.** **1.35*** nectar from flowers							
Grape Applied at 1 x 112 g a.i./ha, pre-bloom (BBCH ca. 14) 17-44 DALA	1306 pollen from flowers	n/a	588	**Yes**	n/a	**Yes**	Single and seasonal application rate in study consistent with registered rates for grapes. Pre-bloom and post-bloom application timing scenario consistent with labelled use on grape. Residues in pollen were generally higher following pre-bloom applications compared to post-bloom applications.	**Yes** Following a single pre-bloom or post-bloom application on grape. Potential for risk from pollen and bee bread exposure following a single pre-bloom or post-bloom application. No risk to bees indicated from nectar exposure.	**Grape** (pre-bloom and post-bloom) *Registered at 1 x 50-105g a.i./ha (maximum seasonal rate 105 g a.i./ha), (pre-bloom and post-bloom)* **Potentially Relevant for Other Labelled Crop(s):**
Grape Applied at 1 x 112 g a.i./ha, post-bloom (BBCH ca. 71)	18.1 pollen from flowers	n/a	8.2	**Yes**	n/a	**Yes**			

Sampled Crop	EEC - highest mean residue value in ppb[a]			Potential risk from pollen, bee bread or nectar?[b,c]			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
325-360 DALA							Risk estimates based on exposure from pollen source only.		**CG 12: Stone fruit (apricot, sweet and tart cherry, nectarine, peach, plum, prune and plumcot)** (single pre-bloom and post-bloom application based on exposure through pollen only) *Registered at 2 x 70-210 g a.i./ha, at 10-14 day intervals (maximum seasonal rate 210 g a.i./ha) (pre-bloom and post-bloom)* **Strawberry** (low end estimate pre-bloom and post-bloom) *Registered at 1 x 224 g a.i./ha (pre-bloom and post-bloom)*
Pumpkin Applied at 2 x 105 g	46.3 pollen from flowers	4.86 nectar from flowers	26.3	**Yes**	No	**Yes**	Single and seasonal application rate in study consistent with registered rates for	**Yes** When two pre-bloom foliar	**Crop Group 9: Cucurbit vegetables** (pre-bloom

Sampled Crop	EEC - highest mean residue value in ppb[a]			Potential risk from pollen, bee bread or nectar?[b,c]			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
a.i./ha at intervals of 2-4 days, pre-bloom 9-28 DALA							pumpkin and other cucurbit crops. Pre-bloom application timing scenario represented. First application at BBCH growth stage ca. 21-23(formation of side shoots). Second application at BBCH ca. 51 (inflorescence emergence i.e., right before flowering). Pollen samples collected 10 DALA in the loam soil site were reported to have contained high amounts of plant filaments which would have led to higher residue concentrations (i.e., 123 ppb max, 108 ppb mean). Residues not determined in control samples. Maximum residues from loamy sand in Ontario.	applications are made in pumpkins at the maximum single application rate. Potential for risk from pollen and bee bread exposure. No risk to bees indicated from nectar exposure.	applications) *Registered at 2 x 70-105 g a.i./ha, 7 days intervals (maximum seasonal rate 210 g a.i./ha) (pre-bloom)* **Potentially Relevant for Other Labelled Crop(s):** **Strawberry** (pre-bloom) *Registered at 1 x 224 g a.i./ha (pre-bloom and post-bloom)*

Sampled Crop	EEC - highest mean residue value in ppb[a]			Potential risk from pollen, bee bread or nectar?[b,c]			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
Pumpkin Applied at 1 x 112 g a.i./ha, pre-bloom 21-53 DALA	1.59 pollen from flowers	0.69 nectar from flowers	1.50	No	No	No	Single application rate in study slightly higher than the registered maximum single application rate of 105 g a.i./ha. Seasonal rate in study much lower than registered seasonal rate on pumpkin and other cucurbit crops. Pre-bloom application timing scenario represented. Controls were used for method validation and quality control. Residues were determined in some samples: the only detections in control pollen and nectar were 1.16 ppb in pollen from Oregon site and 0.24 ppb in nectar from California site.	No When a single pre-bloom foliar application is made in pumpkins at the maximum single application rate.	**Crop Group 9: Cucurbit vegetables** (single pre-bloom application) *Registered at 2 x 70-105 g a.i./ha, 7 days intervals (maximum seasonal rate 210 g a.i./ha) (pre-bloom)* **Potentially Relevant for Other Labelled Crop(s):** **Grapes** (pre-bloom) *Registered at 1 x 50-105 g a.i./ha (maximum seasonal rate 105 g a.i./ha), (pre-bloom and post-bloom)*

Sampled Crop	EEC - highest mean residue value in ppb[a]			Potential risk from pollen, bee bread or nectar?[b,c]			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
Potato Applied at 2 x 75 g a.i./ha at intervals of 7-10 days, pre-bloom 4-18 DALA	clay 601 pollen from flower	n/a	271	**Yes**	n/a	**Yes**	Single application rate in study higher than registered single rate on potato. Seasonal rate in study is consistent with registered rate for potato. Maximum residues from clay soil types in Spain which is not a typical soil type in Canadian potato growing regions (sandy to sandy loam type)	**Yes** When multiple foliar applications are made in potato at higher than the maximum single application rate. Potential for risk from pollen and bee bread exposure.	**Potato** (pre-bloom applications) *Registered at 3 x 35-52.5 g a.i./ha, at minimum of 10 day intervals, (maximum seasonal rate of 157.5 g a.i./ha)* [may not be relevant-see considerations/comments]
	sandy clay loam 94.7 pollen from flower	n/a	43	**Yes**	n/a	**Yes**			
	silt loam 110 pollen from flower	n/a	50	**Yes**	n/a	**Yes**			
Potato Applied at 1 x 56 g a.i./ha, pre-bloom 9-23 DALA	sandy loam 76.1 pollen from flower	n/a	34	**Yes**	n/a	**Yes**	Single application rate is similar to registered single rate on potato. Seasonal rate in study is about 3x lower than registered rate for potato. Pre-bloom application scenario. Pollen could not be collected from all locations and at all sampling times.	**Yes** When a single foliar application is made in potato at the maximum single application rate. Potential for risk from pollen and bee bread exposure.	**Potato** (single pre-bloom application) *Registered at 3 x 35-52.5 g a.i./ha, at minimum of 10 day intervals, (maximum seasonal rate of 157.5 g a.i./ha)*
	loamy sand 28.1 pollen from flower	n/a	13	**Yes**	No	**Yes**			

Sampled Crop	EEC - highest mean residue value in ppb[a]			Potential risk from pollen, bee bread or nectar?[b,c]			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
							Foliar application at BBCH growth stage 33 in California and between 35-50 in Oregon. Clothianidin in pollen from control: up to 7.2 ppb but generally <LOQ. Clothianidin in anthers: up to 21.8 ppb.		
Cotton 2 x 112 g a.i./ha, first application pre-bloom, second application 7 days after during bloom 1-28 DALA	sandy loam 419* pollen from flowers	sandy loam 142 nectar from flowers	348	**Yes**	**Yes**	**Yes**	Pre-bloom and at bloom application scenario. No quantifiable residues in control pollen and nectar. Clothianidin in extrafloral nectar after two applications: up to 4163 ppb in leaf nectar and 651 ppb in subbracteal nectar. Even though these concentrations are higher than in floral nectar, they are not further considered for the refined assessment; extrafloral nectaries	**Yes** Following a pre-bloom and at bloom foliar application in cotton. Potential for risk from nectar, pollen and bee bread exposure.	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):** **Turf** (low end estimate) *Registered at 1 x 350 g a.i./ha* **Strawberry** (pre-bloom) *Registered at 1 x 224 g a.i./ha (pre-bloom and post-bloom)*
	sandy loam 300 pollen from flowers	loamy sand 142 nectar from flowers	294	**Yes**	**Yes**	**Yes**			
	loamy sand 130 pollen from flowers	loamy sand 95.8* nectar from flowers	166	**Yes**	**Yes**	**Yes**			

Sampled Crop	EEC - highest mean residue value in ppb[a]			Potential risk from pollen, bee bread or nectar?[b,c]			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
							are unique to cotton, which is not grown in Canada. Only one sample at some sampling times, explaining why same max and mean concentrations.		**CG 12: Stone fruit (apricot, sweet and tart cherry, nectarine, peach, plum, prune and plumcot)** (pre-bloom only) *Registered at 2 x 70-210 g a.i./ha, at 10-14 day intervals (maximum seasonal rate 210 g a.i./ha) (pre-bloom and post-bloom)*
Cotton 1 x 93 g a.i./ha, pre-bloom 6-35 DALA	loamy sand (CA) 911 pollen from flowers	sandy clay loam (TX) 8.17 nectar from flowers	419	**Yes**	No	**Yes**	Pre-bloom application scenario. Single application was made pre-bloom, right before the onset of flowering (petals visible, buds still closed or beginning to open)	**Yes** Following a single pre-bloom foliar application in cotton. Potential for risk from pollen and bee bread exposure. No risk to bees indicated from nectar exposure.	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):** **Grape** (pre-bloom) *Registered at 1 x 50-105 g a.i./ha (maximum seasonal rate 210 g a.i./ha), (pre-bloom and post-bloom)* **CG 12: Stone**

Sampled Crop	EEC - highest mean residue value in ppb[a]			Potential risk from pollen, bee bread or nectar?[b,c]			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
									fruit (apricot, sweet and tart cherry, nectarine, peach, plum, prune and plumcot) (low end estimate pre-bloom only) *Registered at 2 x 70-210 g a.i./ha, at 10-14 day intervals (maximum seasonal rate 210 g a.i./ha) (pre-bloom and post-bloom)*
Turf 1 x 450 g a.i./ha, during bloom, sampling 8 DALA	n/a	171 nectar from clover flowers	192	n/a	**Yes**	**Yes**	Single application rate is higher than single registered rate. 1 hour after application plots were lightly irrigated Insecticides not detected in control plots Residue and effects study	**Yes** Following a single foliar application during bloom in turf containing clover. Risk to bees is indicated whether turf was irrigated or irrigated and mowed to remove blooms following treatment. Potential for risk from nectar and bee bread	**Turf** *Registered at 1 x 350 g a.i./ha*
Turf 1 x 450 g a.i./ha, during	n/a	2992 nectar from clover flowers	3366	n/a	**Yes**	**Yes**	Single application rate is higher than single registered rate. Plots were treated and		

Sampled Crop	EEC - highest mean residue value in ppb[a]			Potential risk from pollen, bee bread or nectar?[b,c]			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
bloom, sampling 1 DALA							then lightly irrigated Residue and effects study	exposure. No risk from nectar exposure after mowing. No residue information available for pollen	
Turf 1 x 450 g a.i./ha, during bloom, mowed and then sampling on new blooms 10-13 DALA	n/a	18 nectar from clover flowers	22.5	n/a	No	**Yes**	Single application rate is higher than single registered rate. Plots were treated, lightly irrigated and then mowed to remove all blooms. Residue samples from clover flowers produced after mowing Residue and effects study		

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

[a] EEC for pollen and nectar is the highest mean residue value measured among all scenarios within a study. Bee bread is calculated based on highest mean pollen and nectar values.

[b] Colony feeding study critical effect endpoint values include: nectar: 19 ppb (NOEC) to 35.6 ppb (LOEC); pollen and bee bread: 4.9 ppb (LOEC) and 20 ppb (NOEC).

[c] Highest mean clothianidin concentrations measured in pollen and nectar and estimated concentrations in bee bread are compared with the colony feeding study critical effect endpoint values for pollen, nectar and bee bread, respectively. "**Yes**" indicates the measured residue level is greater than the lower bound critical effect endpoint value and poses potential risk to honey bees; "No" indicates that the measured residue level is less than the lower bound critical effect endpoint value and may not pose risk to honey bees. "NA" indicates residue information is not available. The overall potential for risk is considered as 'Yes' when either the pollen, nectar or bee bread exposure route indicates a potential risk.

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

Appendix VII Pollinator Risk Assessment for Soil Application of Clothianidin

Tier I Default Assessment for Soil Applications

Table 1 Soil Application: Acute and chronic dietary risk to bees based on screening level exposure estimates for clothianidin and relevant transformation products (K_{oc} value = 84).

Chemical	Application rate	Briggs EEC	Exposure Estimate for Bees*	Toxicity endpoint	RQ**	LOC exceeded?
	kg a.i./ha	µg a.i./g	µg a.i./bee/day	µg a.i./bee/day		
ADULTS (ACUTE)						
Clothianidin	0.1326	0.038	0.011	LD_{50}: 0.00368	3.0	yes
	0.224	0.064	0.019	LD_{50}: 0.00368	5.2	yes
TZNG	0.1326	0.038	0.011	LD_{50}: 3.95	0.003	no
	0.224	0.064	0.019	LD_{50}: 3.95	0.005	no
ADULTS (CHRONIC)						
Clothianidin	0.1326	0.038	0.011	NOEL: 0.00036	30.6	yes
	0.224	0.064	0.019	NOEL: 0.00036	52.8	yes
BROOD (ACUTE)						
Clothianidin	0.1326	0.038	0.005	LD_{50} > 0.0018	2.8	yes
	0.224	0.064	0.008	LD_{50} > 0.0018	4.4	yes
BROOD (CHRONIC)						
Clothianidin	0.1326	0.038	0.005	NOEL: 0.0009	5.6	yes
	0.224	0.064	0.008	NOEL: 0.0009	8.9	yes

*Exposure estimate for bees=0.292 x Briggs EEC for adults and 0.124 x Briggs EEC for larvae
**Exposure estimate for bees/toxicity endpoint
Note: LOC for bee is set at 0.4 for acute endpoints and 1 for chronic endpoints.

Table 2 Soil Application: Acute and chronic dietary risk to bees based on screening level exposure estimates for clothianidin and relevant transformation products (K_{oc} value = 102).

Chemical	Application rate	Briggs EEC	Exposure Estimate for Bees*	Toxicity endpoint	RQ**	LOC exceeded?
	kg a.i./ha	µg a.i./g	µg a.i./bee/day	µg a.i./bee/day		
ADULTS (ACUTE)						
Clothianidin	0.1326	0.032	0.009	LD_{50}: 0.00368	2.4	yes
	0.224	0.054	0.016	LD_{50}: 0.00368	4.3	yes
TZNG	0.1326	0.032	0.009	LD_{50}: 3.95	0.002	no
	0.224	0.054	0.016	LD_{50}: 3.95	0.004	no

Chemical	Application rate	Briggs EEC	Exposure Estimate for Bees*	Toxicity endpoint	RQ**	LOC exceeded?
	kg a.i./ha	µg a.i./g	µg a.i./bee/day	µg a.i./bee/day		
ADULTS (CHRONIC)						
Clothianidin	0.1326	0.032	0.009	NOEL: 0.00036	25.0	yes
	0.224	0.054	0.016	NOEL: 0.00036	44.4	yes
BROOD (ACUTE)						
Clothianidin	0.1326	0.032	0.004	LD_{50} > 0.0018	2.2	yes
	0.224	0.054	0.007	LD_{50} > 0.0018	3.9	yes
BROOD (CHRONIC)						
Clothianidin	0.1326	0.032	0.004	NOEL: 0.0009	4.4	yes
	0.224	0.054	0.007	NOEL: 0.0009	7.8	yes

*Exposure estimate for bees = 0.292 x Briggs EEC for adults and 0.124 x Briggs EEC for larvae
**Exposure estimate for bees/toxicity endpoint
Note: LOC for bee is set at 0.4 for acute endpoints and 1 for chronic endpoints.

Table 3 Soil Application: Acute and chronic dietary risk to bees based on screening level exposure estimates for clothianidin and relevant transformation products (K_{oc} value = 345)

Chemical	Application rate	Briggs EEC	Exposure Estimate for Bees*	Toxicity endpoint	RQ**	LOC exceeded?
	kg a.i./ha	µg a.i./g	µg a.i./bee/day	µg a.i./bee/day		
ADULTS (ACUTE)						
Clothianidin	0.1326	0.010	0.003	LD_{50}: 0.00368	0.82	yes
	0.224	0.017	0.005	LD_{50}: 0.00368	1.4	yes
TZNG	0.1326	0.010	0.003	LD_{50}: 3.95	0.0008	no
	0.224	0.017	0.005	LD_{50}: 3.95	0.001	no
ADULTS (CHRONIC)						
Clothianidin	0.1326	0.010	0.003	NOEL: 0.00036	8.3	yes
	0.224	0.017	0.005	NOEL: 0.00036	13.9	yes
BROOD (ACUTE)						
Clothianidin	0.1326	0.010	0.001	LD_{50} > 0.0018	0.56	yes
	0.224	0.017	0.002	LD_{50} > 0.0018	1.1	yes
BROOD (CHRONIC)						
Clothianidin	0.1326	0.010	0.001	NOEL: 0.0009	1.1	yes
	0.224	0.017	0.002	NOEL: 0.0009	2.2	yes

*Exposure Estimate for bees=0.292 x Briggs EEC for adults and 0.124 x Briggs EEC for larvae
**Exposure estimate for bees/toxicity endpoint
Note: LOC for bee is set at 0.4 for acute endpoints and 1 for chronic endpoints.

Tier I Refined Assessment for Soil Applications

Table 4 Soil Application: Acute and Chronic Dietary Risk to Different Bee Castes Based on Maximum and Highest Mean Residues of Clothianidin.

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
Potato In-furrow at 1 x 224 g a.i./ha, sampled 40-80 DALA	sandy loam 188 pollen from flower	n/a	No (0.002)	**Yes** **(0.49)**	No (0.38)	sandy loam 92.6 pollen from flower	n/a	No (0.011)	**Yes** **(2.5)**	No (0.37)	Single application rate in study consistent with registered maximum single application rate and seasonal rate on potato. Maximum residues from sandy loam in California. Thiamethoxam in pollen from control: up to 7.2 ppb but generally <LOQ. Amounts of pollen were insufficient in many sites and sampling times. Sufficient amounts of pollen could not be	There is a potential for acute dietary risk to adult nurse bees from in-furrow soil applications in potato. No risk to nectar foragers or bee larvae was indicated in potato. There is a potential for chronic dietary risk to adult nurse bees from in-furrow soil applications in potato. No chronic dietary risk to adult forager bees and bee larvae is indicated.	**Potato** *Registered at 1 x 133-224 g a.i./ha, in-furrow application (maximum seasonal rate 224 g a.i./ha)* **Potentially Relevant for Other Labelled Crop(s):** **Sweet potato** **(low end estimate)** *Registered at 1 x 224 g a.i./ha, soil spray, drench incorporated*
	loamy sand 114 pollen from flower	n/a	No (0.001)	No (0.30)	No (0.23)	loamy sand 89.4 pollen from flower	n/a	No (0.010)	**Yes** **(2.4)**	No (0.36)			

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
											collected at any sampling times in North Dakota. Anthers were collected from all sites. clothianidin in anthers: up to 47 ppb.		
Corn In-furrow at 1 x 224 g a.i./ha, sampled 55-69 DALA	27.9 pollen from plant	n/a	No 0.0003	No (0.07)	No (0.06)	26.6 pollen from plant	n/a	No (0.003)	No (0.71)	No (0.11)	Not a registered crop in Canada for soil application. Single application rate in study consistent with registered maximum single application rate and seasonal rate on potato and sweet potato. Clothianidin in controls typically <LOQ, except for the Nebraska sandy loam, where 12.43 ppb was found in control pollen.	No acute dietary risk to adult bees or bee larvae is indicated following in-furrow soil applications in corn No chronic dietary risk to adult bees or bee larvae is indicated following an in-furrow soil application in corn.	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):** **Potato** *Registered at 1 x 133-224 g a.i./ha, in-furrow application (maximum seasonal rate 224 g a.i./ha)* **Sweet potato** **(low end estimate)** *Registered at 1 x 224 g*

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	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, soil spray, drench incorporated
Pumpkin various chemigation application scenarios maximum residues from: Chemi-gation at 1 x 224 g a.i./ha/y for 3 success-ive years sampled each year at 38-65 DALA and Late season chemi-gation at 1 x 224 g a.i./ha/y for 3 success-ive years, sampled each year at 8-61 DALA	med. soil 44.5 pollen from flowers	med. soil 22.8 nectar from flowers	pollen + nectar **Yes** **(1.8)** pollen only No (0.001)	pollen + nectar **Yes** **(0.98)** pollen only No (0.12)	pollen + nectar **Yes** **(1.6)** pollen only No (0.09)	med. soil 37.9 pollen from flowers	med. soil 20.4 nectar from flowers	pollen + nectar **Yes** **(17)** pollen only No (0.004)	pollen + nectar **Yes** **(8.9)** pollen only **Yes** **(1.01)**	pollen + nectar **Yes** **(2.9)** pollen only No (0.15)	Not a registered crop in Canada for soil application. Single application rate in studies consistent with registered maximum single application rate and seasonal rate on potato and sweet potato. Pumpkin plants provide both a pollen and nectar source whereas potato plants provide a pollen source only. Coarse soils included loamy sand and sandy loam soils. Medium soils included sandy clay loam and loam soils. Fine soils were clay.	There is an acute dietary risk to adult bees and bee larvae following soil applications in pumpkin. Risk estimates based on pollen residues only indicate no acute dietary risk to adult bees or bee larvae. Risk estimates were higher with chemigation application than with subsurface application made with tractor pulled equipment and in-furrow application. Risk estimates did not generally increase when soil applications were repeated over several years.	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):** **Potato (pollen only)** *Registered at 1 x 133-224 g a.i./ha, in-furrow application (maximum seasonal rate 224 g a.i./ha)* **Sweet potato** *Registered at 1 x 224 g a.i./ha, soil spray, drench incorporated*

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**			
Pumpkin various late season sub-surface shank appli-cation scenarios maximum residues from: Late season sub-surface shank appli-cation 1 month after planting at 1 x 224 g a.i./ha/y for 3 success-ive years, sampled each year at 19-49 DALA	coarse soil 26 pollen from flowers	coarse soil 7.52 nectar from flowers	pollen + nectar **Yes** **(0.60)** pollen only No 0.0003)	pollen + nectar No (0.35) pollen only No (0.07)	pollen + nectar **Yes** **(0.55)** pollen only No (0.05)	18.3 pollen from flowers	5.42 nectar from flowers	pollen + nectar **Yes** **(4.4)** pollen only No (0.002)	pollen + nectar **Yes** **(2.6)** pollen only No (0.49)	pollen + nectar No (0.80) pollen only No (0.07)		Risk estimates were higher when the application was made later in the season (resulting in a shorter time interval between application and sampling). Highest risk estimates were from medium soils (sandy clay loam and loam soils). There is a chronic dietary risk to adult bees and bee larvae following soil applications in pumpkin. Risk estimates based on pollen residues only indicate a marginal risk to nurse bees following a chemigation application in	
Pumpkin various in-furrow appli-cation scenarios	coarse soil 13.8 pollen from flower	loam soil 5.84 nectar from	pollen + nectar **Yes** **(0.46)**	pollen + nectar No (0.26)	pollen + nectar **Yes** **(0.42)**	11.6 pollen from flowers	3.24 nectar from flowers	pollen + nectar **Yes** **(2.6)**	pollen + nectar **Yes** **(1.6)**	pollen + nectar No (0.48)			

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
maximum residues from: In furrow at 1 x 224 g a.i./ha/y for 3 success-ive years, sampled each year at 49-68 DALA and In-furrow at planting at 1 x 224 g a.i./ha, sampled at 47-79 DALA	s	flowers	pollen only No 0.0002)	pollen only No (0.04)	pollen only No (0.03)			pollen only No (0.001)	pollen only No (0.31)	pollen only No (0.05)		pumpkin. No chronic dietary risk was indicated for nectar foragers or bee larvae under any soil application scenario. Risk estimates were higher with chemigation application than with subsurface application made with tractor pulled equipment and in-furrow application. Risk estimates did not generally increase when soil applications were repeated over several years. Risk estimates were higher when the application was made later in the season (resulting in a shorter time interval between application and	

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	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). Highest risk estimates were from medium soils (sandy clay loam and loam soils).	
Individual Pumpkin Studies: **Note that risk estimates presented below are based on combined pollen and nectar exposure. No acute risk was estimated for adult bees and bee larvae using pollen residues only under any of the application scenarios. No chronic risk was estimated for adult bees and bee larvae using pollen residues only under any of the application scenarios, except for nurse bees with late season chemigation (year 3: 37.9 ppb).**													
Pumpkin (course soil) Chemi-gation at 1 x 224 g a.i./ha/y for 3 success-ive years sampled each year at 38-65 DALA	Y1: 7.52 pollen from flowers	Y1: 6.36 nectar from flowers	**Yes** **(0.50)**	No (0.26)	**Yes** **(0.44)**	Y1: 7.47 pollen from flowers	Y1: 5.44 nectar from flowers	**Yes** **(4.4)**	**Yes** **(2.3)**	No (0.76)	see above	see above	see above
	Y2: 6.94 pollen from flowers	Y2: 3.91 nectar from flowers	No (0.31)	No (0.17)	No (0.28)	Y2: 6.23 pollen from flowers	Y2: 2.82 nectar from flowers	**Yes** **(2.3)**	**Yes** **(1.3)**	No (0.40)			
	Y3: 7.76 pollen from flowers	Y3: 4.06 nectar from flowers	No (0.32)	No (0.18)	No (0.29)	Y3: 7.70 pollen from flowers	Y3: 4.03 nectar from flowers	**Yes** **(3.2)**	**Yes** **(1.8)**	No (0.57)			
Pumpkin	Y1:	Y1:	No	No	No	Y1:	Y1:	**Yes**	**Yes**	No			

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**			
(medium soil) Chemi-gation at 1 x 224 g a.i./ha/y for 3 success-ive years sampled each year at 38-65 DALA	8.27 pollen from flowers	2.91 nectar from flowers	(0.232)	(0.13)	(0.21)	7.26 pollen from flowers	2.21 nectar from flowers	**(1.8)**	**(1.1)**	(0.32)			
	Y2: 10.6 pollen from flowers	Y2: 5.43 nectar from flowers	**Yes (0.43)**	No (0.23)	No (0.38)	Y2: 9.45 pollen from flowers	Y2: 4.15 nectar from flowers	**Yes (3.4)**	**Yes (1.9)**	No (0.59)			
	Y3: 17 pollen from flowers	Y3: **22.8** nectar from flowers	**Yes (1.8)**	**Yes (0.91)**	**Yes (1.6)**	Y3: 11.5 pollen from flowers	Y3: **20.4** nectar from flowers	**Yes (17)**	**Yes (8.2)**	**Yes (2.8)**			
Pumpkin (fine soil) Chemi-gation at 1 x 224 g a.i./ha/y for 3 success-ive years sampled each year at 38-65 DALA	Y1: 25.8 pollen from flowers	Y1: 9.58 nectar from flowers	**Yes (0.76)**	**Yes (0.43)**	**Yes (0.69)**	Y1: 15.5 pollen from flowers	Y1: 5.8 nectar from flowers	**Yes (4.7)**	**Yes (2.7)**	No (0.84)			
	Y2: 2.26 pollen from flowers	Y2: 1.08 nectar from flowers	No (0.09)	No (0.05)	No (0.08)	Y2: 2.22 pollen from flowers	Y2: 1.08 nectar from flowers	No (0.88)	No (0.48)	No (0.15)			
	Y3:	Y3:	**Yes**	No	No	Y3:	Y3:	**Yes**	**Yes**	No			

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**			
	11.1 pollen from flowers	5.55 nectar from flowers	**(0.44)**	(0.24)	(0.39)	9.98 pollen from flowers	4.66 nectar from flowers	**(3.8)**	**(2.1)**	(0.66)			
Pumpkin (coarse soil) In furrow at 1 x 224 g a.i./ha/y for 3 success-ive years, sampled each year at 49-68 DALA	Y1: 7.65 pollen from flowers	Y1: 4.06 nectar from flowers	No (0.32)	No (0.17)	No (0.29)	Y1: 6.44 pollen from flowers	Y1: 2.94 nectar from flowers	**Yes (2.4)**	**Yes (1.3)**	No (0.42)	see above Residual clothianidin in soil prior to application: 18 ppb in year 2 (Y2) and 14 ppb in year 3 (Y3).	see above	see above
	Y2: 7.71 pollen from flowers	Y2: 3.65 nectar from flowers	No (0.29)	No (0.16)	No (0.269)	Y2: 7.32 pollen from flowers	Y2: 3.24 nectar from flowers	**Yes (2.6)**	**Yes (1.5)**	No (0.46)			
	Y3: 13.8 pollen from flowers	Y3: 2.59 nectar from flowers	No (0.21)	No (0.13)	No (0.20)	Y3: 11.6 pollen from flowers	Y3: 2.08 nectar from flowers	**Yes (1.7)**	**Yes (1.1)**	No (0.32)			
Pumpkin (medium soil) Late season chemi-gation at 1 x 224 g	Y1: 37.6 pollen from flowers	Y1: 13.3 nectar from flowers	**Yes (1.1)**	**Yes (0.60)**	**Yes (0.96)**	Y1: 33.3 pollen from flowers	Y1: 12.8 nectar from flowers	**Yes (10.4)**	**Yes (5.9)**	**Yes (1.8)**	see above Residual clothianidin in soil prior to application: 8 and 11 ppb in medium	see above	see above
	Y2:	Y2:	**Yes**	**Yes**	**Yes**	Y2:	Y2:	**Yes**	**Yes**	**Yes**			

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	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/y for 3 success-ive years, sampled each year at 8-61 DALA	30.3 pollen from flowers	18 nectar from flowers	**(1.4)**	**(0.76)**	**(1.3)**	27.4 pollen from flowers	17 nectar from flowers	**(13.8)**	**(7.3)**	**(2.4)**	and fine soils, respectively in year 2 (Y2). Residual clothianidin in soil prior to application: 18 and 43 ppb in medium and fine soils, respectively in year 3 (Y3).		
	Y3: **44.5** pollen from flowers	Y3: 11.6 nectar from flowers	**Yes (0.92)**	**Yes (0.56)**	**Yes (0.86)**	Y3: **37.9** pollen from flowers	Y3: 11.1 nectar from flowers	**Yes (9.0)**	**Yes (5.4)**	**Yes (1.6)**			
Pumpkin (fine soil) Late season chemi-gation at 1 x 224 g a.i./ha/y for 3 success-ive years, sampled each year at 8-61 DALA	Y1: 13.4 pollen from flowers	Y1: 5.98 nectar from flowers	**Yes (0.47)**	No (0.26)	**Yes (0.43)**	Y1: 9.79 pollen from flowers	Y1: 4.25 nectar from flowers	**Yes (3.4)**	**Yes (1.9)**	No (0.60)			
	Y2: 2.06 pollen from flowers	Y2: 3.21 nectar from flowers	No (0.25)	No (0.13)	No (0.22)	Y2: 1.8 pollen from flowers	Y2: 2.1 nectar from flowers	**Yes (1.7)**	No (0.86)	No (0.29)			
	Y3: 1.65 pollen from flowers	Y3: 1.23 nectar from flowers	No (0.10)	No (0.05)	No (0.09)	Y3: 1.51 pollen from flowers	Y3: 0.94 nectar from flowers	No (0.76)	No (0.41)	No (0.13)			
Pumpkin	Y1:	Y1:	**Yes**	No	**Yes**	Y1:	Y1:	**Yes**	**Yes**	No	see above	see above	see above

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**			
(coarse soil) Late season sub-surface shank appli-cation 1 month after planting at 1 x 224 g a.i./ha/y for 3 success-ive years, sampled each year at 19-49 DALA	26 pollen from flowers	7.52 nectar from flowers	**(0.60)**	(0.35)	**(0.55)**	18.3 pollen from flowers	5.42 nectar from flowers	**(4.4)**	**(3.0)**	(0.80)	Residual clothianidin in soil prior to application: 15 ppb in year 2 (Y2) and 19 ppb in year 3 (Y3).		
	Y2: 10.5 pollen from flowers	Y2: 3.83 nectar from flowers	No (0.30)	No (0.17)	No (0.28)	Y2: 9.79 pollen from flowers	Y2: 3.12 nectar from flowers	**Yes** **(2.5)**	**Yes** **(1.5)**	No (0.46)			
	Y3: 19.9 pollen from flowers	Y3: 5.33 nectar from flowers	**Yes** **(0.42)**	No (0.25)	No (0.39)	Y3: 18.2 pollen from flowers	Y3: 4.94 nectar from flowers	**Yes** **(4.0)**	**Yes** **(2.4)**	No (0.73)			
Pumpkin Chemi-gation at 1 x 224 g a.i./ha, sampled each year at 42-69 DALA	Loam y sand 38.3 pollen from flowers	Loamy sand 5.33 nectar from flowers	**Yes** **(0.42)**	No (0.30)	**Yes** **(0.43)**	Loamy sand 21.4 pollen from flowers	Loamy sand 4.98 nectar from flowers	**Yes** **(4.0)**	**Yes** **(2.5)**	No (0.75)	see above	see above	see above
Pumpkin In-furrow at planting at 1 x 224 g a.i./ha, sampled at	loam 5.57 pollen from flowers	loam 5.84 nectar from flowers	**Yes** **(0.46)**	No (0.24)	**Yes** **(0.40)**	loam 3.11 pollen from flowers	loam 2.34 nectar from flowers	**Yes** **(1.9)**	No (0.99**)**	No (0.32)	see above Clothianidin in controls: typically <LOQ except for 1.16 ppb in pollen	see above	see above

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**	**Pollen**	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**			
47-79 DALA	silt loam 3.91 pollen from flowers	silt loam 1.71 nectar from flowers	No (0.14)	No (0.08)	No (0.12)	silt loam 2.97 pollen from flowers	silt loam 1.44 nectar from flowers	**Yes (1.2)**	No (0.64**)**	No (0.20)	at one site.		
Pumpkin Late season chemi-gation at 1 x 224 g a.i./ha, sampled each year at 21-49 DALA	sand 31.9 pollen from flowers	sand 11.3 nectar from flowers	**Yes (0.90)**	**Yes (0.51)**	**Yes (0.82)**	sand 27.8 pollen from flowers	sand 9.55 nectar from flowers	**Yes (7.7)**	**Yes (4.5)**	**Yes (1.4)**	see above	see above	see above
	silt loam 4.6 pollen from flowers	silt loam 1.59 pollen from flowers	No (0.13)	No (0.07)	No (0.12)	silt loam 2.91 pollen from flowers	silt loam 1.33 pollen from flowers	**Yes (1.1)**	No (0.59**)**	No (0.19)			
Pumpkin Late season sub-surface shank at 1 x 224 g a.i./ha, sampled at 25-53 DALA	sandy loam 5.54 pollen from flowers	sandy loam 2.42 nectar from flowers	No (0.19)	No (0.11)	No (0.17)	sandy loam 4.9 pollen from flowers	sandy loam 2.07 nectar from flowers	**Yes (1.7)**	No (0.94**)**	No (0.30)	see above	see above	see above
Pumpkin Chemi-	21.1 pollen from	7.28 nectar from	**Yes (0.58)**	No (0.33)	**Yes (0.53)**	sandy loam 16.4	sandy loam 5.39	**Yes (4.4)**	**Yes (2.5)**	No (0.78)	see above	see above	see above

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
gation at planting at 1 x 224 g a.i./ha, sampled at 34-62 DALA	flowers	flowers				pollen from flowers	nectar from flowers				Sandy loam soil No residues in pollen, nectar or leaves from controls. Clothianidin in anthers: up to 13.3 ppb. A 40.2 ppb concentration was observed in pollen at 48 days and was considered a potential outlier by study authors (other samples taken at this sampling event contained 4.83 and 5.69 ppb).		
Cucumber Chemi-gation at planting at 1 x 224 g a.i./ha, sampled at 37-56 DALA	34.3* pollen from anthers	39.7 nectar from flowers	pollen + nectar **Yes (3.2)** pollen only No	pollen + nectar **Yes (1.6)** pollen only	pollen + nectar **Yes (2.7)** pollen only No	32* pollen from anthers	32.6 nectar from flowers	pollen + nectar **Yes (26)** pollen only No	pollen + nectar **Yes (14)** pollen only	pollen + nectar **Yes (4.5)** pollen only	Sandy loam soil *Pollen was not collected because of low amounts available. No residues in leaves from controls (no	There is an acute dietary risk to adult bees and bee larvae following soil applications in cucumber. Risk estimates based on pollen residues only indicate no acute	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):**

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
			(0.004)	No (0.09)	(0.07)			(0.004)	No (0.85)	No (0.13)	nectar data from controls).	dietary risk to adult bees or bee larvae. There is a chronic dietary risk to adult bees and bee larvae following soil applications in cucumber.	**Potato (pollen only)** *Registered at 1 x 133-224 g a.i./ha, in-furrow application (maximum seasonal rate 224 g a.i./ha)* **Sweet potato** *Registered at 1 x 224 g a.i./ha, soil spray, drench incorporated*
Melon (canta-loupe) Chemi-gation at planting at 1 x 224 g a.i./ha, sampled at 41-54 DALA	20.8* pollen from anthers	14.7 nectar from flowers	pollen + nectar **Yes (1.2)** pollen only No (0.0002	pollen + nectar **Yes (0.61)** pollen only No (0.05**)**	pollen + nectar **Yes (1.0)** pollen only No (0.04**)**	16.8* pollen from anthers	10.9 nectar from flowers	pollen + nectar **Yes (8.8)** pollen only No (0.002)	pollen + nectar **Yes (4.7)** pollen only No (0.45)	pollen + nectar **Yes (1.5)** pollen only No (0.07)	Sandy loam soil *Pollen was not collected because of low amounts available. No residues in leaves from controls (no nectar data from controls).	There is an acute and chronic dietary risk to adult bees and bee larvae following soil applications in melon. Risk estimates based on pollen residues only indicate no acute or chronic dietary risk to adult bees or bee larvae except for a	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):** **Potato (pollen only)** *Registered at 1 x 133-224 g*
Melon Chemi-	Sandy Loam	Sandy Loam	pollen + nectar	pollen + nectar	pollen + nectar	Sandy Loam	Sandy Loam	pollen + nectar	pollen + nectar	pollen + nectar	Sandy loam soil		

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
gation at planting at 1 x 224 g a.i./ha, sampled at 33-64 DALA	39.5 pollen from flowers	65.5 nectar from flowers	**Yes (5.2)** pollen only No (0.0004	**Yes (2.6)** pollen only No (0.10**)**	**Yes (4.4)** pollen only No (0.08**)**	39.5 pollen from flowers	65.5 nectar from flowers	**Yes (53)** pollen only No (0.005)	**Yes (27)** pollen only **Yes (1.1)**	**Yes (8.9)** pollen only No (0.16)	Only one nectar or pollen sample collected from flower, explaining why same max and mean concentrations.	marginal chronic risk to nurse bees.	*a.i./ha, in-furrow application (maximum seasonal rate 224 g a.i./ha)* **Sweet potato** *Registered at 1 x 224 g a.i./ha, soil spray, drench incorporated*
Squash Chemi-gation at planting at 1 x 224 g a.i./ha, sampled at 33-61 DALA	14.8 pollen from flowers	4.51 nectar from flowers	pollen + nectar No (0.36) pollen only No (0.0002	pollen + nectar No (0.21) pollen only No (0.04)	pollen + nectar No (0.33) pollen only No (0.03)	12 pollen from flowers	4.46 nectar from flowers	pollen + nectar **Yes (3.6)** pollen only No (0.001)	pollen + nectar **Yes (2.1)** pollen only No (0.32)	pollen + nectar No (0.64) pollen only No (0.05)	Sandy loam soil No residues in pollen, nectar or leaves from controls. Clothianidin in anthers: up to 8.7 ppb.	No acute dietary risk to adult bees or bee larvae is indicated following soil applications in squash. There is a chronic dietary risk to adult bees following soil applications in pumpkin. No risk is indicated for bee larvae. Risk estimates based on pollen residues only indicate no chronic dietary	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):** **Potato (pollen only)** *Registered at 1 x 133-224 g a.i./ha, in-furrow application (maximum seasonal rate 224 g a.i./ha)*

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
												risk to adult bees or bee larvae.	**Sweet potato** *Registered at 1 x 224 g a.i./ha, soil spray, drench incorporated*
Rotational Crop Untreated sunflower planted following three consec-utive years of in-furrow soil appli-cations at 1 x 110 g a.i./ha/y. sampled 106-199 DALA	<LOQ[3] 0.65 pollen from flower 1 pollen from bees or from hives	<LOD[3] 0.15 nectar from hives	No (0.01) No (0.01)	No (0.01) No (0.01)	No (0.01) No (0.01)	<LOQ[3] 0.65 pollen from flower pollen from hives 0.88	<LOD[3] 0.15 nectar from hives	No (0.12) No (0.12)	No (0.08) No (0.08)	No (0.02) No (0.02)	Three years of consecutive in-furrow soil applications. Study rates lower than the range of rates registered for soil application. Soil type not reported. No controls. clothianidin in soil sampled at approx. the same time as pollen and nectar: 10 ppb. No information on residues in soil before drilling untreated sunflower.	No acute dietary risk to adult bees or bee larvae indicated in rotational crops following three consecutive years of soil applications of clothianidin (low rate scenario). No chronic dietary risk to adult bees or bee larvae indicated in rotational crops following three consecutive years of soil applications of clothianidin (low rate scenario).	**Rotational crops**

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
											Clothianidin was found at 1 ppb in some pollen samples collected from bees and from hives. Clothianidin was not detected in other sampled matrices.		
Rotational Crop Year 1: winter barley seed treatment at 50 g a.i./ha. Soil spray appli-cation on the day of planting to simulate carryover at 1 x 90 g a.i./ha, (incorp-orated) Year 2: untreated winter rape planned as a rotational crop Year 3:	1 pollen from bees	<LOD[3] 0.15 nectar from bees	No (0.01)	No (0.01)	No (0.01)	1 pollen from bees	<LOD[3] 0.15 nectar from bees	No (0.12)	No (0.09)	No (0.02)	Study rates lower than the range of rates registered for soil application. Soil application to simulate worst-case plateau concentration of approx. 30 ppb expected in soil after several years of use at 80 g a.i./ha. Clothianidin in treated soil was 20-34 ppb after application and 12-13 ppb one day before drilling untreated rape. No measurable	No acute dietary risk to adult bees or bee larvae is indicated in rotational crops following a soil application scenario of clothianidin to simulate carryover (low rate scenario). No chronic dietary risk to adult bees or bee larvae is indicated in rotational crops following a soil application scenario of clothianidin to simulate carryover (low rate scenario).	**Rotational crops**

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	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 winter rape the following season 561-574 DALA.											residues in control.		
Rotational Crop **2355487, 2355488, 2355489** (summer rape, rapeseed or corn; summer rape had highest residues which are reported) Soil application at 1 x 90 a.i./ha incorpor-ated with or without seed treatment Sampled 87-101 DALA	4 pollen from bees	2.15 nectar from bees	No (0.24)	No (0.14)	No (0.22)	4 pollen from bees	2.15 nectar from bees	**Yes (1.7)**	No (0.14)	No (0.22)	Study rates lower than the range of rates registered for soil application. Soil application made within the same season. Soil application to simulate worst-case plateau concentration of approx. 20 ppb expected in soil after several years of use at 50 g a.i./ha. Clothianidin in treated soil was 19.7- 25.8 ppb after application and 18-21 ppb one day before drilling (dry soil).	No acute dietary risk to adult bees or bee larvae is indicated in rotational crops following a soil application scenario of clothianidin to simulate carryover (low rate scenario). There is a chronic dietary risk to adult nectar forager bees in rotational crops following a soil application scenario of clothianidin to simulate carryover (low rate scenario). No acute dietary risk to adult nurse bees or bee larvae is indicated.	**Rotational crops**

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
											No clothianidin in soil prior to trial initiation. No measurable residues in control.		
Rotational Crop 2630589 (rapeseed, corn, mustard, zucchini, field beans and sunflower; mustard had highest pollen residues and rapeseed had highest nectar residues which are reported) Soil appli-cation at 1 x 112 g a.i./ha incorporate d without seed treatment	11 pollen from hives	3 nectar from flowers	No (0.24)	No (0.14)	No (0.22)	10 pollen from hives	2.67 nectar from flowers	**Yes (2.2)**	**Yes (1.3)**	No (0.40)	Study rates lower than the range of rates registered for soil application. Soil application made within the same season. Soil application to simulate worst-case plateau concentration of 40 ppb expected in soil after twenty years of use at an unspecified rate. The maximum clothianidin concentration in pollen was 80 ppb and 16 ppb in nectar. Control pollen was also contaminated at relatively high levels (33 ppb),	No acute dietary risk to adult bees or bee larvae is indicated in rotational crops following a soil application scenario of clothianidin to simulate carryover. There is a chronic dietary risk to adult bees in rotational crops following a soil application scenario of clothianidin to simulate carryover. No chronic dietary risk to bee larvae is indicated.	**Rotational crops**

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	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 47-107 DALA											which greatly lowers the confidence of the concentrations observed in this site. Clothianidin in treated soil reported as 17-104 ppb after application and 7-75 ppb at flowering.		
Rotational crop (corn, mustard or Phacelia; Phacelia had highest residues which are reported) [high rate scenario] Year 1: winter barley seed treatment at 56-73 g a.i./100 kg seed, 99.3 - 100 g a.i./ha. Soil	11 pollen from bees	6.9 nectar from bees	**Yes (0.55)**	No (0.29)	**Yes (0.48)**	11 pollen from bees	6.9 nectar from bees	**Yes (0.55)**	No (0.29)	Yes (0.48)	Rates within range of labelled rates for soil applications, and similar to maximum labelled rate of 224 g a.i./ha. Soil application + barley seed treatment followed by untreated corn, mustard or Phacelia the next season Soil type not provided.	There is a marginal acute dietary risk to adult nectar foragers and bee larvae in rotational crops following a soil application of clothianidin in the preceding year at rates similar to the maximum labelled rate (high rate scenario). There is a marginal chronic dietary risk to nectar foragers in rotational crops following a soil	**Rotational crops**

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
spray application on the day of planting to simulate carryover at 1 x 212-221 g a.i./ha, (incorporated) Year 2: untreated corn, mustard and Phacelia planted as rotational crops Sampled 282-293 (corn), 267-300 (mustard), 278-355 (Phacelia) DALA (sowing of treated barley seeds).											No information on target plateau concentration and choice of rates. Clothianidin in soil for high rate scenario: up to 71-84, 90 and 75-78 ppb (dry soil) in corn, mustard and Phacelia, respectively. No control plot.	application scenario of clothianidin to simulate carryover. No chronic dietary risk to nurse bees or bee larvae is indicated.	
Rotational crop (corn, mustard or Phacelia; mustard had	7.3 pollen from bees	3.6 nectar from bees	No (0.29)	No (0.16)	No (0.25)	7.3 pollen from bees	3.6 nectar from bees	No (0.29)	No (0.16)	No (0.25)	Study rates lower than the range of rates registered for soil application.	No acute or chronic dietary risk to adult bees or bee larvae in rotational crops following soil	

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
highest residues which are reported) [low rate scenario] as above, except that treatment rates in year 1 were lower Winter barley seed treatment at 20-22.5 g a.i./100 kg seed (reported); 0.0004 - 0.0011 mg a.i./seed (calculated) ; 40 g a.i./ha (reported). Soil spray appli-cation at 86-90 g a.i./ha, incorpor-ated. * Sampled 286-293 (corn), 286-											Soil application + barley seed treatment followed by untreated corn, mustard or Phacelia the next season Clothianidin in soil for low rate scenario: up to 52-71, 35-49 and 42-51 ppb (dry soil) in corn, mustard and Phacelia, respectively. A higher clothianidin concentration of 4.2 ppb was found in corn pollen but sample was contaminated with plant material and value was not used (not reported as max and excluded from mean calculation). No control plots.	applications of clothianidin in the preceding year at rates lower than labelled rates (low rate scenario).	

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)			EEC - highest mean residue value in ppb		Did the Chronic RQ[2] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
293 (mustard), 378 (Phacelia) DALA (sowing of treated barley seeds).													

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

[1] **Bold** values indicate that acute LOC (RQ ≥0.4) is exceeded.

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]; 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: adult acute oral LD50 = 0.00368 µg a.i./bee for TGAI; bee larvae 7-day LD_{50} = 0.0018 µg a.i./larva/day for TGAI

[2] **Bold** values indicate that chronic LOC (RQ ≥1.0) is exceeded.

Chronic RQ = Chronic estimated daily dose (EDD)/chronic toxicity endpoint; Chronic EDD = nectar dose [nectar consumption rate (mg/day) x highest mean nectar residue (µg/kg)/ 1.0 x 10^6] + pollen dose [pollen consumption rate (mg/day) x highest mean 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; Note: 10-d NOEL = 0.00036 µg a.i./bee/day for adult worker bees for TGAI; bee larvae 22-d NOEL = 0.0009 µg a.i./larva/day for TGAI

[3]Standardized maximum value ½ LOD or ½ LOQ or ½ LOD +LOQ

Tier II Refined Assessment for Soil Applications

Table 5 Soil Application: Chronic Risk Assessment for Honey Bee Hives Based on the Comparison of Measured Clothianidin Residues and Colony Feeding Study Effects Values.

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
Potato In-furrow at 1 x 224 g a.i./ha,	sandy loam 92.6 pollen	n/a	sandy loam 42	**Yes**	n/a	**Yes**	Single application rate in study consistent with registered maximum single	**Yes** When applied in-furrow at the	**Potato** *Registered at 1 x 133-224 g*

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
sampled 40-80 DALA **PMRA No. 2617876**	from flower						application rate and seasonal rate on potato. Maximum residues from sandy loam in California. Thiamethoxam in pollen from control: up to 7.2 ppb but generally <LOQ. Amounts of pollen were insufficient in many sites and sampling times. Sufficient amounts of pollen could not be collected at any sampling times in North Dakota. Anthers were collected from all sites. Clothianidin in anthers: up to 47 ppb.	maximum single application/ seasonal rate for labelled crops. Potential for risk from pollen and bee bread exposure.	*a.i./ha, in-furrow application (maximum seasonal rate 224 g a.i./ha)* **Potentially Relevant for Other Labelled Crop(s):** **Sweet potato (low-end estimate based on pollen)** *Registered at 1 x 224 g a.i./ha, soil spray, drench incorporated*
	loamy sand 89.4 pollen from flower	n/a	loamy sand 40	**Yes**	n/a	**Yes**			
Corn In-furrow at 1 x 224 g a.i./ha, sampled 55-69 DALA **PMRA No. 2508574**	26.6 pollen from plant	n/a	12	**Yes**	n/a	**Yes**	Not a registered crop in Canada for soil application. Single application rate in study consistent with registered maximum single application rate and	**Yes** When applied in-furrow at the maximum single application/ seasonal rate for labelled crops. Potential for risk	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):** **Potato**

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
							seasonal rate on potato and sweet potato. Clothianidin in controls typically <LOQ, except for the Nebraska sandy loam, where 12.43 ppb was found in control pollen.	from pollen and bee bread exposure.	*Registered at 1 x 133-224 g a.i./ha, in-furrow application (maximum seasonal rate 224 g a.i./ha)* **Sweet potato (low-end estimate)** *Registered at 1 x 224 g a.i./ha, soil spray, drench incorporated*
Pumpkin various chemigation application scenarios highest mean residues are from: Chemigation at 1 x 224 g a.i./ha/y for 3 successive years sampled each year at 38-65 DALA and Late season chemigation at 1 x 224 g a.i./ha/y	med. soil 37.9 pollen from flowers	med. soil 20.4 nectar from flowers	med. soil 40 pollen + nectar 17.1 pollen only	**Yes**	**Yes**	**Yes** pollen + nectar **Yes** pollen only	Not a registered crop in Canada for soil application. Single application rate in studies consistent with registered maximum single application rate and seasonal rate on potato and sweet potato. Pumpkin plants provide both a pollen and nectar source whereas potato plants provide a pollen source only.	**Yes** Following soil applications in pumpkin. Potential for risk from pollen, nectar and bee bread exposure. Risk potential higher with chemigation application compared with subsurface application made with tractor pulled equipment and in-furrow	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):** **Potato** *Registered at 1 x 133-224 g a.i./ha, in-furrow application (maximum seasonal rate 224 g a.i./ha)* **Sweet potato** *Registered at 1 x 224 g a.i./ha, soil spray, drench*

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
for 3 successive years, sampled each year at 8-61 DALA							Coarse soils included loamy sand and sandy loam soils. Medium soils included sandy clay loam and loam soils. Fine soils were clay.	application. Risk potential did not generally increase when soil applications were repeated over several years. Risk potential higher when the application was made later in the season (resulting in a shorter time interval between application and sampling). Highest potential risk from medium soils (sandy clay loam and loam soils).	*incorporated*
Pumpkin various late season sub-surface shank applica-tion scenarios highest mean residues from: Late season sub-surface shank applica-tion 1 month after planting at 1 x 224 g a.i./ha/y for 3 successive years, sampled each year at 19-49 DALA	18.3 pollen from flowers	5.42 nectar from flowers	14.3 pollen + nectar 8.24 pollen only	**Yes**	No	**Yes** pollen + nectar **Yes** pollen only			

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
Pumpkin various in-furrow application scenarios highest mean residues from: In furrow at 1 x 224 g a.i./ha/y for 3 successive years, sampled each year at 49-68 DALA	11.6 pollen from flowers	3.24 nectar from flowers	8.9 pollen + nectar 5.2 pollen only	**Yes**	No	**Yes** pollen + nectar **Yes** pollen only			
Individual Pumpkin Studies									
Pumpkin (course soil) Chemigation at 1 x 224 g a.i./ha/y for 3 successive years sampled each year at 38-65 DALA	Y1: 7.47 pollen from flowers	Y1: 5.44 nectar from flowers	Y1: 9.48 pollen+ nectar 3.36 pollen only	**Yes**	No	**Yes** pollen + nectar No pollen only	see above	see above	see above
	Y2: 6.23 pollen from flowers	Y2: 2.82 nectar from flowers	Y2: 5.98 pollen+ nectar 2.80	**Yes**	No	**Yes** pollen+ nectar No			

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
			pollen only			pollen only			
	Y3: 7.70 pollen from flowers	Y3: 4.03 nectar from flowers	Y3: 8.0 pollen+ nectar 3.47 pollen only	**Yes**	No	**Yes** pollen+ nectar No pollen only			
Pumpkin (medium soil) Chemigation at 1 x 224 g a.i./ha/y for 3 successive years sampled each year at 38-65 DALA	Y1: 7.26 pollen from flowers	Y1: 2.21 nectar from flowers	Y1: 5.76 pollen+ nectar 3.27 pollen only	**Yes**	No	**Yes** pollen+ nectar No pollen only			
	Y2: 9.45 pollen from flowers	Y2: 4.15 nectar from flowers	Y2: 8.92 pollen+ nectar pollen only 4.26	**Yes**	No	**Yes** pollen+ nectar No pollen only			
	Y3: 11.5 pollen	Y3: **20.4** nectar from	Y3: 28.1 pollen+	**Yes**	**Yes**	**Yes** pollen+ nectar			

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Bee bread**	**Pollen**	**Nectar**	**Bee Bread**			
	from flowers	flowers	nectar 5.18 pollen only			 **Yes** pollen only			
Pumpkin (fine soil) Chemigation at 1 x 224 g a.i./ha/y for 3 successive years sampled each year at 38-65 DALA	Y1: 15.5 pollen from flowers	Y1: 5.8 nectar from flowers	Y1: 13.5 pollen+ nectar 6.98 pollen only	**Yes**	No	**Yes** pollen + nectar **Yes** pollen only			
	Y2: 2.22 pollen from flowers	Y2: 1.08 nectar from flowers	Y2: 2.21 pollen+ nectar 1.0 pollen only	No	No	No pollen+ nectar No pollen only			
	Y3: 9.98 pollen from flowers	Y3: 4.66 nectar from flowers	Y3: 9.74 pollen+ nectar 4.49 pollen only	No	No	**Yes** pollen+ nectar No pollen only			

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
Pumpkin (coarse soil) In furrow at 1 x 224 g a.i./ha/y for 3 successive years, sampled each year at 49-68 DALA	Y1: 6.44 pollen from flowers	Y1: 2.94 nectar from flowers	Y1: 6.21 pollen+ nectar 2.90 pollen only	**Yes**	No	**Yes** pollen+ nectar No pollen only	see above Residual clothianidin in soil prior to application: 18 ppb in year 2 (Y2) and 14 ppb in year 3 (Y3).	see above	see above
	Y2: 7.32 pollen from flowers	Y2: 3.24 nectar from flowers	Y2: 6.94 pollen+ nectar 3.29 pollen only	**Yes**	No	**Yes** pollen+ nectar No pollen only			
	Y3: 11.6 pollen from flowers	Y3: 2.08 nectar from flowers	Y3: 7.56 pollen+ nectar 5.22 pollen only	**Yes**	No	**Yes** pollen+ nectar **Yes** pollen only			
Pumpkin (medium soil) Late season chemigation at 1 x 224 g a.i./ha/y	Y1: 33.3 pollen from flowers	Y1: 12.8 nectar from flowers	Y1: 29.4 pollen+ nectar	**Yes**	No	**Yes** pollen+ nectar	see above Residual clothianidin in soil prior to application: 8 and 11 ppb in medium and	see above	see above

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
for 3 successive years, sampled each year at 8-61 DALA			15.0 pollen only			**Yes** pollen only	fine soils, respectively in year 2 (Y2). Residual clothianidin in soil prior to application: 18 and 43 ppb in medium and fine soils, respectively in year 3 (Y3).		
	Y2: 27.4 pollen from flowers	Y2: 17 nectar from flowers	Y2: 31.5 pollen+ nectar	**Yes**	No	**Yes** pollen+ nectar			
			12.3 pollen only			**Yes** pollen only			
	Y3: **37.9** pollen from flowers	Y3: 11.1 nectar from flowers	Y3: 29.6 pollen+ nectar	**Yes**	No	**Yes** pollen+ nectar			
			17.1 pollen only			**Yes** pollen only			
Pumpkin (fine soil) Late season chemigation at 1 x 224 g a.i./ha/y for 3 successive years, sampled each year at 8-61 DALA	Y1: 9.79 pollen from flowers	Y1: 4.25 nectar from flowers	Y1: 9.19 pollen+ nectar	**Yes**	No	**Yes** pollen+ nectar			
			4.41 pollen only			No pollen only			
	Y2: 1.8	Y2: 2.1	Y2: 3.17	No	No	No pollen+			

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Bee bread**	**Pollen**	**Nectar**	**Bee Bread**			
	pollen from flowers	nectar from flowers	pollen+ nectar 0.81 pollen only			nectar No pollen only			
	Y3: 1.51 pollen from flowers	Y3: 0.94 nectar from flowers	Y3: 1.74 pollen+ nectar 0.68 pollen only	No	No	No pollen+ nectar No pollen only			
Pumpkin (coarse soil) Late season sub-surface shank appli-cation 1 month after planting at 1 x 224 g a.i./ha/y for 3 successive years, sampled each year at 19-49 DALA	Y1: 18.3 pollen from flowers	Y1: 5.42 nectar from flowers	Y1: 14.3 pollen+ nectar 8.24 pollen only	**Yes**	No	**Yes** pollen+ nectar **Yes** pollen only	see above Residual clothianidin in soil prior to application: 15 ppb in year 2 (Y2) and 19 ppb in year 3 (Y3).	see above	see above
	Y2: 9.79 pollen from flowers	Y2: 3.12 nectar from flowers	Y2: 7.92 pollen+ nectar 4.41 pollen only	**Yes**	No	**Yes** pollen+ nectar No pollen only			

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
	Y3: 18.2 pollen from flowers	Y3: 4.94 nectar from flowers	Y3: 13.8 pollen+ nectar 8.20 pollen only	**Yes**	No	**Yes** pollen+ nectar **Yes** pollen only			
Pumpkin Chemigation at 1 x 224 g a.i./ha, sampled each year at 42-69 DALA	21.4 pollen from flowers	4.98 nectar from flowers	15.2 pollen+ nectar 9.64 pollen only	**Yes**	No	**Yes** pollen+ nectar **Yes** pollen only	see above Loamy sand	see above	see above
Pumpkin In-furrow at planting at 1 x 224 g a.i./ha, sampled at 47-79 DALA	loam 3.11 pollen from flowers	loam 2.34 nectar from flowers	loam 4.03 pollen+ nectar 1.40 pollen only	No	No	No pollen+ nectar No pollen only	see above Clothianidin in controls: typically <LOQ except for 1.16 ppb in pollen at one site.	see above	see above
	silt loam 2.97 pollen from flowers	silt loam 1.44 nectar from flowers	silt loam 2.96 pollen+ nectar	No	No	No pollen + nectar			

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
			1.34 pollen only			No pollen only			
Pumpkin Late season chemigation at 1 x 224 g a.i./ha, sampled each year at 21-49 DALA	sand 27.8 pollen from flowers	sand 9.55 nectar from flowers	sand 23.3 pollen+ nectar 12.5 pollen only	**Yes**	No	**Yes** pollen+ nectar **Yes** pollen only	see above	see above	see above
	silt loam 2.91 pollen from flowers	silt loam 1.33 pollen from flowers	pollen 2.81 pollen+ nectar 1.31 pollen only	No	No	No pollen+ nectar No pollen only			
Pumpkin Late season sub-surface shank at 1 x 224 g a.i./ha, sampled each year at 25-53 DALA	sandy loam 4.9 pollen from flowers	sandy loam 2.07 nectar from flowers	sandy loam 4.54 pollen+ nectar 2.21 pollen only	No	No	**Yes** pollen+ nectar No pollen only	see above	see above	see above
Pumpkin	sandy	sandy loam	sandy	**Yes**	No	**Yes**	see above	see above	see above

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
Chemigation at planting at 1 x 224 g a.i./ha, sampled at 34-62 DALA **PMRA No. 2617877**	loam 16.9 pollen from flowers	5.39 nectar from flowers	loam 13.7 pollen+ nectar 7.61 pollen only			pollen+ nectar **Yes** pollen only	No residues in pollen, nectar or leaves from controls. clothianidin in anthers: up to 13.3 ppb. A 40.2 ppb concentration was observed in pollen at 48 days and was considered a potential outlier by study authors (other samples taken at this sampling event contained 4.83 and 5.69 ppb).		
Cucumber Chemigation at planting at 1 x 224 g a.i./ha, sampled at 37-56 DALA **PMRA No. 2617877**	32* pollen from anthers	32.6 nectar from flowers	51 pollen+ nectar 14 pollen only	**Yes**	**Yes**	**Yes** pollen+ nectar **Yes** pollen only	Sandy loam soil *Pollen was not collected because of low amounts available. No residues in leaves from controls (no nectar data from controls).	**Yes** Following a soil application in cucumber. Potential for risk from pollen, nectar and bee bread exposure.	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):** **Potato (pollen only)** *Registered at 1 x 133-224 g a.i./ha, in-furrow application (maximum seasonal rate 224 g a.i./ha)*

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
									Sweet potato *Registered at 1 x 224 g a.i./ha, soil spray, drench incorporated*
Melon (cantaloupe) Chemigation at planting at 1 x 224 g a.i./ha, sampled at 41-54 DALA **PMRA No. 2617877**	16.8* pollen from anthers	10.9 nectar from flowers	19.8 pollen+ nectar 7.57 pollen only	**Yes**	No	**Yes** pollen+ nectar **Yes** pollen only	Sandy loam soil *Pollen was not collected because of low amounts available. No residues in leaves from controls (no nectar data from controls).	**Yes** Following a soil application in melon. Potential for risk from pollen and bee bread exposure. No risk from nectar exposure.	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):** **Potato (pollen only)** *Registered at 1 x 133-224 g a.i./ha, in-furrow application (maximum seasonal rate 224 g a.i./ha)* **Sweet potato** *Registered at 1 x 224 g a.i./ha, soil spray, drench incorporated*
Melon Chemigation at planting at 1 x 224 g a.i./ha, sampled at 33-64 DALA	Sandy Loam 39.5 pollen from flowers	Sandy Loam 65.5 nectar from flowers	91 pollen+ nectar 17.8 pollen only	**Yes**	**Yes**	**Yes** pollen+ nectar **Yes** pollen only	Sandy loam soil Only one nectar or pollen sample collected from flower, explaining why same max and mean concentrations.	**Yes** Following a soil application in melon. Potential for risk from nectar pollen and bee bread exposure.	
Squash Chemigation at planting at 1 x 224 g a.i./ha, sampled at 33-61	12 pollen from flowers	4.46 nectar from flowers	10.4 pollen+ nectar	**Yes**	No	**Yes** pollen+ nectar	- Sandy loam. - No residues in pollen, nectar or leaves from controls. - Clothianidin in anthers: up to 8.7 ppb.	**Yes** Following a soil application in squash. Potential for risk	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled**

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
DALA **PMRA No. 2617877**			5.40 pollen only			**Yes** pollen only		from pollen and bee bread exposure. No risk from nectar exposure.	**Crop(s):** **Potato (pollen only)** *Registered at 1 x 133-224 g a.i./ha, in-furrow application (maximum seasonal rate 224 g a.i./ha)* **Sweet potato** *Registered at 1 x 224 g a.i./ha, soil spray, drench incorporated*
Rotational Crop untreated sunflower planted following three consecutive years of in-furrow soil applications at 1 x 110 g a.i./ha/y sampled 106-199 DALA **PMRA No. 2532797**	<LOQ 0.65[2] pollen from flower pollen from hives 0.88	<LOD 0.15[2] nectar from hives	0.46 pollen+ nectar 0.29 pollen only	No	No	No pollen+ nectar No pollen only	Three years of consecutive in-furrow soil applications. Study rates lower than the range of rates registered for soil application. Soil type not reported. No controls. clothianidin in soil sampled at approx. the same time as pollen and nectar: 10 ppb. No information on residues in soil before drilling untreated	No Following three consecutive years of in-furrow soil applications of clothianidin (low rate scenario).	**Rotational crops**

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
							sunflower. Clothianidin was found at 1 ppb in some pollen samples collected from bees and from hives. Clothianidin was not detected in other sampled matrices.		
Rotational Crop Year 1: winter barley seed treatment at 50 g a.i./ha. Soil spray application on the day of planting to simulate carryover at 1 x 90 g a.i./ha, (incorporated) Year 2: untreated winter rape planted as a rotational crop Year 3: sampled winter rape the following season 561-574 DALA.	1 pollen from bees	<LOD 0.15[2] nectar from bees	0.62 pollen+ nectar 0.45 pollen only	No	No	No pollen+ nectar No pollen only	Study rates lower than the range of rates registered for soil application. Soil application to simulate worst-case plateau concentration of approx. 30 ppb expected in soil after several years of use at 80 g a.i./ha. Clothianidin in treated soil was 20-34 ppb after application and 12-13 ppb one day before drilling untreated rape. No measurable residues in control.	No Following a soil application of clothianidin to simulate carryover (low rate scenario).	**Rotational crops**
Rotational Crop **Various studies** summer rape,	4 pollen from bees	2.15 nectar from bees	4.22 pollen+ nectar	No	No	No pollen+ nectar	Study rates lower than the range of rates registered for soil application.	No Following a soil application scenario of	**Rotational crops**

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
rapeseed or corn; summer rape had highest residues which are reported) Soil applica-tion at 1 x 90 a.i./ha incorpor-ated with or without seed treatment Sampled 87-101 DALA **PMRA Nos. 2355487, 2355488, 2355489**			1.80 pollen only			No pollen only	Soil application made within the same season. Soil application to simulate worst-case plateau concentration of approx. 20 ppb expected in soil after several years of use at 50 g a.i./ha. clothianidin in treated soil was 19.7- 25.8 ppb after application and 18-21 ppb one day before drilling (dry soil). No clothianidin in soil prior to trial initiation. No measurable residues in control.	clothianidin to simulate carryover (low rate scenario).	
Rotational Crop (rapeseed, corn, mustard, zucchini, field beans and sunflower mustard had highest pollen residues and rapeseed had highest nectar residues which	10 pollen from hives	2.67 nectar from flowers	7.51 pollen+ nectar 4.50 pollen only	**Yes**	No	**Yes** pollen+ nectar No pollen only	Study rates lower than the range of rates registered for soil application to simulate carryover. Soil application made within the same season. Soil application to simulate worst-case	**Yes** Following a soil application scenario of clothianidin to simulate carryover. Potential for risk from pollen and bee bread exposure.	**Rotational crops**

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
are reported) Soil application at 1 x 112 g a.i./ha incorporated without seed treatment Sampled 47-107 DALA **PMRA No. 2630589**							plateau concentration of 40 ppb expected in soil after twenty years of use at an unspecified rate. The maximum clothianidin concentration in pollen was 80 ppb and 16 ppb in nectar. Control pollen was also contaminated at relatively high levels (33 ppb), which greatly lowers the confidence of the concentrations observed in this site. Clothianidin in treated soil reported as 17-104 ppb after application and 7-75 ppb at flowering.	No risk from nectar exposure or pollen only residues in bee bread.	
Rotational crop (corn, mustard or Phacelia; Phacelia had highest residues which are reported) [high rate scenario] Year 1: winter	10.1 pollen from bees	6.2 nectar from bees	11.5 pollen+ nectar 4.6 pollen only	**Yes**	No	**Yes** pollen+ nectar No pollen only	Rates within range of labelled rates for soil applications, and similar to maximum labelled rate of 224 g a.i./ha. Soil application + barley seed treatment followed by untreated corn, mustard or	**Yes** Following a soil application of clothianidin in the preceding year at rates similar to the maximum labelled soil rate (high rate scenario).	**Rotational crops**

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
barley seed treatment at 56-73 g a.i./100 kg seed, 99.3 -100 g a.i./ha. Soil spray application on the day of planting to simulate carryover at 1 x 212-221 g a.i./ha, (incorporated) Year 2: untreated corn, mustard and Phacelia planted as rotational crops Sampled 282-293 (corn), 267-300 (mustard), 278-355 (Phacelia) DALA (sowing of treated barley seeds).							Phacelia the next season Soil type not provided. No information on target plateau concentration and choice of rates. Clothianidin in soil for high rate scenario: up to 71-84, 90 and 75-78 ppb (dry soil) in corn, mustard and Phacelia, respectively. No control plot.	Potential for risk from pollen and bee bread exposure. No risk from nectar exposure or pollen only residues in bee bread.	
Rotational crop (corn, mustard or Phacelia; mustard had highest residues which are reported) [low rate scenario] as above, except that treatment	6.73 pollen from bees	2.73 nectar from bees	6.10 pollen+ nectar 3.03 pollen only	**Yes**	No	**Yes** pollen+ nectar No pollen only	Study rates lower than the range of rates registered for soil application. Soil application + barley seed treatment followed by untreated corn, mustard or Phacelia the next season	**Yes** Following soil applications of clothianidin in the preceding year at rates lower than labelled rates (low rate scenario). Potential for risk from pollen and	**Rotational crops**

Sampled Crop	EEC - highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee Bread			
rates in year 1 were lower Winter barley seed treatment at 20-22.5 g a.i./100 kg seed (reported)0.0004 - 0.0011 mg a.i./seed (calc-ulated); 40 g a.i./ha (reported)Soil spray application at 86-90 g a.i./ha, incorporated. * Sampled 286-293 (corn), 286-293 (mustard), 378 (Phacelia) DALA (sowing of treated barley seeds).							Clothianidin in soil for low rate scenario: up to 52-71, 35-49 and 42-51 ppb (dry soil) in corn, mustard and Phacelia, respectively. A higher clothianidin concentration of 4.2 ppb was found in corn pollen but sample was contaminated with plant material and value was not used (not reported as max and excluded from mean calculation). No control plots.	bee bread exposure. No risk from nectar or pollen only residues in bee bread	

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

[a] EEC for pollen and nectar is the highest mean residue value measured among all scenarios within a study. Bee bread is calculated based on highest mean pollen and nectar values.

[b] Colony feeding study critical effect endpoint values include: nectar: 19 ppb (NOEC) to 35.6 ppb (LOEC); pollen and bee bread: 4.9 ppb (LOEC) and 20 ppb (NOEC).

[c] Highest mean clothianidin concentrations measured in pollen and nectar and estimated concentrations in bee bread are compared with the colony feeding study critical effect endpoint values for pollen, nectar and bee bread, respectively. "**Yes**" indicates the measured residue level is greater than the lower bound critical effect endpoint value and poses potential risk to honey bees; "No" indicates that the measured residue level is less than the lower bound critical effect endpoint value and may not pose risk to honey bees. "NA" indicates residue information is not available. The overall potential for risk is considered as 'Yes' when either the pollen, nectar or bee bread exposure route indicates a potential risk.

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

Appendix VIII Pollinator Risk Assessment for Seed Treatment of Clothianidin

Tier I Default Assessment for Seed Treatment Applications

Table 1 Seed Treatment: Acute and chronic dietary risk to bees based on screening level exposure estimates for clothianidin and relevant transformation products.

Chemical	EEC	Exposure Estimate for Bees*	Toxicity endpoint	RQ**	LOC exceeded?
	µg a.i./g	µg a.i./bee/day	µg a.i./bee/day		
ADULTS (ACUTE)					
Clothianidin	1	0.292	LD_{50}: 0.00368	79.3	yes
TZNG			LD_{50}: 3.95	0.07	no
ADULTS (CHRONIC)					
Clothianidin	1	0.292	NOEL: 0.00036	811	yes
BROOD (ACUTE)					
Clothianidin	1	0.124	LD_{50} > 0.0018	68.9	yes
BROOD (CHRONIC)					
Clothianidin	1	0.124	NOEL: 0.0009	138	yes

*Exposure Estimate for bees=0.292 x EEC for adults and 0.124 x EEC for larvae
**Exposure estimate for bees/toxicity endpoint
Note: LOC for bee is set at 0.4 for acute endpoints and 1 for chronic endpoints.

Tier I Refined Assessment for Seed Treatment Applications

Table 2 Seed Treatment: Acute and Chronic Dietary Risk to Different Bee Castes Based on Maximum and Highest Mean Residues of Clothianidin

Sampled Crop	EEC-maximum residue value in ppb		Did the Acute RQ[1] exceed the LOC (0.4)? (RQ)			EEC-highest mean residue value in ppb		Did the Chronic RQ[2] exceed the LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae			
Rapeseed For residues in pollen: Applied at 1000 g a.i./100 kg seed, 43 g a.i./ha, 0.02 to 0.055 mg a.i./seeds Sampled 56-66 DAP Sampled 69 DAP For residues in nectar: Applied at 860 g a.i./100 kg seed, 50 g a.i./ha, 0.017 to 0.048 mg a.i./seed	12 pollen from bees	8.6 nectar from bees 7.2 floral nectar	**Yes** **(0.68)** **Yes** **(0.57)**	No (0.36) No (0.31)	**Yes** **(0.60)** **Yes** **(0.50)**	9.6 pollen from bees	8.6 nectar from bees 4.2 floral nectar	**Yes** **(7.0)** **Yes** **(3.4)**	**Yes** **(3.6)** **Yes** **(1.9)**	**Yes** **(1.2)** No (0.60)	Residue information available from eleven semi-field/field studies. The tested rates in all studies are more than two times higher than the registered rates for rapeseed and other oilseed crops. Spring, summer or winter rape was planted. Pollen and nectar samples were collected in the same growing season for summer and spring rape and the following spring for winter rate. Highest residues from spring (pollen) and summer (nectar) rapeseed. Semi-field conditions (i.e., bees were confined to the test plot). Pollen and nectar collected from foraging bees.	There is a potential acute dietary risk to adult forager bees and bee larvae following seed treatment applications in rapeseed at more than twice the labelled rate. No acute dietary risk to nurse bees is indicated. There is a potential chronic dietary risk to adult bees and bee larvae following seed treatment applications in rapeseed at more than twice the labelled rate.	**Rapeseed** *Registered at 150-400 g a.i./100 kg seed, 0.006 to 0.016 mg a.i./seed and 16 to 32.5 g a.i./ha* **Potentially Relevant for Other labelled Crop(s):** **Mustard, Carinata** *Registered at 400 g a.i./100 kg seed, 0.016 mg a.i./seed and 18 to 45.5 g a.i./ha* **Canola** *Registered at 150-400 g a.i./100 kg seed, 0.006 to 0.016 mg a.i./seed and 16 to 32.5 g a.i./ha*

Sampled Crop	EEC-maximum residue value in ppb		Did the Acute RQ[1] exceed the LOC (0.4)? (RQ)			EEC-highest mean residue value in ppb		Did the Chronic RQ[2] exceed the LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae			
Sampled 69 DAP											Nectar also collected from flowers. No measurable residues in pollen and nectar from control for pollen samples. No mention of controls in nectar samples		
Canola Applied at 400 g a.i./100 kg seed, 0.008 to 0.022 mg a.i./seeds, 32 g a.i./ha Sampled 37-142 DAP	2.59 pollen from bees	2.24 nectar in-hive	No (0.18)	No (0.09)	No (0.15)	1.15 pollen from bees	1.07 nectar in-hive	No (0.87)	No (0.45)	No (0.15)	The tested application rate on a per seed and a per hectare basis is similar to the registered rate. Field conditions (i.e., bees were not confined to the test plot). Pollen collected from bees and nectar collected from in-hives. Clothianidin in control: generally <LOQ in pollen and nectar, except for low residue concentrations (up to 0.97 ppb) observed in nectar at certain sampling events. Transformation products not measured. No clear	No acute or chronic dietary risk to adult bees or bee larvae is indicated from seed treatment applications in canola	**Canola** *Registered at 150-400 g a.i./100 kg seed, 0.006 to 0.016 mg a.i./seed and 16 to 32.5 g a.i./ha* **Potentially Relevant for Other labelled Crop(s):** **Mustard, Carinata** *Registered at 400 g a.i./100 kg seed, 0.016 mg a.i./seed and 18 to 45.5 g a.i./ha* **Rapeseed** *Registered at 150-400 g a.i./100 kg seed, 0.006 to 0.016 mg*

Sampled Crop	EEC-maximum residue value in ppb		Did the Acute RQ[1] exceed the LOC (0.4)? (RQ)			EEC-highest mean residue value in ppb		Did the Chronic RQ[2] exceed the LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae			
											relationship between residue levels and sampling time.		*a.i./seed and 16 to 32.5 g a.i./ha*
Corn Various studies (3) applied at 1.25 mg a.i./seed, 100-125 g a.i./ha Sampled 66-98 DAP	2.24 - 15 pollen from plant	n/a	No (≤ .0002)	No (≤ 0.039)	No (≤0.03)	2.16 - 14.5 pollen from plant	n/a	No (≤0.002)	No (≤0.39)	No (≤0.06)	The study rate is similar to the maximum labelled rate for corn. Three residue studies conducted at the maximum labelled rate. No measurable residues in pollen from control (all soils). Loam, loamy sand and sandy silt soils tested. Similar residue levels in all soils except for loam; lower residues in loam likely not only due to differences in soil type (textural classes are not that different).	No acute or chronic dietary risk to adult bees or bee larvae is indicated from seed treatment application in corn.	**Corn** *Registered at 0.25 to 1.25 mg a.i./seed, and 15.1 to 118.3 g a.i./ha*
Corn Applied at 1.0 mg a.i./seed, 15-76 g a.i./ha Sampled 65-69	<LOQ[3] 0.65 pollen from plant	n/a	No (< 0.0001)	No (0.002)	No (0.001)	<LOQ[3] 0.65 pollen from plant	n/a	No (0.0001)	No (0.02)	No (0.003)	One study conducted at the tested rated which is within the registered rate range for corn Effects on bees were assessed.		

Sampled Crop	EEC-maximum residue value in ppb		Did the Acute RQ[1] exceed the LOC (0.4)? (RQ)			EEC-highest mean residue value in ppb		Did the Chronic RQ[2] exceed the LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae			
DAP											For the effect component of the study, bees were confined to a tunnel placed in an oats field in Germany and were fed the corn pollen originating from Brazil. The corn pollen was oven dried after it was collected; it is not clear whether this could have affected residue levels. The stability of clothianidin and its metabolites during shipping and handling is not known. No measurable residues in control pollen.		
Corn Various studies (13) applied at 0.5 mg a.i./seed, ~ 50 g a.i./ha Sampled 66-95 DAP	1.0 – 14 pollen from plant	n/a	No (≤0.0002)	No (≤ 0.037)	No (≤0.03)	<LOD[3] 0.15 to 9.75 pollen from plant	n/a	No (≤0.001)	No (≤0.26)	No (≤0.04)	Thirteen studies conducted at the tested rate which is within the registered rate range for corn. No measurable residues in pollen from control in most studies including study with highest mean residues.		

Sampled Crop	EEC-maximum residue value in ppb		Did the Acute RQ[1] exceed the LOC (0.4)? (RQ)			EEC-highest mean residue value in ppb		Did the Chronic RQ[2] exceed the LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae			
											In 10 of 13 corn studies, pollen residues from plant ≤4.35 ppb. Clothianidin in control: up to 3.8 ppb (from plants) and 17 ppb (from hives) from some studies (4).		
Corn Applied at 0.25 mg a.i./seed, ~ 20 g a.i./ha Sampled 75 DAP	7.78 pollen from plant	n/a	No	No	No	4.38 pollen from plant	n/a	No	No	No	One study conducted at the tested rate which is within the registered rate range for corn. Trials conducted in clay loam and clay. Highest residues from clay soil.		
Melon Applied at 1 mg a.i./seed, 30 g a.i./ha Sampled 92-120 DAP	<LOD[3] 0.15[2] pollen from in-hive	<LOD[3] 0.15[2] nectar from in-hive	No (0.012)	No (0.006)	No (0.01)	<LOD[3] 0.15[2] pollen from in-hive	<LOD[3] 0.15[2] nectar from in-hive	No (0.12)	No (0.06)	No (0.02)	The tested application rate on melon is similar to the registered rate for this crop on a per seed and per hectare basis. Semi-field conditions. Pollen and nectar from hives. Soil type not reported. No measurable	No acute or chronic dietary risk to adult bees or bee larvae is indicated from seed treatment application in melon. See considerations.	**Crop Group 9: Cucurbit vegetables (squash, melon and cucumber)** *Registered at 0.75 mg a.i./seed, 40 g a.i./ha.* **Potentially Relevant for Other Labelled Crop(s):**

Sampled Crop	EEC-maximum residue value in ppb		Did the Acute RQ[1] exceed the LOC (0.4)? (RQ)			EEC-highest mean residue value in ppb		Did the Chronic RQ[2] exceed the LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae			
											residues in pollen and nectar from control. Plants were sown in greenhouse and transplanted to field approximately one month later. Measurable clothianidin residues were found in flowers (up to 3 ppb), however, up to 2.5 ppb found in flowers from control; the exact source of contamination could not be determined.		**CG4A: Leafy greens subgroup (lettuce); CG5: Brassica leafy vegetables (cabbage and broccoli)** *Registered at 0.6 to 0.9 mg a.i./seed, 65-98 g a.i./ha*
Sweet Pepper Applied at 12 g a.i./ha, 0.17 mg a.i./seed. Sampled 99 to 124 DAP.	2.4 whole flower	2.4 whole flower	No (0.19)	No (0.098)	No (0.17)	1.17 whole flower	1.17 whole flower	No (0.95)	No (0.49)	No (0.16)	The tested application rate on sweet pepper falls within the range of registered rates on a per seed basis and is higher than the registered rate on a per ha basis. Pollen and nectar not sampled. Soil type not reported. Residues in treatment flowers decreased to <LOQ at 117 and 120 days	No acute or chronic dietary risk to adult bees or bee larvae is indicated from seed treatment application in sweet pepper.	**Crop Group 8: Fruiting vegetables (except cucurbits) (pepper, tomato)** *Registered at 0.038 to 0.25 mg a.i./seed, and 3 g a.i.//ha* **Potentially Relevant for Other Labelled Crop(s):** **CG1B: root**

Sampled Crop	EEC-maximum residue value in ppb		Did the Acute RQ[1] exceed the LOC (0.4)? (RQ)			EEC-highest mean residue value in ppb		Did the Chronic RQ[2] exceed the LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae			
											after sowing Residues in control flowers detected up to 3.6 ppb; the exact source of contamination could not be determined. Plants were sown in greenhouse and transplanted to field approximately two months later.		**vegetables (carrot only); CG3: Bulb vegetables (leek, bulb onion, bunching onion)** *Registered at 0.035 to 0.12 mg a.i./seed, and 79.5 to 114 g a.i.//ha*
Soybean Applied at 56-71 g a.i./ha, 0.13 mg a.i./seed. Sampled 57 to 71 DAP.	n/a	<LOD[3] 0.04 nectar from bees	No (0.003)	No (0.002)	No (0.003)	n/a	<LOD[3] 0.04 nectar from bees	No (0.03)	No (0.02)	No (0.005)	Trials conducted in sand, sandy loam and silt loam; same results in all soils. No measurable clothianidin residues in whole flowers. Transformation products not measured.	No acute or chronic dietary risk to adult bees or bee larvae is indicated following seed treatment applications in soybean, sunflower or cotton.	**Crops not registered in Canada** supporting information
Soybean Applied at 54 g a.i./ha, 0.081-0.109 mg a.i./seed. Sampled 61-70 DAP.	<LOD[3] 0.15 pollen from in-hive	<LOD[3] 0.15 nectar from bees	No (0.011)	No (0.006)	No (0.01)	<LOD[3] 0.15 pollen from in-hive	<LOD[3] 0.15 nectar from bees	No (<0.12)	No (0.06)	No (0.02)	Trial conducted in sandy loam soil. clothianidin and TZNG in one control sample at DALA 45 has detected residue at <LOQ.		

Sampled Crop	EEC-maximum residue value in ppb		Did the Acute RQ[1] exceed the LOC (0.4)? (RQ)			EEC-highest mean residue value in ppb		Did the Chronic RQ[2] exceed the LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae			
Soybean Applied at 54 g a.i./ha, 0.081-0.109 mg a.i./seed. Sampled 63 to 78 DAP.	<LOD[3] 0.15 pollen from in-hive	<LOQ[3] 0.65 nectar from bees	No (0.05)	No (0.03)	No (0.04)	<LOD[3] 0.15 pollen from in-hive	<LOD[3] 0.65 nectar from bees	No (0.52)	No (0.26)	No (0.09)	Trial conducted in sandy clay Clothianidin and TZNG in control leaves samples at DALA 52 has detected residue ranged from 1.7 to 4.0 ppb. The source of contamination could not be traced.		
Sunflower Applied at 25.6 g a.i./ha, 0.289 mg a.i./seed. Sampled 92 to 97 DAP.	3.1 pollen from flower	<LOD[3] 0.15 nectar from hive	No (0.01)	No (0.01)	No (0.02)	2.78 pollen from flower	<LOD[3] 0.15 nectar from hive	No (0.12)	No (0.13)	No (0.03)	Soil type not reported. No measurable residues in pollen and nectar from control.		
Cotton Applied at 51 g a.i./ha, 0.353 mg a.i./seed. Sampled 78-83, 90-95 and 102-111 DAP.	4.57 pollen from flower	<LOD[3] 0.1 nectar from flower	No (0.008)	No (0.02)	No (0.02)	2.49 pollen from flower	<LOD[3] 0.1 nectar from flower	No (0.08)	No (0.11)	No (0.02)	Clothianidin in control pollen: generally not detected, but up to 0.75 ppb found in California and 0.71 in Texas. Not detected in control nectar. Clothianidin in extrafloral nectar: up to 3.84 ppb in Missouri and 2.32 ppb in Texas (<LOD in California). These		

Sampled Crop	EEC-maximum residue value in ppb		Did the Acute RQ[1] exceed the LOC (0.4)? (RQ)			EEC-highest mean residue value in ppb		Did the Chronic RQ[2] exceed the LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae	Pollen	Nectar	Nectar forager	Nurse bee	Bee larvae			
											may be higher than floral nectar, but they are not further considered for the refined assessment as extrafloral nectaries are unique to cotton, which is not grown in Canada.		

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

[1] **Bold** values indicate that acute LOC (RQ ≥0.4) is exceeded.

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]; 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: adult acute oral LD50 = 0.00368 µg a.i./bee for TGAI; bee larvae 7-day LD_{50} = 0.0018 µg a.i./larva/day for TGAI

[2] **Bold** values indicate that chronic LOC (RQ ≥1.0) is exceeded.

Chronic RQ = Chronic estimated daily dose (EDD)/chronic toxicity endpoint; Chronic EDD = nectar dose [nectar consumption rate (mg/day) x highest mean nectar residue (µg/kg)/ 1.0 x 10^6] + pollen dose [pollen consumption rate (mg/day) x highest mean 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; Note: 10-d NOEL = 0.00036 µg a.i./bee/day for adult worker bees for TGAI; bee larvae 22-d NOEL = 0.0009 µg a.i./larva/day for TGAI

[3]Standardized maximum value ½ LOD or ½ LOQ or ½ LOD +LOQ

Table 3 Seed Treatment Application: Acute Dietary Risk to Different Bee Castes Based on Maximum Residues of Clothianidin Transformation Products.

Compound	Test Crop	Matrix	EEC-maximum residue value	Did the Acute RQ[1] exceed LOC (0.4)? (RQ)		Risk Characterization
				Nectar forager	Nurse bee	
TZNG	Rapeseed	pollen	<LOQ[2] 0.65	No (<0.0001)	No (<0.0001)	No acute dietary risk to adult bees is indicated from TZNG following seed treatment applications with clothianidin.
		nectar	<LOQ[2] 0.65			
	Corn	pollen	1.8	No (<0.0001)	No (<0.0001)	
		nectar	n/a			
	Melon	pollen	<LOD[2] 0.15	No (<0.0001)	No (<0.0001)	
		nectar	<LOD[2] 0.15			
	Sweet Pepper	pollen	<LOD[2] 0.15	No (<0.0001)	No (<0.0001)	
		nectar	<LOD[2] 0.15			

EEC = estimated environmental concentration, RQ = risk quotient

Bold values indicate that acute LOC (RQ ≥0.4) 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]

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: adult acute oral LD50 = 3.95 µg a.i./bee for TGAI

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

Tier II Refined Assessment for Seed Treatment Applications

Table 4 Seed Treatment: Chronic Risk Assessment for Honey Bee Hives Based on a Comparison of Measured Clothianidin Residues and Colony Feeding Study Effects Values.

Sampled Crop	EEC-highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
Rapeseed **Various studies (11)** Applied at 780-1035 g a.i./100 kg seed, 0.017-0.066 mg a.i./seed and 28.4-52 g a.i./ha, 55-94 DAP (spring summer rapeseed), 244-261 DAP (winter rapeseed) **For highest residues in pollen:** Applied at 1000 g a.i./100 kg seed, 43 g a.i./ha, 0.02 to 0.055 mg a.i./seed Sampled 56-66 DAP **For highest residues in nectar:** Applied at 860 g a.i./100 kg seed, 50 g a.i./ha, 0.017 to 0.048 mg a.i./seed,	0.5-9.6 pollen from bees, in-hive	0.15- 8.6 nectar from bees, floral nectar, nectar in-hive	0.39-13.9	**Yes**	No	**Yes**	Residue information available from eleven (11) semi-field/field studies. The tested rates in all studies are more than two times higher than the registered rates for rapeseed and other oilseed crops. Spring, summer or winter rape was planted. Pollen and nectar samples were collected in the same growing season for summer and spring rape and the following spring for winter rape. Highest mean residues from spring rapeseed (pollen from bees) and summer rapeseed (nectar from bees) Semi-field conditions (i.e., bees were confined to the test plot). Pollen and nectar collected from foraging bees. Nectar also collected	**Yes** following a seed treatment application in rapeseed at more than two times the registered rates for rapeseed and other oilseed crops. Potential for risk from pollen and bee bread exposure using highest mean residues. No risk from nectar exposure.	**Rapeseed** *Registered at 150-400 g a.i./100 kg seed, 0.006 to 0.016 mg a.i./seed and 16 to 32.5 g a.i./ha* **Potentially Relevant for Other labelled Crop(s):** **Mustard, Carinata** *Registered at 400 g a.i./100 kg seed, 0.016 mg a.i./seed and 18 to 45.5 g a.i./ha* **Canola** *Registered at 150-400 g a.i./100 kg seed, 0.006 to 0.016 mg a.i./seed and 16 to 32.5 g a.i./ha*

Sampled Crop	EEC-highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
Sampled 69 DAP							from flowers. No measurable residues in pollen and nectar from control for pollen samples. No mention of controls in nectar samples		
Canola Applied at 600 g a.i./100 kg seed, 0.012 to 0.033 mg a.i./seeds, 40 g a.i./ha Sampled 64-70 DAP	3.0 pollen in-hive	3.7 nectar in-hive	5.51	No	No	**Yes**	The tested application rate on a per seed and a per hectare basis is higher than the registered rate. Field conditions (i.e., bees were not confined to the test plot). Pollen and nectar collected from in-hives. Loam soil No measurable residues in pollen and nectar from control. Transformation products not measured.	Yes following a seed treatment application in canola at two times the registered rates for canola and other oilseed crops. Potential for risk from bee bread exposure. No risk from pollen and nectar exposure.	**Canola** *Registered at 150-400 g a.i./100 kg seed, 0.006 to 0.016 mg a.i./seed and 16 to 32.5 g a.i./ha* **Potentially Relevant for Other labelled Crop(s):** **Mustard, Carinata** *Registered at 400 g a.i./100 kg seed, 0.016 mg a.i./seed and 18 to 45.5 g a.i./ha* **Rapeseed** *Registered at 150-*

Sampled Crop	EEC-highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
Canola Applied at 600 g a.i./100 kg seed, 0.012 to 0.033 mg a.i./seeds, 40 g a.i./ha Sampled 51-57 DAP	2.8 pollen in-hive	1.1 nectar in-hive	2.5	No	No	No	The tested application rate on a per seed and a per hectare basis is higher than the registered rate. Field conditions (i.e., bees were not confined to the test plot). Pollen and nectar collected from in-hives. Loam soil No measurable residues in pollen and nectar from control. Transformation products not measured.	No following a seed treatment application in canola at two times the registered rates for canola and other oilseed crops.	*400 g a.i./100 kg seed, 0.006 to 0.016 mg a.i./seed and 16 to 32.5 g a.i./ha*
Canola Applied at 400 g a.i./100 kg seed, 0.008 to 0.022 mg a.i./seeds, 32 g a.i./ha Sampled 37-142 DAP	1.15 pollen from bees	1.07 nectar in-hive	1.72	No	No	No	The tested application rate on a per seed and a per hectare basis is similar to the registered rate. Field conditions (i.e., bees were not confined to the test plot). Pollen collected from bees and nectar collected from in-hives. Clothianidin in control: generally <LOQ in pollen and nectar, except for low residue concentrations (up to	No following a seed treatment application in canola.	

Sampled Crop	EEC-highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
							0.97 ppb) observed in nectar at certain sampling events. Transformation products not measured. No clear relationship between residue levels and sampling time.		
Canola Applied at 377 g a.i./100 kg seed, 0.0075 to 0.022 mg a.i./seeds, 32 g a.i./ha Sampled 62 DAP	0.62 pollen from bees	1.0 nectar in-hive	1.4	No	No	No	The tested application rate on a per seed and a per hectare basis is similar to the registered rate. Field conditions (i.e., bees were not confined to the test plot). Pollen collected from bees and nectar collected from in-hives. Clothianidin in control pollen: 1.5 ppb MNG, TMG, TZMU and TZNG were not found above 50 ppb.	No following a seed treatment application in canola.	
Corn Various studies (3) applied at 1.25 mg a.i./seed, 100-125 g a.i./ha Sampled 66-98	2.16 -14.5 pollen from plant	n/a	0.97-6.53	**Yes**	n/a	**Yes**	Three residue studies conducted at the maximum labelled rate The study rate is similar to the maximum labelled rate for corn..	**Yes** Potential for risk from pollen and bee bread exposure at highest maximum application rate.	**Corn** *Registered at 0.25 to 1.25 mg a.i./seed, and 15.1 to 118.3 g a.i./ha*

Sampled Crop	EEC-highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
DAP							No measurable residues in pollen from control (all soils). Loam, loamy sand, silt loam and sandy silt soils tested. Similar residue levels in all soils except for loam; lower residues in loam likely not only due to differences in soil type (textural classes are not that different).	Maximum application rate not typically used by growers in Canada. No potential risk indicated following seed treatment applications at lower rates typically used on corn in Canada.	
Corn Applied at 1.0 mg a.i./seed, 15-76 g a.i./ha Sampled 65-69 DAP	<LOQ 0.65 pollen from plant	n/a	0.29	No	n/a	No	One study conducted at the tested rated which is within the registered rate range for corn Effects on bees were assessed. For the effect component of the study, bees were confined to a tunnel placed in an oats field in Germany and were fed the corn pollen originating from Brazil. The corn pollen was oven dried after it was collected; it is not clear whether this could have affected residue levels. The stability of clothianidin and its metabolites during		

Sampled Crop	EEC-highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
							shipping and handling is not known. No measurable residues in control pollen.		
Corn Various studies (13) applied at 0.5 mg a.i./seed, ~ 50 g a.i./ha Sampled 66-95 DAP	0.625-9.75 pollen from plant	n/a	0.28-4.39	**Yes**	n/a	No	Thirteen studies conducted at the tested rate which is within the registered rate range for corn. In 11 of 13 corn studies, pollen residues from plant ≤4.35 ppb. Clothianidin in control: up to 3.8 ppb (from plants) and 17 ppb (from hives) from some studies (4). No measurable residues in pollen from control in most studies including study with highest mean residues.		
Corn Applied at 0.25 mg a.i./seed, ~ 20 g a.i./ha Sampled 75 DAP	0.625-4.38 pollen from plant	n/a	0.28-1.97	No	n/a	No	One study conducted at the tested rate which is within the registered rate range for corn. Trials conducted in clay loam and clay. Highest residues from clay soil.		

Sampled Crop	EEC-highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
Melon Applied at 1 mg a.i./seed, 30 g a.i./ha Sampled 92-120 DAP	<LOD 0.15[2] pollen from in-hive	<LOD 0.15[2] nectar from in-hive	0.24	No	No	No	The tested application rate on melon is similar to the registered rate for this crop on a per seed and per hectare basis Semi-field conditions. Pollen and nectar from in-hives. Soil type not reported. No measurable residues in pollen from control. Plants were sown in greenhouse and transplanted to field ~ one month later. Measurable clothianidin residues were found in flowers (up to 3 ppb), however, up to 2.5 ppb found in flowers from control; the source of contamination could not be determined.	No following a seed treatment application in melon.	**Crop Group 9: Cucurbit vegetables (squash, melon and cucumber)** *Registered at 0.75 mg a.i./seed, 40 g a.i./ha.* **Potentially Relevant for Other Labelled Crop(s):** **CG4A: Leafy greens subgroup (lettuce); CG5: Brassica leafy vegetables (cabbage and broccoli)** *Registered at 0.6 to 0.9 mg a.i./seed, 65-98 g a.i./ha*
Sweet Pepper Applied at 12 g a.i./ha, 0.17 mg a.i./seed. Sampled 99 to 124 DAP.	1.17 whole flower	1.17 whole flower	1.84	No	No	No	The tested application rate on sweet pepper falls within the range of registered rates on a per seed basis and is higher than the registered rate on a per ha basis. Pollen and nectar not sampled.	No following a seed treatment application in sweet pepper	**Crop Group 8: Fruiting vegetables (except cucurbits) (pepper, tomato)** *Registered at 0.038 to 0.25 mg a.i./seed, and 3 g a.i.//ha* **Potentially Relevant for Other**

Sampled Crop	EEC-highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
							Soil type not reported. Residues in treatment flowers decreased to <LOQ at 117 and 120 days after sowing Residues in control flowers detected up to 3.6 ppb; the exact source of contamination could not be determined. Plants were sown in greenhouse and transplanted to field approximately two months later.		**Labelled Crop(s):** **CG1B: root vegetables (carrot only); CG3: Bulb vegetables (leek, bulb onion, bunching onion)** *Registered at 0.035 to 0.12 mg a.i./seed, and 79.5 to 114 g a.i.//ha*
Soybean Applied at 56-71 g a.i./ha, 0.13 mg a.i./seed. Sampled 57 to 71 DAP.	n/a	<LOD 0.04[2] nectar from bees	0.05	No	No	No	Trials conducted in sand, sandy loam and silt loam; same results in all soils. No measurable clothianidin residues in whole flowers. Transformation products not measured.	No following a seed treatment application in soybean, sunflower or cotton.	**Crops not registered in Canada** supporting information
Soybean Applied at 54 g a.i./ha, 0.081-0.109 mg a.i./seed. Sampled 61-70	<LOD[3] 0.15 pollen from in-hive	<LOD[3] 0.15 nectar from bees	0.24	No	No	No	Trial conducted in sandy loam soil. Clothianidin and TZNG in one control sample at DALA 45 has detected residue at <LOQ.		

Sampled Crop	EEC-highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
DAP.									
Soybean Applied at 54 g a.i./ha, 0.081-0.109 mg a.i./seed. Sampled 63 to 78 DAP.	<LOD[3] 0.15 pollen from in-hive	<LOD[3] 0.65 nectar from bees	0.80	No	No	No	Trial conducted in sandy clay Clothianidin and TZNG in control leaves samples at DALA 52 has detected residue ranged from 1.7 to 4.0 ppb. The source of contamination could not be traced.		
Sunflower Applied at 25.6 g a.i./ha, 0.289 mg a.i./seed. Sampled 92 to 97 DAP.	2.78 pollen from flower	<LOD 0.15[2] nectar from hive	1.42	No	No	No	Soil type not reported. No measurable residues in pollen and nectar from control.		
Cotton Applied at 51 g a.i./ha, 0.353 mg a.i./seed. Sampled 78-83, 90-95 and 102-111 DAP.	2.49 pollen from flower	<LOD 0.1[2] nectar from flower	1.23	No	No	No	Clothianidin in control pollen: generally not detected, but up to 0.75 ppb found in California and 0.71 in Texas. Not detected in control nectar. Clothianidin in extrafloral nectar: up to 3.84 ppb in Missouri and 2.32 ppb in Texas (<LOD in California). These may be higher than floral nectar, but they are not further considered for the refined assessment as		

Sampled Crop	EEC-highest mean residue value in ppb			Potential risk from pollen, bee bread or nectar?			Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Bee bread	Pollen	Nectar	Bee bread			
							extrafloral nectaries are unique to cotton, which is not grown in Canada.		

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

[a] EEC for pollen and nectar is the highest mean residue value measured among all scenarios within a study. Bee bread is calculated based on highest mean pollen and nectar values.

[b] Colony feeding study critical effect endpoint values include: nectar: 19 ppb (NOEC) to 35.6 ppb (LOEC); pollen and bee bread: 4.9 ppb (LOEC) and 20 ppb (NOEC).

[c] Highest mean clothianidin concentrations measured in pollen and nectar and estimated concentrations in bee bread are compared with the colony feeding study critical effect endpoint values for pollen, nectar and bee bread, respectively. "**Yes**" indicates the measured residue level is greater than the lower bound critical effect endpoint value and poses potential risk to honey bees; "No" indicates that the measured residue level is less than the lower bound critical effect endpoint value and may not pose risk to honey bees. "NA" indicates residue information is not available. The overall potential for risk is considered as 'Yes' when either the pollen, nectar or bee bread exposure route indicates a potential risk.

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

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[4]; Nicolson, 2009[5]). Unlike honey bees, individual bumble bees are unlikely to drink water for their own water needs and it is not clear whether solitary bees drink water (Nicolson, 2009). Therefore, based on the large water fluxes in honey bee hives at the colony level, the honey bee can be considered to be a conservative surrogate for bumble bees and other non-*Apis* bees for potential pesticide exposure via contaminated water, particularly since it is unclear whether non-*Apis* bees utilise water sources at all. EFSA also took the approach of using honey bees as a conservative surrogate (2014)[6].

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

Water consumption of honey bee adults

EFSA (2014) estimated that the water consumption for an adult bee was 11.4 µL/bee/day. This estimate was the maximum water consumption measured in honey bee adults that were confined

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

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

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

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

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

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

in cages under laboratory conditions at 35°C (Free and Spencer-Booth, 1958)[10]; 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., 201011), the majority of bees are under a temperature of no more than 35°C inside hives, and 11.4 µL/bee/day is considered to be a conservative water consumption rate for adult bees.

Two methods of estimating water consumption of adult bees were proposed in a white paper (2011)[12] that was authored by 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)[13]. In this study, six hives were placed in the field and water consumption was measured daily and hive adult bees were weighed three times during the study. Data was corrected for water evaporation. The calculation was conducted by the PMRA based on the assumptions that average bee weight was 128 mg/bee and daily hive weight was normalized linearly between two weight measurements. The reported water consumption at the colony level in the field appeared to be similar to what was measured in the lab by Free and Spencer-Booth (1958).

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

[10] 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.

[11] 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.

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

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

Water consumption of honey bee larvae

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

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

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

Surface water exposure route

Residues in surface water sources

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

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

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

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

There were also water samples taken from water sources in urban, suburban, and rural settings in the 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 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 or lack of detections, transformation products of imidacloprid were not considered further.

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

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

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

In conclusion, neonicotinoids, particularly clothianidin, thiamethoxam and imidacloprid, have been detected in puddle water and to a lesser extent, other sources of water near bee hives. In general, neonicotinoid levels were higher in puddles than in other sources of water near bee hives. All sampling from Canada was from agricultural areas, primarily in corn growing regions of Ontario and Quebec. Neonicotinoid concentrations in puddles located in corn fields were highest during corn planting likely as a result of drifting and deposition of dust.

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

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

ND = not detected

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

Risk assessment for surface water exposure route using monitoring data

The potential risks resulting from exposure to contaminated water sources were assessed using the same approach as for pollen and nectar. For the Tier I risk assessment, the exposure estimate was calculated using the water consumption rates of 11.4 µL/ng water contaminated at the

maximum (acute) or maximum mean (chronic) detected/bee/day for adults and 111 µL/larvae/5-days development for larvae (the total water consumption for larvae over 5 days of larvae development period). The exposure estimates were compared with the same toxicity endpoints that were used for pollen and nectar to calculate a risk quotient (RQ). These toxicity endpoints were adjusted for larvae to consider the total exposure over the entire larval development period for better comparison with the exposure estimates. The RQs were considered to identify a potential for risk via water exposure routes when calculated RQ values were greater than the Level of Concern (LOC), which is 0.4 for acute, and 1 for chronic risk.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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
Johnson and Pettis, 2014 (2538821); Johnson, 2012 (2373072)	2010	Maryland, US	Fountains, bird baths, car wash, culvert, statue with standing water, drainpipe, fish pond, storm management pond, lowland, irrigation pipes, springs	Urban, suburban, rural	Imidacloprid	ELISA: 0.07	0.683	27	4	42	10
						LC-MS: 1	0.131	3.8	4	42	10
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

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; 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 crop Maize*	-	-	-	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		
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 oilseed rape	14.64	-	-	-	-	-	273.6	248.84	2766426
Maximum*			717000	4900	9000	200000	640	120	100000	85600	
Mean*			64912	1298	2252	30744	318	44	26553	24208	

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		
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 CG1: Root and Tuber Vegetables: Crop Subgroup 1B: Root Vegetables (Excludes potato and sweet potato) Carrot only	ST (carrot only)	**Products:** 30972 **Current Label Statements:** 30972: Environmental Precautions: *Toxic to bees. Bees may be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications.*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Insect pollination not required for crop production (unless grown for seed). Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada. **Exposure potential**: O: N[2] C: N **Overall, there is minimal potential for exposure.** **Pollinator Exposure (pollen/nectar): Negligible.** There is minimal potential for exposure through pollen and nectar as harvested before bloom. Not grown for seed in Canada. **Pollinator Exposure (dust): Minimal potential for exposure from dust generated during planting of treated seed.** Exposure through dust generated during planting of treated seed is not expected. Crop Group 1 treated seeds typically have low dust levels and may be pelletized for certain crops within the crop group (including carrot). Certain planting	**Minimal potential for risk through pollen and nectar exposure route as harvested before bloom.** **Minimal potential for exposure or risk from dust generated during planting of treated seed.**	**None**	**Maintain use considering negligible pollinator exposure as harvested before bloom.** **No additional risk management.** **Label update:** May update label language to include the following: Environmental Precautions: Add: *When used according to label directions and/or harvested before bloom 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
			equipment can increase emission of pesticide containing dust, but is not typically used when planting seeds from these CG1.			
From Crop group 1 Root and Tuber Vegetables: Potato and Sweet Potato	FO (potato only)	**Potato: pre-bloom (restricted to before 50% row closure) and post-bloom (petal fall)** **Products:** 29382 29384 **Current Label Statements:** 29382, 29384: Environmental Hazards: *Toxic to bees exposed to direct treatment, drift, or residues on flowering crops or weeds. DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 29382, 29384: Use Directions-crop specific (potato):*Do not apply treatment between 50% row closure and petal fall. Do not make more than one application per year prior to 50% row closure.*	**Attractive to**: Potato: BB, SB **Agronomic considerations**: Insect pollination not required for crop production. Potato: Harvested after bloom. Bloom time 2 – 3 weeks. Some cultivars do not flower. Potato plants produce no nectar and very little pollen, which is not considered attractive to most bees. **Exposure potential**: O: Y C: Y **Potato foliar spray has potential for exposure through pollen (potato has only pollen).** **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 and; some plant 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	Tiered Framework (potato): T1SL: Y Residues: Potato residues, pre-bloom application. Canadian relevant rates. Potato produces only pollen. T1R: Y T2 CFS: nectar-N (potato has no nectar); pollen-Y Non-*Apis* T2 CFS similarly sensitive as HB. T2 Tunnel: NA T3: NA Incidents : None **Overall:** **Potential for risk pre-bloom (pollen; potato has only pollen)** **Negligible post-bloom risk (annual crop)** **Consider Pollinator Exposure: Low**	**Crop Specific residues at relevant rates and timing.** [potato (pre-bloom)] Note: From current label mitigation, pre-bloom timing is restricted to the 50% row closure (the point at which 50% of the plants meet between rows) which occurs before the first flower petals are visible. The application timing restriction is expected to limit pollinator exposure by lengthening the time between applications and flowering. However, available residue studies were not conducive for assessing these specific pre-bloom label restrictions. **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 or longer; 6 weeks nectar; 9-12 weeks pollen). **Risk may be overestimated**. **Effects endpoints**: Uncertainty and differences among some	**Maintain pre-bloom use considering low pollinator exposure. Maintain post-bloom use considering negligible risk (annual crop).** **Maintain current crop specific restrictions, which restrict use as follows:** Use Directions- crop specific (potato): *Do not apply treatment between 50% row closure and petal fall. Do not make more than one application per year prior to 50% row closure.* **Add under:** 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
			can be large in some areas.		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 and Sweet Potato	SO (potato and sweet potato)	**Application at planting.** **Potato: In-furrow (boom sprayer)** **Sweet Potato: Soil spray/drench pre-plant incorporated prior to transplanting the sweet potato** **Products:** 29382 29384 27449 **Current Label Statements:** 29382, 29384: Environmental Hazards: *Toxic to bees exposed to direct treatment, drift, or residues on flowering crops or weeds. DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 27449: Environmental Precautions: *Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatments*.	**Attractive to**: Potato: BB, SB; Sweet Potato: HB, BB, SB **Agronomic considerations**: Insect pollination not required for crop production. Potato and sweet potato: Harvested after bloom. Bloom time 2 – 3 weeks. Some cultivars do not flower. Potato plants produce no nectar and very little pollen, which is not considered attractive to most bees. Sweet potato produces nectar and pollen. **Exposure potential**: O: Y C: N **There is potential for exposure through pollen/nectar; Sweet Potato (pollen and nectar); Potato (pollen).** **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 plant cultivars produce many flowers while some do not produce any flowers. Not attractive	Tiered Framework (potato and sweet potato): T1SL: Y Residues: Potato (pollen); Surrogates considered for nectar in sweet potato included corn, cucurbit crops (pumpkin, cucumber, melon, squash). Canadian relevant rates and in-furrow timing for potato and for other crop soil applications. Potato produces only pollen; sweet potato produces pollen and nectar. T1R: Y T2 CFS: nectar-Y (sweet potato), nectar -N (potato; has no nectar); pollen-Y Non-*Apis* T2 CFS similarly sensitive as HB. T2 Tunnel: NA T3: NA Incidents : None **Overall: Potential for risk from pollen and nectar from pre-bloom soil application. (potato has only pollen; sweet potato has nectar and pollen).**	**Crop Specific residues at relevant rates and timing for soil application to potato. Potato has pollen only.** Potato was planted in-furrow at planting in relevant soil types. Potato pollen residues were higher or similar to the highest range of pollen residues from other crops with residues from soil application. **No crop specific residues for sweet potato.** Considered potato (pollen) and other crops including corn, cucurbit crops (pumpkin, cucumber, melon, squash) (nectar and/or pollen). Information from surrogate crops suggested residues may be higher when using chemigation, when applied closer to bloom period, and in coarser soils. These trends do not affect risk management options for potato or sweet potato, as application to potato/sweet potato is at planting, does not use chemigation, and residue studies showed no clear relationship between soil	**Maintain use considering low pollinator exposure.** **Propose additional risk management:** **Add:** Environmental Precautions: *Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from soil treatments. Do not place managed bees in soil treated potato or sweet potato crops during bloom period.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
			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.	**Consider Pollinator Exposure: Low to Moderate; considered low** **Rotational crops**: Rotational crop residue information indicated that minimal risk is expected following soil applications with clothianidin the preceeding year. (T2 CFS: nectar N; pollen-N)	type and residues in potato. **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 or longer; 6 weeks nectar; 9-12 weeks pollen). **Risk may be overestimated**. **Effects endpoints**: Uncertainty 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 only)	**Products:** 30362 27449 28975 **Current Label Statements:** 30362, 27449: Environmental Hazards: *Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatments*. 28975 (label includes corn seed treatments; therefore more extensive): Environmental Hazards:	**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:** O: Y	Tiered Framework (potato): T1SL: Y Residues: No potato specific residues for seed piece treatments. For potato, extrapolation from other available crops is not considered appropriate. T1R: NA T2 CFS: NA Non-*Apis* T2 CFS: NA; similarly sensitive as HB.	**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 is expected.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		Clothianidin 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 seed treated with this insecticide. Carefully follow use directions for the seed flow lubricant.* *Do not load or clean planting equipment near bee colonies, and avoid places where bees may be foraging, such as flowering crops or weeds.* *When turning on the planter, avoid engaging the system where emitted dust may contact honey bee colonies.* *Spilled or exposed seeds and dust must be incorporated into the soil or cleaned up from the soil surface.* *Bees can be exposed to*	C: N **There is a potential for exposure through pollen (potato has only pollen).** **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.	T2 Tunnel: NA T3: NA Incidents : None **Overall:** **Potential for risk from pollen from potato seed piece treatment. (pollen exposure route)** **Consider Pollinator Exposure: Low** **Minimal potential for exposure or risk from dust generated during planting of treated seed.** **Rotational crops**: **Minimal potential for risk.** Soil residues from potato seed piece treatments would be similar to or lower than those from soil treatments. Rotational crop residue information indicated that minimal risk is expected following soil applications with clothianidin the preceeding year. Therefore, minimal risk would also be expected from potato seed piece treatments used the previous year.	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 (381 g ai/ha) and potato soil treatment (224 g ai/ha). **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 or longer; 6 weeks nectar; 9-12 weeks pollen). **Risk may be overestimated**. **Effects endpoints**: Uncertainty and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	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
		product residues in flowers, leaves, pollen and/or nectar resulting from seed treatments. LABELLING OF TREATED SEED: *All treated corn for sale or use in Canada must also be labeled with the following information:* *Clothianidin 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 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,*				

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		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.*				
From Crop Group 3: Bulb vegetables onion (bulb and bunching) and leek	ST [onion (bulb, bunching) and leek only]	**Products:** 30972 **Current Label Statements:** 30972: Environmental Precautions: *Toxic to bees. Bees may be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications*.	**Attractive to**: HB, BB, SB **Agronomic considerations**: Insect pollination not required for crop production (unless grown for seed). Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada. **Exposure potential**: O: N^2 C: N **Overall, there is minimal potential for exposure.** **Pollinator Exposure (pollen/nectar): Negligible.** There is minimal potential for exposure through pollen and nectar as harvested before bloom. Not grown for seed in Canada.	**Minimal potential for risk through pollen and nectar exposure route as harvested before bloom.** **Minimal potential for risk from dust generated during planting of treated seed.**	**None**	**Maintain use considering negligible pollinator exposure as harvested before bloom.** **No additional risk management.** **Label update:** May update label language to include the following: Environmental Precautions: **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
			Pollinator Exposure (dust): Minimal potential for exposure from dust generated during planting of treated seed. Exposure through dust generated during planting of treated seed is not expected. CG3 treated seeds typically have low dust levels and may be pelletized for certain crops within the crop group (including onion). Certain planting equipment can increase emission of pesticide containing dust, but is not typically used when planting seeds from CG3.			
From Crop Group 4: Leafy Vegetables (except brassica vegetables) Lettuce (head, leaf)	ST [lettuce (head, leaf) only]	**Products:** 30972 **Current Label Statements:** 30972: Environmental Precautions: *Toxic to bees. Bees may be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment 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	**Minimal potential for risk through pollen and nectar exposure route as harvested before bloom.** **Minimal potential for risk from dust generated during planting of treated seed.**	**None**	**Maintain use considering negligible pollinator exposure as harvested before bloom.** **No additional risk management.** **Label update:** May update label language to include the following: Environmental Precautions: **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***

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
			for seed in Canada. **Pollinator Exposure (dust): Minimal potential for exposure from dust generated during planting of treated seed.** Exposure through dust generated during planting of treated seed is not expected. All seeds from CG4 typically have low dust levels and may be pelletized for certain crops within the crop group (including lettuce). Certain planting equipment can increase emission of pesticide containing dust, but is not typically used when planting seeds from CG4.			***minimal exposure or risk is expected.***
From Crop Group 5: Brassica (Cole) Leafy Vegetables Broccoli and Cabbage	ST (broccoli, cabbage only)	**Products:** 30972 **Current Label Statements:** 30972: Environmental Precautions: *Toxic to bees. Bees may be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications*.	**Attractive to**: HB, BB, SB **Agronomic considerations**: Insect pollination not required for crop production (unless grown for seed). Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada. **Exposure potential**: O: N^2 C: N **Overall, there is minimal potential for exposure.** **Pollinator Exposure (pollen/nectar): Negligible.** There is minimal potential for exposure	**Minimal potential for risk through pollen and nectar exposure route as harvested before bloom.** **Minimal potential for risk from dust generated during planting of treated seed.**	**None**	**Maintain use considering negligible pollinator exposure as harvested before bloom.** **No additional risk management.** **Label update:** May update label language to include the following: Environmental Precautions: **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*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
			through pollen and nectar as harvested before bloom. Not grown for seed in Canada. **Pollinator Exposure (dust): Minimal potential for exposure from dust generated during planting of treated seed.** Exposure through dust generated during planting of treated seed is not expected. CG5 treated seeds typically have low dust levels and may be pelletized for certain crops within the crop group. Certain planting equipment can increase emission of pesticide containing dust, but is not typically used when planting seeds from CG5.			*treatment applications*. ***When used according to label directions minimal exposure or risk is expected.***
From Crop Group 8: Fruiting Vegetables Tomato and Pepper	ST (pepper and tomato only)	**Products:** 30972 **Current Label Statements:** 30972: Environmental Precautions: *Toxic to bees. Bees may be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications*.	**Attractive to**: BB, SB **Agronomic considerations**: Do not require insect pollination, but production enhanced by pollination. Managed bumble bees are used, primarily in greenhouse production. Indeterminate blooming. **Exposure potential**: O: Y C: N **There is potential for exposure through pollen and nectar.** **Pollinator Exposure (pollen/nectar): Moderate** Crop does not require insect pollination; Crop production is enhanced by	Tiered Framework (CG8 tomato, pepper): T1SL: Y Residues: CG8: sweet pepper. T1R: N T2 CFS: nectar-N; pollen-N Non-*Apis* T2 CFS: similarly sensitive as HB T2 Tunnel: NA T3 field: NA Incidents : None. **Overall:** **Minimal potential for risk from seed treatments through pollen and nectar exposure**	**Crop Specific residues at relevant rates and timing (sweet pepper).** **T2 Tunnel; T3 field; Incidents:** None **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 or longer; 6 weeks nectar; 9-12 weeks pollen). **Effects endpoints**: Uncertainty and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis*	**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 and/or nectar resulting from seed*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
			pollination; Pollination services may be used (BB particularly in greenhouse crops). Crop is a major source of pollen and nectar for BB, minor source for SB, and not attractive to HB. Acreage is low to medium. **Pollinator Exposure (dust): Minimal potential for exposure from dust generated during planting of treated seed.** Exposure through dust generated during planting of treated seed is not expected. CG8 seeds typically have low dust levels and may be pelletized for certain crops within the crop group. Certain planting equipment can increase emission of pesticide containing dust, but is not typically used when planting CG8 seeds.	**route.** **Minimal potential for exposure or risk from dust generated during planting of treated seed.**	endpoints considered.	*treatment applications.* ***When used according to label directions minimal exposure or risk is expected.***
9: Cucurbit Vegetables Representative commodities: cucumber, muskmelon, summer squash	FO	**Cucurbit Vegetables: pre-bloom only (not after 4th true leaf on main steam is unfolded)** **Products:** 29382 29384 **Current Label Statements:** 29382, 29384: Environmental Hazards: *Toxic to bees exposed to direct treatment, drift, or residues on flowering crops or weeds. DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 29382, 29384: Use	**Attractive to**: HB, BB, SB **Agronomic considerations**: Requires insect pollination for crop production. Squash bees, a type of solitary bee, specialize on cucurbit crops and are important in pollination of cucurbits. They live and reproduce using cucurbit crops. Indeterminate blooming. Flowers close in afternoon; bloom lasts only for one day. **Exposure potential**: O: Y	Tiered Framework (CG9 cucurbits): T1SL: Y Residues: CG9: pumpkin, pre-bloom applications. Canadian relevant rates. T1R: Y (with multiple pre-bloom applications) T2 CFS: nectar-N (single and multiple applications); pollen-Y (with multiple pre-bloom applications) Non-*Apis* T2 CFS: similarly sensitive as HB T2 Tunnel: NA	**Crop Specific residues at relevant rates and timing.** [pumpkin (pre-bloom)] Pumpkin residue studies were conducted with multiple or single pre-bloom applications; 2x 105 g ai/ha (Ontario) or 1 x 112 gai/ha (Oregon, North Dakota, California). Single and multiple applications indicated no risk from nectar; multiple applications indicated risk for pollen while single applications did not. Oregon and North Dakota are in Canadian relevant	**Propose additional restrictions to further reduce exposure. Reduce the number of pre-bloom applications from two to one.** Considering that single applications in Canadian relevant ecoregions did not result in risk from pollen or nectar, it is proposed to allow only a single application. **Under:** Use Directions- crop specific (cucurbit): Reduce the number of pre-bloom applications on cucurbit crops from 2 to 1 application. Reduce the seasonal application rate from 210 g a.i/ha to 105 g a.i./ha. As well, maintain the current crop-specific restrictions which do not allow applications during bloom,

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		Directions-crop specific (cucurbits): *This product is toxic to bees exposed to direct treatment or residues on blooming crops. Do not apply during bloom or when bees are present.* *Do not make application after 4th true leaf on main stem is unfolded.*	C: N (applied pre-bloom) (Some potential for squash bee exposure through soil) **There is potential for exposure through pollen and nectar.** **Pollinator Exposure: 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.	T3: NA Incidents : None. **Overall: Potential for risk pre-bloom (pollen exposure) with multiple pre-bloom applications.** **Annual crops; no risk post-bloom.** **Consider Pollinator Exposure: High**	ecoregions. **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 duration (6 weeks or longer; 6 weeks nectar; 9-12 weeks pollen). **Effects endpoints**: Uncertainty and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered. **Additional considerations**: Flowers close in afternoon; bloom lasts only for one day. Squash bees, a type of solitary bee, specialize on cucurbit crops and are important in pollination of cucurbits. They live and reproduce using cucurbit crops.	when bees are present, or after the 4th true leaf on main stem unfolds. **Add under:** 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.*
9: Cucurbit Vegetables Representative commodities: cucumber, muskmelon,	ST (cucumber, melon, squash, only)	**Products:** 30972 **Current Label Statements:** 30972: Environmental Precautions: *Toxic to bees. Bees may be exposed to*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Requires insect pollination for crop	Tiered Framework (CG9 cucurbits): *Apis* and non-*Apis* bees: T1SL: Y	**Crop Specific residues at relevant rates and timing (melon).** **T2 Tunnel; T3 field; Incidents:** None	**Maintain use based on risk characterization of low risk.** **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
summer squash		*product residues in flowers, leaves, pollen and/or nectar resulting from seed treatment applications*.	production. Squash bees, a type of solitary bee, specialize on cucurbit crops and are important in pollination of cucurbits. They live and reproduce using cucurbit crops. Indeterminate blooming. Flowers close in afternoon; bloom lasts only for one day. **Exposure potential**: O: Y C: N **There is potential for exposure through pollen and nectar.** **Pollinator Exposure (pollen/nectar): High** Crop requires insect pollination; crop is a major or minor source of pollen and nectar for BB, SB (including squash bees), and minor source for HB. Acreage is low to medium **Pollinator Exposure (dust): Minimal potential for exposure from dust generated during planting of treated seed.** Exposure through dust generated 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.	Residues: CG9: melon. Canadian relevant rates. T1R: N T2 CFS: nectar-N; pollen-N Non-*Apis* T2 CFS similarly sensitive as HB T2 Tunnel and T3 field: HB/BB/BB- No or negligible short or long term colony level effects observed in available seed treatment tunnel and field studies at Canadian relevant rates. Incidents : None. **Overall:** **Minimal potential for risk through pollen and nectar exposure route from seed treatments.** **Minimal potential for exposure or risk from dust generated during planting of treated seed.**	**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 or longer; 6 weeks nectar; 9-12 weeks pollen). **Effects endpoints**: Uncertainty and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered. **Additional considerations**: Flowers close in afternoon; bloom lasts only for one day. Squash bees, a type of solitary bee, specialize on cucurbit crops and are important in pollination of cucurbits. They live and reproduce using cucurbit crops.	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 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
11: Pome Fruit Representative commodities: apple and pear	FO	**Pome fruit: post-bloom** **Products:** 29382 29384 **Current Label Statements:** 29382, 29384: Environmental Hazards: *Toxic to bees exposed to direct treatment, drift, or residues on flowering crops or weeds. DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 29382, 29384: Use Directions-crop specific (Pome fruit): *Apply <PRODUCT> post-bloom only. This product is toxic to bees exposed to direct treatment or residues on blooming crops. Do not apply during bloom or when bees are present.*	**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 post-bloom only. There is the potential for oral exposure from residues present in flowers (pollen and nectar) the following year. C: N (not applied during bloom) (Y if foraging on flowering groundcover in treated area.) **There is potential for exposure through pollen and nectar.** **Pollinator Exposure: High** Crop requires insect pollination; crop is a major source of pollen and nectar for HB, BB, SB. Pome fruit are medium acreage. Orchards in some locations can cover large areas.	Tiered Framework (CG11 Pome Fruit): T1SL: Y Residues: CG11: apple (post-bloom). CG12 : peach (post-bloom). Canadian relevant rates. T1R: Y T2 CFS: nectar-N; pollen-Y (year one of two years of apple), pollen-N (peach, year two of two years of apple) Non-*Apis* T2 CFS similarly sensitive as HB T2 Tunnel: NA T3: NA Incidents : None. **Potential for risk post-bloom (pollen exposure).** Risk potential may depend on timing. Earlier post-bloom (pre-harvest) application timing reduces risk. Potential risk expected for later post-bloom (post-harvest) application timing **Consider Pollinator Exposure: High**	**Crop specific and additional orchard crop post-bloom residues at relevant rates and timing.** [Pome fruit: apple (post-bloom); Stone fruit: peach (post-bloom); Tree nut: Almond (pre-bloom and post-bloom)] **T2 Tunnel; T3 field; Incidents:** None **Bloom time shorter than CFS exposure durations** CG11 bloom time (2-3 weeks) shorter than CFS exposure duration (6 weeks or longer; 6 weeks nectar; 9-12 weeks pollen). **Risk may be overestimated**. **Effects endpoints**: Uncertainty and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	**Propose removal of use.**
12: Stone Fruit Representative commodities: sweet cherry or	FO	**Stone fruit: pre-bloom and post-bloom** **Products:** 29382 29384	**Attractive to**: HB, BB, SB	Tiered Framework (CG12 Stone Fruit): T1SL: Y	**Crop specific and additional orchard crop post-bloom residues at relevant rates and timing**.[Stone fruit: peach	**Propose removal of use.**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
tart cherry, peach, and plum or prune plum		**Current Label Statements:** 29382, 29384: Environmental Hazards: *Toxic to bees exposed to direct treatment, drift, or residues on flowering crops or weeds. DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 29382, 29384: Use Directions-crop specific (Stone fruit): *This product is toxic to bees exposed to direct treatment or residues on blooming crops. Do not apply during bloom or when bees are present.*	**Agronomic considerations**: Requires insect pollination for crop production. Orchards are perennial crops. Approximately 2 – 3 week bloom period. There may be flowering groundcover in orchards. **Exposure potential**: O: Y Application currently allowed pre- and post-bloom only. There is the potential for oral exposure from residues present in flowers (pollen and nectar) from pre-bloom applications the same year, or from post-bloom applications in the following year. C: N (not applied during bloom) (Y if foraging on flowering groundcover in treated area.) **There is potential for exposure through pollen and nectar.** **Pollinator Exposure: High** Crop requires insect pollination; crop is a major source of pollen and nectar for HB, SB, used by BB. Stone fruit are medium acreage. Orchards in some locations can cover large areas.	Residues: CG12 : peach (post-bloom). CG11: apple (post-bloom). Canadian relevant rates. T1R: Y T2 CFS: nectar-N; pollen-Y (year one of two years of apple), pollen-N (peach, year two of two years of apple) Non-*Apis* T2 CFS similarly sensitive as HB T2 Tunnel: NA T3: NA Incidents : None. **Potential for risk pre-bloom and post-bloom (pollen exposure).** Risk potential may depend on timing. Earlier post-bloom (pre-harvest) application timing reduces risk. Potential risk expected for later post-bloom (post-harvest) application timing **Consider Pollinator Exposure: High**	(post-bloom); Pome fruit: apple (post-bloom); Tree nut: Almond (pre-bloom and post-bloom)] **T2 Tunnel; T3 field; Incidents:** None **Bloom time shorter than CFS exposure durations** CG12 bloom time (2-3 weeks) shorter than CFS exposure duration (6 weeks or longer; 6 weeks nectar; 9-12 weeks pollen). **Risk may be overestimated**. **Effects endpoints**: Uncertainty 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 13: Small fruit and berries; Subgroup 13D: Small Fruit	FO (grape only)	**Grape: pre-bloom and post-bloom** **Products:** 29382 29384	**Attractive to**: HB (minor pollen only) **Agronomic considerations**:	Tiered framework (grape): T1SL: Y Residues: grape (pre-bloom and post-bloom applications).	**Crop Specific residues at relevant rates and timing.** [Grape (pre-bloom and post-bloom)] **T2 Tunnel; T3 field;**	**Maintain pre-bloom and post-bloom use considering low pollinator exposure.** **Maintain current crop specific restrictions, which restrict use as**

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
Vine Climbing: Grape		**Current Label Statements:** 29382, 29384: Environmental Hazards: *Toxic to bees exposed to direct treatment, drift, or residues on flowering crops or weeds. DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 29382, 29384: Use Directions-crop specific (Grape): *Do not make more than one application per year and do not exceed 210 g/ha/year. This product is toxic to bees exposed to direct treatment or residues on blooming crops. Do not apply during bloom or when bees are present.*	Does not require insect pollination. Grape is wind and self- pollinated and is considered only a minor pollen source for honey bees. Pollination services are not typically used. Grape bloom period is typically 1 – 3 weeks. **Exposure:** O: Y (minor pollen, only) C: N (not applied during bloom). **There is potential for exposure through pollen.** **Pollinator Exposure: Low** Crop does not require insect pollination; cultivated grape is primarily wind and self-pollinated. Grape is a minor source of pollen for HB only. Not a nectar source. It is not attractive to BB, SB. Grape is medium acreage. Vineyards in some locations can cover large areas.	Canadian relevant rates. T1R: Y T2 CFS: nectar-Y; pollen-Y Non-*Apis* T2 CFS similarly sensitive as HB T2 Tunnel: NA T3: NA Incidents : None. **Potential for risk pre-bloom and post-bloom (pollen exposure).** Risk potential may depend on timing. Potential risk from pre-bloom application greater than post-bloom application **Consider Pollinator Exposure: Low**	**Incidents:** None **Bloom time shorter than CFS exposure durations.** Grape bloom time (1-3 weeks) shorter than CFS exposure duration (6 weeks or longer; 6 weeks nectar; 9-12 weeks pollen). **Risk may be overestimated**. **Effects endpoints**: Uncertainty and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	**follows:** Use Directions- crop specific: (grape): *Do not apply during bloom or when bees are present.* *[Note that only one application can be made per year].* **And add under**: Use Directions- crop specific: (grape): *Avoid applications when bees are foraging in the treatment area in ground cover containing blooming weeds 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.* **Add under:** 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
From Crop Group 13: Small fruit and berries; Subgroup 13G: Low growing berry Strawberry	FO (strawberry only)	**Strawberry: pre-bloom and post-bloom** **Products:** 29382 29384 **Current Label Statements:** 29382, 29384: Environmental Hazards: *Toxic to bees exposed to direct treatment, drift, or residues on flowering crops or weeds. DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 29382, 29384: Use Directions-crop specific (Strawberry): *Do not make more than one application per year and do not exceed 448 g/ha/year. This product is toxic to bees exposed to direct treatment or residues on blooming crops. Do not apply during bloom or when bees are present.*	**Attractive to**: HB, BB, SB **Agronomic considerations**: Many cultivars are self-fertile. Pollination in commercial fields likely results from a combination of wind and pollinators delivering both self-and cross-pollen. Pollination services are not essential for most varieties of strawberry, but may be used to enhance crop production. Some strawberry varieties bloom throughout the season. **Exposure:** O: Y C: N (not applied during bloom). **There is potential for exposure through pollen and nectar.** **Pollinator Exposure: Low to Moderate** Most 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. Crop is a minor source of pollen and nectar for HB, BB, SB. Strawberry is low acreage.	Tiered Framework (strawberry): T1SL: Y Residues: grape (pre-bloom and post-bloom applications). Grape rates 2x lower than Canadian registered rate on strawberry. Residues for cotton (pre-bloom; during bloom) and pumpkin (pre-bloom) were also considered. T1R: Y T2 CFS: nectar-Y; pollen-Y Non-*Apis* T2 CFS similarly sensitive as HB T2 Tunnel: NA T3: NA Incidents : Several Canadian incidents reported mortality of managed honey bees resulting from spray application of clothianidin during bloom on strawberry (contrary to label directions). Incidents were reported in 2013, 2015, 2016. **Overall:** **Potential for risk pre-bloom and post-bloom (pollen and nectar exposure).** Risk potential may depend on timing. Potential risk from pre-bloom application greater than post-bloom application Pre-bloom and post-bloom risk	**No crop specific residues at relevant rates**. Considered grape (rate 2x lower than strawberry, and uncertain crop relevance (woody perennial)). Considered seasonal crops (cotton, pumpkin) uncertain relevance. It is noted that thiamethoxam foliar pre-bloom application to strawberry resulted in residues that tended to be high and pose a risk for both pollen and nectar exposure. **Incidents**: Several Canadian incidents reported mortality of managed honey bees resulting from spray application of clothianidin during bloom on strawberry (contrary to label directions). **Bloom time may be relevant for CFS exposure durations in some varieties.** Strawberry bloom time variable, and may be indeterminate. CFS exposure duration (6 weeks or longer; 6 weeks nectar; 9-12 weeks pollen) may be relevant for longer blooming strawberry. **Effects endpoints**: Uncertainty and	**Propose removal of use.** **Note that the following option would be acceptable; however, the use pattern for strawberry includes only pre-bloom application for control of a specific pest. Therefore removal of pre-bloom application results in removal of use.** **The following option is acceptable from a risk perspective:** **Remove pre-bloom application timing based on potential for risk. Maintain post-bloom application timing.** While risk is based on a lack of specific residue data for strawberry, it is noted that thiamethoxam foliar pre-bloom application to strawberry resulted in residues that tended to be high and pose a risk for both pollen and nectar exposure. Additionally, several Canadian incidents reported mortality of managed honey bees resulting from application of clothianidin during bloom on strawberry (contrary to label directions). As specific data on strawberry is not available to fully assess risk, removal of pre-bloom use is proposed, while maintaining post-bloom use to allow some crop protection, and considering that strawberry has low to moderate pollinator exposure potential. **Under:** Use Directions- crop specific *(strawberry):* Remove pre-bloom application timing.

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
				determination for strawberry based on very limited information. **Consider Pollinator Exposure: Low to Moderate**	differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered.	Add: *Post-bloom (after petal fall) application only.* [29382, 29384: Use Directions-crop specific (Strawberry): *Do not make more than one application per year and do not exceed 448 g/ha/season. This product is toxic to bees exposed to direct treatment or residues on blooming crops. Do not apply during bloom or when bees are present. Post-bloom (after petal fall) application only.*] **Add under:** 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 15: Cereal Grains Corn, Wheat	ST [corn (field, sweet, pop); wheat, only]	**Products:** 31357 30972 28975 27453 **Current Label Statements:** 31357 (includes wheat, not corn): Environmental Hazards: Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatments.	**Attractive to**: HB (corn pollen only) **Agronomic considerations**: **Co**rn and wheat cereal grain crops are wind pollinated and do not need insect pollination. Wheat does not provide any pollen or nectar source. Corn provides only a pollen source. **Exposure:**	Tiered Framework (corn): T1SL: Y Residues: corn (pollen) T1R: N T2 CFS: nectar-N (no nectar from corn); pollen-N Non-*Apis* T2 CFS similarly sensitive as HB	**Crop Specific residues at relevant rates and timing (corn).** **T2 Tunnel and T3 field**: HB/BB/SB No or negligible short or long term colony level effects observed in available seed treatment tunnel and field studies at Canadian relevant rates. Studies on corn. **Incidents :** Bee mortality	**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 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

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		30972 (includes wheat, not corn): Environmental Precautions: *Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatments*. 28975, 27453 (label includes corn seed treatments; therefore more extensive): Environmental Hazards: *Clothianidin 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 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,*	O: Y (only corn pollen) C: N **There is potential for exposure through corn pollen.** **Pollinator Exposure (pollen/nectar): Moderate (Corn); None (wheat)** Corn and wheat do not require insect pollination (wind pollinated); Wheat is not a source of pollen or nectar. Corn has only pollen, and is considered a minor source of pollen for HB, not attractive to 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.	T2 Tunnel and T3 field: HB/BB/BB- No or negligible short or long term colony level effects observed in available seed treatment tunnel and field studies at Canadian relevant rates. Studies on corn, considering pollen and nectar exposure routes. Incidents : Bee mortality incidents associated with corn and soybean dust. PMRA has already implemented dust exposure reduction strategies for treated corn and soybean seed. See additional considerations. In 2017, a possible bee mortality incident resulted when a planter loaded with treated bean seed was turned on in the immediate vicinity of bee colonies, with exhaust directed towards the bee colonies. **Overall:** **Minimal potential for risk from seed treatments through pollen and nectar exposure route.** **Potential for risk during planting of treated seed when label requirements or best management practices for planting of treated seed are not followed**	incidents associated with corn and soybean dust. PMRA has already implemented dust exposure reduction strategies for treated corn and soybean seed. See additional considerations. In 2017, a possible bee mortality incident resulted when a planter loaded with treated bean seed was turned on in the immediate vicinity of bee colonies, with exhaust directed towards the bee colonies. **Bloom time/pollen shed is shorter than CFS exposure durations**. Corn pollen shedding time (~2 weeks) is shorter than CFS exposure duration (6 weeks or longer; 6 weeks nectar; 9-12 weeks pollen). **Risk may be overestimated.** **Effects endpoints**: Uncertainty and differences among some CFS endpoints, particularly for pollen route CFS; full range of endpoints considered. *Apis* and non-*Apis* endpoints considered. **Additional considerations**: Pollinator exposure to dust generated during planting was previously identified as a concern for corn and soybean seed.	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 (wheat; all other CG15 cereal seeds excluding corn): *Additionally, wheat and all treated CG 15 cereal seed (excluding corn) for sale or use in Canada must be labeled with the following information:* *Clothianidin 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.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		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.* *Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatments.* LABELLING OF TREATED SEED: *All treated corn seed for sale or use in Canada must also be labeled with the following information:* *Clothianidin 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*			Risk mitigation was implemented, including label requirements and education on best practices when planting treated seed. Reduction in bee mortality incidents during planting of treated corn and soybean seed has been observed since 2014 when mitigation was implemented.	*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: *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, only a dust reducing fluency agent is permitted. Talc and graphite are not permitted to be used as a seed flow lubricant for corn seed treated with this insecticide. Carefully follow use directions for the seed flow lubricant. *Do not load or clean planting equipment near bee colonies, and avoid places where bees may be foraging, such as flowering crops or weeds.* *When turning on the planter, avoid engaging the system where emitted dust may contact honey bee colonies.* *Spilled or exposed seeds and dust must be incorporated into the soil or cleaned up from the soil surface.*				
From Crop Group 20: Oilseeds Canola, rapeseed, mustard, carinata	ST (canola, rapeseed, mustard, carinata, only)	**Products:** 27564 29158 29159 30363 31355 28975 27453 **Current Label Statements:** 27564, 29158, 29159, 30363, 31355: Environmental Hazards: *Toxic to bees. Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatments.*	**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:**	Tiered Framework (oilseed grains; canola/rapeseed): T1SL: Y Residues: CG20 - canola, rapeseed. Canola at relevant rates. T1R: N T2 CFS: nectar-N; pollen-N for canola at Canadian relevant rates Non-*Apis* T2 CFS similarly sensitive as HB	**Crop Specific residues at relevant rates and timing (canola, rapeseed; canola at Canadian relevant rates).** **T2 Tunnel and T3 field**: HB/BB/SB No or negligible short or long term colony level effects observed in available seed treatment tunnel and field studies at Canadian relevant rates. Studies on CG20 crops included canola, rapeseed, and sunflower.	**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.*

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		28975, 27453 (label includes corn seed treatments; therefore more extensive): Environmental Hazards: *Clothianidin 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 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.*	O: Y C: N **There is a potential for exposure through pollen and nectar.** **Pollinator Exposure (pollen/nectar): High** Most oilseed varieties planted in Canada are self-compatible and will set seed in the absence of insect pollination. Crop production is enhanced by pollination. Additionally, pollination services (both HB, SB) are used extensively in canola seed production in Canada. Canola/rapeseed are 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.	T2 Tunnel and T3 field: HB/BB/BB- No or negligible short or long term colony level effects observed in available seed treatment tunnel and field studies at Canadian relevant rates. Studies on CG20 crops included canola, rapeseed, and sunflower. Incidents : None **Minimal potential for risk from seed treatments through pollen and nectar exposure route.** **Minimal potential for exposure from dust generated during planting of treated seed.**	**Bloom time is shorter than CFS exposure durations**. Canola/rapeseed bloom time (2-3 weeks) is shorter than CFS exposure duration (6 weeks or longer; 6 weeks nectar; 9-12 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.	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
		Spilled or exposed seeds and dust must be incorporated into the soil or cleaned up from the soil surface. *Bees can be exposed to product residues in flowers, leaves, pollen and/or nectar resulting from seed treatments.* LABELLING OF TREATED SEED: *All treated corn seed for sale or use in Canada must also be labeled with the following information:* *Clothianidin 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*				

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
		seed treated with this insecticide. Carefully follow use directions for the seed flow lubricant. *Do not load or clean planting equipment near bee colonies, and avoid places where bees may be foraging, such as flowering crops or weeds.* *When turning on the planter, avoid engaging the system where emitted dust may contact honey bee colonies.* *Spilled or exposed seeds and dust must be incorporated into the soil or cleaned up from the soil surface.*				

Crop Group	Application Type	Products and Current Restrictions	Pollinator Exposure Potential[1]	Risk Characterization[3]	Considerations / Limitations[4]	Proposed Risk Mitigation
No associated crop group **Turfgrass** Turfgrass sites including golf courses; sod farms; professional lawn care on municipal, industrial, residential, recreational turfgrass	FO	**Turf: No timing restrictions for turf. As with all the foliar sprays, indicates DO NOT apply to flowering crops or weeds when bees are visiting treatment area**. **Products:** 29383 29384 **Current Label Statements:** 29383, 29384: Environmental Hazards. *Toxic to bees exposed to direct treatment, drift, or residues on flowering crops or weeds. DO NOT apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.* 29383, 29384: Use Directions-crop specific (turfgrass):*For use on all areas of golf course turfgrass, sod farms, and for use in professional lawn care on residential, municipal, industrial and recreational turfgrass. DO NOT make more than 1 application per year. Avoid mowing turfgrass until after irrigation or rainfall has occurred so that uniformity of application will not be affected.*	**Attractive to:** HB, BB, SB Pollinator attractive only if turf contains flowering plants that are bee attractive (e.g., clover, dandelions) **Agronomic considerations:** Turf grass may contain flowering weeds, such as clover or dandelions, which may be attractive to pollinators. Attractiveness may depend on the type and abundance of weeds present. Both golf courses and sod farms manage weeds and, therefore, there is minimal exposure potential. Other turfgrass lawns may contain weeds that are attractive to pollinators. **Exposure:** O: Y (when flowering weeds are in turfgrass) C: Y (when flowering weeds are in turfgrass) **Overall there is potential for exposure to pollen and/or nectar if turfgrass contains bee attractive plants.** **Pollinator Exposure: May vary from Low to Moderate to High. Varies depending on weeds/flowering plants present in turf.** Clover and dandelions may be major sources of nectar and/or pollen for HB, BB, SB. Turf may cover large areas.	Tiered Framework (turf; when flowering weeds are present): *Apis* and non-*Apis* bees: T1SL: Y Residues: Turf containing bee attractive flowering weeds (clover) (residues from tunnel study), higher than Canadian registered rate. Also considered cotton (rates lower than Canadian turf rate). T1R: Y T2 CFS: nectar-Y; pollen-Y Non-*Apis* T2 CFS similarly sensitive as HB T2 Tunnel: BB **:** Foliar application was made to turf with flowering weeds present (clover). Rates were higher than Canadian rates. Immediately following application, turf was either irrigated or irrigated and mowed to remove blooms that were directly sprayed. In the case where mowed, flowers present/sampled came up after mowing. Bees were allowed to forage on the turf with flowering weeds present under the scenarios with irrigation or irrigation/mowing. Residues were also measured in sampled clover nectar. Potential for risk was identified in both scenarios but was much reduced in the case of irrigation and mowing (risk was based on effects observed in the tunnel studies,	**Crop specific residues (turf with flowering weeds-clover) at rates higher than the Canadian rate** (residues are from tunnel study described below). **T2 tunnel study:** Foliar application was made to turf with flowering weeds present (clover). Rates were higher than Canadian rates. Immediately following application, turf was either irrigated or irrigated and mowed to remove blooms that were directly sprayed. In the case where mowed, flowers present/sampled came up after mowing. Bees were allowed to forage on the turf with flowering weeds present under the scenarios with irrigation or irrigation/mowing. Residues were also measured in sampled clover nectar. Potential for risk was identified in both scenarios but was much reduced in the case of irrigation and mowing (risk was based on effects observed in the tunnel studies, and also through comparing resides to CFS effects endpoints). **Effects endpoints**: Limitations and differences among some CFS endpoints, particularly for pollen	**Remove turf uses other than golf courses and sod farms.** Remove use in professional lawn care on residential, municipal, industrial and recreational turfgrass, as pollinator attractive flowering weeds may frequently be present in these turfgrass areas. **Add under:** 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
				and also through comparing resides to CFS effects endpoints). T3: NA Incidents : None **Potential for risk (pollen and nectar) when presence of bee attractive plants/weeds in turf.** **Consider Pollinator Exposure: May vary from Low to Moderate to High**	route CFS; full range of endpoints considered. *Apis* 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 s: 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 Limitations: There were 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 limitations s and 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
1086418	1999, Residue Levels of Imidacloprid and Imidacloprid Metabolites in Nectar, Blossoms, Pollen of Sunflowers Cultivated on Soils with Different Imidacloprid Residue Levels and Effects of These Residues on Foraging Honeybees., DACO: 9.2.9
1086427	1998, The Impact of GAUCHO and TI-435 Seed Treated Canola on Honey Bees, *Apis* mellifera L., DACO: 9.2.9
1194190	OECD/IIA/8.7.1/&/8.7.2, OECD/IIA/8.7.2/&/8.7.1: TI-435 Technical: Acute Contact And Oral Toxicity To Honey Bees. G.Weyman. Completion Date: March 13,1998. (110049;586/135;586/135-1018). [Clothianidin Technical;SUBN#2001-1293;OECD# IIA 8.7.1 & 8.7.2, OPPTS# 850.3020, PMRA DACO# 9.2.4.1; OECD Point 8: Ecotoxicology. Reference Number 1; Submitted: April 30,2001], DACO: 9.2.4.2
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1194194	OECD/IIA/8.7.1: TI-435 Metabolite MNG: Acute Oral Toxicity To Honey Bees (*Apis* Mellifera). P.Wilkins. Completion Date: January 27, 2000. (110056;GQ3203). [Clothianidin Technical; SUBN#2001-1293;OECD# IIA 8.7.1, OPPTS# N/A, PMRA DACO# 9.2.4.2; Oecd Point 8: Ecotoxicology. Reference Number 3; Submitted: April 30,2001], DACO: 9.2.4.2
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1194197	OECD/IIA/8.7.1: TI-435 Metabolite TZNG: Acute Oral Toxicity To Honey Bees (*Apis* Mellifera). P.Wilkins. Completion Date: January 27,2000. (110057;GQ3204). [Clothianidin Technical; SUBN#2001-1293;OECD# IIA 8.7.1, OPPTS# N/A, PMRA DACO# 9.2.4.2; OECD Point 8: Ecotoxicology. Reference Number 5; Submitted: April 30,2001], DACO: 9.2.4.2
1194863	2001, TI-435 Residue Levels In Corn Seeds And Seedlings, DACO: 9.6.5
1194868	2000, Residues Of Ti 435 In Nectar, Blossoms, Pollen And Honey Bees Sampled From A Summer Rape Field In Sweden And Effects Of These Residues On Foraging Honeybees., DACO: 9.2.8
1194869	2000, Residues of TI 435 in Nectar, Blossoms, Pollen And Honey Bees Sampled From A British Summer Rape Field And Effects Of These Residues On Foraging Honeybees., DACO: 9.2.8
1194870	2000, Residues of TI 435 in Nectar, Blossoms, Pollen And Honey Bees Sampled From A French Summer Rape Field And Effects Of These Residues On Foraging Honeybees, DACO: 9.2.8
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1194872	2001, The Impact of Gaucho and TI-435 Seed-Treated Canola On Honey Bees, *Apis* Mellifera L., DACO: 9.2.9
1194873	2001, Residue Levels of TI 435 FS 600 and Its Relevant Metabolites in Nectar, Blossoms and Pollen of Summer Rape From Dressed Seeds and Effects of These Residues on Foraging Honeybees (Test Location: Farmland "Laacher Hof")., DACO: 9.2.8
1194874	2001, Residue Levels of TI-435 FS 600 and Its Relevant Metabolites in Nectar, Blossoms and Pollen of Summer Rape From Dressed Seeds and Effects of These Residues on Foraging Honeybees (Test Location: Farmland "Hofchen")., DACO: 9.2.8
1194876	2001, Residue Levels of TI 435 FS 600 and Its Relevant Metabolites in Pollen of Maize Plants From Dressed Seeds (Test Location: Farmland "Laacher Hof"), DACO: 9.2.8
1194877	2001, Residue Levels of TI 435 FS 600 and Its Relevant Metabolites in Pollen of Maize Plants From Dressed Seeds (Test Location: Farmland Hofchen), DACO: 9.2.8
1194878	2001, Effects of TI-435 Technical Residues in Pollen on the Development of Small Bee Colonies and On Behavior and Mortality of Honey Bees., DACO: 9.2.8
1464606	2005, An Investigation of the Potential Long-term Impact of Clothianidin Seed Treated Canola on Honey Bees, *Apis* Mellifera L., DACO: 9.2.4.3
1464608	2006, Spring 2006 Assessment of Overwintered Colonies Studied in an Investigation of the Potential Long-term Impact of Clothianidin Seed Treated Canola on Honey Bees, *Apis* mellifera L., DACO: 9.2.4.3
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B.1.0 Environmental Assessment

B.1.1 Environmental Fate and Effects Assessment

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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

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