Re-evaluation Note REV2016-05

Re-evaluation of Imidacloprid - Preliminary Pollinator Assessment

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Overview

Introduction

Over the past few years, there has been an emerging body of scientific research which suggests that there may be potential short-term and long-term effects on pollinators resulting from exposure to imidacloprid. Reported effects have included changes in bee behaviour, bee mortality, and adverse effects on queens and developing bees. These studies have generally been conducted under laboratory situations or in the field with bees exposed to imidacloprid at doses higher than may normally be encountered in the environment.

In 2012, Health Canada's Pest Management Regulatory Agency (PMRA) announced the re-evaluation of neonicotinoid insecticides including imidacloprid. The re-evaluations were initiated to assess the potential risk to pollinators in light of international updates to the pollinator risk assessment framework. This re-evaluation considers all agricultural and outdoor uses of imidacloprid that could result in potential bee exposure, including foliar applications, soil applications, seed treatment applications, greenhouse and tree injection applications.

For the pollinator risk assessment, the PMRA is reviewing the emerging body of scientific research and available monitoring data to assess whether risks to pollinators from imidacloprid at the levels anticipated to be present in the Canadian environment continue to be acceptable. This includes working cooperatively with scientists from around the world.

The PMRA has requested additional data from the imidacloprid registrants which must be submitted by December 2016. In the interim, PMRA has conducted a preliminary pollinator risk assessment for foliar, soil and seed treatment applications based on currently available data. The final pollinator risk assessment will assess all imidacloprid uses and application methods.

What is Imidacloprid?

Imidacloprid is a neonicotinoid insecticide which is used to control a broad spectrum of insect pests on a wide variety of sites. This re-evaluation considers only the sites for which an environmental risk assessment for pollinators is needed, including cereals, fruits, greenhouse food and ornamental crops, herbs, legumes, oilseeds, vegetables, Christmas trees, outdoor ornamentals and turf. The Commercial Class imidacloprid products are applied using conventional ground equipment such as airblast sprayers, boom sprayers, backpack and hand wand sprayers, conventional aerial equipment (such as fixed wing and rotary aircraft), tree injection equipment, granular spreaders, chemigation equipment, seed treatment equipment (commercial treatment facilities and on-farm using closed and open systems), potato seed piece treatment equipment by farmers, farm workers and professional applicators. The Domestic Class imidacloprid products are applied by the general public using granular spreaders on turf.

What happens when Imidacloprid is introduced into the environment?

Imidacloprid is a systemic insecticide which is absorbed and transported throughout the plant, thereby protecting the whole plant. Imidacloprid is readily taken up by plants through treated leaves, treated seed or roots growing in treated soil. Imidacloprid moves upward inside the plant. Pollen and nectar may contain imidacloprid as a result of this upwards movement.

Once inside the plant, imidacloprid remains the predominant residue, although many compounds are formed as a result of the plant's metabolism. Of these, 5-hydroxy-imidacloprid and imidacloprid-olefin are considered to be the most relevant for the pollinator risk assessment given their higher toxicity to bees.

Imidacloprid is persistent in the environment. In treated fields, imidacloprid has been shown to carry over from one growing season to the next. When imidacloprid is used for multiple years in succession, concentrations in soil initially increase and then stabilize after approximately three years.

Imidacloprid is water soluble and mobile in the environment. Imidacloprid can leach through the soil profile and has been detected in groundwater. Imidacloprid is routinely found in surface water, including puddles which are known drinking water sources for pollinators.

What was considered for the preliminary assessment?

The review was based on the data submitted to the PMRA by the registrants and available information from the open scientific literature. The evaluation was conducted according to the Guidance for Assessing Pesticide Risks to Bees.[1] This guidance was collaboratively developed by the PMRA, the United States Environmental Protection Agency (USEPA) and the California Department of Pesticide Regulation.

The risk assessment consists of characterizing the exposure and effects of imidacloprid to bees, and determining whether exposures resulting from its uses are expected to pose a risk of concern to bees. A tiered approach is used for characterizing the risks, from the most conservative (likely an overestimation) at the lower tier (Tier I) to more realistic at higher tiers (Tiers II and III). Effect endpoints for individual bees, colonies, and bee species other than honey bees are considered in the risk characterization.

At Tier I, individual bee effect endpoints from the laboratory are used along with conservative (likely overestimated) exposure estimates. Refinements to Tier I and higher tiers consider measured residues in pollen and nectar, and colony level effect endpoints from semi-field (tunnel studies or colony feeding studies) and field studies. In semi-field tunnel studies, bee colonies are confined in tents or tunnels with crops treated using specific application methods.

[1] http://www2.epa.gov/pollinator-protection/pollinator-risk-assessment-guidance

In semi-field feeding studies, hives are fed with known amounts of test chemical in either sugar solution, pollen/pollen substitute, or both. In field studies, which are meant to provide the most realistic exposure scenario, unconfined colonies are placed in fields where the crops have been treated using specific application methods.

The honey bee is used in the risk assessment to represent all types of bees and other insect pollinators. Available information on other types of bees, such as bumble bees, is also considered. Information from all tiers of the risk assessment along with the associated strengths and weaknesses are considered to characterize the risk.

Crop attractiveness is considered when identifying potential risk to bees. Bees may be exposed to pesticides when they forage on crop pollen or nectar. For crops that are harvested prior to bloom, there will be no exposure to crop pollen or nectar. Some crops do not have pollen or nectar sources. Other crops may not be very attractive to bees. Therefore when crop pollen or nectar is unavailable or unattractive to bees, there is minimal potential for exposure through consumption of crop pollen and nectar, and therefore minimal risk.

Label statements also affect potential exposure to pollinators and are considered when identifying potential risk to bees. For example, foliar applications of imidacloprid include restrictions on application during-bloom, thus reducing pollinator exposure. Some crops allow only post-bloom application. As well, the Canadian labels do not allow Group 4 Insecticides (which includes imidacloprid) to be applied by multiple application methods to the same crop in the same season.

Can approved uses of Imidacloprid affect pollinators?

The risk characterizations are presented by application method to the crop (for example foliar, soil, and seed treatment). As described previously, the individual bee and colony level effects are compared to pollen and nectar residues to determine potential risk. As well, available tunnel-studies and field studies associated with specific applications are considered. In addition, current imidacloprid product label language and use directions as well as crop attractiveness to pollinators are considered in the risk characterization. This pollinator risk characterization is based on information available to date from registrants and the public literature. Additional data is expected, and will be considered when finalizing the pollinator risk assessment.

Foliar applications

Potential risk from foliar application varies with application timing. Current label restrictions aid in minimizing risk.

For foliar applications, residue information in pollen and nectar was available, although residue studies were typically conducted at rates higher than Canadian application rates and/or with crops not grown in Canada. Available residues were used to the extent possible to compare with individual and colony level effects information to characterize the risk for Canadian foliar uses.

A potential risk to bees was indicated for bee attractive crops associated with pre-bloom, during-bloom, and some post-bloom applications, however, current label restrictions minimize potential risk. A relevant Tier II tunnel study on potential risk to bees from foliar turf application suggests Canadian label mitigation adequately minimises risk for this use.

When foliar applications are used, rotational crops planted the following season are not expected to pose a risk to bees.

Foliar application during-bloom is expected to result in low risk to bees based on current label restrictions.

While foliar applications made during-bloom are expected to pose a risk to bees, current labels prohibit or reduce application during-bloom for most bee attractive crops.

Further residue information on Canadian specific agricultural crops could refine the risk assessment for pre-bloom foliar applications.

Pre-bloom foliar applications may pose a risk to bees. However, residue information for pre-bloom applications was only available on crops not grown in Canada. Pre-bloom applications are currently prohibited for some uses, including orchard crops (stone fruit and pome fruit), which are highly attractive to bees.

Post-bloom applications to orchard, tree and field agricultural crops are not expected to pose a risk to bees.

Post-bloom applications to agricultural crops that are harvested at the end of the season are not expected to pose a risk to bees, as pollen and nectar are no longer available for forage. For orchard and tree crops, there is evidence that the timing of the post-bloom application can affect the residue levels found in pollen and nectar the next season. Lower residues were observed with a longer time period between application and next season’s bloom, thus affecting the potential for risk to bees. Based on available information, no potential for risk was identified when post-bloom applications were made prior to harvest.

Soil applications

A potential risk to bees was identified for some soil treatments.

The data set available to assess risk from soil applications included residue information in pollen, nectar or flowers for a variety of Canadian relevant crops and application rates. Potential for risk varied with crop, soil type, application timing relative to bloom-period and residue sampling date relative to application timing. The data set also included one relevant Tier II tunnel study to address potential for risk to bees from turf soil application. It suggests current Canadian label mitigation adequately minimises risk for use on turf. Field studies for soil treatment applications are expected in 2016 and will help further inform the pollinator risk assessment.

Higher application rates and application timing closer to plant blooming time appears to result in higher residue levels. Soil type also seems to affect residue levels. Crops grown in coarser soils (sandy soils, less organic matter) tended to have higher residues than those grown in medium or fine soils (higher organic matter).

No potential risk was identified for crops such as melon, pumpkin, and blueberry. Minimal risk is expected for bee-attractive crops in other registered crop groups (such as legumes and herbs).

Potential risk was identified for tomato and strawberry with certain application rates and soil types.

No potential risk was identified for rotational crops or off-field bee attractive forage plants which could be exposed to runoff.

Seed treatments

No potential risk to bees was indicated for seed treatment use.

The data set available to assess risk from treated seed included residue information in pollen, nectar or flowers of Canadian relevant crops, Tier II tunnel studies and Tier III field studies specific to seed treatment applications. Available higher tier tunnel-studies and field studies with seed treatments did not result in notable effects on bees.

The residue levels in crop pollen and nectar resulting from seed treatment uses are typically below levels expected to pose a risk to bees at both the individual bee and colony levels.

The exposure route of dust generated during planting of treated seed was also considered. Dust generated from planting of neonicotinoid treated corn and soybean seed was previously identified as a concern in Canada, and risk reduction measures were put in place in 2014 to reduce exposure to dust during planting of treated corn and soybean seed. Dust generation is related to multiple factors including the planting equipment and seed types, and at this time planting of other seed types in Canada is not associated with dust-generation or harm to pollinators.

What about native bees?

Information on native (non-*Apis*) bees was considered and incorporated into the pollinator risk assessment. Non-*Apis* bees include bees other than honey bees (*Apis* bees), such as bumble bees or solitary bees like the alfalfa leafcutting bee. There are approximately 1000 non-*Apis* bee species in Canada which have varying biological and ecological traits. Like honey bees, bumble bees live in colonies, however, their colonies are much smaller than honey bee colonies and only the queens overwinter to start a new colony every season. Unlike honey bees and bumble bees, most other non-*Apis* bees are solitary and nest in the ground or pithy plant stems.

Available individual bee effect information suggested that toxicity of imidacloprid to non-*Apis* bees is similar to that of honey bees. Tier I acute adult effect information was available for bumble bees, mason bees, leafcutting bees and stingless bees. Available Tier I effect information supports use of honey bee as a surrogate for non-*Apis* bees.

Available Tier II tunnel studies and Tier III field studies were consistent with tunnel and field studies on honey bees, and were used to support the overall risk conclusions for pollinators. Tier II and III studies were conducted primarily with bumble bees, and typically did not show notable effects for Canadian relevant use patterns.

Results of the available Tier II colony level feeding studies with non-*Apis* bees suggested that bumble bees may be more sensitive to imidacloprid exposure than honey bees. Measured pollen and nectar residues were often above the lowest dose where colony effects were detected in bumble bee feeding studies, suggesting a potential for risk. At this time, there is uncertainty as to whether colony level effects observed in feeding tests would represent impacts to bumble bee colonies in nature. Recent available non-*Apis* research has yet to be incorporated into the assessment; this additional information may be informative. There is also uncertainty about whether the bumble bee effects information is relevant for other non-*Apis* bees, such as solitary bees.

There has been additional recent research published on non-*Apis* bees which will be reviewed and considered for the final pollinator risk assessment. The PMRA expects that the science of non-*Apis* effect testing and risk assessment will continue to improve, and any new developments will also be considered in the final pollinator risk assessment.

Measures to Minimize Risk

Labels of registered pesticide products include specific instructions for use. Directions include risk-reduction measures to protect the environment, including pollinators. The current imidacloprid labels include restrictions to protect pollinators from exposure to pesticides. The need for additional mitigation measures for protection of pollinators will be developed based on the final pollinator risk assessment. Any additional data available prior to the final pollinator risk assessment will also be considered when proposing risk mitigation.

Next Steps

In order to provide the public with timely information, the PMRA published a pre-release version of REV2016-05, *Re-evaluation of Imidacloprid – Preliminary Pollinator Assessment* on 6 January 2016. The pre-release document contained the Overview and Science Evaluation but it did not contain the related Appendices.

The full preliminary assessment document, containing the Appendices, is now available. The PMRA will accept written comments for up to 60 days from the date of the publication of this document.

The PMRA will consider all comments received from the public in response to this consultation document. The PMRA will then publish a Proposed Re-evaluation Decision document that will include an updated final pollinator risk assessment, and related regulatory proposal.

Science Evaluation

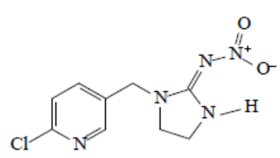
1.0 Introduction

Imidacloprid is one of the first-generation neonicotinoids. It acts via contact exposure or ingestion. Imidacloprid and other neonicotinoids bind 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 in target pests.

Following the re-evaluation announcement for imidacloprid, the registrants of the technical grade active ingredients in Canada indicated that they intend to provide continued support for all uses included on the label of the Commercial Class end-use products in Canada.

2.0 Imidacloprid Properties and Uses

2.1 Identity of Imidacloprid

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

2.2 Description of Registered Imidacloprid Uses

Appendix I lists all imidacloprid products that are registered under the authority of the *Pest Control Products Act*. Only products and uses considered in the environmental risk assessment of pollinators were included in this list. Appendix IIa lists all Commercial Class uses, while Appendix IIb lists all Domestic Class uses.

Imidacloprid uses relevant to pollinators belong to the following use-site categories: forests and woodlots, greenhouse food crops, greenhouse non-food crops, terrestrial non-food and non-feed seed and fiber crops, seed and plant propagation materials food and feed, terrestrial feed crops, terrestrial food crops, outdoor ornamentals and turf.

3.0 Fate and Behaviour in the Environment

3.1 Fate and Behaviour in the Terrestrial Environment

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

Imidacloprid is not expected to volatilize when applied to the soil surface. Also, abiotic processes such as hydrolysis and phototransformation are not likely to contribute significantly to the dissipation of imidacloprid in the terrestrial environment. Imidacloprid is stable to hydrolysis at environmentally relevant pH and phototransformation is typically not rapid enough to represent a major route of transformation for imidacloprid in soil. In addition, the transformation of imidacloprid through the action of soil microbes is slow. Imidacloprid is classified as moderately persistent to persistent in the terrestrial environment. As a result, imidacloprid may carry over from one growing season to the next. This is confirmed in long term field dissipation studies which reveal that imidacloprid residues in soil increased with each successive year of treatment to eventually reach a plateau concentration after approximately 3 years. Imidacloprid-urea is identified as a major transformation product formed from the microbial degradation of imidacloprid in aerobic soil. Minor biotransformation products in soil include imidacloprid-guanidin, imidacloprid-olefin, imidacloprid-nitrosimine, 6-chloronicotinic acid and 2,5-diketo-imidacloprid.

3.2 Fate and Behaviour in the Aquatic Environment

Imidacloprid can enter the aquatic environment through spray drift and run-off from the application site.

Imidacloprid is highly soluble in water. Once in water, imidacloprid is stable to hydrolysis, but in the presence of sunlight will transform rapidly. Many aqueous phototransformation products have been reported, although it is not clear whether any of these are formed in important amounts; these include imidacloprid-urea, imidacloprid-guanidine, monohydroxy-imidacloprid, 6-chloronicotinoic aldehyde, 6-chloro-N-methylnicotinacidamide and 6-chloro-3-pyridyl-methylethylenediamine. Imidacloprid is classified as slightly persistent to persistent in the aquatic environment. It has been shown that imidacloprid tends to remain in the water phase rather than partition to sediment. Imidacloprid-guanidine is the only major biotransformation product identified under aquatic conditions (aerobic and anaerobic). Minor transformation products include monohydroxy-imidacloprid, 6-hydroxynicotinic acid, imidacloprid nitrosamine, imidacloprid-urea and 6-chloronicotinic acid. Aquatic field studies on the environmental fate of imidacloprid demonstrate that imidacloprid dissipates relatively quickly under actual environmental conditions. Residues in water and sediment remain detectable up to 7 weeks after the last application.

3.3 Fate and Behaviour in Plants

Imidacloprid is readily taken up by the plant upon application and moves upwards through the xylem. Once inside the plant, imidacloprid remains the predominant residue, although many compounds are formed as a result of the plant metabolism. Metabolites include imidacloprid-urea, 5-hydroxy-imidacloprid, imidacloprid-olefin, imidacloprid-guanidine (also known as desnitro-imidacloprid), 6-chloronicotinic acid and others.

Imidacloprid spray droplets or dust containing imidacloprid (produced during the sowing of treated seeds) can be deposited directly on pollen and nectar when plants are in bloom. Imidacloprid can also reach pollen and nectar via translocation from other parts of the plant such as treated leaves, treated seed or roots growing in soil containing imidacloprid. Residues of imidacloprid and its metabolites have been measured in pollen and nectar from a variety of crops following foliar spray applications, seed treatments or soil applications.

4.0 Approach to the Pollinator Risk Assessment

4.1 Pollinator Risk Assessment Framework

The evaluation is conducted according to the Guidance for Assessing Pesticide Risks to Bees. This guidance was collaboratively developed by PMRA, USEPA and California Department of Pesticide Regulation (DPR). The protection goals for the risk assessment for pollinators include the maintenance of biodiversity and pollination services and hive product production.

The risk assessment consists of the characterization of exposure and effects to bees, and whether exposures resulting from the use of pesticides are expected to pose a risk to bees. A tiered approach is used for characterizing the risks, from the most conservative at lower tiers (Tier I) to more realistic at higher tiers (Tiers II and III). Effect endpoints for individual bees, colonies, and bee species other than honey bees are considered in the risk characterization. At Tier I, individual bee effect endpoints from laboratory studies are used along with conservative exposure estimates, and refined with measured residues in pollen and nectar. Higher tiers consider measured residues in pollen and nectar, colony level effect endpoints, and semi-field (tunnel studies and colony feeding studies) and field studies. In the higher tier assessments, the focus is shifted from understanding the impacts of a pesticide on individual bees to understanding colony level impacts under more realistic use conditions.

As described in the guidance, the honey bee species, *Apis mellifera*, is used as a surrogate species for other bees including non-*Apis* bees, recognizing they may have different biology from the honey bee. Available information on non-*Apis* bee species is also considered in the risk characterization and a section further discussing non-*Apis* bees is included in this review.

The risk assessment is presented based on the application methods, such as foliar application, soil application and seed treatment. This is because the application method affects the potential exposure routes for pollinators. This is further discussed in the next section. For each application method, a tiered risk assessment approach is conducted according to the Guidance for Assessing Pesticide Risks to Bees.

4.2 Pollinator Exposure Routes

Pollinators may be exposed to pesticides through a number of exposure routes. Exposure is affected by many factors including but not limited to the chemical properties of the pesticide, application methods used, timing of application, and crops to which the pesticide is applied. The Guidance for Assessing Pesticide Risks to Bees includes a number of generic conceptual models of exposure and risk assessment based on application methods and systemicity of pesticides. These models depict potential exposure routes and risk considerations for different stages of bees.

The exposure routes considered in this assessment include contact exposure and oral exposure through consumption of pesticides found in pollen and nectar. These are the primary exposure routes for bees. Exposure can also occur through drinking water sources. Bees may drink from moist soil, puddles, or other water sources in or near agricultural fields. These water sources, especially puddles or moist soil in agricultural fields, may have high pesticide residue levels. Bees may also consume plant guttation fluid, a plant excretion that may contain pesticide residues. While bees may consume guttation fluid, current research indicates that it may not occur often, and while high guttation fluid residues could impact individual bees, impacts to the colony are not observed. Available information regarding pesticide residues in drinking water sources and potential risk to pollinators is not presented in this preliminary pollinator risk assessment, but will be presented in the final assessment.

The primary potential exposure routes to bees resulting from imidacloprid uses are presented by application methods. This preliminary pollinator risk assessment will focus on three application methods: foliar application, soil application, and seed treatment.

4.2.1 Foliar application

Foliar applications of imidacloprid may result in both contact and oral (dietary) exposure to bees. Foliar spray may result in contact exposure to bees through direct deposition of spray droplets onto bees as well as deposition onto plant surfaces (leaf, flower, pollen, nectar) followed by contact with and/or ingestion of residues.

Due to its systemic property in plants, imidacloprid deposited onto plant surfaces and soil may also translocate to other plant tissues, including pollen and nectar, which bees may consume. The translocation in plants may also result in imidacloprid in plant excretions such as plant guttation fluid.

While in some cases multiple foliar applications may be applied, the maximum single application rate is considered for estimating the potential level of exposure to bees. This is because the major exposure routes for bees are from nectar and pollen in flowers and the same flowers are unlikely to be exposed multiple times to the foliar application. Most foliar application intervals are 7 days or longer, which is longer than the blooming span of a single flower.

4.2.2 Soil application

Soil applications of imidacloprid may result primarily in oral (dietary) exposure to bees. Following soil application, plants may take up and translocate imidacloprid residues to plant tissues, including pollen and nectar. There is also potential for exposure via runoff and subsequent translocation into plants adjacent to the treated field.

4.2.3 Seed treatment

Similar to soil application, the major exposure route to bees when imidacloprid is used as a seed treatment is dietary, through foraging on pollen and nectar containing imidacloprid residues. As the seed grows into a plant, imidacloprid residues may be taken up and transported from the seed to the growing plant tissues, including pollen and nectar.

For some seed types, including corn and soybean seed, seed treatment of imidacloprid may also result in exposure of bees through dust abraded from coated seed during planting. 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 seed, including those treated with imidacloprid. Generation of dust from planting of treated seed is related to many factors, including the planting equipment and seed type. To date, exposure to dust from seed types other than corn and soybean have not been identified as posing a risk to pollinators in Canada.

4.2.4 Exposure Considerations: Crop Attractiveness and Label Restrictions

Crop attractiveness is considered when identifying potential risk to bees. Bees may be exposed to pesticides when they forage on crop pollen or nectar. For crops that are harvested prior to bloom, there will be no exposure to crop pollen or nectar. Some crops do not have pollen or nectar sources, for example corn has only pollen. Other crops may not have pollen or nectar sources that are attractive to bees. Therefore when crop pollen or nectar is not available to bees or not attractive to bees, there is minimal potential for exposure or risk through consumption of crop pollen and nectar.

Label statements may also affect potential exposure to pollinators. Foliar applications of imidacloprid include restrictions on application during-bloom, thus reducing pollinator exposure. For example, some crops allow only post-bloom application. As well, the Canadian labels do not allow Group 4 Insecticides (which includes imidacloprid) to be applied by multiple application methods in the same season. For soil applications, only one soil application can be applied per season, and no other application of a Group 4 insecticide can be applied following a soil application (including in-furrow, soil, or foliar). Foliar applications cannot be made following a soil, in-furrow, or seed treatment application of a Group 4 insecticide.

Appendix III describes the potential for exposure to pollinators for each crop group. Attractiveness, label mitigation, and agricultural practices are considered.

The following crop groups or named crops were determined to pose a minimal risk to bees. The listed crop groups contain crops that are mainly harvested before bloom. If these crops are grown for seed, they will not be harvested before bloom, however, very little, if any, of these crops are grown for seed in Canada. Within these crop groups, there are a few exceptions that are not harvested before bloom, including potato which is not considered attractive to pollinators. Additionally, coniferous evergreens and the listed cereal grains are not attractive to pollinators. Applications to the following listed crops and crop groups, therefore, are expected to pose minimal risk to pollinators as exposure to pollen and nectar is typically not expected.

- Crop Group 1: Root and Tuber vegetables (examples: beet, carrot, potato, radish)
- Crop Group 2: Leaves of Root and Tuber Vegetables (examples: beet, turnip)
- Crop Group 3: Bulb Vegetables (example: onion)
- Crop Group 4: Leafy Vegetables (except brassica vegetables) (examples: lettuce, spinach)
- Crop Group 5: Brassica (Cole) Leafy Vegetables (examples: broccoli, cabbage, cauliflower)
- Barley, oats, rye, wheat (in Crop Group 15: Cereal Grains) are not attractive to pollinators.
- Coniferous Evergreens (arborvitae, pines, boxwood, balsam fir, spruce, juniper, Christmas trees) are not attractive to pollinators.

4.3 Considerations for Non-*Apis* Bees

There are approximately 1000 non-*Apis* bee species in Canada in addition to *Apis* bees, the genus including the honey bees (Packer et al. 2007[2]). These non-*Apis* bees have different biological and ecological traits from each other. Unlike the honey bees, most of the non-*Apis* bees are solitary and nest in the ground or pithy plant stems. These non-*Apis* bees contribute to crop pollination and are ecologically important.

[2] Packer L. et al, 2007, The Bee Genera of Eastern Canada. Canadian Journal of Arthropod Identification No.3

There are many challenges to conducting a specific risk assessment of pesticides for non-*Apis* bees. The challenges mainly result from a lack of specific toxicity information for non-*Apis* bees, and the variation in the potential exposure levels to a pesticide resulting from their unique and diverse biology and ecology.

The level of pesticide exposure to non-*Apis* bees may be different from honey bees due to variations of biological and ecological traits among the many species in the bee taxa. For example, some non-*Apis* bee species may start foraging earlier in the morning and/or forage later in the evening than the honey bees, affecting the types and quantities of forage collected. Some non-*Apis* bees may be unique foragers on certain plant species, which differs from honey bees that may forage on a variety of plant species. While primary exposure routes for all bees include pollen and nectar, other non-*Apis* bees, such as leaf-collecting bees and soil-dwelling bees, may have additional exposure routes through leaves or soil. Lack of biological and ecological information of non-*Apis* bees in the field and the wide variation in their ecological traits makes it difficult to estimate the potential level of exposure across the entire group of non-*Apis* bees.

The risk assessment process described in the pollinator risk assessment framework identifies a tiered approach using honey bee data as a surrogate for all bees. While additional data may be available for other non-*Apis* bee species and may be included in the tiered risk assessment process as an additional line of evidence, the primary process relies on honey bee data as a surrogate for both *Apis* and non-*Apis* bees. The framework indicates that as the science evolves methods and studies using non-*Apis* bees may be considered and incorporated into the risk assessment.

For this interim report, the PMRA considered available information on non-*Apis* bees and incorporated the information into the risk assessment. It is noted that only minimal non-*Apis* data was submitted by the registrant, with the majority of available information from the open literature. Limitations regarding the available non-*Apis* information are highlighted as follows:

- The amount of data reviewed to date is small in comparison to the *Apis* data reviewed and mainly consists of open literature sources that did not have raw data available for further analysis. In some cases, the PMRA would like to contact authors to get access to the raw data and complete a full assessment for inclusion in the final imidacloprid pollinator risk assessment.
- There is a large amount of relevant and recent open literature data that has not been fully reviewed by the PMRA for incorporation into the non-*Apis* risk assessment. The PMRA acknowledges this important data and plans to incorporate our assessments of this body of work in the final imidacloprid pollinator risk assessment.
- As the science of non-*Apis* effects testing improves, and further information is developed regarding exposure estimations for non-*Apis* bees, the PMRA expects that improvements in conducting non-*Apis* risk assessments will be developed. PMRA will consider improvements to consideration of non-*Apis* information in the final imidacloprid pollinator risk assessment.

5.0 Pollinator Effects Summaries

5.1 Tier I Effects Information

5.1.1 Honey bees

Twenty-seven effect studies were conducted on individual honey bees and submitted to the PMRA by the registrant. In addition to registrant sponsored studies, 26 studies relevant to the toxicity of imidacloprid and its transformation products were reviewed from the open literature. The most relevant endpoints for imidacloprid were selected for the risk assessment considering the strengths and limitations of each study.

Considering the Tier I acute toxicity data from both the open literature and registrant studies it was determined that imidacloprid is highly toxic to adult honey bees via acute oral and contact exposure routes (registrant study LD_{50} endpoint range: 0.043 to 0.104 µg a.i./bee for contact exposure and 0.0038 to 0.081 µg a.i./bee for oral exposure; open literature LD_{50} endpoint range: 0.013 to 0.24 µg a.i./bee for contact exposure and 0.0037 to 0.536 µg a.i./bee for oral exposure). The most sensitive endpoints from the registrant studies were selected considering the strengths and limitations of all the studies.

Considering the Tier I chronic data from both the open literature and registrant studies it was determined that chronic exposure to imidacloprid adversely affects adult honey bees. Multiple 10-day adult oral toxicity studies were reviewed and the NOEL varied widely from <0.001 to 2.8 ng a.i./bee/day by dose, or from <0.1 to >100 µg a.i./L by concentration. The wide variation appeared to be related in part to the amount of food consumed by the bees and the age and caste of bee tested. Considering all available 10-day chronic exposure studies for honey bee adults, an endpoint of 3.9 µg/L in feeding solution, estimated to be 0.16 ng/bee/day, appeared to be a reasonable and conservative NOEC/NOEL for the adult chronic exposure study. Therefore, this endpoint from the open literature was chosen to conduct the Tier I risk assessment for pollinators.

Considering the Tier I chronic data from an available registrant study, it was determined that chronic exposure of bee larvae to imidacloprid at concentrations up to 40 µg a.i./kg diet (actual intake of 1.8 ng a.i./bee/day) did not adversely affect adult emergence.

Considering the Tier I acute oral data on imidacloprid transformation products from both the open literature and registrant studies it was determined that 5-hydroxy imidacloprid and olefin are toxic to adult honey bees on an acute oral basis. The risk assessment will not include an assessment of the imidacloprid transformation products urea-imidaclorpid and 6-chloronicotinic acid because the acute oral LD_{50} values for adult honey bees were all greater than 100 µg a.i./bee which would classify them as relatively non-toxic according to the classification scheme of Atkins et al. 1981. In addition as no significant acute adult mortality was observed with 4,5-dihydroxy-imidacloprid and desnitroimidacloprid in the range of doses tested, these transformation products were not included in the risk assessment. The toxicity of the transformation products are expected to be covered off by the risk assessment for the parent, imidacloprid.

Table 1 of Appendix IV summarises the toxicity endpoints which were selected for use in the Tier I risk assessment for honey bees.

5.1.2 Non-*Apis* bees

Tier I imidacloprid adult acute oral and contact laboratory toxicity data from registrants and from the open literature were reviewed for bumble bees (*Bombus terrestris*, *B. impatiens*), mason bees (*Osmia cornifrons*, *O. lignaria*), the alfalfa leafcutting bee (*Megachile rotundata*) and stingless bees (*Melipona quadrifasciata*, *Nannotrigona perilampoides*). It is noted that standard test protocols are not currently available for non-*Apis* bees. Imidacloprid is toxic to adult non-*Apis* bees via oral (LD_{50} range: 0.0046 – 0.15 μg a.i./bee) and contact (LD_{50} range: 0.001 – 0.66 μg a.i./bee; one study at 85.3 μg a.i./bee) exposure routes. The range and toxicity of non-*Apis* endpoints is similar to the honeybee Tier I endpoints: oral (LD_{50} range: 0.0037 – 0.536 μg a.i./bee) and contact (LD_{50} range: 0.013 – 0.24 μg a.i./bee). No toxicity endpoints were available for non-*Apis* larvae at this time. Overall, the toxicity information available suggests that the acute toxicity of imidacloprid to honey bees is similar to non-*Apis* bees.

Based on the similarity in adult acute oral and contact toxicity, honey bee effects information is considered an adequate surrogate for non-*Apis* bees for the Tier 1 risk assessment. It is noted that dietary exposure is also expected to be similar between honey bee and non-*Apis* bees based on similarity of food consumption rates, further supporting use of honey bee as a surrogate for non-*Apis* bees in the Tier I risk assessment. Therefore, Tier I non-*Apis* effects information will not be used to estimate specific risk quotients for non-*Apis* bees at this time, as methods have not been standardized and it is expected that honey bees are an adequate surrogate for non-*Apis* bees.

Table 2 of Appendix IV summarises the toxicity endpoints available for non-*Apis* bees. While they will not be used specifically in the risk assessment, they are provided to allow comparison with honey bee Tier I endpoints.

5.2 Tier II Effects Information

Tier II effect studies are colony studies conducted under confined conditions and/or artificial feeding conditions with either commercial or modified small hives. There are two types of Tier II effect studies, colony tunnel studies and colony feeding studies. Colony tunnel studies are conventionally conducted in confined tents or tunnels, where crops may be treated using specific application methods. In colony feeding studies, hives are fed with either sugar solution, pollen/pollen substitute, or both, with known amounts of test chemicals under open field or confined tunnel conditions. These two different types of feeding studies are referred to as either open or closed feeding studies.

Honey bees: Thirty-four Tier II studies were available and reviewed. Data that was reviewed with colony tunnel study designs (15 studies; 11 from the registrant and four published studies) examined colony effects for specific application methods under confined conditions. Data that was reviewed with colony feeding study designs (19 studies; 6 from the registrant, 9 published studies and 4 other datasets that were represented by both registrant and sometimes more than one open literature publication) investigated the effects after hives were fed pollen and/or sucrose solutions containing known amounts of imidacloprid.

Non-Apis bees: Nine published articles containing Tier II studies were available and reviewed. Among these studies, the majority were conducted with bumble bees; only one was conducted using an orchard mason bee. One article with Tier II tunnel studies contained bumble bee data from a foliar application trial and a soil treatment trial (Gels et al., 2002) and another article contained bumble bee data from both a Tier II and Tier III seed treatment tunnel and field trial, respectively (Tasei et al., 1999; PMRA 2142738). The remaining seven journal articles were all classified as Tier II feeding studies, and included closed feeding protocols with spiked pollen on orchard mason bees (Abbott et al., 2008) or bumble bees (Morandin and Winston 2003) and spiked sucrose on bumble bees (Laycock et al., 2012), as well as open feeding protocols with spiked pollen and sucrose exposure on bumble bees (Feltham et al., 2014; Whitehorn et al., 2012) or only spiked sucrose feeding on bumble bees (Gill et al., 2012, and Gill and Raine, 2014). Studies generally had observation periods of up to 30 days. Potential longer-term effects beyond 30 days were not addressed in the available Tier II or III studies.

5.2.1 Summary of Tier II tunnel studies

5.2.1.1 Honey bees

A total of 15 tunnel studies were reviewed and considered. The majority of these studies (14 studies; 11 from the registrant and 3 published studies) were conducted to examine potential effects that may result from seed treatments. One study provided limited information for foliar applications, but the study was conducted with low rates that do not represent the Canadian use patterns for foliar applications.

Seed Treatment:
The tunnel studies investigating the effect of seed treatments on honey bee colonies were conducted on test crops including summer rape, winter rape, canola, maize, sunflower, and field bean. In these studies, tents were placed on test plots when crops started flowering. Hives were confined in the tents for a short period of 3-24 days, with about 10 days for the majority of studies. Most of these studies had no true treatment replicates except for one (PMRA 2364429) in which there were two replicates. Small honey bee hives were used in these studies, except for (PMRA 2351140) in which commercial hives were tested. During the study, hives were observed in the tents except in PMRA 2364427, where the observation period was extended for 10 days after the tent was removed. In these studies, lethal effects to adult bees were estimated by counting the number of dead bees in front of hives and sometimes also at the edge of the tunnel.

During the course of these studies, multiple observations were recorded on hive conditions, such as pollen and nectar stores in the hives, hive weight, colony strength, the number of eggs, open brood, and capped brood in hives and on flower visits (measured as the number of bees observed per square meter). In general, no effects were observed on any of these measurement parameters in the majority of seed treatment studies.

Seed treatment rates used in these studies were typically relevant to the Canadian use pattern. Further details regarding the results of the relevant seed treatment tunnel studies are discussed as part of the higher tier risk characterization.

5.2.1.2 Non-*Apis* bees

Foliar and soil granular application (turf):
One study investigated the effects from foliar spray or granular in-furrow applications to turf containing 25 – 50% white clover forage (Gels *et al*., 2002). Overall, no short-term effects (up to 30 days) were detected on *Bombus impatiens* colonies foraging on turf fields that were treated with spray application of imidacloprid at 336 g a.i./ha or granular application at 448.3 g a.i./ha immediately followed by irrigation. However, effects were detected when the foliar application was not followed with irrigation.

The Canadian use pattern has similar foliar and soil granular turf applications at a lower rate of 280 g a.i./ha which require rainfall or irrigation after application.

Seed treatment:
No treatment related effects on foraging (number and duration of visits to flowers) were seen over an exposure period of 3 days in bumble bee colonies exposed to potted sunflower plants grown in a greenhouse from treated sunflower seed (0.7 mg imidacloprid/seed). Residue analysis was not conducted on sunflower pollen or nectar to measure residue exposure levels.

The Canadian use pattern does not include sunflower seed treatment; however, this study may be applicable for other seeds treated at similar rates and expected to have similar residue levels.

5.2.2 Summary of Tier II feeding studies

5.2.2.1 Honey bees

A total of nineteen studies with colony feeding study designs were considered. The test hives were artificially fed with known amounts or concentrations of spiked sugar solution and/or pollen patties in either enclosed or open fields. Six of these studies were submitted by the registrant, nine were from published articles and four represented datasets that were from both the registrant and from one or more open literature publication.

A total of six of these studies were conducted in enclosed tunnels where bees were excluded from foraging on natural food sources. Two of the studies fed honey bee colonies pollen collected from maize plants grown from treated seed, one had hives fed with spiked maize pollen patties and the remaining three studies examined effects from being fed spiked sugar solution or honey.

Overall, the enclosed Tier II feeding studies showed that maize pollen grown from treated seed has no short-term effects on honey bee colonies. However, feeding hives with spiked sunflower honey at 20 µg a.i./kg of imidacloprid for 39 days may result in reduced pollen consumption, and hive honey storage, and at 25 ppb in sucrose solution exposure, less sucrose syrup may be consumed.

Thirteen feeding studies were conducted in the open field, where bees were allowed to forage freely in the test field. Two studies tested the effects with spiked pollen only (PMRA 2142798 which was also reviewed under Dively et al. 2009, Pettis et al. 2012, and Dively et al. 2015); nine studies tested the effects with contaminated sugar solution only (PMRA 1086429 which was also reviewed under Cure et al. 1999, and PMRA 2142777 which was also reviewed under Yang et al. 2008, PMRA 2463188, Belien et al. 2009, Bortolotti et al. 2003, Faucon et al. 2005, Lu et al. 2014, Schneider et al. 2012 and Tan et al. 2014), one study tested the effects of feeding hives with contaminated pollen and nectar separately in the same study (PMRA 2270894) while part of the Dively et al. 2015 article also examined the different exposure routes; and another tested the effects of feeding hives with both contaminated pollen and sugar at the same time (PMRA 2270888). Out of all of these feeding studies, two were selected for the Tier II risk assessment based on the relevance, completeness and the quality of the data. The registrant submitted feeding study PMRA 2463188 was selected for the nectar exposure route risk assessment and the Dively et al. 2015 was selected for the pollen exposure route risk assessment.

In the open colony feeding study selected for the risk assessment with pollen, multiple colony parameters were measured such as foraging, hive strength, brood development, food storage, pollen collection, food consumption, queen cells, disease levels, and overwintering success. Honey bee hives fed contaminated pollen at 5 and 20 µg/kg (ppb) for 9-12 weeks did not demonstrate any treatment effects at the colony level. Some effects were observed on hives fed pollen with imidacloprid concentrations of 100 ppb, though these effects were not consistent across multiple years. While no differences on measured colony parameters (such as colony strength, brood, food storage, and food consumption) were observed prior to overwintering in any year, there was a trend for increasing queen supersedures and *Varroa* mite infestation level with increasing concentration, and overwintering success was significantly lower than controls at 100 µg/kg in one year of a two year study. The pollen feeding dose of 100 ppb is considered to be the lowest observed effect level for 9 – 12 weeks of pollen feeding exposure based on effects observed in some years of a study. While the pollen feeding dose of 20 ppb is considered a no observed effect level for 9 – 12 weeks of pollen feeding exposure, it is noted that there is wide dose spacing between 20 ppb (NOEL) and 100 ppb (LOEL), and the effects observed at 100 ppb were not consistent in all years. Therefore, there is some uncertainty associated with this pollen feeding NOEL and LOEL in the risk assessment.

In the open colony feeding study selected for risk assessment with sucrose solution, multiple colony parameters were measured such as foraging, hive weight, number of individuals at different life stages in hive, hive honey and pollen stores, disease levels, and hive overwintering survival. Feeding honey bee hives with sugar solution containing imidacloprid at a dose of 25 µg/L (23.3 ppb (µg/kg)) and lower for six weeks showed no colony level effects after overwintering; some transient effects at the colony level were detected about one month after the end of the six week exposure period but colony condition was comparable to control colonies after overwintering. Imidacloprid at 50 µg/L (46.7 ppb (µg/kg)) and greater resulted in reduced hive conditions compared to control after overwintering, and imidacloprid at 100 µg/L (96.3 ppb) and greater, resulted in a reduction of the hive overwintering survival rate. The NOEC and LOEC for this study were determined to be 25 (23.3 ppb) and 50 µg/L (46.7 ppb), respectively, after weighing biological significance and the natural seasonal changes of honey bee colonies, as well as supporting conclusions from the statistical analysis. In other colony feeding studies that tested sucrose solution, effects on foraging communications were seen at concentrations of 20 ppb and higher in spiked sugar solution in an open field test that showed the frequency of recruitment waggle dances was reduced, the frequency of tremble dances was increased, and the overall accuracy of the dances were diminished.

There is some uncertainty regarding how different exposure routes in colony feeding studies (pollen; nectar as simulated with sugar solution; or both pollen and nectar at the same time) may affect the observed colony level treatment effects and relate to natural exposures.

- In general, more nectar is consumed by the colony than pollen. Therefore, higher residue concentrations in pollen are required to result in the same total amount of imidacloprid taken up by the hive. For example in Dively et al., 2015, it took five times the imidacloprid concentration in pollen (100 ppb) as in nectar (20 ppb) to result in the same total amount of imidacloprid being taken up by the hive (40 µg imidacloprid per week). It can be expected that pollen feeding studies conducted at similar concentrations as nectar feeding studies may demonstrate fewer effects as less total imidacloprid is likely taken up by the hive.
- In the same Dively et al., 2015 study discussed above, the exposure route affected distribution of residues throughout the hive, and effects observed. With the same total amount taken up per week (40 µg imidacloprid per week), the pollen exposure route resulted in imidacloprid being detected in hive matrices at a higher level and at a higher frequency, and for longer durations than in the hives fed with the same total weekly amount of imidacloprid through spiked sugar solution. The hives exposed to imidacloprid through pollen also had 14–26% fewer frames of adult bees when compared to the hives exposed through sugar solution by the end of the exposure period, but this difference was not seen 6 weeks after the exposure period concluded. The study demonstrated that exposure route had an effect on where and at what levels residues were distributed in hive matrices, and on the effects observed, as further discussed below.
- Various feeding studies showed that provision of residues in either pollen or nectar resulted in distribution of residues throughout hive food matrices (such as hive nectar, bee bread and royal jelly) at varying concentrations. This may be consistent with bee biology in that bees collect and process nectar and pollen into different hive foods. These hive foods contain varying amounts of pollen and nectar and associated residues, and are

consumed in different amounts by different bee stages. The source of residues (pollen or nectar) is expected to affect how residues are distributed among hive foods, and therefore which bee stages are most highly exposed. This could affect the types of effects observed on the colony.

- Providing pollen or nectar as the residue exposure route could affect colony behaviour by reducing the need to forage outside the hive for pollen or nectar, respectively. If foraging success is impaired by residue exposure, the provision of pollen or nectar could mask effects associated with foraging success, such as quantity of pollen or nectar stores and hive development which relies on those stores.
- Since colony feeding exposure routes occur through experimentally supplied concentrations of pollen or nectar or both, there is uncertainty in how these relate to actual measured residue levels recovered in pollen and nectar. In the natural environment, there will be exposure to both pollen and nectar in varying ratios. Differences in experimental feeding concentrations and ratios could affect the distribution of imidacloprid in food matrices, exposure of different bee stages, and types of effects induced.

Overall, honey bee colony feeding effects studies have advantages as well as some uncertainties. One of the advantages of feeding studies is that they may allow establishment of dose-response relationships based on a known test concentration/dose and the effects observed. The open feeding studies can also be used to investigate chronic exposure and potential long-term effects of imidacloprid. However, it is noted that with open feeding studies, test hives are at risk of contamination that likely results from drift of bees, cross-foraging between hives, and pesticides used near the surrounding test sites. Contamination in control hives has been confirmed in almost all available open feeding studies, although at levels much less than the treatment groups. In most cases, the low level of contamination is not thought to affect the interpretation of the open feeding studies. Finally, as discussed above, there are a number of uncertainties regarding the impact of colony feeding exposure routes on observed effects, and how best to relate these exposures to potential exposures from pollen and/or nectar in the environment.

5.2.2.2 Non-*Apis* bees

Multiple colony feeding studies demonstrated that after exposure orally to non-*Apis* bees through pollen or sucrose solution, imidacloprid may result in reduced queen, worker, or brood production, reduced colony size, and reduced pollen foraging efficiency. The lowest dose where effects were detected was for imidacloprid tested on bumble bees in combination of 6 ppb in pollen and 0.7 ppb in sugar solution for an exposure period of 14 days, or 10 ppb in sugar solution alone for an exposure period of 28 days. A NOEL could not be established from the available information.

Based on the feeding study information, bumble bees appear to be more sensitive to effects from imidacloprid in pollen and/or nectar feeding solutions than honey bees. Studies generally had observation periods up to 30 days, and therefore the longer-term impact on bumble bee colonies is not known. As well, there is limited information at this time regarding the overall impact of observed effects on the growth, reproduction and survival of bumble bees and other non-*Apis* bees. Regarding exposures, as with honey bees, there is uncertainty in relating non-*Apis* feeding exposures to realistic exposures expected from field residues in pollen and nectar. Also, as was previously noted, there are additional recent non-*Apis* feeding studies and other information from the public literature that need to be reviewed and considered. New information is expected to improve understanding of potential impacts to non-*Apis* bees, and will be incorporated into the final pollinator risk assessment.

5.3 Tier III Effects Information

Tier III studies are colony studies conducted under actual pesticide use patterns to examine effects under field conditions. In many cases this type of study is also referred to as a field study.

Seventeen Tier III honey bee field studies were available and reviewed. Seed treatment effects were studied in 13 of the studies, one study investigated the effect of soil treatment and three others were categorized as field monitoring studies. One additional seed treatment study examined effects on bumble bees (Tasei et al., 1999).

5.3.1 Honey bees

Overall, the available Tier III effect studies on honey bees suggested that imidacloprid seed treatments at rates 1.4 mg a.i./seed and lower did not show remarkable short-term effects to honey bee colonies; in a few studies some minor effects on hive weight gain and foraging activity were observed during exposure, but were usually gone by the end of the exposure period. Overwintering effects after hives were exposed to imidacloprid seed treatments were examined in two studies by the same author; both indicated no treatment-related effects on overwintering success. It is noted that these studies were conducted in Argentina or Europe, which may have different overwintering conditions from Canada. There were no seed treatment field studies conducted in North America that examined overwintering effects.

5.3.2 Non-*Apis* bees

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

While the Canadian use pattern does not include sunflower seed treatment, this study suggests that effects on bumble bees are not expected from seed treatments that have similar pollen and nectar exposure levels.

5.3.3 Additional studies underway

Additional Tier III field studies are currently being conducted by the registrant. These studies are examining honey bee and bumble effects following exposure to soil applications in agricultural crops including pumpkin and cotton. Results from these field studies are expected in 2016, and will be incorporated into the final pollinator risk assessment. In addition any pertinent new studies from the open literature will also be considered.

6.0 Incident Reports

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

Two bumblebee incidents relating to the active ingredient imidacloprid were found in the PMRA database. One of these incidents occurred in the United States and was reported to both the USEPA and the PMRA. Bumblebees and carpenter bees died following an application of imidacloprid to linden trees via soil injection. In the second incident bumblebees died after foraging on an ornamental plant (lobelia) that had been treated with imidacloprid.

Many incidents involving honey bees and neonicotinoid insecticides were reported in Canada. Samples collected during the pollinator incident investigations from the corn and soybean growing regions in Canada demonstrated the presence of imidacloprid in hives and in the environment. Imidacloprid was detected mainly in comb pollen from 50 bee yards sampled during 2014 (42 of 161 samples collected) with levels ranging from < LOQ to 32 ppb. Detections of imidacloprid occurred throughout the summer season with the majority occurring from June through to September. The highest concentration was detected in August. The analysis of the information related to these incidents is on-going; however, given that imidacloprid is not widely used as a seed treatment for corn and soybean in Canada it is unlikely that these detections were associated with dust-off of imidacloprid during planting of corn and soybeans.

The USEPA Ecological Incident Information System (EIIS) contains 36 incident reports of adverse effects associated with the potential exposure to imidacloprid involving various pollinator species including butterflies, bumble bees, carpenter bees and unspecified bees with most incidents involving honey bees or likely honey bees. Primarily, bees died following exposure to imidacloprid in agricultural settings where a spray or soil treatment was used. Additionally, four cases of bumblebee death were reported following applications of imidacloprid to ornamental trees.

Seventeen of the 36 USEPA EIIS incident reports, included residue analyses of imidacloprid with detection in at least one matrix (dead bees, floral pollen, or nectar) had levels of imidacloprid as high as 2460 ppb in dead bees. Available incident reports covered almost all registered application methods, including spray applications, soil treatments, seed treatments and tree injections. The numbers of incidents associated with various application methods are summarized in Table 1.

Table 1 Number OF Incidents Reporting in the USEPA EIIS Involving Different Application Methods

Application method	Associated crops	Bloom	Country	Certainty	Total
Seed Treatment Total					**7**
Seed treatment	seed treated canola	unknown	United Kingdom	Probable	1
			United States	Possible	2
	seed treated corn	unknown	Slovenia	Probable	1
			United States	Unlikely	2
	seed treated sunflower	unknown	France	Possible	1
Soil Total					**11**
Chemigation	watermelons	unknown	United States	Possible	1
Soil drench	citrus trees	Yes	United States	Highly Probable	1
	linden trees	unknown	United States	Highly Probable	4
	orange orchard	unknown	United States	Highly Probable	1
	Rose	No	United States	Possible	1
Soil injection	garden	unknown	United States	Possible	1
	linden trees	No	United States	Highly Probable	1
Soil treatment	sweet pepper bushes	No	United States	Possible	1
Tree Injection Total					**2**
Tree Injection	Arbutus and Laurel trees	unknown	United States	Possible	1
	linden tree	unknown	United States	Highly Probable	1
Spray Total					**12**
Aerial	orange orchard	unknown	United States	Probable	1
Aerial and ground	cotton field	unknown	United States	Possible	1
Ground	holly tree	unknown	United States	Probable	1
	soybean	unknown	United States	Probable	2
Spray to tree	citrus trees	Yes	United States	Possible	1
	linden trees	No	United States	Probable	1
		Yes	United States	Highly Probable	1
	orange orchard	unknown	United States	Possible	1
				Probable	3
Unknown Total					**4**
Unknown	Apple	unknown	United States	Possible	1
	commercial flowers	unknown	United States	Probable	1
	unknown	unknown	United States	Possible	1
				Unlikely	1
Grand Total					**36**

7.0 Imidacloprid Pollinator Risk Assessment

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.

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

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

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

Acute and chronic risk estimates considered the amount of pesticide that could be ingested by relevant bee castes (*estimated daily dose value*). The **estimated daily dose value** for relevant bee castes is based on the refined acute or chronic EEC values from residue studies and the most conservative estimated food consumption rates for adult bees (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 crops where crop specific residue information was not available by using residues from available relevant crops.

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.

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.

For this pollinator risk assessment on imidacloprid, the PMRA has relied primarily on Tier II colony feeding studies for effect endpoints to use in the risk characterization based on the relevance, completeness and the quality of the data. There are uncertainties associated with the use of colony feeding studies for characterizing risk, however, the majority of these uncertainties are expected to result in conservative estimates of risk. These uncertainties, 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.

Uncertainties 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). As discussed in the effects section, 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 uncertain 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 uncertainties 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, may be unknown. There are uncertainties when residues are compared with the effect outcome of the feeding study in which hives were fed with imidacloprid at a consistent level during the entire exposure period.

- *Field exposure*
  The actual level of exposure to bees is expected to be a function of foraging activity of bees, the residue levels in crops and the bee-attractiveness of the crop. The measured residues in crop pollen and nectar may represent the potential level of exposure to bees, but they likely do not represent the actual level of exposure to bees. Honey bees may forage on certain crops more than others, and as demonstrated in multiple open field Tier II and III studies, honey bees forage on multiple plants. This observation indicates that the level of exposure to specific crops in the field may be diluted by other forage. Therefore, when the level of residues measured in plants is compared to effects information, the risk assessment approach is likely to be conservative.

- *Residues information compared to Canadian use pattern*
  The use patterns in available residue studies may be different from registered use patterns in Canada. Some residue studies may have higher test rates than Canadian registered rates, or include test crops that are not registered in Canada. At this time, extrapolation from other applications cannot be done, as there is no established correlation between residue levels and application rate, timing, or crop species. Differences in use patterns, including application rates, compared to available residue information adds uncertainty to the expected residue levels used in the 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 uncertainties associated with the field study, which are discussed in the Guidance for Assessing Pesticide Risks to Bees. The main limitation resulting in uncertainty 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.

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 uncertainties in the assessment.

7.1 Foliar Application Risk Assessment

The primary routes of exposure resulting from foliar application are considered to be through contact (to either the spray droplets during flight, or to residues which may be on the leaves following application as a result of direct spray or spray drift) and through oral exposure (i.e., consumption of contaminated pollen or nectar). As imidacloprid is systemic, translocation from leaves and soil through the plant into pollen and nectar may also occur. Therefore residues in pollen or nectar can result from directly spraying pollen and nectar, as well as through translocation. Contact exposure is mainly relevant for adult forager bees, while oral exposure is relevant for both adult bees (inside and outside the hive) as well as brood.

7.1.1 Tier I Screening Level Assessment for Foliar Application

A Tier I screening level assessment was conducted for foliar uses according to the Guidance for Assessing Pesticide Risks to Bees. This screening level assessment uses highly conservative estimations (default values) of pollen and nectar residue levels based on foliar application rates. The lowest and highest foliar application rates were considered for this assessment (highest: 281 g a.i./ha for use on turf; lowest: 24.4 g a.i./ha for use on soybean). Risk from spray drift was also considered in this assessment.

Based on the Tier I screening level assessment, all foliar uses and spray drift from those uses pose a potential risk to pollinators. Therefore, the potential risk will be further examined using higher Tier information.

7.1.2 Pollen and Nectar Residues for Foliar Application

Residue information related to foliar applications was drawn from studies conducted on cherry (post-bloom applications, PMRA 2486614), orange (pre-bloom applications, PMRA 2479562), cotton (applications pre-bloom in PMRA 2474499 and during-bloom in PMRA 2287070 and 2548345) and tomato (applications during-bloom, PMRA 2548347). Information on rotational crops was also available.

Clear relationships between residue levels and factors such as the application rate or the sampling time (number of days between the last application and sampling) could not be established using all the available data on foliar uses, although some relationships were observed within individual studies. For example, some studies showed a decline in residues with an increasing sampling time from the date of application. It should be noted that none of the studies were designed to compare these factors. Despite a lack of trends, it is expected that lower rates and longer application intervals before bloom would also result in lower residues in pollen and/or nectar.

When selecting residues relevant for the refined risk assessment, considerations such as the relevance of the studied application rate, application timing and crop type to labelled uses were taken into account. Overall, the available data for foliar applications was not highly representative of the Canadian use pattern.

The cherry residues were used to assess post-bloom applications to cherry trees as well as other stone fruit, recognizing the rate used in the study is much higher than Canadian label rates. Additionally, cherry residues were thought to be relevant for post-bloom applications on pome fruit and bee-attractive tree nuts, recognizing not only that the rates are higher than Canadian rates, but also that these trees are in a different crop group, and that there may be differences in the uptake and metabolism of residues. The orange study was thought to be less relevant to Canadian labelled crops than the cherry study. Cotton residues were used to represent pre-bloom and during-bloom foliar application to all seasonal agricultural crops. Cotton studies that were thought to be the most relevant for the risk assessment had only one application during-bloom (PMRA 2287070) or multiple pre-bloom applications (PMRA 2474499) and the timing of the sampling did not capture directly sprayed flowers. Residues may therefore be higher in Canadian crops sprayed during the blooming period than would be expected based on the cotton residues. While the above cotton studies do not address multiple applications during-bloom on seasonal agricultural crops, other studies on cotton and tomatoes suggest that multiple during-bloom applications would result in higher residue levels than a single during-bloom application. Because these studies included a soil application and foliar applications during the same growing season, which complicates the interpretation of the results for the risk assessment on foliar uses, residues from these studies will initially be used only in discussion rather than for risk quotient calculations.

Differences in plant uptake and metabolism as well as flower structure and duration of the flowering period are expected to affect residues among agricultural crops. The available residue data was used to the extent possible to estimate potential residues in labelled crops despite possible differences between different crop groups or within crop groups. As more information becomes available, residue estimates may be updated.

7.1.3 Tier I Refined Risk Assessment for Foliar Application

Risk estimates from foliar applications were based on field residues from cherry, cotton and orange, as well as clover as a rotational crop following foliar applications. When residues specific to a registered crop were not available, all residue data were considered for relevance based on the similarity of the crop type, application rate and application timing to the registered use pattern. The attractiveness of registered crops and level of exposure expected was also taken into consideration in the risk assessment.

The results of the refined risk assessment for foliar applications using residue values from relevant residue information are presented in Tables 1 and 2 of Appendix V for imidacloprid and Table 1 of Appendix VI for the transformation products.

Summary of the Tier I Refined Foliar Risk Assessment

- The refined Tier I foliar risk assessment indicates that there is a potential for acute and chronic dietary risk to adult bees and bee brood in all registered crops that are bee attractive. This potential for risk was indicated regardless of whether the foliar application was made pre-bloom, during-bloom, or post-bloom.
- Risk estimates based on nectar and pollen residues from cherry trees (CG 12: Stone fruit) are considered relevant for cherry and other registered stone fruit crops. Risk estimates in cherry are also potentially relevant for other orchard tree crops including pome fruit (CG 11) and tree nuts (CG 14). The application rate (conducted post-bloom) in the cherry residue study is approximately twice the registered rates for stone fruit and pome fruit, both in terms of the single and seasonal application rates. It is thus recognized that the selected residue concentrations may be overly conservative for the risk assessment on orchard crops.
- Based on cherry (CG 12: Stone fruit) residue information, there was some indication that post-bloom application timing may affect the potential for risk to bees in orchard and tree crops. A potential acute risk to adults and chronic risk to larvae were indicated with post-harvest application timing but not pre-harvest application timing. This suggests a longer

time period between the post-bloom application and the next season's bloom may reduce residue levels, and thus reduce risk. However, a potential chronic risk to adult bees was indicated with both pre- and post-harvest post-bloom application timing.

- Based on cotton residue information, pre-bloom and during bloom foliar application to seasonal agricultural crops may pose a potential risk to adults and brood. The cotton residues are expected to be a lower-end estimate of residues resulting from during-bloom foliar applications. This is because there was only one during-bloom application, and residues were likely not collected from directly sprayed flowers given the sampling time. Therefore, although cotton is not a crop grown in Canada, during-bloom foliar residues on seasonal agricultural crops are expected to be similar or higher to that of cotton, and are therefore expected to pose a potential risk to bees.
- A potential for chronic dietary risk to adult forager bees was indicated in rotational crops (clover) following a foliar application with imidacloprid the preceding year. No potential for risk was indicated for adults on an acute basis, or for larvae.
- No risk to adult bees is indicated from dietary exposure to the transformation products hydroxy-imidacloprid and olefin following foliar spray applications for all registered crops.

Uncertainties for Foliar Application

- It is recognized that there could be differences in the plant uptake and metabolism of imidacloprid due to differences among plants in different crop groups or within crop groups. The available residue data was used to the extent possible to estimate potential residues in labelled crops, based on potential similarities in crops, application rates and timing. As more information becomes available, residue estimates may be updated.
- No clear relationship was seen in the available residue information between application rate and timing and the residue levels, although it is noted that available studies were not designed to determine these relationships. Therefore there is further uncertainty when selecting available residue information to estimate risk in other crops not represented by the data.

Overall Tier I Refined Risk Assessment Conclusions for Foliar Application

Overall, the Tier I refined assessment, based on available residue information, indicates the potential for risk from foliar applications to bee-attractive crops applied pre-bloom, during-bloom or post-bloom. Minimal risk is expected for crop groups 1 (root and tuber vegetables), 2 (leaves of root and tuber vegetables), 4A (leafy vegetables) and 5 (brassica leafy vegetables) which are typically harvested before bloom and therefore no exposure to pollen and nectar is expected unless the crop is grown for seed, which generally does not occur in Canada. The assessment of higher tier studies is required to further assess the acute and chronic risk to bee colonies from foliar applications with imidacloprid.

7.1.4 Tier II and III Risk Characterization for Foliar Application

Tier II Risk Characterization for Foliar Application

Tunnel Studies

No honey bee tunnel studies were available except for one in which foliar spray application rates were 14 g a.i./ha and less and bees were observed for a 4 day period (Schnier et al., 2003). Foraging activity was temporarily reduced at higher concentrations, but no increased mortality was observed. These test rates are much lower than any Canadian labelled rates, thus, the study does not represent typical exposure scenarios for foliar applications in Canada and was not further considered for the risk assessment.

There was a bumble bee tunnel study available using a foliar application to turf that is relevant to the Canadian use pattern. This study examined effects from foliar application to turf containing 25 to 50% white clover forage. Overall, no effects (up to 30 days) were detected on bumble bee colonies foraging on turf fields that were treated with foliar application of imidacloprid at 336 g a.i./ha immediately followed by irrigation. However, effects were detected when the foliar application was not followed with irrigation. The Canadian use pattern has a similar foliar turf application at a lower rate of 280 g a.i./ha which requires rainfall or irrigation after application. Because irrigation is required on the label, effects to bees are not expected from the Canadian foliar turf application based on this tunnel-study information.

Honey bee Colony Feeding Studies

Effect endpoints from the honey bee colony feeding study were compared with crop specific residue information. For comparison with nectar residue values, the sucrose solution colony feeding study NOEL of 25 μg/L (23.3 ppb) and LOEL of 50 μg/L (47.6 ppb) were considered. For comparison with pollen residue values, the pollen colony feeding study NOEL of 20 ppb and LOEL of 100 ppb were considered. However, in the pollen study because there is wide dose spacing between the NOEL and LOEL treatment groups, and because there were inconsistent effects observed at the LOEL among different years, it is expected that the true NOEL is likely higher than 20 ppb, and there is less confidence overall in the effects values for pollen. In comparing residues to the pollen study NOEL, there is a large degree of uncertainty regarding the potential for risk. Because effects at the LOEL were inconsistent between years, there is also uncertainty regarding the potential for risk at residues at or above the LOEL. At this time, the LOEL will be considered in the risk characterization for pollen.

In comparing the colony feeding study effect endpoints to the available measured residues for a particular crop, a potential for risk was indicated when either the pollen or nectar residues levels were greater than the effects endpoint for pollen or nectar, respectively.

As shown in Table 1 of Appendix VII, the comparison between colony level effects and residues indicates the potential for chronic risks to honey bees with during-bloom and pre-bloom foliar applications, but not for some post-bloom applications.

- Post-bloom application timing may affect the potential for risk to orchard and tree crops. Based on cherry, no potential for risk was identified for colony level effects when post-bloom application was made earlier in the summer prior to harvest. Potential for risk at the colony level was still identified for cherry with a post-bloom application made after harvest, for pollen exposure only. It is noted that the cherry application rate is higher than Canadian application rates.
- Potential for risk was identified for during-bloom and pre-bloom application to cotton which was used to represent seasonal agricultural crops in Canada. Cotton is expected to represent a lower-end estimate of residues resulting from during-bloom foliar applications, as discussed previously. Therefore, although cotton is not a crop grown in Canada, during-bloom foliar residues on seasonal agricultural crops are expected to be similar or higher to that of cotton and are therefore expected to pose a potential risk to bees based on colony level effect endpoints.
- Pre-bloom applications are expected to pose a potential risk to honey bee colonies based on pre-bloom cotton applications, and pre-bloom citrus applications. While neither of these crops is grown in Canada, this is the only pre-bloom information available.
- Additionally no risk was indicated for rotational crops following foliar applications made in previous seasons, based on residue information from clover planted as a rotational crop.

Non-Apis Feeding Studies:

Multiple artificial feeding studies demonstrated that after non-*Apis* bees are exposed orally to imidacloprid through pollen or sucrose solution, queen, worker, or brood production, colony size, and pollen foraging efficiency were reduced. The lowest dose where effects were detected was for imidacloprid tested on bumble bees in combination of 6 ppb in pollen and 0.7 ppb in sugar solution for an exposure period of 14 days, or 10 ppb in sugar solution alone for an exposure period of 28 days. A NOEL could not be established from the available information.

Based on this preliminary information, all residues from crops treated with foliar applications (pre-bloom, during-bloom or post-bloom) exceed the non-*Apis* endpoints identified. The residues from rotational crops following foliar-treated crops in the previous season do not exceed the non-*Apis* endpoints identified. It is noted that there is uncertainty regarding interpretation of the non-*Apis* colony effect endpoints, and additional information will be considered for the final pollinator risk assessment.

Tier III Risk Characterization for Foliar Application

No Tier III effect studies were available for foliar application.

Incident information for Foliar Application

Incident reports related to spray applications have been reported to the USEPA. The crops associated with these incidents included orange trees, cotton, soybean, holly trees and linden trees. Information reported to the USEPA indicated that in two of the incidents imidacloprid was applied during-bloom on citrus and linden trees. For the remaining spray incidents it is uncertain if the application occurred during the bloom period when bees would be actively foraging on these crops. Foliar spray applications made while bees are foraging on crops or when bees are nearby and spray drift could contact bees might be expected to result in bee mortalities. Applications and rates may be different from Canadian uses. There is prohibitive language regarding spraying during-bloom or when bees are actively foraging on Canadian labels.

7.1.5 Overall Summary of Foliar Application Risk Assessment

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

Applications during-bloom to bee-attractive crops are expected to pose a risk to bees. On the Canadian labels, there are restrictions either prohibiting or reducing applications to bee-attractive crops, thus minimizing the risk of during-bloom application.

Pre-bloom applications to bee-attractive crops may pose a potential risk to bees. There was minimal pre-bloom foliar application pollen and nectar residue information available. The pre-bloom information submitted by the registrant was for citrus and cotton, neither of which are grown in Canada. As well, the pre-bloom application rates used in these residue studies were higher than Canadian rates. Therefore, there is uncertainty regarding whether pre-bloom applications may pose a risk when using Canadian application rates on crops grown in Canada. However, a number of crops which are attractive to bees already have pre-bloom restrictions in addition to during-bloom restrictions.

For post-bloom applications, application timing may affect the potential for risk in orchard and tree crops. Based on cherry residue information, no potential for risk was identified for colony level effects when post-bloom application was made earlier in the summer prior to harvest. When application was made post-harvest, however, a potential for risk was still identified at the colony level. The longer time period between application and the next season bloom may result in lower residue levels and lower potential for risk. It is noted that the cherry application rate is higher than Canadian application rates, adding uncertainty to the residue levels expected with Canadian rates. Furthermore, the duration of bloom for orchard crops is typically 2 – 3 weeks, which is shorter than the exposure duration for the colony effects study (6 weeks or longer). Overall, the risk estimation for post-bloom application to orchard crops is expected to be conservative (protective) for honey bees, considering the higher application rates and shorter expected exposure duration.

For post-bloom applications on other perennial crops, such as those in crop Group 13: Small fruit and berries, there is uncertainty regarding potential for risk. There is no residue information available for post-bloom foliar application on perennial crops other than cherry, and trees may not be representative of perennial crops like bushberries. Information on risk from post-bloom soil applications (see section 7.2) on perennial crops in Crop Group 13 is likely informative regarding post-bloom foliar application as both exposures result in post-bloom systemic uptake of residues by plants, and indicates risk is not expected.

Post-bloom foliar applications on seasonal agricultural crops are not expected to pose a risk since there is no longer pollen or nectar for bee forage, and the crop is harvested at the end of the season.

No potential risk to bees was identified for rotational crops such as clover, that are grown following crops treated foliarly with imidacloprid in the previous season.

As previously discussed, bee-attractiveness must be considered in describing the potential for risk. Crops that are harvested prior to bloom, or do not produce pollen or nectar that is attractive to bees are not expected to pose a risk to bees.

Crops currently labelled for foliar uses are listed below along with their risk characterization and considerations. It is noted that where no specific crop group information is available, there is greater uncertainty in the risk characterization.

Table 2 Summary of Foliar Application Risk Characterization for Registered Crops in Canada

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations
Orchard and Tree crops			
Crop Group 11: Pome fruit	All CG11 attractive to pollinators 2- 3 week bloom period Only post-bloom application allowed	Risk description based on CG 12 residue information (post-bloom applications). Overall risk description: • Potential risk depends on application timing. Earlier post-bloom application reduces risk. • Risk not expected for earlier post-bloom application timing (pre-harvest) • Potential risk for later post-bloom application timing (post-harvest)	• Uncertainty regarding residues - No specific CG11 residue information - Based on cherry (CG 12) • Application rate on cherry higher than Canadian rates (twice as high) • Bloom time shorter than colony feeding study exposure duration. - CG11: 2 to 3 week bloom duration ; CFS exposure duration (6 week nectar; 9 – 12 week pollen) Overall, risk estimation expected to be conservative as residues are based on rates higher than Canadian application rates, and CG11 bloom time is shorter than duration of exposure in the colony feeding studies; however, there is uncertainty

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations
			due to lack of specific residues information for CG11. Pome fruit (CG11) residue data expected for 2016; however, application is different from Canadian use pattern (study: soil application and two post-bloom foliar applications in same season).
Crop Group 12: Stone fruit	All CG12 attractive to pollinators 2-3 week bloom period Only post-bloom application allowed	Risk estimate based on specific residues for CG12 (cherry) Tier I (individual bees): • Potential risk from post bloom application • Reduced potential for risk with earlier post-bloom application timing (pre-harvest) Tier II (colony level): • Risk may depend on application timing • Potential risk later post-bloom application timing (post-harvest) • Risk not expected for earlier post-bloom application timing (pre-harvest) • No tunnel study or field study information for specific applications Overall risk description: • Risk potential depends on application timing. Earlier post-bloom application timing reduces risk. • Risk not expected for earlier post-bloom application timing (pre-harvest) • Potential risk for later post-bloom application timing (post-harvest)	• Relevant CG residues available - Based on cherry (CG 12) • Application rate on cherry higher than Canadian rates (twice as high) • Bloom time shorter than colony feeding study exposure duration. - CG13: 2 to 3 week bloom duration ; CFS exposure duration (6 week nectar; 9 – 12 week pollen) Overall, risk estimation expected to be conservative as residues are based on rates higher than Canadian application rates, and CG12 bloom time is shorter than duration of exposure in the colony feeding studies.

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations
Crop Group 14: Tree nuts and pistachio	CG 14 has variable attractiveness to pollinators A low acreage of tree nuts which are attractive to bees are grown in Canada. Estimated 2- 3 week bloom period Do not apply immediately prior to bud opening or during bloom or when bees are actively foraging.	Risk description based on CG 12 residue information (post-bloom applications), and pre-bloom residues from citrus. Overall risk description for bee-attractive crops in CG14: Pre-bloom application • May pose risk Post-bloom application • Risk potential depends on application timing. Earlier post-bloom application timing reduces risk. • Risk not expected for earlier post-bloom application timing (pre-harvest) • Potential risk for later post-bloom application timing (post-harvest)	• Uncertainty regarding residues - No specific CG14 residue information - Based on cherry (CG 12) for post-bloom - Based on citrus for pre-bloom • Application rates used in residue studies for cherry (post-bloom) and citrus (pre-bloom) are higher than Canadian rates (twice as high). • Bloom time shorter than colony feeding study exposure duration. - CG14: estimated 2 to 3 week bloom duration ; CFS exposure duration (6 week nectar; 9 – 12 week pollen) Overall, risk estimation expected to be conservative as residues are based on rates higher than Canadian application rates, and CG14 bloom time is shorter than duration of exposure in the colony feeding studies; however, there is uncertainty due to lack of specific residues information for CG14.
Christmas trees	Negligible pollinator attractiveness	Minimal potential for exposure as Coniferous Evergreens (arborvitae, pines, boxwood, balsam fir, spruce, juniper, Christmas trees) are not attractive to pollinators. Negligible risk	None identified

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations
Agricultural crops and other uses			
Crop Group 1: Root and Tuber Vegetables	Variable pollinator attractiveness Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada	Typically harvested before bloom. Exceptions: • Potato- not considered attractive to most pollinators • Sweet potato- label restrictions do not allow application during-bloom Minimal potential for risk.	None identified
Crop Group 2: Leaves of root and tuber vegetables	Variable pollinator attractiveness Typically harvested before bloom	Minimal potential for exposure as harvested before bloom. Minimal potential for risk	None identified
Crop Group 4A: Leafy greens subgroup of CG4 leafy vegetables (except Brassica)	Minimal pollinator attractiveness Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada	Minimal potential for exposure as harvested before bloom, and minimal pollinator attractiveness. Minimal potential for risk.	None identified
Crop Group 5: Brassica leafy vegetables	Variable pollinator attractiveness- includes highly attractive crops Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada	Minimal potential for exposure as harvested before bloom. Minimal potential for risk.	None identified

Labelled crop	**Exposure**	**Potential for risk**	**Uncertainties / Considerations**
Crop Group 6: Legume vegetables	Variable pollinator attractiveness Variable bloom periods Label does not allow application to flowering crops if bees are visiting the treatment area.	Risk description was based on considering residue information from cotton (pre-bloom and during-bloom applications). Cotton was used to represent residues for pre-bloom and during-bloom application to agricultural crops. Overall risk description for bee-attractive crops in CG6: • Potential risk for pre-bloom and during-bloom applications • Label reduces potential for risk	• Uncertainty regarding residues - No specific CG6 residue information - Based on residues for cotton (pre-bloom; during-bloom) • Foliar application rates used for residues were higher than pre-bloom Canadian rates, and representative of a single during-bloom application. • Bloom time may be shorter than colony feeding study exposure duration for some crops. • Only some CG6 crops are bee-attractive Overall, risk estimation expected to be conservative as residues are based on rates higher than Canadian rates for pre-bloom applications, bloom time is likely shorter than duration of exposure in the colony feeding studies. There is uncertainty due to lack of specific residues information for CG6.
Crop Group 8: Fruiting vegetables (except cucurbits)	All CG8 attractive to pollinators (not attractive to honey bees; attractive to bumble bees and other species) Indeterminate blooming periods Label does not	Risk description was based on considering residue information from cotton (pre-bloom and during-bloom applications). It is noted that CG8 tomato residue information was available for multiple applications during-bloom following a soil application. While this is not a Canadian use pattern, the information supports use of cotton as a lower-end estimate of residues for during bloom application, and suggests multiple during-bloom applications will result in higher residues.	• Uncertainty regarding residues - Residues available for CG 8 tomatoes (during-bloom), but expected to be overestimate as multiple foliar applications followed a soil application - Determination based on residues for cotton (pre-bloom; during-bloom) • Foliar application rates used for residues were representative of Canadian rates.

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations
	allow application to flowering crops if bees are visiting the treatment area.	Cotton was used to represent residues for pre-bloom and during-bloom application to agricultural crops. Overall risk description for CG8: • Potential risk for pre-bloom and during-bloom applications • Label reduces potential for risk	• Bloom time (indeterminate blooming throughout season) relevant for colony feeding study exposure duration (6 weeks or longer). Overall, risk estimation expected to be representative, with uncertainty associated with the residues information for CG8.
Crop Group 13: Small Fruit and Berries (Registered Subgroups 13A Caneberry 13B Bushberry 13F Berry and small fruit vines including grapes 13G Low growing berry	Many CG13 attractive to pollinators Variable blooming periods. Some strawberry varieties have indeterminate blooming. Some crops are perennials, some are seasonal. Label restrictions: 13A: Post-bloom applications only 13B: Do not apply immediately prior to bud opening or during-bloom Highbush blueberry: Post-bloom application only 13F, 13G: No application to	Risk description was based on considering residue information from cotton (pre-bloom and during-bloom applications) as well as cherry (post-bloom). Additionally, soil application to blueberry may potentially be relevant for post-bloom application timing. The available residue information may not be relevant for CG13 foliar applications, thus risk characterization is uncertain. Overall risk description for bee-attractive crops in CG13: • Foliar pre-bloom applications may pose potential risk, based on limited information. Some crops allow only post-bloom application. • During-bloom applications may pose potential for risk. Some crops allow only post-bloom application. • It is uncertain whether post-bloom foliar applications to perennial crops may pose potential risk. Risk is expected to be reduced with longer time period between application and next seasons bloom period. • Label reduces potential for risk	• Uncertainty regarding residues - Determination based on residues for cotton (pre-bloom; during-bloom). • Foliar application rates used for residues were representative of or higher than Canadian rates. • Bloom time variable. Typically shorter bloom time than colony feeding study duration (6 weeks or longer), but some strawberries have indeterminate blooming throughout season. Overall, risk estimation expected to be representative to conservative, with uncertainty associated with the residues information for foliar application on CG13.

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations
	flowering crops if bees are visiting the treatment area.		
Crop Group 19: Herbs	Most are pollinator attractive Variable bloom times Label does not allow application to flowering crops if bees are visiting the treatment area or during bloom. For foliar-herbs: Apply post-bloom after bees have been removed.	Risk description considered residue information from cotton (pre-bloom and during-bloom applications). Overall risk description for bee-attractive crops in CG19: • Potential risk for pre-bloom and during-bloom applications • Label reduces potential for risk	• Uncertainty regarding residues - No specific residue information - Based on residues for cotton (pre-bloom; during-bloom) • Foliar application rates used for residues were representative of or higher than Canadian rates. Overall, risk estimation expected to be representative to conservative, with uncertainty due to lack of specific residues information.

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations

Hops, Peanut, Tobacco	Low pollinator attractiveness for tobacco and peanut
	
	Tobacco may be harvested before bloom.
	
	Label does not allow application to flowering crops if bees are visiting the treatment area.
		Minimal potential for exposure based on low attractiveness, harvest before bloom, and label mitigation.
		
		Potential risk for hops if applied pre-bloom or during-bloom based on residue information from cotton.
		
		Overall risk description for bee-attractive crops:
		• Potential risk for pre-bloom applications and for during-bloom applications
		• Label reduces potential for risk
			• Uncertainty regarding residues
			  - No specific residue information
			  - Based on residues for cotton (pre-bloom; during-bloom)
			• Foliar application rates used for residues were representative of Canadian rates.
			• Bloom time may be shorter than colony feeding study exposure duration.
			• Generally not considered bee-attractive
			
			Overall, risk estimation expected to be conservative, with uncertainty due to lack of specific residues information.

Turf	Pollinator attractive only if turf contains flowering plants (such as clover) that are bee attractive.
	
	Minimal exposure for turf on golf course or sod farms where few weeds present.
	
	Irrigation is required following application.
		Risk description considered residue information from cotton (pre-bloom and during-bloom applications). Additionally, a tunnel-study relevant for this application demonstrated effects without irrigation, but no effects when irrigation occurred after application. Rates were slightly higher than Canadian application rates.
		
		Overall risk description for turf containing bee-attractive flowers:
		• Minimal potential for risk. The current label restrictions requiring irrigation following application are expected to minimize risk.
			• Uncertainty regarding residues
			  - No specific residue information
			  - Based on residues for cotton (pre-bloom; during-bloom)
			• Tier II tunnel study available and relevant to Canadian use pattern.
			
			Overall, risk estimation expected to be relevant to Canadian application, given availability of tunnel-study.

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations
Rotational crops	Some rotational crops are bee-attractive Variable bloom times	Risk estimate based on specific residues for rotational crops. Tier I (individual bees): • Some potential for risk identified Tier II (colony level): • No potential for risk identified Overall risk description: • No potential for risk identified	• Relevant residues for a rotational crop were available (clover grown following cotton which had received multiple foliar applications the previous season). • Foliar application rates the previous season were representative of or higher than Canadian rates. Overall, expected to be a reasonable representation of risk from rotational crops following foliar applications to crops the previous season.

7.2 Soil Application Risk Assessment

The primary route of exposure from soil applied products is through the diet via systemic transport of pesticide residues (including parent and transformation products) from the soil into the pollen and nectar of the plant. For these application types, it is assumed that honey bees will not be directly exposed through contact because they are not expected to be present on the surface of the soil.

7.2.1 Tier I Screening Level Assessment for Soil Application

A Tier I screening level assessment was conducted for soil uses according to the Guidance for Assessing Risks to Bees. This screening level assessment uses conservative estimations of pollen and nectar residue levels based on a model estimating plant uptake from soil which considers application rate and chemical properties of imidacloprid.

Based on the Tier I screening level assessment, all soil treatment uses pose a potential risk to pollinators. Therefore, the potential risk will be further examined using higher Tier information.

7.2.2 Pollen and Nectar Residues for Soil Application

Residue information related to soil application of imidacloprid was available for approximately 20 studies with treatments on tomato (PMRA 2287073 and 2548347), cotton (PMRA 2548345), cucurbits (Dively and Kamel (2012); PMRA 2287080), potato (PMRA 2142736), strawberry (PMRA 2287084), blueberry (PMRA 2486615), citrus (PMRA 2287076; Byrne et al., 2013), apple trees (PMRA 2542286), horse chestnut (PMRA 2542283 and 2542288), several ornamental plants (various studies on serviceberry, dogwood, hibiscus and Rhododendron), as well as rotational crops (PMRA 2535897). Many soil application studies included tests in various soil types.

A general analysis of the data available for soil applications suggests a relationship between the residue concentrations measured in bee-relevant matrices and the application rate. In addition, soil type was shown to have an influence on residue levels. Residue concentrations were typically higher in coarse soil > medium soil > fine soil, thus indicating that uptake through the root system is greater in soils with a higher fraction of sand.

As was the case for the foliar studies, the relevance of the application rate, application timing and crop type to labelled uses was taken into account when selecting residues for the risk assessment. Other factors such as the interval between application and sampling and the soil type were also considered, as appropriate.

The most relevant residues for the preliminary assessment on soil applications included residues from studies on potato, cotton, citrus, tomato, cucurbits (cantaloupe, melon, pumpkin), blueberry, and strawberry, as well as rotational crops. These crops can be related to crops or crop groups listed on Canadian labels. For other labelled crops or crop groups, residues from available crops were selected to estimate the exposure to pollinators, recognizing the limitations of the data and that there could be differences in imidacloprid uptake and metabolism between different crops groups.

7.2.3 Tier I Refined Risk Assessment for Soil Application

Risk estimates from soil applications were based on field residues from studies on potato, cotton, tomato, cucurbits (cantaloupe, melon, pumpkin), blueberry, strawberry and citrus, as well as non-target plants off-field, and rotational crops following soil applications. When residues specific to a registered crop were not available, all residue data were considered for relevance based on the similarity of the crop type, application rate and application timing to the registered use pattern.

The attractiveness of registered crops and level of exposure expected was also taken into consideration in the risk assessment.

The results of the refined risk assessment for soil applications using residue values from relevant residue information are presented in Tables 3 and 4 of Appendix V for imidacloprid and Table 2 of Appendix VI for the transformation products.

Summary of the Tier I Refined Risk Assessment for Soil Applications

The refined Tier I risk assessment, based on residue values in nectar and pollen from various crops conducted at the high end of registered rates for the Canadian label, indicates a potential concern for pollinators from exposure to pollen and nectar from crops treated with soil applications of imidacloprid, from non-target plants off-field, and from some rotational crops grown in soil previously treated with imidacloprid.

- There is more risk when the rate is high in combination with application to coarse textured soils (sandy soils with less organic matter which may increase the bioavailability of imidacloprid for uptake and systemic transport by plants).
- No acute risk to adult bees is indicated from dietary exposure to the transformation products, hydroxy-imidacloprid and olefin following soil application with imidacloprid in any of the registered crops/crop groups.
- No dietary risk to bee larvae is indicated following soil application with imidacloprid in any of the registered crops/crop groups except for citrus. However, citrus is not a registered crop in Canada.
- The assessment of higher tiered studies is required to further assess the acute and chronic risk to bee colonies from soil applications with imidacloprid. Attractiveness of the crop to pollinators including *Apis* and non-*Apis* will also be considered in the overall assessment.

Uncertainties for Soil Application

- It is recognized that there could be differences in the plant uptake and metabolism of imidacloprid due to differences among plants in different crop groups or within crop groups. The available residue data was used as well as possible to estimate potential residues in labelled crops, based on potential similarities in crops, application rates and timing. As more information becomes available, residue estimates may be updated.
- For some crops, residues in only pollen or nectar were collected. In these cases there is uncertainty for residue levels in the uncollected pollen or nectar matrix.
- Target pollen or nectar collected from hives for residue analysis are most likely diluted because they become mixed with other types of pollen and nectar stored by the bees. Therefore hive collected pollen and nectar may not represent a conservative measure of risk.

Overall Tier I Refined Risk Assessment Conclusions for Soil Application

Overall, the Tier I refined assessment, based on available residue information, indicates a potential for risk from most soil applications, including crop applications, rotational crops, and off-field non-target forage plants. Higher application rates and an application timing that is closer to the blooming period result in higher pollen and nectar residue levels, and therefore greater potential for risk. The soil type also affects residue levels, with highest residues resulting from applications to coarse soils (soils with higher sand content), and lowest residues resulting in fine soils (soils with higher organic matter). Imidacloprid is likely more bioavailable in coarse soils where there is less organic matter available for becoming bound and unavailable for uptake by plants.

7.2.4 Tier II and III Risk Characterization for Soil Application

Tier II Risk Characterization for Soil Application

Tunnel Studies

There was a bumble bee tunnel study available using a granular in-furrow application to turf that is relevant to the Canadian use pattern. This study examined effects from granular in-furrow application to turf containing 25 to 50% white clover forage. Overall, no effects (up to 30 days) were detected on bumble bee colonies foraging on turf fields that were treated with soil granular in-furrow application of imidacloprid at 448 g a.i./ha immediately followed by irrigation. No effects were detected. The Canadian use pattern has a similar soil turf application at a lower rate of 280 g a.i./ha which requires rainfall or irrigation after application. Because irrigation is required on the label, effects to bees are not expected from the Canadian soil turf application based on this tunnel-study information.

Honey bee Colony Feeding studies

Effect endpoints from the honey bee colony feeding study were compared with crop specific residue information resulting from soil application. For comparison with nectar residue values, the sucrose solution colony feeding study NOEL of 25 ug/L (23.3 ppb) and LOEL of 50 ug/L (47.6 ppb) were considered. For comparison with pollen residue values, the pollen colony feeding study NOEL of 20 ppb and LOEL of 100 ppb were considered. However, in the pollen study because there is wide dose spacing between the NOEL and LOEL treatment groups, and because there were inconsistent effects observed at the LOEL among different years, it expected that the true NOEL is likely higher than 20 ppb, and there is less confidence overall in the effects values for pollen.

In comparing residues to the pollen study NOEL, there is a large degree of uncertainty regarding the potential for risk. Because effects at the LOEL were inconsistent between years, there is also uncertainty regarding the potential for risk at residues at or above the LOEL. At this time, the LOEL will be considered in the risk characterization for pollen.

In comparing the colony feeding study effect endpoints to the available measured residues for a particular crop, a potential for risk was indicated when either the pollen or nectar residues levels were greater than the effects endpoint for pollen or nectar, respectively.

As shown in Table 2 of Appendix VII, the comparison between colony level effects and residues indicates the potential for risks to honey bees for a number of soil applications.

- Potential for risk was identified for tomato at higher application rates (CG 8: Fruiting vegetables) and for strawberry in coarse soils (CG 13G: Low growing berries); strawberry grown in medium soils had much lower pollen residues and is not expected to pose a potential risk in contrast to strawberry grown in coarse soils. Only pollen residues were available for tomato and strawberry.

- No potential for risk was identified for crops such as melon and pumpkin (Crop Group 9: Cucurbit vegetables), as well as blueberry (CG 13B: Bushberry).
- Minimal risk is expected for bee-attractive crops in other registered crop groups, such as legume vegetables (CG 6) and herbs (CG 19).
- No potential for risk was identified for rotational crops or off-field bee attractive forage plants which could be exposed to runoff.
- Higher application rates, timing closer to plant blooming time appears to result in higher residue levels and increased exposure.
- Soil type also seems to affect residue levels. Crops grown in coarser soils (sandy soils, less organic matter) tended to have higher residues than those grown in medium or fine soils (higher organic matter). Increasing bioavailability and plant uptake is associated with decreasing soil organic matter.

Non-Apis Feeding Studies

Multiple artificial feeding studies demonstrated that after exposure orally to non-*Apis* bees through pollen or sucrose solution, imidacloprid may result in reduced queen, worker, or brood production, reduced colony size, and reduced pollen foraging efficiency. The lowest dose where effects were detected was for imidacloprid tested on bumble bees in combination of 6 ppb in pollen and 0.7 ppb in sugar solution for an exposure period of 14 days, or 10 ppb in sugar solution alone for an exposure period of 28 days. A NOEL could not be established from the available information.

Based on this preliminary information, most residues from crops treated with soil applications exceed the non-*Apis* endpoints identified. It is noted that there is uncertainty regarding interpretation of the non-*Apis* colony effect endpoints, and additional information will be considered for the final pollinator risk assessment.

Tier III Risk Characterization for Soil Application

No relevant Tier III effect studies were available for soil applications. The only available Tier III effect study for soil application was on a rotation crop planted three years after the treatment. It was considered that this study was not directly related to the soil treatment and was not used for the refinement at Tier III risk assessment.

Additional Tier III field studies are currently being conducted by the registrant. These studies are examining honey bee and bumble bee effects following exposure to soil applications in agricultural crops including pumpkin and cotton. Results from these field studies are expected in 2016, and will be incorporated into the final pollinator risk assessment.

Incident information for Soil Application

Incident reports related to soil application of imidacloprid have been reported to both the PMRA and the USEPA. The PMRA received a report of bumble bee mortality following foraging on an ornamental plant that previously had received a soil drench application of imidacloprid. The USEPA EIIS database contained incident information on soil application to various crops (watermelons, orange and citrus trees, linden trees, rose bushes, sweet pepper bushes and garden). Aside from one incident when it is known that the application occurred just as the trees were blooming the timing of application is either known to occur prior to bloom or it is unclear from the information available in the database. The incident information suggests that a potential risk to pollinators exists which is supported by the conclusion of the risk assessment.

7.2.5 Overall Summary of Soil Application Risk Assessment

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

The comparison between colony level effects and residues indicates the potential for risks to honey bees for tomato at higher application rates and for strawberry when grown in soils with a higher sand fraction; strawberry grown in medium soils had much lower pollen residues and is not expected to pose a potential risk in contrast to strawberry grown in coarse soils. There is some uncertainty around the tomato and strawberry risk estimates, as only pollen was collected from the plant. No potential for risk was identified for melon, pumpkin, blueberry, rotational crops or off-field bee attractive forage plants.

The Tier II risk assessment based on the selected colony feeding study endpoints is considered to be conservative. From the higher tier studies that measured and identified incoming pollen, honey bee hives did not collect high amounts of pollen from nearby crop species (i.e. blueberry, cranberry, cucumber, pumpkin and watermelon). This suggests that although the level of residues in the crops may be high, the level of natural exposure to a colony may be much lower based on foraging behaviour.

No risk was identified for turf soil uses as irrigation is required following application and is expected to mitigate potential risk. A relevant Tier II tunnel study on turf indicates that this practice adequately minimises risk to bees.

As previously discussed, bee-attractiveness must be considered in describing the potential for risk. Crops that are harvested prior to bloom, or do not produce pollen or nectar that is attractive to bees are not expected to pose a risk to bees.

Crops currently labelled for soil uses are listed below along with their risk characterization and considerations. It is noted that where no specific crop group information is available, there is greater uncertainty in the risk characterization.

Table 3 Summary of Soil Application Risk Characterization for Registered Crops in Canada

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations
Agricultural crops and other uses			
Crop Group 1: Root and Tuber Vegetables	Variable pollinator attractiveness Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada	Minimal potential for risk. Typically harvested before bloom. Exceptions: • Potato- not considered attractive to most pollinators • Sweet potato Overall risk description for bee-attractive crops: • Uncertain potential for risk	• Uncertainty regarding residues - No specific sweet potato residue information There is uncertainty due to lack of specific residues information for sweet potato.
Crop Group 2: Leaves of root and tuber vegetables	Variable pollinator attractiveness Typically harvested before bloom	Minimal potential for exposure as harvested before bloom. Minimal potential for risk	None identified
Crop Group 4A: Leafy greens subgroup of CG4 leafy vegetables (except Brassica)	Minimal pollinator attractiveness Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada	Minimal potential for exposure as harvested before bloom, and minimal pollinator attractiveness. Minimal potential for risk.	None identified

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations
Crop Group 5: Brassica leafy vegetables	Variable pollinator attractiveness- includes highly attractive crops Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada	Minimal potential for exposure as harvested before bloom. Minimal potential for risk.	None identified
Crop Group 6: Legume vegetables	Variable pollinator attractiveness Variable bloom periods	Risk description considered residue information from melon, pumpkin cotton Overall risk description for bee-attractive crops in CG6: • Minimal potential for risk	• Uncertainty regarding residues - No specific CG6 residue information - Based on residues for melon, pumpkin, cotton • Rates used in residue studies relevant to Canadian use pattern • Bloom time may be shorter than colony feeding study exposure duration for some crops. • Only some CG6 crops are bee-attractive Overall, risk estimation expected to be representative There is uncertainty due to lack of specific residues information for CG6.

Labelled crop	**Exposure**	**Potential for risk**	**Uncertainties / Considerations**
Crop Group 8: Fruiting vegetables (except cucurbits)	All CG8 attractive to pollinators (not attractive to honey bees; attractive to bumble bees and other species) Indeterminate blooming periods	Risk description considered residue information from tomato CG8. Tier I (individual bees): • Some potential for risk identified Tier II (colony level): • Some potential for risk identified Overall risk description for CG8: • Some potential for risk • Greater risk with coarser soils, higher application rates.	• Relevant residues from tomato (CG8) - Only pollen available for tomato; residues from other crops such as pumpkin can estimate exposure from both pollen and nectar. • Rates used in residue studies relevant to Canadian use pattern. • Bloom time (indeterminate blooming throughout season) relevant for colony feeding study exposure duration (6 weeks or longer). Overall, risk estimation expected to be representative.
Crop Group 9: Cucurbits	All CG9 attractive to pollinators Indeterminate blooming periods	Risk description considered residue information from melon and pumpkin CG9. Tier I (individual bees): • Some potential for risk identified Tier II (colony level): • No potential for risk identified Overall risk description for CG8: • Minimal potential for risk	• Relevant residues from melon and pumpkin (CG9) - Melon pollen and nectar collected from hive - Pumpkin pollen and nectar collected from plant • Rates used in residue studies relevant to Canadian use pattern. Pumpkin residues based on transplant water application. • Bloom time (indeterminate blooming throughout season) relevant for colony feeding study exposure duration (6 weeks or longer). Overall, risk estimation expected to be representative.

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations
Crop Group 13: Small Fruit and Berries Registered Subgroups: 13A Caneberry 13B Bushberry 13D: Small fruit vine climbing 13G Low growing berry	Many CG13 attractive to pollinators Variable blooming periods. Some strawberry varieties have indeterminate blooming. Some crops are perennials, some are seasonal. Label restrictions: 13A: Do not apply pre-bloom or during-bloom or when bees are actively foraging. 13B, 13G: Do not apply immediately prior to bud opening or during-bloom or when bees are actively foraging.	Risk description considered residue information from blueberry and strawberry (CG 13). Tier I (individual bees): • Some potential for risk identified Tier II (colony level): • No potential for risk identified for blueberry • Potential risk identified for strawberry grown in coarse soil, but not grown in medium soil. Overall risk description for CG8: • Minimal potential for risk for blueberry, representing post-bloom application. Label allows post-bloom application only for many CG13 crops. • Potential for risk for strawberry, representing pre-bloom application, varies with soil type; only pollen available for consideration in risk assessment.	• Relevant residues from blueberry and strawberry (CG 13) - Strawberry pollen only; collected from plant - Blueberry pollen collected from bees; nectar collected from hive • Application rates used for residues were representative of or higher than Canadian rates. • Bloom time variable. Typically shorter bloom time than colony feeding study duration (6 weeks or longer), but some strawberries have indeterminate blooming throughout season. Overall, risk estimation expected to be representative.

Labelled crop	**Exposure**	**Potential for risk**	**Uncertainties / Considerations**
Crop Group 19: Herbs	Most are pollinator attractive Variable bloom times	Risk description considered residue information from melon, pumpkin cotton Overall risk description for bee-attractive crops in CG19: • Minimal risk	• Uncertainty regarding residues - No specific residue information - Based on residues for melon, pumpkin, cotton • Application rates used for residues were representative of than Canadian rates. Overall, risk estimation expected to be representative, with uncertainty due to lack of specific residues information.
Hops, Peanut, Tobacco	Low pollinator attractiveness for tobacco and peanut Tobacco may be harvested before bloom.	Minimal potential for exposure based on low attractiveness, harvest before bloom. Risk description considered residue information from melon, pumpkin cotton. Overall risk description for bee-attractive crops: • Minimal risk	• Uncertainty regarding residues - No specific residue information - Based on residues for melon, pumpkin cotton • Foliar application rates used for residues were representative of Canadian rates. • Bloom time may be shorter than colony feeding study exposure duration. • Generally not considered bee-attractive Overall, risk estimation expected to be conservative, with uncertainty due to lack of specific residues information.

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations
Turf	Pollinator attractive only if turf contains flowering plants (such as clover) that are bee attractive. Minimal exposure for turf on golf course or sod farms where few weeds present. Irrigation is required following application.	Risk description considered residue information from melon, pumpkin, and cotton. Additionally, a tunnel-study relevant for this application demonstrated effect no effects when irrigation after application. Rates were slightly higher than Canadian application rates. Overall risk description for turf containing bee-attractive flowers: • Minimal potential for risk. The current label restrictions requiring irrigation following application are expected to minimize risk.	• Uncertainty regarding residues - No specific residue information - Based on residues for melon, pumpkin, cotton • Tier II tunnel study available and relevant to Canadian use pattern. Overall, risk estimation expected to be relevant to Canadian application, given availability of tunnel-study.
Rotational crops (following crops treated with a soil application in previous year)	Some rotational crops are bee-attractive Variable bloom times	Risk estimate based on residues for rotational crops. Tier I (individual bees): • Some potential for risk identified Tier II (colony level): • No potential for risk identified Overall risk description: • Minimal potential for risk identified	• Relevant residues for a rotational crop were available • Soil application rates the previous season were representative of or higher than Canadian rates. Overall, expected to be a reasonable representation of risk from rotational crops following foliar applications to crops the previous season.

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations
Off-field non-target forage plants may be exposed through runoff.	Some off-field forage are bee-attractive plants Variable bloom times.	Risk estimate based on residues for off-field forage crops. Tier I (individual bees): • Some potential for risk identified Tier II (colony level): • No potential for risk identified Overall risk description: • Minimal potential for risk identified	• Relevant residues for off-field forage plants were available • Soil application rates were representative of or higher than Canadian rates. Overall, expected to be a reasonable representation of risk from runoff to off-field bee-attractive forage crops.

7.3 Seed Treatment Risk Assessment

The major exposure route to bees when imidacloprid is used as a seed treatment is dietary, through foraging on pollen and nectar containing imidacloprid residues. As the seed grows into a plant, imidacloprid residues may be taken up and transported from the seed to the growing plant tissues, including pollen and nectar.

7.3.1 Tier I Screening Level Assessment for Seed Treatment

A Tier 1 screening level assessment was conducted for seed treatment uses according to the Guidance for Assessing Risks to Bees. This screening level assessment uses conservative estimations of pollen and nectar residue levels of 1 ppm for all seed treatments.

Based on the Tier I screening level assessment, all seed treatment uses pose a potential risk to pollinators. Therefore, the potential risk will be further examined using higher Tier information.

7.3.2 Pollen and Nectar Residues for Seed Treatment

Residue information related to seed treatment was available from close to 20 studies carried out with canola (PMRA 1086427), rapeseed (PMRA 1086415, 1086419, 1086423, 1086435, 2351149 and 2351169), mustard (Choudhary and Sharma, 2008), corn (Donnaruma et al., 2011; PMRA 2474497, 2142762, 2142763, 1086424 and 1086436), melon (PMRA 1856879), sweet pepper (PMRA 1856875) or sunflower (PMRA 1086426, 2351151, 2351185, 1086434, 1086418 and 2142760). Information on rotational crops was also available.

Two studies were from open literature, one with mustard and one with corn. The mustard study carried some important uncertainty with regard to the application rate and was not further considered for the risk assessment.

Other studies were submitted by the registrant. Many of the registrant studies were completed more than 15 years ago, at a time where the analytical methods used to detect imidacloprid and its metabolites were less sensitive than today. Older studies were on rapeseed, corn or sunflower. The LOQ in these studies ranged from 5 to 10 ppb and (when reported) the LOD ranged from 1.5 to 3 ppb. Results from these studies typically showed no measurable residues in bee-relevant matrices. The higher LOQ and LOD were, therefore, taken into account when considering potential residue levels from these studies.

More recent studies included one corn study from the open literature and several registrant submitted studies: canola, melon and sweet pepper as well as a two year study on corn which also included a clover rotation. The LOQ and LOD for these studies were 1 ppb and 0.3 - 0.5 ppb, respectively.

The most relevant residues for the preliminary assessment on seed treatments are those on canola, corn, melons and sweet pepper. These crops can be related to crops or crop groups listed on Canadian labels. For other labelled crops or crop groups, residues from the melon and sweet pepper studies may be used to estimate the exposure to pollinators, recognizing the limitations of the data itself (residues in flowers rather than in pollen and nectar) and that there could be differences in imidacloprid uptake and metabolism between different crop groups.

7.3.3 Tier I Refined Risk Assessment for Seed Treatment

Residue information was available for the following crops considered relevant to the Canadian use pattern for seed treatment uses: rapeseed, canola, mustard, corn, sweet pepper and melon. Residue information was also available for sunflower; however, this crop is not registered for seed treatment application in Canada and was not further considered for use in the refined risk assessment. In addition residue information from a clover rotation study was available to assess carryover.

Potential risk from other registered crops where crop specific residue information was not available was also considered, based on how similar the crop type, application rate and application timing in the study design were in comparison to the registered use pattern for each crop. The attractiveness of registered crops and level of exposure expected was also taken into consideration.

The results of the refined risk assessment for seed treatment applications using selected residue values are presented in Tables 5 and 6 of Appendix V for imidacloprid and Table 3 of Appendix VI for the transformation products.

Summary of the Tier I Refined Risk Assessment for Seed Treatment Applications

- A potential for acute dietary risk to adult bees was indicated following seed treatment application with imidacloprid in cucurbit (CG9), legume (CG6), leafy (CG4A) and brassica leafy (CG5) vegetables. Leafy vegetables and brassica leafy vegetables are typically harvested before bloom and therefore no exposure is expected unless these crops are grown for seed.

- No acute dietary risk is indicated for adult bees following seed treatment applications with imidacloprid in oilseeds (canola, mustard and rapeseed), corn and fruiting (CG8), root (CG1B) and bulb (CG3) vegetables.
- A potential for chronic dietary risk to adult bees was indicated following seed treatment application with imidacloprid in oilseeds (canola, mustard and rapeseed) and cucurbit (CG9), legume (CG6), leafy (CG4A) and brassica leafy (CG5) vegetables. Leafy vegetables and brassica leafy vegetables are typically harvested before bloom and therefore no exposure is expected unless these crops are grown for seed.
- No chronic dietary risk is indicated for adult bees following seed treatment application with imidacloprid in corn and fruiting (CG8), root (CG1B) and bulb (CG3) vegetables.
- No acute risk to adult bees is indicated from dietary exposure to the transformation products, hydroxy-imidacloprid and olefin following seed treatment application with imidacloprid in any of the registered crops/crop groups.
- No dietary risk to bee larvae is indicated following seed treatment application with imidacloprid in any of the registered crops/crop groups.
- No acute or chronic dietary risk to adult bees or bee larvae is indicated in rotational crops following a seed treatment application with imidacloprid.
- The assessment of higher tiered studies is required to further characterize the acute and chronic dietary risk to bee colonies. While no concern was identified for bee larvae when pollen and nectar is brought back to the hive, the result will be considered in relation to available higher tiered studies.

Uncertainties for Seed Treatment

- It is recognized that there could be differences in the plant uptake and metabolism of imidacloprid due to differences among plants in different crop groups or within crop groups. The available residue data was used as well as possible to estimate potential residues in labelled crops, based on potential similarities in crops, application rates and timing. As more information becomes available, residue estimates may be updated.
- No clear relationship was seen in the available residue information between application rate and timing and the residue levels, although it is noted that available studies were not designed to determine these relationships. Therefore there is further uncertainty when selecting available residue information to estimate risk in other crops not represented by the data.
- Plant collected residue samples were available for corn, clover, pepper and melon. In the corn and clover studies, pollen and/or nectar samples were collected from the plant, whereas samples utilized in the pepper and melon study were from whole flowers. Whole flowers are expected to represent a more conservative exposure matrix compared to pollen and/or nectar; residues from whole flowers were used as a surrogate for both pollen and nectar in the risk assessment.
- Canola pollen and nectar were sampled from bee hives, which may be diluted, compared to plant collected samples, and may underrepresent potential exposure.

Overall Tier I refined Risk Assessment Conclusions for Seed Treatment

Overall, the Tier I refined assessment, based on available residue information, indicates the potential for risk to adult bees from seed treatment applications in bee-attractive crops from crop groups 6 (legume vegetables), 9 (cucurbit vegetables) and 20 (oilseeds: canola, mustard and rapeseed). A potential risk was also indicated for crops in crop groups 4A (leafy vegetables) and 5 (brassica leafy vegetables); however, these crops are typically harvested before bloom and therefore no exposure to pollen and nectar is expected unless the crop is grown for seed, which generally does not occur in Canada. No potential for risk was identified for corn, crop group 8 (fruiting vegetables), crop groups 1B (root vegetables) or 3 (bulb vegetables), or for rotational crops planted following crops grown from treated seed. The assessment of higher tier studies is required to further assess the potential acute and chronic risk to bee colonies from seed treatment applications with imidacloprid.

7.3.4 Tier II and III Risk Characterization for Seed Treatment

Tier II Risk Characterization for Seed Treatment

Tunnel Studies

Overall, a number of Tier II tunnel studies were conducted for potential effects that may result from seed treatments (14 studies, 11 from the registrant and three published studies). All seed treatment studies were conducted with a short exposure duration and a short observation period (up to 30 days). They are not expected to address potential long-term sublethal 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 imidacloprid seed treatments. All available studies with an exposure period of 14 days or less showed no treatment related effects at rates of 34.7 to 89.2 g a.i./ha, or 4 to 21 g a.i./kg seed. It is noted that these tested seed treatment rates are in the range of registered rates in Canada for canola, mustard, corn, oats, barley, and wheat. But the test rates are lower than the registered rates for soybeans, faba bean, lentils, chickpeas, field peas, various beans, and potato.

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

Honey bee Colony Feeding Studies

Effect endpoints from the honey bee colony feeding study were compared with crop specific residue information. For comparison with nectar residue values, the sucrose solution colony feeding study NOEL of 25 μg/L (23.3 ppb) and LOEL of 50 μg/L (47.6 ppb) were considered. For comparison with pollen residue values, the pollen colony feeding study NOEL of 20 ppb and LOEL of 100 ppb were considered. However, in the pollen study because there is wide dose spacing between the NOEL and LOEL treatment groups, and because there were inconsistent effects observed at the LOEL among different years, it expected that the true NOEL is likely higher than 20 ppb, and there is less confidence overall in the effects values for pollen. In comparing residues to the pollen study NOEL, there is a large degree of uncertainty regarding the potential for risk. Because effects at the LOEL were inconsistent between years, there is also uncertainty regarding the potential for risk at residues at or above the LOEL. At this time, the LOEL will be considered in the risk characterization for pollen.

In comparing the colony feeding study effect endpoints to the available measured residues for a particular crop, a potential for risk was indicated when either the pollen or nectar residues levels were greater than the effects endpoint for pollen or nectar, respectively.

As shown in Table 3 of Appendix VII, the comparison between colony level effects and residues does not indicate a potential risk for any seed treatment uses or rotational crops following seed treatment uses. For all crops where residue information was available (including canola, corn, melon, sweet pepper and rotational clovers), seed treatments resulted in residues below the colony level effect endpoints of concern. Due to the consistent finding of low imidacloprid residues in available residue studies at Canadian relevant rates, it is likely that residues will be low in crops for which specific residue data was not available. Therefore, potential risk at the colony level is not expected for Canadian seed treatments.

Non-Apis Feeding Studies

Multiple artificial feeding studies demonstrated that after exposure orally to non-*Apis* bees through pollen or sucrose solution, imidacloprid may result in reduced queen, worker, or brood production, reduced colony size, and reduced pollen foraging efficiency. The lowest dose where effects were detected was for imidacloprid tested on bumble bees in combination of 6 ppb in pollen and 0.7 ppb in sugar solution for an exposure period of 14 days, or 10 ppb in sugar solution alone for an exposure period of 28 days. A NOEL could not be established from the available information.

Based on this preliminary information, residues for canola (7.6 ppb pollen and 0.81 ppb nectar) and for corn (11 ppb) are similar to residue levels where effects were observed in bumble bee feeding studies. Residues in sweet pepper, melon, and rotational clover crops do not exceed levels where effects were observed in bumble bee feeding studies. It is noted that there is uncertainty regarding interpretation of the non-*Apis* colony effect endpoints, and additional information will be considered for the final pollinator risk assessment.

Tier III Risk Characterization for Seed Treatment

Various Tier III field studies were available and demonstrate a lack of effects for seed treatment in the field. There were some uncertainties on their relevance to Canadian use patterns, as discussed in the summary below.

Under field conditions, three Tier III studies reported no detection of any long-term effects to honey bee hives for imidacloprid seed treatment on oilseed, maize and sunflower during the entire study period that included overwintering. The sunflower study (PMRA 2351151, similar to

Stadler *et al*., 2003) was conducted in Argentina where the overwintering conditions are likely more moderate than in Canada. The other two studies on spring and winter oilseed rape and maize (Pohorecka et al., 2012 and 2013) were conducted in Poland where the winter conditions are more similar to Canadian conditions. In addition to climate related uncertainties, the test rate for oilseed (2 g a.i./kg seed) was less than the labelled rate on canola in Canada (4-8 g a.i./kg seed). The mean imidacloprid residues detected in this study were lower (0.6 ppb in hive nectar, and 0.8 ppb in honey) than what were measured in a short-term canola study conducted in Canada and US (maximum of 7.6 ppb in pollen and 0.81 ppb in hive nectar, PMRA 1086427). In the maize study (Pohorecka et al. 2012), the test rate (1 mg a.i./seed) was similar to the labelled rate in Canada (0.6 mg a.i./seed), with no imidacloprid residues detected in the maize pollen. While sunflower is not registered for imidacloprid seed treatment in Canada, the test rate in the sunflower study (0.26 mg a.i./seed) was within the range of labelled rates in Canada for other crops, but, again, the test was conducted in a warmer region than Canada. In addition, high levels of contamination of other pesticides in test hives were detected in all of the three field studies. These contaminations likely have complicated the detection of treatment effects in the field.

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

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

Incident information for Seed Treatment

The PMRA has not received any incident reports suspected to be associated with imidacloprid treated seeds. The USEPA EIIS database contains 7 reports with a suspected link to seeds treated with imidacloprid. One of the incident reports showed a suspected link to treated corn seed; however, information resulted in the USEPA determining that it was unlikely that imidacloprid contributed to this incident. Two of the reports listed in the database dated back to 1995 and 1999. In 1995, beekeepers reported losing “thousands” of honey bee colonies during the period when canola was treated with imidacloprid. In 1999, imidacloprid treated sunflower seeds in France were suspected to be related to declines in honey bee populations. Limited information was available for these two incident reports. Two more recent incidents (one in the US and one in the United Kingdom) both reported an incident that was suspected to be associated with the planting of imidacloprid treated canola/rape oilseed.

For both of these incidents imidacloprid was detected in hives samples. One incident that occurred in Slovenia was suspected to be associated with the planting of imidacloprid treated corn seed. Information available for this incident indicates that dust generated during planting was likely deposited on neighbouring canola plants that were in bloom.

Incidents with seed treatments have primarily been associated with dust generated during planting of treated seeds. Dust generated from planting of treated corn and soy seed was previously identified as a concern in Canada, and risk reduction measures were put in place in 2014 to reduce exposure to dust during planting of treated corn and soy seed which includes those treated with imidacloprid. The number of incident reports suspected to be associated with imidacloprid treated seeds is significantly lower than those reported for other neonicotinoids. As such, based on the risk assessment, the incident information available and the mitigation measures that have been established to reduce pollinator exposure to dust generated during planting of corn and soybean, the PMRA concludes that risk resulting from imidacloprid treated seed is low.

7.3.5 Overall Summary of Seed Treatment Risk Assessment

Overall, considering all the available information, including the low level of residues detected in all tested crops, the outcome of Tier II feeding studies compared to residue levels, and the lack of effects identified in the available Tier II tunnel studies and Tier III field studies, it is considered that imidacloprid seed treatments are unlikely to pose a potential risk to bees at the colony level. There was consistently a low level of imidacloprid residues detected in pollen and nectar after seed treatments in all test crops.

Table 4 Summary of Seed Treatment Risk Characterization for Registered Crops in Canada

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations
Agricultural crops and other uses			
Crop Group 1: Root and Tuber Vegetables	Variable pollinator attractiveness Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada	Minimal potential for risk. Typically harvested before bloom. Exceptions: • Potato- not considered attractive to most pollinators • Sweet potato – not registered for seed treatment use Overall risk description: • Minimal potential for risk	None identified

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations
Crop Group 3: Bulb Vegetables	Variable pollinator attractiveness Typically harvested before bloom	Minimal potential for exposure as harvested before bloom. Minimal potential for risk	None identified
Crop Group 4A: Leafy greens subgroup of CG4 leafy vegetables (except Brassica)	Minimal pollinator attractiveness Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada	Minimal potential for exposure as harvested before bloom, and minimal pollinator attractiveness. Minimal potential for risk.	None identified
Crop Group 5: Brassica leafy vegetables	Variable pollinator attractiveness- includes highly attractive crops Typically harvested before bloom except when grown for seed. Generally not grown for seed in Canada	Minimal potential for exposure as harvested before bloom. Minimal potential for risk.	None identified
Crop Group 6: Legume vegetables	Variable pollinator attractiveness Variable bloom periods	Risk description considered residue information from sweet pepper and melon. Additional higher tier information also considered (Tier II and Tier III studies). Tier I (individual bees): • No potential for risk identified Tier II (colony level): • No potential for risk identified	• Uncertainty regarding residues - No specific CG6 residue information - Based on residues for sweet pepper and melon • Rates used in residue studies relevant to Canadian use pattern • Bloom time may be shorter than colony feeding study exposure duration for some crops.

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations
		Overall risk description for bee-attractive crops in CG6: • Minimal potential for risk	• Only some CG6 crops are bee-attractive Overall, risk estimation expected to be representative to conservative as rates were relevant to Canadian use pattern and bloom time is likely shorter than duration of exposure in the colony feeding studies. There is uncertainty due to lack of specific residues information for CG6.
Crop Group 8: Fruiting vegetables (except cucurbits)	All CG8 attractive to pollinators (not attractive to honey bees; attractive to bumble bees and other species) Indeterminate blooming periods	Risk description considered residue information from sweet pepper CG8. Additional higher tier information also considered (Tier II and Tier III studies). Tier I (individual bees): • No potential for risk identified Tier II (colony level): • No potential for risk identified Overall risk description for CG8: • Minimal potential for risk	• Relevant residues from sweet pepper (CG8) • Rates used in residue studies relevant to Canadian use pattern • Bloom time (indeterminate blooming throughout season) relevant for colony feeding study exposure duration (6 weeks or longer). Overall, risk estimation expected to be representative.
Crop Group 9: Cucurbits	All CG9 attractive to pollinators Indeterminate blooming periods	Risk description considered residue information from melon CG9. Additional higher tier information also considered (Tier II and Tier III studies). Tier I (individual bees): • Some potential for risk identified Tier II (colony level): • No potential for risk identified Overall risk description for CG9: • Minimal potential for risk	• Relevant residues from melon (CG9) • Rates used in residue studies relevant to Canadian use pattern • Bloom time (indeterminate blooming throughout season) relevant for colony feeding study exposure duration (6 weeks or longer). Overall, risk estimation expected to be representative.

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations
Crop Group 15: Cereal Grains	Most cereals not attractive to pollinators including wheat, rye, barely. Corn pollen may be used. Buckwheat attractive. Pollen available over shorter duration (1-3 weeks)	Risk description considered residue information from corn CG15. Additional higher tier information also considered (Tier II and Tier III studies). Tier I (individual bees): • No potential for risk identified Tier II (colony level): • No potential for risk identified Overall risk description for bee-attractive crops in CG 15: • Minimal potential for risk	• Relevant residues from corn (CG15) • Rates used in residue studies relevant to or greater than Canadian use pattern • Bloom time shorter than colony feeding study exposure duration (6 weeks or longer). Overall, risk estimation expected to be representative.
Oilseeds (canola, rapeseed, mustard) [from CG20: Oilseeds]	Highly pollinator attractive 2 – 3 week blooming period	Risk description considered residue information from canola (CG20). Additional higher tier information also considered (Tier II and Tier III studies). Tier I (individual bees): • Some potential for risk identified Tier II (colony level): • No potential for risk identified Overall risk description oilseeds: • Minimal potential for risk	• Relevant residues from canola • Rates used in residue studies relevant to Canadian use pattern • Bloom time shorter than colony feeding study exposure duration (6 weeks or longer). Overall, risk estimation expected to be representative.
Rotational crops (following crops planted with treated seed in previous year)	Some rotational crops are bee-attractive Variable bloom times	Risk estimate based on specific residues for rotational crops. Additional higher tier information also considered (Tier II and Tier III studies). Tier I (individual bees): • No potential for risk identified Tier II (colony level):	• Relevant residues for a rotational crop were available • Foliar application rates the previous season were representative of or higher than Canadian rates. Overall, expected to be a reasonable representation of risk from rotational crops

Labelled crop	Exposure	Potential for risk	Uncertainties / Considerations
		• No potential for risk identified Overall risk description: • No potential for risk identified	following foliar applications to crops the previous season.

8.0 Overall Conclusions

The risk characterizations are presented by application method to the crop (foliar, soil, and seed treatment). As described previously, the individual bee and colony level effects are compared to pollen and nectar residues to determine potential risk. As well, available tunnel-studies and field studies associated with specific applications are considered. In addition, current imidacloprid product label language and use directions as well as crop attractiveness to pollinators are considered in the risk characterization. This pollinator risk characterization is based on information available to date from registrants and the public literature. Additional data is expected, and will be considered when finalizing the pollinator risk characterization. Appendix III: Exposure Considerations: Crop Attractiveness and Label Restrictions, contains a table that summarizes the overall risk conclusions.

Crop attractiveness is considered when identifying potential risk to bees. Bees may be exposed to pesticides when they forage on crop pollen or nectar. For crops that are harvested prior to bloom, there will be no exposure to crop pollen or nectar. Some crops do not have pollen or nectar sources. Other crops may not be very attractive to bees. Therefore when crop pollen or nectar is unavailable or unattractive to bees, there is minimal potential for exposure through consumption of crop pollen and nectar, and therefore minimal risk.

For foliar applications, a potential risk to bees was indicated for bee attractive crops associated with pre-bloom, during-bloom, and some post-bloom applications, however, current label restrictions minimize potential risk.

- The data set available to assess risk from foliar applications included residue information in pollen and nectar, although residue studies were typically conducted at rates higher than Canadian application rates (such as for cherry) and/or with crops not grown in Canada (such as cotton and citrus). One relevant Tier II tunnel study was available to address potential for risk to bees from foliar turf application, and suggested Canadian label mitigation adequately minimises risk for this use. Available residues were used as well as possible to compare with individual and colony level effects information for characterizing the risk for Canadian uses. Overall, potential risk for foliar application varied with application timing, with current label restrictions minimizing risk.
- Applications during-bloom to bee-attractive crops are expected to pose a risk to bees. On the Canadian labels, there are restrictions either prohibiting or reducing applications to bee-attractive crops, thus minimizing the risk of during-bloom application.

- Pre-bloom applications to bee-attractive crops may pose a potential risk to bees. There was minimal pre-bloom foliar application pollen and nectar residue information available. The pre-bloom information submitted by the registrant was for citrus and cotton, neither of which are grown in Canada. As well, the pre-bloom application rates used in these residue studies were higher than Canadian rates. Therefore, there is uncertainty regarding whether pre-bloom applications may pose a risk when using Canadian application rates on crops grown in Canada. However, a number of crops which are attractive to bees already have pre-bloom restrictions in addition to during-bloom restrictions.
- For post-bloom applications, application timing may affect the potential for risk in orchard and tree crops. Based on cherry residue information, no potential for risk was identified for colony level effects when post-bloom application was made earlier in the summer prior to harvest.
- For post-bloom applications on other perennial crops, such as those in crop Group 13: Small fruit and berries, there is uncertainty regarding potential for risk. Information on risk from post-bloom soil applications on perennial crops in Crop Group 13 is likely informative regarding post-bloom foliar application as both exposures result in post-bloom systemic uptake of residues by plants, and indicates risk is not expected.
- Post-bloom foliar applications on seasonal agricultural crops are not expected to pose a risk since there is no longer pollen or nectar for bee forage, and the crop is harvested at the end of the season.
- No potential risk to bees was identified for rotational crops such as clover, that are grown following crops treated foliarly with imidacloprid in the previous season.
- Uncertainties in the foliar risk assessment include limited residue information based on application rates higher than the Canadian rates or on crops not grown in Canada, and a lack of higher tier tunnel-studies or field studies for most foliar uses.

For soil applications, a potential risk to bees was indicated from some soil treatments. Potential for risk varied with crop type, soil type, application timing relative to bloom-period or residue sampling date after application.

- The data set available to assess risk from soil applications included residue information in pollen, nectar or flowers for a variety of Canadian relevant crops and application rates. One relevant Tier II tunnel study addressed the potential for risk to bees from turf soil application. It suggests current Canadian label mitigation adequately minimises risk for use on turf. Field studies for soil treatment applications are expected in 2016 and will help further inform the pollinator risk assessment.
- Potential for risk was identified for tomato at higher application rates (CG 8: Fruiting vegetables) and for strawberry in coarse soils (CG 13G: Low growing berries); strawberry grown in medium soils had much lower pollen residues and is not expected to pose a potential risk in contrast to strawberry grown in coarse soils. There is some uncertainty around the tomato and strawberry risk estimates, as only pollen was collected from the plant.
- No potential for risk was identified for crops such as melon and pumpkin (Crop Group 9: Cucurbit vegetables), as well as blueberry (CG 13B: Bushberry).

- Minimal risk is expected for bee-attractive crops in other registered crop groups, such as legumes vegetables (CG 6) and herbs (CG 19).
- No potential for risk was identified for rotational crops or off-field bee attractive forage plants which could be exposed to runoff.
- Soil type also seems to affect residue levels. Crops grown in coarser soils (sandy soils, less organic matter) tended to have higher residues than those grown in medium or fine soils (higher organic matter). Increasing bioavailability and plant uptake is associated with decreasing soil organic matter.

For seed treatments, a potential for risk to bees was not indicated.

- The data set available to assess risk from treated seed included residue information in pollen, nectar or flowers of Canadian relevant crops, Tier II tunnel studies and Tier III field studies specific to seed treatment applications. The residue levels in crop pollen and nectar resulting from seed treatment uses are typically below levels expected to pose a risk to bees at both the individual level and colony level. Available higher tier tunnel-studies and field studies with seed treatments did not result in notable effects on bees.
- The exposure route of dust generated during planting of treated seed was also considered. Dust generated from planting of neonicotinoid treated corn and soybean seed was previously identified as a concern in Canada, and risk reduction measures were put in place in 2014 to reduce exposure to dust during planting of treated corn and soybean seed. Dust generation is related to multiple factors including the planting equipment and seed types, and at this time planting of other seed types in Canada is not associated with dust-generation or harm to pollinators.

Information on non-*Apis* bees was considered and incorporated into the pollinator risk assessment. Non-*Apis* bees include bees other than honey bees (*Apis* bees), such as bumble bees or solitary bees like the alfalfa leafcutting bee. There are approximately 1000 non-*Apis* bee species in Canada which have varying biological and ecological traits. Like honey bees, bumble bees live in colonies, however, these colonies are much smaller than honey bee colonies and only the queens overwinter to start a new colony every season. Unlike honey bees and bumble bees, most other non-*Apis* bees are solitary and nest in the ground or pithy plant stems. The following points are highlighted regarding the non-*Apis* information considered as a line of evidence in the pollinator risk assessment.

- Available individual bee effects information suggested that toxicity of imidacloprid to non-*Apis* bees was similar to that of honey bees. Tier I acute adult effects information was available for bumble bees, mason bees, leafcutting bees and stingless bees. Available Tier I effects information supports the use of honey bee as a surrogate for non-*Apis* bees.
- Available Tier II tunnel studies and Tier III field studies were consistent with tunnel and field studies on honey bees, and were used to support the overall risk conclusions for pollinators. These studies were conducted primarily with bumble bees, and typically did not show notable effects for Canadian relevant use patterns.

- Available Tier II colony level effects information from feeding studies with non-*Apis* bees suggested that bumble bees may be more sensitive to imidacloprid exposure than honey bees. Measured pollen and nectar residues were often above the lowest dose where colony effects were detected in bumble bee feeding studies, suggesting a potential for risk. At this time, there is uncertainty as to whether colony level effects observed in feeding tests would represent impacts to bumble bee colonies in nature.
- There has been additional recent research published on non-*Apis* bees which will be reviewed and considered for the final pollinator risk assessment. The PMRA expects that the science of non-*Apis* effects testing and risk assessment will continue to improve, and any new developments will also be considered in the final pollinator risk assessment.

List of Abbreviations

μg	microgram(s)
a.i.	active ingredient
California DPR	California Department of Pesticide Regulation
CFS	colony feeding study
CG	Crop Group
CI	confidence interval
Cont'd	continued
d	day(s)
DALA	days after last application
DAP	days after planting
DBH	diameter at breast height
EDD	estimated daily dose
EEC	estimated environmental concentration
EIIS	Ecological Incident Information System
g	gram(s)
ha	hectare(s)
hr	hour(s)
IMI	imidacloprid
kg	kilogram(s)
L	litre(s)
LD_{50}	lethal dose to 50% (a dose causing 50% mortality in the test population)
LOC	level of concern
LOD	limit of detection
LOEC	lowest observed effect concentration
LOEL	lowest observed effect level
LOQ	limit of quantification
mg	milligram(s)
ng	nanogram(s)
NOEC	no observed effect concentration
NOEL	no observed effect level
OH-IMI	5-hydroxy-imidacloprid
Olefin-IMI	Olefin-imidacloprid
ppb	parts per billion
ppm	parts per million
PMRA	Pest Management Regulatory Agency
RQ	risk quotient
TGAI	Technical Grade Active Ingredient
USEPA	United States Environmental Protection Agency
Y	year

Appendix I Registered imidacloprid products with uses considered in the pollinator risk assessment in Canada as of 17 August 2015

Note: List excludes discontinued products or products with a submission for discontinuation.

Registrant	Marketing Class	Registration Number	Product Name	Guarantee	Formulation type
Adama Agricultural Solutions Ltd.	Commercial	28475	Alias 240 SC Systemic Insecticide	Imidacloprid 240 g/L	Suspension
		29130	Quali-Pro Imidacloprid 75 WSP Insecticide	Imidacloprid 75%	Wettable powder
		29185	Quali-Pro Imidacloprid 0.5 Granular Insecticide	Imidacloprid 0.5%	Granular
		30505	Sombrero 600 FS	Imidacloprid 600 g/L	Suspension
Arborjet Inc.	Commercial + Restricted	31375	IMA- Jet	Imidacloprid 58.5 g/L	Solution
Cheminova Canada Inc.	Commercial	28726	Grapple Insecticide	Imidacloprid 240 g/L	Suspension
		29048	Grapple-2 Insecticide		
Bayer CropScience Inc.	Commercial	24094	Admire 240 Flowable Systemic Insecticide	Imidacloprid 240 g/L	Suspension
		25556	Gaucho 75 ST	Imidacloprid 75%	Wettable powder
		25636	Merit 60 WP Greenhouse And Nursery Insecticide	Imidacloprid 60%	
		25932	Merit Solupack Insecticide	Imidacloprid 75.0%	
		25933	Merit 0.5 G Insecticide	Imidacloprid 0.5%	Granular
		26124	Gaucho 480 FL Insecticide	Imidacloprid 480 g/L	Suspension
		27170	Gaucho 600 FL Insecticide	Imidacloprid 600 g/L	
		27174	Gaucho CS FL (Insecticide/Fungicide Seed Treatment)	Carbathiin 47.6 g/L Thiram 95.3 g/L Imidacloprid 285.7 g/L	
		27349	Genesis 240 Flowable Systemic Insecticide	Imidacloprid 240 g/L	
		27357	Intercept 60 WP Greenhouse and Nursery Insecticide	Imidacloprid 60%	Wettable powder
		27702	Admire 240 SPT Flowable Systemic Insecticide	Imidacloprid 240 g/L	Suspension
		28159	Genesis MZ Potato Seed-Piece Treatment	Imidacloprid 1.25% mancozeb 6.0%	Dust
		28160	Genesis XT Potato Seed-Piece Treatment	Imidacloprid 1.25% mancozeb 6.0% thiophanate-methyl 3.0%	
		29609	Stress Shield For Cereals	Imidacloprid 480 g/L	Suspension
		29610	Stress Shield For Cereals and Soybeans		
		29611	Concept Liquid Insecticide	Imidacloprid 75 g/L deltamethrin 10 g/L	Suspension
		30668	Stress Shield 600	Imidacloprid 600 g/L	Suspension
		30972	Sepresto 75 WS	Imidacloprid 18,75 % clothianidin 56.25%	Wettable Powder
		31068	Acceleron IX-409 Insecticide Seed Treatment	Imidacloprid 600 g/L	Suspension
	Commercial + Restricted	29703	Confidor 200 SL	Imidacloprid 17.1%	Solution

Registrant	Marketing Class	Registration Number	Product Name	Guarantee	Formulation type
	Domestic	29738	Bayer Advanced^{TM} Season Long Grub Control (Merit Insecticide)	Imidacloprid 0.25%	Granular

Appendix IIa Commercial and Restricted Class uses of imidacloprid considered in the pollinator risk assessment registered in Canada as of 17 August 2015

Site(s)	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single[1]	Maximum Number of Applications per year[1]	Minimum Application Interval (Days)[1]
Crop group 5A (greenhouse seedling production): Head & Stem Brassica (including cabbage, broccoli, cauliflower, Nappa cabbage, Chinese broccoli, Brussels sprouts, Chinese mustard cabbage, kohlrabi)	Swede midge larvae	Wettable powder	Transplant tray plug drench	2.46 g a.i./1000 seedlings Early season transplants: (1.24 g a.i./m^2) Mid- to late season transplants: (2.1 to 3.2 g a.i./m^2)	1/crop cycle	Not applicable
Greenhouse cucumber, tomato Greenhouse eggplant	Aphids, whiteflies	Wettable powder	Ground application: chemigation: soil drench using micro-irrigation, drip irrigation, overhead irrigation, or hand-held or motorized calibrated irrigation equipment soil/soilless media/hydroponic treatment	9.6 g a.i./1000 plants	1/crop cycle	Not applicable
Greenhouse lettuce (transplant seedlings)	Aphids, whiteflies	Wettable powder	Transplant tray plug drench: drip irrigation or automated sprayer (irrigation) system	2.46 g a.i./1000 seedlings	1/crop cycle	Not applicable
Greenhouse pepper (mature plants)	Green peach aphid, whiteflies	Wettable powder	Ground application: chemigation: soil drench using micro-irrigation, drip irrigation, overhead irrigation, or hand-held or motorized calibrated irrigation equipment soil/soilless media/hydroponic treatment	9.6 g a.i./1000 plants	1/crop cycle	Not applicable
Greenhouse Pepper (transplant seedlings)			Transplant tray plug drench	2.46 g a.i./1000 seedlings		
Greenhouse ornamentals (container plants)	Aphids, whiteflies	Wettable powder	Ground application: soil drench using micro-irrigation, drip irrigation, overhead irrigation, or hand-held or motorized calibrated irrigation equipment soil/soilless media/hydroponic treatment	0.002 g a.i./2.5 cm pot: 1-2 herbaceous plants/pot 0.003 g a.i./2.5 cm pot: 3+ herbaceous plants/pot or woody perennials	1/crop cycle	365

Site(s)	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single[1]	Maximum Number of Applications per year[1]	Minimum Application Interval (Days)[1]
Crop group 1B: root vegetables Carrot	Carrot rust fly (suppression)	Wettable powder	Ground application: commercial seed treatment facilities only: seed treatment equipment Seeds are not treated in Canada but are imported pre-treated with imidacloprid.	0.012 to 0.023 g a.i./1000 seed	1	Not applicable
Crop group 1B: Root vegetables (except sugarbeet): **Crop group 1D: Tuberous and corm vegetables (except potatoes)**	Aphids, leafhoppers, flea beetles	Suspension	Ground: Soil application (In-furrow, soil injection or shanked or apply a narrow seed row band directly below the eventual seed row in a bedding operation 14 or fewer days before planting)	1.88 to 2.88 g a.i./100 m of row	1 (1 per crop cycle for ginseng)	Not applicable
	Reduction in numbers of larvae of the European chafer			288 g a.i./ha	1 (1 per crop cycle for ginseng)	
Crop group 2: Leaves of root and tuber vegetables	Aphids, leafhoppers (suppression)		Ground: foliar application	48 g a.i./ha	2	5
Globe artichoke	Aphids, leafhoppers (suppression)	Suspension	Ground: foliar application	48 g a.i./ha	2	7
Potato	Colorado potato beetle, potato leafhopper, aphids, potato flea beetle	Suspension	Ground application: on farm seed piece treatment equipment	6.2 g a.i./100 kg seed pieces to 9.4 g a.i./100 kg seed pieces	1	(365)
	Colorado potato beetle, potato leafhopper, aphids, potato flea beetle	Dust or powder	Ground application: on farm seed piece treatment equipment	6.25 g a.i./100 kg seed or 9.4 g a.i./100 kg seed	(1)	(365)
	Colorado potato beetle, aphids, leafhoppers, flea beetles	Suspension	Ground application: soil drench (in furrow)	1.8 to 2.9 g a.i./100 m of row or 100 to 480 g a.i./ha	1	(365)
	Reduction in numbers of larvae of the European chafer		Ground: soil drench	288 g a.i./ha	1	(365)
	Colorado potato beetle, aphids, leafhoppers (suppression)		Ground application: foliar spray	48 g a.i./ha	2	7

Site(s)	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single[1]	Maximum Number of Applications per year[1]	Minimum Application Interval (Days)[1]
Potato	Colorado potato beetle, aphids, leafhopper, potato flea beetle, tarnished plant bug, European corn borer (suppression)	Suspension	Ground application: foliar spray Aerial application: foliar spray	49 g a.i./ha imidacloprid 6.5 g a.i./ha deltamethrin	3	5
Crop group 3: bulb vegetables Leek (Allium ampeloprasum, A. porrum, A. tricoccum); Onion, dry bulb and green (*Allium cepa, A. fistulosum*)	Onion maggot, seedcorn maggot, thrips	Wettable powder	Ground application: commercial seed treatment facilities only: seed treatment equipment Seeds are not treated in Canada but are imported pre-treated with imidacloprid.	0.04 g a.i./1000 seed (onion - bulb, leek) 0.03 g a.i./1000 seeds (onion- bunching)	1	Not applicable
Crop group 4A: Leafy greens subgroup of leafy vegetables (except Brassica)	Aphids	Suspension	Ground: transplant tray plug drench	2.45 g a.i./1000 plants	1	(365)
	Aphids		Ground: soil drench – in-furrow, subsurface side dress, post seeding drench, transplant water drench, hill drench	1.44 g a.i./100m of row	1	(365)
	Aphids, leafhopper (suppression)		Ground: foliar spray	48 g a.i./ha	2	5
Crop group 4A: Leafy greens Lettuce (leaf and head)	Aphids, leafminer (suppression)	Wettable powder	Commercial seed treatment facilities only: seed treatment equipment Seeds are not treated in Canada but are imported pre-treated with imidacloprid.	0.2 g a.i./1000 seeds	1	(Not applicable)
Crop group 4B: cardoon, celery, Chinese celery (fresh leaves and stalk only), celtuce, florence fennel (including sweet anise, sweet fennel, finocchio), rhubarb, Swiss chard	Aphids	Suspension	Ground application: soil drench – in-furrow, subsurface side dress, post seeding drench, transplant water drench, hill drench	1.44 g a.i./100m of row 79.92 to 480 g a.i./ha	1	365
Crop Group 5 Brassica (cole) leafy vegetables Broccoli and cabbage	Aphids, flea beetle	Wettable powder	Commercial seed treatment facilities only: seed treatment equipment Seeds are not treated in Canada but are imported pre-treated with imidacloprid.	0.3 g a.i./1000 seeds	1	(Not applicable)

Site(s)	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single[1]	Maximum Number of Applications per year[1]	Minimum Application Interval (Days)[1]
Crop group 5: Brassica (cole) leafy vegetables	Aphids	Suspension	Ground application: soil drench - subsurface side dress, post seeding drench, transplant water drench, hill drench	1.56 g a.i./100 m of row	1	365
Crop group 5: Brassica (cole) leafy vegetables	Aphids (including cabbage aphid, green peach aphid and turnip aphid)		Ground application: side dress application - soil injection	(175.2 g a.i./ha)	1	365
	Aphids, leafhoppers (suppression)		Ground application: foliar spray	48 g a.i./ha	2	7
Head and stem brassica crop sub-group 5A	Imported cabbageworm diamondback moth, cabbage looper, crucifer flea beetle, aphids		Ground application: foliar spray	48.75 g a.i./ha imidacloprid 6.5 g a.i./ha deltamethrin	3	5
Crop group 6: Legume vegetables (except dry soybean)	Aphids	Suspension	Ground application: in-furrow, surface band spray, post seeding drench, transplant water drench, hill drench	1.8 g a.i./100m of row 100 to 400 g a.i./ha	1	(365)
	Aphids, leafhoppers (suppression)		Ground: foliar application	48 g a.i./ha	2	7
Peanut	Aphids		Ground application: in-furrow drench, transplant water drench, soil injection	1.8 g a.i./100 m of row 100 to 400 g a.i./ha	1	(365)
	Aphids, leafhoppers (suppression)		Ground application: foliar spray	48 g a.i./ha	2	5
Crop group 6A and C: Edible podded beans (*Phaseolus* sp. and *Vigna* sp.) Jackbean, Dry shelled beans (*Lupinus* sp., *Phaseolus* sp. and *Vigna* sp.) Broad bean (fava bean)	Potato leafhopper	Suspension	Ground application: commercial seed treatment facilities and on farm seed treatment equipment	62.4 to 62.5 g a.i./100 kg seed	(1)	(365)
	Wireworm		Ground application: commercial seed treatment facilities only: seed treatment equipment	62.5 g a.i./100 kg seed		

Site(s)	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single[1]	Maximum Number of Applications per year[1]	Minimum Application Interval (Days)[1]
Chickpea, lentil, field pea			Ground application: commercial seed treatment facilities and on farm: seed treatment equipment			
Faba bean	Pea leaf weevil, wireworm					
Field pea	Pea leaf weevil			62.5 to 125 g a.i./100 kg seed		
Soybean	Soybean aphid, bean leaf beetle, wireworm, seedcorn maggot European chafer, Japanese beetle		Ground application: commercial seed treatment facilities and on farm: seed treatment equipment	62.5 to 125 g a.i./100 kg seed	(1)	(365)
	Soybean aphid, bean leaf beetle (suppression), Japanese beetle		Ground application: foliar spray Aerial application: foliar spray	24.4 to 49 g a.i./ha imidacloprid 3.25 to 6.5 g a.i./ha deltamethrin	3	5
Crop group 8: Fruiting vegetables (except cucurbits): Tomato and pepper	Aphids, leafminer (suppression on tomato), thrips	Wettable powder	Ground application: commercial seed treatment facilities only: seed treatment equipment Seeds are not treated in Canada but are imported pre-treated with imidacloprid.	0.0126 g a.i./ 1000 seeds (tomato) 0.083 g a.i./ 1000 seed (pepper)	1	Not applicable
Crop group 8: Fruiting vegetables except cucurbits (including eggplant and tomato)	Colorado potato beetle, aphids	Suspension	Ground application: in-furrow, surface band spray, post seeding drench, transplant water drench, hill drench	1.68 to 2.88 g a.i./100m of row 93.36 to 559.92 g a.i./ha	1	(365)
	Colorado potato beetle, aphids, leafhoppers (suppression)		Ground application: foliar spray	48 g a.i./ha	2	5
Eggplant	Colorado potato beetle	Suspension	Ground application: Transplant soil application - in-furrow at transplanting or as a drench in the transplanting water or banded over the row	1.68 to 2.4 g a.i./100m of row	1	(365)
			Ground application: foliar spray	48 g a.i./ha	2	5

Site(s)	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single[1]	Maximum Number of Applications per year[1]	Minimum Application Interval (Days)[1]
Tomato	Colorado potato beetle		Ground application: Transplant Soil application - in-furrow at transplanting or as a drench in the transplanting water or banded over the row	1.68 to 2.4 g a.i./100m of row	1	Not applicable
			Ground application: foliar spray	48 g a.i./ha	2	5
	Colorado potato beetle, tomato hornworm			49 g a.i./ha imidacloprid 6.5 g a.i./ha deltamethrin	3	5
Crop Group 9 Cucurbit vegetables: Citron melon; muskmelon; watermelon; Chayote (fruit); Chinese waxgourd; cucumber; gherkin; gourd, edible; Momordica spp.; pumpkin; squash, summer; squash, winter	Aphids, thrips	Wettable powder	Ground application: commercial seed treatment facilities only: seed treatment equipment Seeds are not treated in Canada but are imported pre-treated with imidacloprid.	0.25 g a.i./1000 seeds	1	Not applicable
Crop group 9: Cucurbit vegetables	Aphids	Suspension	Ground application: soil drench: in-furrow, surface band, hill drench	1.8 g a.i./100m of row 100 to 280 g a.i./ha	1	Not applicable
	Cucumber beetles		Ground application: soil drench: in-furrow, surface band, hill drench, subsurface side dress	4.32 g a.i./100 m of row 240 to 280 g a.i./ha		
			Ground application: transplant water	6 g a.i./1000 plants		
Crop group 11: Pome fruit	Aphids (except woolly apple aphid)		Ground application: foliar spray using airblast sprayers	55.2 g a.i./ha	2	(10)
	Mullein bug			91.2 g a.i./ha		
	Tentiform leafminer					10
	Leafhoppers			48 g a.i./ha		(10)
Crop group 12: Stone fruit	Aphids (except woolly aphid)		Ground application: foliar spray using airblast sprayers	55.2 g a.i./ha	2	7
	Leafhoppers			48 g a.i./ha	2	7

Site(s)	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single[1]	Maximum Number of Applications per year[1]	Minimum Application Interval (Days)[1]
Cherries	Western cherry fruit fly, black cherry fruit fly		Ground application: foliar spray using airblast sprayers	55.2 g a.i./ha	5	[7][2] 10
Crop Group 13A: cane berries	Aphids, leafhoppers (suppression only)		Ground application: foliar spray	42 g a.i./ha	3	7
	Reduction in numbers of white grubs (larvae of European chafer)		Ground application: Soil drench	288 g a.i./ha	1	Not applicable
Raspberry	Rednecked and raspberry caneborer (suppression)		Ground application: foliar spray	112 g a.i./ha	3	7
Crop group 13B: Berry and small fruit Bushberry: Berry, aronia; Blueberry, highbush, and/or hybrids of these; Blueberry, lowbush; Currant, buffalo, black, and red; Elderberry; Gooseberry; Cranberry (highbush); Honeysuckle; Huckleberry; Jostaberry; and Juneberry (Service berry or Saskatoon berry)	Reduction in numbers of white grubs (larvae of European chafer and Japanese beetle)	Suspension	Ground application: field drench	288 g a.i./ha	1	(365)
	Aphids, leafhoppers (suppression)		Ground application: foliar spray	42 g a.i./ha	2	7
	Blueberry maggot			55.2 to 84 g a.i./ha		
	Japanese beetle adult			84 g a.i./ha		
Saskatoon berry	Woolly elm aphid (suppression), woolly apple aphid (suppression)		Ground application : field drench (band spray)	0.03 g/plant	1	(365)
Crop group 13F: Berry and small fruit vine including grapes	Leafhoppers		Ground application: sub-surface side dress, hill drench	1.8 to 2.88 g a.i./ 100m of row 100 to 480 g a.i./ha	1	(365)
			Ground application: foliar spray	48 g a.i./ha	2	14
Blueberry (lowbush and highbush)	Blueberry aphid		Ground application: foliar spray	42 g a.i./ha imidacloprid 5.6 g a.i./ha deltamethrin	3	5

Site(s)	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single[1]	Maximum Number of Applications per year[1]	Minimum Application Interval (Days)[1]
Crop group 13G: Berry and small fruit low growing berries including: bearberry; bilberry; blueberry lowbush; cloudberry; lingonberry; muntries; partridgeberry; strawberry	Aphids		Ground application: surface band spray	1.8 to 2.88 g a.i. /100m of row 100 to 480 g a.i./ha	1	(365)
	Strawberry aphid (on strawberry only)			204 to 312 g a.i./ha		
	Reduction in numbers of white grubs (larvae of European chafer)		Ground application: soil drench	288 g a.i./ha	1	(365)
Crop group 13G: Berry and small fruit low growing berries including: bearberry; bilberry; blueberry lowbush; cloudberry; lingonberry; muntries; partridgeberry; strawberry	Aphids, leafhoppers (suppression)	Suspension	Ground application: foliar spray	42 g a.i./ha	2	Not stated
Cranberry	Reduction in numbers of white grubs (larvae of European chafer)		Ground application: soil drench	288 g a.i./ha	1	(365)
Crop group 14: Tree nuts plus Pistachio	Aphids (except woolly apple aphid)	Suspension	Ground application: foliar spray airblast sprayer	55.2 g a.i./ha	2	6
	leafhoppers (suppression)			48 g a.i./ha		
Barley, oats, wheat	Wireworm	Suspension	Ground application: commercial and on farm seed treatment equipment	10 to 30 g a.i./100 kg seed for early season crop protection 20 to 30g a.i./100 kg seed in fields with high pest pressure	(1)	(365)
Field corn (seed production only),	Corn flea beetle	Suspension	Ground application: commercial seed treatment equipment	48 g a.i./80 000 seeds	(1)	(365)
Field corn (including seed production)	Wireworm		Ground application: commercial and on farm seed treatment equipment	13 g a.i./80 000 seeds		
Sweet corn (Ontario and Québec only)	Corn flea beetle			250 g a.i./100 kg seed		
	Wireworm			67.2g a.i./100 kg seed		

Site(s)	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single[1]	Maximum Number of Applications per year[1]	Minimum Application Interval (Days)[1]
Crop group 19A: Herbs	Aphids	Suspension	Ground application: in-furrow drench, transplant water drench, soil injection	1.44 g a.i./100 m of row 79.92 to 480 g a.i./ha	1	(365)
	Aphids, leafhoppers (suppression)		Ground application: foliar spray	48 g a.i./ha	2	5
Hops	Aphids	Suspension	Ground Application: foliar spray	55.2 g a.i./ha	2	28
Canola, mustard (condiment type only), rapeseed	Flea beetle	Wettable powder, suspension	Ground application: commercial seed treatment equipment	400-802 g a.i./ 100 kg seed	(1)	(365)
Mustard (oilseed type)		Suspension		400 g a.i./100 kg seed or 800 g a.i./100 kg seed		
Tobacco	Aphids	Suspension	Ground application: foliar spray	48 g a.i./ha	2	7
	Aphids, flea beetles		Ground application: in-furrow drench, transplant water drench, sub-surface side dress	2.04 g a.i./100m of row 113.28 to 453.36 g a.i./ha	1	(365)
Christmas trees	Balsam twig aphid	Suspension	Ground application: airblast sprayer	60 g a.i./ha	2	7
Albizia, ash, birch, box elder, buckeye, elm, hackberry, horse chestnut, maple, mountain ash, poplar, silk tree, sycamore/London plane tree, willow	Asian longhorned beetle (suppression)	Solution	Ground application: trunk injection	0.09 to 0.19 g a.i./cm DBH	1	(365)
Birch, elm, hackberry, horse chestnut, maple, mountain ash, poplar, silk tree, sycamore/London plane, willow	Asian longhorned beetle (suppression)	Solution	Ground application: trunk injection	0.257 g a.i./cm DBH	1	(365)
Spruce	Brown spruce longhorn beetle (suppression)					
Ash	Emerald ash borer (suppression)			0.09 to 0.275 g a.i./cm DBH		
	cottony ash psyllid			0.062 g a.i./cm DBH		

Site(s)	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate Single[1]	Maximum Number of Applications per year[1]	Minimum Application Interval (Days)[1]
Birch	Bronze birch borer (suppression)					
Elm	European elm scale, elm leafminer					
Hemlock	Hemlock woolly adelgid					
Black locust	Locust leafminer					
Ornamental apple	Woolly apple aphid					
Ornamentals (field grown) including herbaceous perennials, ornamental grasses, trees, shrubs	European chafer (larvae) Japanese beetle (larvae)	Wettable powder	Ground application: soil drench	280 g a.i./ha	1	(365)
Ornamentals (container grown) including herbaceous perennials, ornamental grasses, trees, shrubs						
Turf (home lawns, business and office complexes, shopping complexes, multi-family residential complexes, airports, cemeteries, parks, playgrounds, athletic fields, golf courses and sod farms	European chafer (larvae) Japanese beetle (larvae) Ataenius beetle (larvae)	Wettable powder (in water soluble bags)	Ground application: boom sprayer, etc.	281.25 g a.i./ha	1	(365)
	European crane fly larvae (suppression)					
	European chafer (larvae) Japanese beetle (larvae) Ataenius beetle (larvae)	Granular	Ground application: granular spreader drop and rotary type	280 g a.i./ha	1	(365)
	European crane fly larvae (suppression)					

[1] All information is from the registered labels. Information added by the PMRA is indicated by round brackets ( ).

[2] The minimum application interval for cherries supported by the registrants is indicated by square brackets [ ].

Appendix IIb Domestic Class uses of imidacloprid considered in the pollinator risk assessment registered in Canada as of 17 August 2015

Site(s)	Pest(s)	Formulation Type	Application Methods and Equipment	Application Rate (a.i.)		Maximum Number of Applications per Year	Minimum Number of Days Between Applications
				Maximum Single[1]	Maximum Cumulative		
Turf	Larval stages of: European chafer, Japanese beetle, black turfgrass ataenius beetle, European crane fly	Granular	Granular broadcast spreaders	280 g/ha	280 g/ha	1	365

Appendix III Exposure Considerations: Crop Attractiveness and Label Restrictions

Crop Group	Attractive to Honey bees (HB), Bumble bees (BB), or solitary bees (SB)	Pollination services (Y/N)	Application	PMRA label restrictions	Potential for oral exposure (Y/N)	Potential for contact exposure on field (Y/N)	Notes and Overall conclusion regarding exposure potential for pollinators	Overall risk conclusion*
1: Root and Tuber Vegetables (Excluding potato and sweet potato) Representative commodities: carrot, radish, sugarbeet.	HB (Pollen and Nectar), BB, SB	N[1]	FO	<u>Under hazards:</u> *'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.'*	N[1]	N[1]	Typically harvested before bloom except when grown for seed. Bees could be important for seed production. Generally not grown for seed in Canada. **Overall, there is minimal exposure potential from most crops in this crop group.**	Minimal potential for risk.
			SO	none	N[1]	N		Minimal potential for risk.
			ST	Only registered for carrot seed treatment.	N[1]	N		Minimal potential for risk.
From Crop group 1: potato and sweet potato Representative commodities: potato, sweet potato	BB, SB	N	FO	Sweet Potato: From ADMIRE 240 label: *DO NOT apply ADMIRE 240 Flowable Systemic Insecticide during flowering of the crop.* <u>Under hazards:</u> *'DO NOT apply this product to flowering*	Y	N	**For foliar application to sweet potato, there is negligible exposure based on label restrictions.** **While potatoes are harvested after bloom, they only provide a pollen source which is not considered attractive to most bees.**	Minimal potential for risk.

Crop Group	Attractive to Honey bees (HB), Bumble bees (BB), or solitary bees (SB)	Pollination services (Y/N)	Application	PMRA label restrictions	Potential for oral exposure (Y/N)	Potential for contact exposure on field (Y/N)	Notes and Overall conclusion regarding exposure potential for pollinators	Overall risk conclusion*
				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.’			**Overall there is limited potential for exposure**.	
			SO	From Alias 240 SC: Field drench- sweet potatoes: *Do not apply Alias 240SC Systemic Insecticide during flowering of sweet potatoes.*	Y	N		Uncertain potential for risk (sweet potato). Label restrictions may reduce potential for risk.
			ST	Only registered for potato seed piece treatment.	Y	N		Minimal potential for risk.
2: Leaves of Root and Tuber Vegetables Representative commodities: turnip, garden beet, or sugarbeet	HB (Pollen and Nectar), BB, SB	N[1]	FO	Under hazards: ‘*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*	N (harvested before bloom)	N (harvested before bloom)	Grown for leaves only, and therefore typically harvested before bloom. **Overall, there is minimal exposure potential from most crops in this crop group.**	Minimal potential for risk.

Crop Group	Attractive to Honey bees (HB), Bumble bees (BB), or solitary bees (SB)	Pollination services (Y/N)	Application	PMRA label restrictions	Potential for oral exposure (Y/N)	Potential for contact exposure on field (Y/N)	Notes and Overall conclusion regarding exposure potential for pollinators	Overall risk conclusion*
				site.'				
			SO	none	N (harvested before bloom)	N		Minimal potential for risk.
3: Bulb vegetables Representative commodities: onion (bulb) and onion (green)	HB, BB, SB	N[1]	ST	none	N[1]	N[1]	Typically harvested before bloom except when grown for seed. Bees could be important for seed production. Generally not grown for seed in Canada. **Overall, there is minimal exposure potential from most crops in this crop group.**	Minimal potential for risk.
4: Leafy Vegetables (except brassica vegetables) Representative commodities: celery, head lettuce, leaf lettuce, spinach	HB (Pollen and Nectar), BB, SB	N	FO	<u>Under hazards:</u> *'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.'*	N[1]	N[1]	Typically harvested before bloom except when grown for seed. Bees could be important for seed production. Generally not grown for seed in Canada. **Overall, there is minimal exposure potential from most crops in this crop group.**	Minimal potential for risk.
			SO	none	N[1]	N		Minimal potential for risk.
			ST	none	N[1]	N		Minimal potential for risk.

Crop Group	Attractive to Honey bees (HB), Bumble bees (BB), or solitary bees (SB)	Pollination services (Y/N)	Application	PMRA label restrictions	Potential for oral exposure (Y/N)	Potential for contact exposure on field (Y/N)	Notes and Overall conclusion regarding exposure potential for pollinators	Overall risk conclusion*
5: Brassica (Cole) Leafy Vegetables Representative commodities: broccoli or cauliflower, cabbage, mustard green	HB (Pollen and Nectar), BB, SB	N[1]	FO	Under hazards: '*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.*'	N[1]	N[1]	Typically harvested before bloom except when grown for seed. Bees could be important for seed production. Generally not grown for seed in Canada. **Overall, there is minimal exposure potential from most crops in this crop group.**	Minimal potential for risk.
			SO	none	N[1]	N		Minimal potential for risk.
			ST	none	N[1]	N		Minimal potential for risk.
6: Legume Vegetables (Succulent or Dried) Representative commodities: bean (*Phaseolus spp*); pea (*Pisum spp*.); and soybean	HB (Pollen and Nectar), BB, SB	N	FO	Under hazards: '*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.*'	Y	Y	Not harvested prior to bloom. Most beans do not require pollination. **Overall, there is potential for exposure to some crops. Other crops are not considered attractive to bees.**	Potential risk for pre-bloom and during-bloom applications identified, however label reduces potential for risk.
			SO	none	Y	N		Minimal potential for risk.
			ST	none	Y	N		Minimal potential for risk.
8: Fruiting Vegetables	HB (okra only), BB, SB	Y	FO	Under hazards: '*DO NOT*	Y	Y	Bumblebees are used for greenhouse	Potential risk for pre-bloom and during-bloom

Crop Group	Attractive to Honey bees (HB), Bumble bees (BB), or solitary bees (SB)	Pollination services (Y/N)	Application	PMRA label restrictions	Potential for oral exposure (Y/N)	Potential for contact exposure on field (Y/N)	Notes and Overall conclusion regarding exposure potential for pollinators	Overall risk conclusion*
Representative commodities: Tomato (standard size and one cultivar of small tomato); Bell pepper and one cultivar of nonbell pepper; one cultivar of small nonbell pepper or one cultivar of small eggplant				*apply this product to flowering crops or weeds if bees are visiting the treatment area. Minimize spray drift to reduce harmful effects on bees in habitats close to the application site.*'			production. **There is some potential for exposure.**	applications, label reduces potential for risk.
			SO	none	Y	N		Some potential for risk. Greater risk with coarser soils, higher application rates.
			ST	none	Y	N		Minimal potential for risk.
9: Cucurbit Vegetables Representative commodities: cucumber, muskmelon, summer squash	HB (Pollen and Nectar), BB, SB	Y	SO	none	Y	N	**Overall, there is potential for exposure.**	Minimal potential for risk.
			ST	none	Y	N		Minimal potential for risk.
11: Pome Fruit Representative commodities: apple and pear	HB (Pollen and Nectar), BB, SB	Y	FO	Pome fruit: Apply post-bloom only.	Y	N (applied post bloom)	Not harvested prior to bloom. Potential oral exposure is from residues in flowers the following year. **Overall, there is potential for exposure from residues in flowers**	Potential risk depends on application timing. Earlier post-bloom application reduces risk. Risk not expected for earlier post-bloom application timing (pre-harvest). Potential risk for later post-bloom application timing (post-harvest).

Crop Group	Attractive to Honey bees (HB), Bumble bees (BB), or solitary bees (SB)	Pollination services (Y/N)	Application	PMRA label restrictions	Potential for oral exposure (Y/N)	Potential for contact exposure on field (Y/N)	Notes and Overall conclusion regarding exposure potential for pollinators	Overall risk conclusion*
							(pollen and nectar) the following year.	
12: Stone Fruit Representative commodities: sweet cherry or tart cherry, peach, and plum or prune plum	HB (Pollen and Nectar), BB, SB	Y	FO	Stone fruit: Apply post-bloom only.	Y	N (applied post bloom)	Not harvested prior to bloom. Potential oral exposure is from residues in flowers the following year. **Overall, there is potential for exposure from residues in flowers (pollen and nectar) the following year, based on application timing.**	Potential risk depends on application timing. Earlier post-bloom application timing reduces risk. Risk not expected for earlier post-bloom application timing (pre-harvest). Potential risk for later post-bloom application timing (post-harvest).
13: Small fruit and berries Subgroup 13A: Caneberry (representative crop: blackberry or raspberry)	HB (Pollen and Nectar), BB, SB	Y (for some crops)	FO	Caneberry: *Do not apply pre-bloom or during bloom or when bees are atively foraging.*	Y	N (applied post bloom)	Potential oral exposure from residues in flowers the following year. Crops are mostly self-pollinated. **Overall, there is potential for exposure from residues in flowers (pollen and nectar) the following year.**	Only post-bloom application is allowed. It is uncertain whether post-bloom foliar applications to perennial crops may pose potential risk. Risk is expected to be reduced with longer time period between application and the bloom period next season. Post-bloom soil application may be relevant to post-bloom foliar application, and indicates minimal risk.
			SO	Caneberry	Y	N		Minimal

Crop Group	Attractive to Honey bees (HB), Bumble bees (BB), or solitary bees (SB)	Pollination services (Y/N)	Application	PMRA label restrictions	Potential for oral exposure (Y/N)	Potential for contact exposure on field (Y/N)	Notes and Overall conclusion regarding exposure potential for pollinators	Overall risk conclusion*
				and bushberry: *Do not apply pre-bloom or during bloom or when bees are actively foraging.*				potential for risk, based on blueberry, representing post-bloom application.
13: Small fruit and berries Subgroup 13B: Bushberry representative crop: highbush blueberry	HB (Pollen and Nectar), BB, SB	Y (for some crops)	FO	Bushberry: *Do not apply immediately prior to bud opening or during bloom, or when bees are actively foraging.* Blueberries*:* *Apply post-bloom after bees have been removed* Highbush blueberries (British Columbia only): *post-bloom applications only*	Y	N	For post-bloom applications, potential oral exposure is from residues in flowers the following year. **Overall, there is some potential for oral exposure.**	. Where pre-bloom applications allowed, may be potential risk based on limited information. It is uncertain whether post-bloom foliar applications may pose potential risk. Risk is expected to be reduced with longer time period between application and the bloom period next season. Post-bloom soil application may be relevant to post-bloom foliar application, and indicates minimal risk.
			SO	Caneberry and bushberry: *Do not apply pre-bloom or during bloom, or when bees are actively foraging.*	Y	N		Minimal potential for risk, based on blueberry, post-bloom application.

Crop Group	Attractive to Honey bees (HB), Bumble bees (BB), or solitary bees (SB)	Pollination services (Y/N)	Application	PMRA label restrictions	Potential for oral exposure (Y/N)	Potential for contact exposure on field (Y/N)	Notes and Overall conclusion regarding exposure potential for pollinators	Overall risk conclusion*
13: Small fruit and berries Subgroup 13D: Small Fruit Vine Climbing Representative crop: grape and fuzzy kiwifruit	HB (Pollen and Nectar), BB, SB	Y	FO	Under hazards: *'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.'*	Y	Y	**Overall there is potential for exposure.**	Foliar pre-bloom applications may pose potential risk, based on limited information. During-bloom applications may pose potential for risk. Label statements reduce potential for risk for during-bloom application.
			SO	none	Y	N		May be potential for risk in certain soil types and application rates/timing. Higher potential for risk expected with pre-bloom application in coarse/light soils.
13: Small fruit and berries Subgroup 13G: Low growing berry representative crop: strawberry	HB (Pollen and Nectar), BB, SB	Y (for some crops)	FO	Under hazards: *'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.'*	Y	Y	Pollination services are not essential for most varieties of strawberry. May improve yield. **Overall, there is potential for exposure**	Foliar pre-bloom applications may pose potential risk, based on limited information. During-bloom applications may pose potential for risk. Label statements reduce potential for risk for during-bloom application.
			SO	Low growing	Y	N		Potential for risk for strawberry,

Crop Group	Attractive to Honey bees (HB), Bumble bees (BB), or solitary bees (SB)	Pollination services (Y/N)	Application	PMRA label restrictions	Potential for oral exposure (Y/N)	Potential for contact exposure on field (Y/N)	Notes and Overall conclusion regarding exposure potential for pollinators	Overall risk conclusion*
				berries including strawberries: *Do not apply immediately prior to bud opening or during bloom or when bees are actively foraging.*				representing pre-bloom application Risk varies with soil type (potential risk identified for strawberry grown in light/coarse soil, but not in medium soil); only pollen available for consideration in risk assessment.
14: Tree Nuts Representative commodities: almond and pecan	HB (Pollen and Nectar), BB, SB	N	FO	Tree nuts: *Do not apply immediately prior to bud opening or during bloom or when bees are actively foraging.*	Y	N	**Overall, given the low acreage of tree nuts grown in Canada which may be used by bees, and application restrictions, limited exposure is expected.**	Risk potential depends on application timing. Pre-bloom application may pose potential risk. Earlier post-bloom application timing reduces risk. Risk not expected for earlier post-bloom application timing (pre-harvest). Potential risk for later post-bloom application timing (post-harvest).
15: Cereal Grains Representative commodities: corn (fresh sweet corn and dried field corn), barley, wheat	HB (corn pollen can be used); buckwheat attractive	N	ST	Seed dust mitigation. See footnote 2.	Y (for buckwheat, and for corn pollen only)	Minimal	Exposure to dust generated during planting expected to be minimal owing to label mitigation[2.] **Some potential for exposure to corn pollen (which is wind pollinated, but can be used as a source of pollen by bees).**	Minimal potential for risk.

Crop Group	Attractive to Honey bees (HB), Bumble bees (BB), or solitary bees (SB)	Pollination services (Y/N)	Application	PMRA label restrictions	Potential for oral exposure (Y/N)	Potential for contact exposure on field (Y/N)	Notes and Overall conclusion regarding exposure potential for pollinators	Overall risk conclusion*
							Buckwheat attractive to pollinators. **Negligible exposure for other crops (barley, oats, rye and wheat).**	
19: Herbs Representative commodities: basil, black pepper, chive, celery seed or dill seed.	HB (Pollen and Nectar), BB, SB	N[1]	FO	Herbs: *Do not apply immediately prior to bud opening or during bloom or when bees are actively foraging.*	Y	Y	**Overall there is potential for exposure for most crops.** **For foliar applictions, label restrictions reduce potential for exposure.**	Potential risk for pre-bloom and during-bloom applications, however, label reduces potential for exposure.
		N[1]	SO	None	Y	N		Minimal potential for risk.
20: Oilseeds Representative commodities: rape seed (canola varieties only), sunflower, cottonseed.	HB (Pollen and Nectar), BB, SB	Y	ST	None	Y	N	Not harvested prior to bloom. **Overall there is potential for exposure.**	Minimal potential for risk.
No associated crop group *Hops, peanut and Tobacco*	HB (Some crops only have pollen), BB, SB	N	FO	<u>Under hazards:</u> *'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*	Y	Y	Tobacco may be harvested before bloom. Hops are only registered for foliar application. **Overall there may be some potential for exposure. However, these crops are not considered attractive to most bees.**	Potential risk identified for pre-bloom and during-bloom applications, however label reduces potential for risk.

Crop Group	Attractive to Honey bees (HB), Bumble bees (BB), or solitary bees (SB)	Pollination services (Y/N)	Application	PMRA label restrictions	Potential for oral exposure (Y/N)	Potential for contact exposure on field (Y/N)	Notes and Overall conclusion regarding exposure potential for pollinators	Overall risk conclusion*
				site.'				
			SO	none	Y	N		Minimal potential for risk.
No associated crop group *Christmas trees*	None	N	FO	none	N	N	**Overall, there is minimal potential for exposure.**	Negligible risk
Turf grass sites, including, but not limited to: lawns, golf courses, turfgrass in parks, recreational areas, sod farms, turf soil, crops grown for seed for subsequent planting as turf	Pollinator attractive only if turf contains flowering plants that are bee attractive (e.g., clover, dandelions)	N	FO	*'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.'* Irrigation is required following application.	Y	Y	Potential for exposure from flowering weeds. Attractiveness to bees would depend on the type of weed. **Overall there is potential for exposure if turf contains bee attractive plants.** **Minimal exposure for turf on golf course or sod farms where few weeds present.**	Minimal potential for risk. The current label restrictions requiring irrigation following application are expected to minimize risk.
			SO	None Irrigation is required following application.	Y	N		Minimal potential for risk. The current label restrictions requiring irrigation following application are expected to minimize risk.

FO = foliar, SO = soil, ST = seed treatment
* Compiled from Tables 2, 3, and 4 of the Science Evaluation.
[1] Unless grown for seed. Typically not grown for seed in Canada.
[2] Corn and soybean seed treatment products are required to have the following label language:
ENVIRONMENTAL HAZARDS
Imidacloprid is toxic to bees. Dust generated during planting of treated seed may be harmful to bees and other pollinators. To help minimize the dust generated during planting, refer to the complete guidance "Pollinator Protection and Responsible Use of Treated Seed- Best Management Practices" on the Health Canada webpage on pollinator protection at www.healthcanada.gc.ca/pollinators. When using a seed flow lubricant with corn seed treated with <PRODUCT>, only a dust-reducing fluency agent is permitted. Talc and graphite are not permitted to be used as a seed flow lubricant for corn seed

treated with this insecticide. Carefully follow use directions for the seed flow lubricant. Do not load or clean planting equipment near bee colonies, and avoid places where bees may be foraging, such as flowering crops or weeds. When turning on the planter, avoid engaging the system where emitted dust may contact honey bee colonies. Spilled or exposed seeds and dust must be incorporated into the soil or cleaned up from the soil surface.

LABELLING OF TREATED SEED

Imidacloprid is toxic to bees. Dust generated during planting of treated seed may be harmful to bees and other pollinators.

To help minimize the dust generated during planting, refer to the complete guidance “Pollinator Protection and Responsible Use of Treated Seed- Best Management Practices” on the Health
Canada webpage on pollinator protection at www.healthcanada.gc.ca/pollinators.

When using a seed flow lubricant with this treated seed, only a dust-reducing fluency agent is permitted. Talc and graphite are not permitted to be used as a seed flow lubricant for corn seed treated with this insecticide. Carefully follow use directions for the seed flow lubricant.

Do not load or clean planting equipment near bee colonies, and avoid places where bees may be foraging, such as flowering crops or weeds.

When turning on the planter, avoid engaging the system where emitted dust may contact honey bee colonies.

Spilled or exposed seeds and dust must be incorporated into the soil or cleaned up from the soil surface.

Appendix IV Tier I: Toxicity endpoint selection

Table 1 Toxicity Endpoints Selected for Use in the Tier I Risk Assessment for Honey Bees

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

[1] Atkins et al. 1981

Table 2 Toxicity Endpoints Available for Use in the Tier I Risk Assessment for Non-*Apis* Bees

Test Species	Test Item	Exposure	Endpoint Value (µg a.i./bee)	Comments	Reference
Bumble bee *(Bombus terrestris)*	Technical (98.6% Imidacloprid)	Contact exposure on thorax, 72-hr observation period	LD_{50}: Unable to calculate, estimated at approximately 0.1 µg a.i./bee (47% mortality)	Adult mortality was 0, 47, 83, 83, 83 and 87% after 72 hrs at doses of 0, 0.1, 4, 8, 31, 65 and 101 µg a.i./bee, respectively. Abnormal effects, described as "frozen behaviour" at which the bumblebees are motionless except for a little trembling of body parts like abdomen, antennae or tarsus, were observed in all test concentrations (0.1-101 µg a.i./bee). These effects were observed during entire test period of 72 hrs. Acute contact LD_{50} for bumble bees could not be calculated as the mortality was reported as 47% at 0.1 µg a.i./bee (the lowest concentration tested) after 72 hrs with continuously increasing mortality during the observation period.	PMRA 1086422

Test Species	Test Item	Exposure	Endpoint Value (µg a.i./bee)	Comments	Reference
Bumble bee *(Bombus terrestris)*	Imidacloprid FS 350 (350 g/L imidacloprid)	Contact exposure on thorax, 96-hr observation period	LD_{50}: 85.3 µg a.i./bee (CI: 24.6-32 315) Uncertainty with this endpoint.	Adult mortality was 0, 20.0, 33.3, 26.7, 53.3 and 46.7% after 96 hrs at doses of 0, 1.23, 3.70, 11.11, 33.33 and 100 µg a.i./bee, respectively. There was a lack of dose-response relationship. The wide confidence interval associated with the estimated LD_{50} indicates a very high level of uncertainty with this endpoint. Moribund, affected and apathetic bumble bees were observed at all tested dose levels during the entire test period of 96 hrs.	PMRA 2513415
Bumble bee *(Bombus terrestris)*	Technical (98.6% Imidacloprid)	Oral single dose; 72-hr observation period	LD_{50}: 0.15 µg a.i./bee (CI: not determined)	Adult mortality was 0, 13, 97, 100, 100 and 100% after 72 hrs at doses of 0, 0.11, 0.33, 0.53, 0.72 and 0.96 µg a.i./bee, respectively. The ED_{50} (motionless, spasms and paralysis) was estimated to be <0.11 µg a.i./bee, the lowest test dose where effects were observed during 72-hrs of study period.	PMRA 1086421
Hornfaced bee *(Osmia cornifrons)*	Provado 1.6F (imidacloprid 17.4%)	Contact exposure on thorax; 48-hr observation period	LD_{50}: 0.66 µg a.i./bee (CI: 0.287 – 2.19)	The fungicide fenbuconazole was mixed with imidacloprid and also tested. This combination enhanced the effects of imidacloprid slightly, but not significantly.	Biddinger et al., 2013
Bumble bee *(Bombus terrestris)*	Confidor (imidacloprid 17.8%)	Contact exposure on thorax; 72-hr observation period	*Imidacloprid dissolved in water:* LD_{50}: 0.39 µg a.i./bee (CI: not determined) *Imidacloprid dissolved in acetone:* LD_{50}: 0.0053 µg a.i./bee (CI: not determined)	*Imidacloprid dissolved in water:* The contact LD_{50} for Confidor dissolved in water was 160, 19 and 2.2 µg product/bee after 24, 48 and 72 hours, respectively. These values represent approximately 50, 6 and 1 times the field dose, respectively. Based on a guarantee of 17.8% imidacloprid in Confidor, the reviewer calculated the LD_{50} to be 0.39 µg a.i./bee after a period of 72 hours. *Imidacloprid dissolved in acetone:* The contact LD_{50} for Confidor dissolved in acetone was 2.5, 0.08 and 0.03 µg product/bee after 24, 48 and 72 hours, respectively. These values represent approximately 1, 1/40 and 1/100 times the field dose, respectively. Based on a guarantee of 17.8% imidacloprid in Confidor, the reviewer calculated the LD_{50} to 0.0053 µg a.i./bee after a period of 72 hours.	Bortolotti et al., 1999
Bumble bee *(Bombus terrestris)*	imidacloprid (not reported)	Contact exposure between coxae; 72-hr observation period	LD_{50}: 0.02 µg/bee (CI: not determined)	No comments.	Marletto et al., 2003
Bumble bee *(Bombus impatiens)* Alfalfa leafcutting bee	imidacloprid >95%	Potter spray tower exposure; 48-hr observation period	*Bombus impatiens:* LC_{50}: 32.2 µg/kg of bee (CI: not determined)	These endpoints were converted by the reviewer based on the assumption that density of the test solution is 1 g/ml. Reported results were concentrations expressed as percentage of solution (wt:vol) (x 10^{-3}):	Scott-Dupree et al., 2009

Test Species	Test Item	Exposure	Endpoint Value (µg a.i./bee)	Comments	Reference
(Megachile rotundata) Orchard mason bee *(Osmia lignaria)*			*Megachile rotundata:* LC_{50}: 1.7 µg/kg of bee (CI: not determined) *Osmia lignaria*: LC_{50}: 0.7 µg/kg of bee (CI: not determined)	*B impatiens:* LC_{50}=3.22 (95% Fiducial Limits 2.54 - 4.10) *M. rotundata:* LC_{50}=0.17 (FL: 0.14 – 0.21) *O. lignaria:* LC_{50}=0.07 (FL: 0.06 – 0.09)	
Stingless bee *(Nannotrigona perilampoides)*	imidacloprid (not reported)	Contact exposure on thorax; 24-hr observation period	LD_{50}: 0.001 µg/bee (95% CI: 0.0008 – 0.0015)	No comments.	Valdovinos-Nunez et al., 2009
Bumble bee *(Bombus terrestris)*	Confidor (imidacloprid 17.8%)	Oral single dose; 72-hr observation period	LD_{50}: 0.0046 µg a.i./bee (CI: not determined)	The oral LD_{50} for Confidor was 0.04, 0.03 and 0.026 µg product/bee after 24, 48 and 72 hours, respectively. These values represent approximately 1/100 of the field dose. Based on a guarantee of 17.8% imidacloprid in Confidor, the reviewer calculated the LD_{50} to be 0.0046 µg a.i./bee after a period of 72 hours.	Bortolotti et al., 1999
Bumble bee *(Bombus terrestris)*	imidacloprid (not reported)	Oral single dose for 15 minutes; 24 and 72-hr observation period	*24 hours:* LD_{50}: 0.04 µg/bee (CI: not determined) *72 hours:* LD_{50}: 0.02 µg/bee (CI: not determined)	No comments.	Marletto et al., 2003
Stingless bee *(Melipona quadrifasciata anthidioides)*	imidacloprid (700 g a.i./L)	Oral single dose; 24-hr observation period	LD_{50}: 0.0235 µg a.i./bee (CI: not determined)	*Flight activity:* Flight activity in imidacloprid-exposed bees was greatly compromised, with the bees not reaching heights above 35 cm when all control bees could reach a height of 120 cm. Imidacloprid also significantly impaired the free-fall flight of the workers, which were unable to recover from the initial free-fall after being released, unlike the unexposed workers. Other results were available in this article but they were written in relation to other pesticides tested and actual values were not included for comparison.	Tome et al., 2015
Bumble bee *(Bombus impatiens)*	Imidacloprid (technical standard)	*Experiment 1:* Oral chronic dose fed for 14 days followed by untreated food	*Brood production (pulsed after 14 days):* EC_{50}: 1.44 ppb (CI: not	*Experiment 1 (pulsed treatment for 14 days):* <u>Brood production:</u> On day 14 of 'on-dose', fewer brood were produced as dosage increased up to 98 ppb imidacloprid. EC_{50} = 1.44 ppb	Laycock and Cresswell, 2013

Test Species	Test Item	Exposure	Endpoint Value (µg a.i./bee)	Comments	Reference
		for 14 days; daily observations for 28 days total *Experiment 2:* Oral chronic dose fed for 28 days; daily observations for 28 days total	determined) *Pollen consumption (pulsed after 14 days):* EC_{50}: 4.4 ppb (CI: not determined) *Syrup consumption (pulsed after 14 days):* EC_{50}>98 ppb (CI: not determined) *Brood production (pulsed after 28 days):* EC_{50}>98 ppb (CI: not determined) *Pollen consumption (pulsed after 28 days):* EC_{50}: 43.7 ppb (CI: not determined) *Syrup consumption (pulsed after 28 days):* EC_{50}>98 ppb (CI: not determined)	On day 14 of 'off-dose', dosage did not significantly impact brood production. Over the entire 28-day pulsed exposure, total brood production was not significantly correlated with imidacloprid dosage EC_{50}>98 ppb <u>Oviposition:</u> Where brood were produced, imidacloprid did not affect the timing of first ovipositon during the 'on dose' period, but it delayed oviposition in the subsequent 'off dose' period. <u>Food consumption:</u> During pulsed exposure, dose-dependent reductions were observed while 'on dose'. Reduced pollen consumption: EC_{50}= 4.4 ppb Reduced syrup consumption: EC_{50}>98 ppb During the 'off dose' period for pulsed exposure, colonies showed dose-dependent recovery of both syrup and pollen consumption. For the entire 28-day pulsed exposure period, the quantity of syrup and pollen consumed in colonies decreased as imidacloprid dosage increased. Reduced pollen consumption: EC_{50}=43.7 ppb Reduced syrup consumption EC_{50} >98 ppb *Experiment 2 (continuous treatment for 28 days):* <u>Brood production:</u> Brood production remained repressed under continuous exposure at 98 ppb over 28 days. After 28 days, colonies dosed at 98 ppb imidacloprid displayed significantly lower brood production compared to control.	
Bumble bee *(Bombus terrestris)*	Confidor SC (imidacloprid 20%)	*Experiment 1:* Oral chronic dose fed for 11 weeks (77 days); observations made every 3 days for the first 3 observations then weekly for the remainder of the 11 week period *Experiment 2:* Bees were	*Experiment 1 (without foraging):* LC_{50}: 59 ppb (estimated by reviewer to be equivalent to 16.3 ng a.i./bee/day) (CI: 52 – 68) *Experiment 2 (with foraging):* LC_{50}: 20 ppb (estimated by reviewer to be equivalent to	*Experiment 1 (without foraging):* 100% mortality was seen after a few hours, 14, 28 and 49 days in the 200, 20, 2 and 0.2 ppm treatments, respectively. 0 and 15% mortality was seen in the 10 and 20 ppb treatments. Sublethal effects were evaluated and in the nests exposed to concentrations of imidacloprid up to 0.2 ppm, drone production was significantly lower. Imidacloprid at 20 and 10 ppb did not pose sublethal effects on the nest reproduction. *Experiment 2 (with foraging):* 100% mortality was seen after a few hours, 7, 14 and 49 days in the 200, 20, 2 and 0.2 ppm treatments, respectively. 0% mortality	Mommaerts et al., 2010

Test Species	Test Item	Exposure	Endpoint Value (µg a.i./bee)	Comments	Reference
		initially trained to forage from feeder, then supplied with oral chronic dose fed for 11 weeks (77 days); observations made every 3 days for the first 3 observations then weekly for the remainder of the 11 week period	5.54 ng a.i./bee/day) (CI: 19 - 21)	in 10 ppb and 50% in the 20 ppb after 49 days. Significant sublethal effects were observed in the nests treated with imidacloprid where at 200, 20, 2 and 0.2 ppm and 20 ppb, 0 ± 0, 0 ± 0, 0 ± 0, 4.8 ± 4.0 and 7.0 ± 6.4 drones were observed, respectively. The total loss with 200, 20 and 2 ppm was due to the high worker mortality. For imidacloprid at 0.2 ppm and 20 ppb, significantly lower numbers of drones were produced as a consequence of the high worker mortality in these nests. In the lowest concentration tested, 10 ppb, significantly lower numbers of drones (10.8 ± 7.2) were observed compared to the controls (28.4 ± 2.9).	

Appendix V Tier I: Refined Risk Assessment for Imidacloprid

Table 1 Foliar Application: Acute Dietary Risk to Different Bee Castes Based on Maximum Residues of Imidacloprid

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)		Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees			
Cherry Applied at 5 x112 g a.i./ha post-bloom at intervals of 8-10 days. (seasonal rate 560 g a.i./ha) Year 1 (Y1) applied in fall after cherry harvest: sampled 205-219 DALA Year 2 (Y2) applied in summer before cherry harvest: sampled 274 – 303 DALA	Y1: 965.4 pollen from flowers	Y1: 7.8 nectar from flowers	**Yes (0.61)**	**Yes (2.7)**	Single application rate in study higher than registered single rate on cherries and other orchard/tree crops. Seasonal rate exceeds registered seasonal rates on cherries and other orchard/tree crops. Post-bloom scenario consistent with labelled use on cherries and other orchard/tree crops Pre-bloom scenario not represented. Two post-bloom application timings are represented: pre-harvest or post-harvest application.	There is a potential for acute dietary risk to adult bees following post-bloom foliar applications on cherry with post-harvest application timing. No acute dietary risk is expected from post-bloom foliar applications with pre-harvest application timing; indicating that application timing may affect acute dietary risk to adult bees.	**CG 12: Stone fruit** [e.g. peach, plum, cherries] *Registered at 2-5 x 48-55 g a.i./ha (seasonal rate 276 g a.i./ha)* *(post-bloom)* **Potentially Relevant for Other Labelled Crop(s):** **CG 11: Pome fruit** *Registered at 2 x 48-91 g a.i./ha (seasonal rate 182 g a.i./ha) (post-bloom)* **CG 14: Tree nuts** *Registered at 2 x 48-55 g a.i./ha (seasonal rate 110 g a.i./ha) (pre-bloom and post-bloom)*
	Y2: 50.8 pollen from flowers	Y2: 1.3 nectar from flowers	No (0.10)	No (0.18)			

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)		Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees			
Cotton Various application scenarios at bloom (1 x 71 g a.i./ha) and pre-bloom (5 x 68 g a.i./ha at intervals of 5-8 days). Sampled 6-50 DALA.	53 pollen from cotton	61.5 nectar from flowers	**Yes (4.7)**	**Yes (2.3)**	Residue levels may be representative of one application during bloom or several pre-bloom applications. However, many applications during bloom, and pollen/nectar residue levels on directly sprayed flowers are not represented. Other studies on cotton and tomato have multiple applications during bloom; however a soil application earlier in the season increased residues in pollen and nectar and complicates the interpretation of results. The LOC would be exceeded using residues from the soil + foliar studies. The cotton residues also have additional imidacloprid treatments (seed treatment or soil applications in previous years), but contribution of these additional treatments to residue levels is relatively low. For crops harvested before bloom, pollinator exposure is not expected. For crops that are not bee-attractive, exposure is not expected.	There is a potential for acute dietary risk to adult bees following pre-bloom and during-bloom foliar applications in cotton.	**Not a registered crop in Canada**. **Potentially Relevant for Other Labelled Crop(s):** Turf; Potatoes; CG1B: Root vegetables (except sugar beet); CG1D: Tuberous & corm vegetables; CG2: Leaves of root & tuber vegetables; CG4A: Leafy greens; Globe artichoke; CG5: Brassica leafy vegetables; CG6: Legume vegetables; Soybeans; CG8: Fruiting vegetables; G13A: Caneberry; CG13B: Bushberry; CG13F: Berry & small fruit vines; CG 13G: Low growing berry; CG19: Herbs; Hops; Peanut; Tobacco *Refer to summary of imidacloprid application rates table for use pattern*

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)		Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees			
Orange Foliar spray pre-bloom (2 x 280.5 g a.i./ha). Sampled 3-44 DALA.	3705 pollen from flower	409 nectar from flower	**Yes (32)**	**Yes (24)**	**S**tudied single and seasonal application rates are higher than registered rates. Pre-bloom applications are not permitted in orchard crops, but permitted in tree nuts and pistachio. Even though pre-bloom applications are of interest for some tree crops, citrus trees may not be representative of tree crops found in Canada. The pre-bloom application timing of the orange study may thus not adequately represent the Canadian tree crops with pre-bloom application.	There is a potential for acute dietary risk to adult bees following pre-bloom foliar applications on citrus.	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):** **CG 14: Tree nuts** (pre-bloom) *Registered at 2 x 48-55 g a.i./ha (seasonal rate 110 g a.i./ha) (pre-bloom and post-bloom)* [may not be relevant - see considerations]
Clover Treated cotton seed planted in 2012 (54 g a.i./ha) followed by foliar applications in 2012 (5 x 68 g a.i./ha). Sampled clover in 2013 at 405-447 DALA.	8.2 pollen from bees	2 nectar from flowers	No (0.15)	No (0.09)	Foliar applications in cotton within range of registered single and seasonal rates for other agricultural crops. Seasonal rate of 394 g a.i./ha when combining foliar applications and seed treatment, which is slightly higher than labelled maximum seasonal rates for foliar applications. For rotational crops that are not bee-attractive, exposure is not expected.	No acute risk estimated for adult bees foraging in rotational crops grown in soils where imidacloprid had previously been applied as a foliar application.	**Rotational forage crops**

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

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
Note: adult acute oral LD_{50} = 0.0038 μg a.i./bee for TGAI

Table 2 Foliar Application: Chronic Dietary Risk to Different Bee Castes Based on Highest Mean Residues of Imidacloprid

Sampled Crop	EEC - highest mean residue value in ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
Cherry Applied at 5 x 112 g a.i./ha post-bloom at intervals of 8-10 days. (seasonal rate 560 g a.i./ha) Year1 (Y1) applied in fall after cherry harvest: sampled 205 - 219 DALA Year 2 (Y2) applied in summer before cherry harvest: sampled 274 – 303 DALA	Y1: 509 pollen from flowers	Y1: 3.4 nectar from flowers	**Yes (6.3)**	**Yes (34)**	**Yes (1.2)**	Single application rate in study higher than registered single rate on cherries and other orchard/tree crops. Seasonal rate exceeds registered seasonal rates on cherries and other orchard/tree crops. Post-bloom scenario consistent with labelled use on cherries and other orchard/tree crops Pre-bloom scenario not represented. Two post-bloom application timings are represented: pre-harvest or post-harvest application.	There is a potential for chronic dietary risk to adult bees following post-bloom foliar applications on cherry with both pre-harvest and post-harvest application timing. There is a potential for chronic dietary risk to bee brood following post-bloom foliar applications on cherry with post-harvest application timing. No chronic dietary risk to bee brood is indicated from post bloom foliar applications with pre-harvest application timing; indicating that application timing may affect chronic dietary risk to bee brood.	**CG 12: Stone fruit** [e.g. peach, plum, cherries] *Registered at 2-5 x 48-55 g a.i./ha (seasonal rate 276 g a.i./ha)* *(post-bloom)* **Potentially Relevant for Other Labelled Crop(s):** **CG 11: Pome fruit** *Registered at 2 x 48-91 g a.i./ha (seasonal rate 182 g a.i./ha)* *(post-bloom)* **CG 14: Tree nuts** *Registered at 2 x 48-55 g a.i./ha (seasonal rate 110 g a.i./ha)* *(pre-bloom and post-bloom)*
	Y2: 20.3 pollen from flowers	Y2: 1.0 nectar from flowers	**Yes (1.8)**	**Yes (2.1)**	No (0.11)			

Sampled Crop	EEC - highest mean residue value in ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
Cotton Various application scenarios at bloom (1 x 71 g a.i./ha) and pre-bloom (5 x 68 g a.i./ha at intervals of 5-8 days). Sampled 6-50 DALA.	24.8 pollen from cotton	52.2 nectar from flowers	**Yes (95)**	**Yes (47)**	**Yes (3.5)**	Residue levels may be representative of one application during bloom or several pre-bloom applications. However, many applications during bloom and pollen/nectar residue levels on directly sprayed flowers are not represented. Other studies on cotton and tomato have multiple applications during bloom; however a soil application earlier in the season increased residues in pollen and nectar and complicates the interpretation of results. The LOC would be exceeded using residues from the soil + foliar studies. The cotton residues also have additional imidacloprid treatments (seed treatment or soil applications in previous years), but contribution of these additional treatments to residue levels is relatively low. For crops harvested before bloom, pollinator exposure is not expected. For crops that are not bee-attractive, exposure is not expected.	There is a potential for chronic dietary risk to adult bees and bee brood following pre-bloom and during-bloom foliar applications in cotton.	**Not a registered crop in Canada**. **Potentially Relevant for Other Labelled Crop(s):** Turf; Potatoes; CG1B: Root vegetables (except sugar beet); CG1D: Tuberous & corm vegetables; CG2: Leaves of root & tuber vegetables; CG4A: Leafy greens; Globe artichoke; CG5: Brassica leafy vegetables; CG6: Legume vegetables; Soybeans; CG8: Fruiting vegetables; G13A: Caneberry; CG13B: Bushberry; CG13F: Berry & small fruit vines; CG 13G: Low growing berry; CG19: Herbs; Hops; Peanut; Tobacco *Refer to summary of imidacloprid application rates table for use pattern.*

Sampled Crop	EEC - highest mean residue value in ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
Orange Foliar spray pre-bloom (2 x 280.5 g a.i./ha). Sampled 3-44 DALA.	2878 pollen from flower	301 nectar from flower	**Yes (550)**	**Yes (436)**	**Yes (25.8)**	Studied single and seasonal application rates are higher than registered rates. Pre-bloom applications are not permitted in orchard crops, but permitted in tree nuts and pistachio. Even though pre-bloom applications are of interest for some tree crops, citrus trees may not be representative of tree crops found in Canada. The pre-bloom application timing of the orange study may thus not adequately represent the Canadian tree crops with pre-bloom application.	There is a potential for chronic dietary risk to adult bees and bee brood following pre-bloom foliar applications on citrus.	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):** **CG 14: Tree nuts** (pre-bloom) *Registered at 2 x 48-55 g a.i./ha (seasonal rate 110 g a.i./ha) (pre-bloom and post-bloom)* [may not be relevant - see considerations]
Clover Treated cotton seed planted in 2012 (54 g a.i./ha) followed by foliar applications in 2012 (5x68 g a.i./ha). Sampled clover in 2013 at 405-447 DALA.	1.57 pollen from bees	1 nectar from flowers	**Yes (1.8)**	No (0.97)	No (0.07)	Foliar applications in cotton within range of registered single and seasonal rates for other agricultural crops. Seasonal rate of 394 g a.i./ha when combining foliar applications and seed treatment For rotational crops that are not bee-attractive, exposure is not expected.	There is a potential for chronic dietary risk for adult bees foraging in rotational crops grown in soils where imidacloprid has previously been applied as a foliar application. No chronic dietary risk was estimated for bee brood.	**Rotational forage crop**

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

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

[1] 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 = 0.00016 µg a.i./bee/day for adult worker bees for TGAI; 21-d NOEL = 0.0018 µg a.i./larvae/day for bee larvae for TGAI

Table 3 Soil Application: Acute Dietary Risk to Different Bee Castes Based on Maximum Residues of Imidacloprid

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)		Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees			
Tomato (coarse soil) In-furrow at 1 x 422 g a.i./ha sampled 31-77 DALA	226 pollen from bees	n/a	No (0.0024)	**Yes (0.57)**	Tomato plants provide mainly pollen and only pollen was sampled. Tomato plants are not an important source of nectar. To have only pollen residues is a limitation when expanding to fruiting vegetables other than tomato and to other crop groups. Therefore information from other residue studies where nectar was sampled is further considered for crops in CG8 that provide both pollen and nectar. The two tomato studies were at different rates. Studied rates are within registered rates for fruiting vegetables (although slightly lower than maximum rate) and other crops. The timing between application and sampling was considered applicable for other crops in CG8. Pollen sampled from bees may have lower residues compared to samples taken from the anther.	There is a potential for acute dietary risk to adult nurse bees from soil applications in tomato. No risk to nectar foragers was indicated in tomato. Risk was highest in coarse soil followed by medium then heavy/fine soil. Studied rates in the chemigation study were lower and a soil containing more sand (such as a coarse soil) was not included in the study design, and therefore results were not completely comparable to the in-furrow study. It is postulated that higher organic matter in the soil may bind imidacloprid and thus make it less available for uptake (and systemic transport). The relationship with soil type is less pronounced in the tomato studies than in other studies (such as strawberry).	**Crops that mainly produce pollen from Crop Group 8: Fruiting vegetables (except cucurbits)** *Registered at 1x 93.36 - 560g a.i./ha for single application*
Tomato (medium soil) In-furrow at 1 x 422 g a.i./ha sampled 31-77 DALA	111 pollen from bees	n/a	No (0.0012)	No (0.28)			
Tomato (fine soil) In-furrow at 1 x 422 g a.i./ha sampled 31-77 DALA	162.3 pollen from bees	n/a	No (0.0018)	**Yes (0.41)**			
Tomato (medium soil) Chemigation at 1 x 202 g a.i./ha sampled 79-102 DALA	48.7 pollen from anther	n/a	No (0.0005)	No (0.12)			
Tomato (heavy soil [fine soil]) Chemigation at 2 x 140 g a.i./ha sampled 79-102 DALA	26.7 pollen from anther	n/a	No (0.0003)	No (0.068)			
Melon (medium soil) Drip irrigation	28.8 pollen from hive	6.4 nectar from hive	**Yes (0.49)**	No (0.31)	Both pollen and nectar were sampled in the hive, which may result in lower residues	There is a slight acute dietary risk to adult nectar forager bees from soil	**Crop Group 9: Cucurbit vegetables** *Registered at 1x*

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)		Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees			
at 1 x 404 g a.i./ha sampled 125 DALA					compared to collection from the plant. Residues in the hive may be diluted.	applications in melon based on hive residues. No dietary risk to adult bees was indicated in heavy/fine soils. It is postulated that higher organic matter in the soil may bind imidacloprid and thus make it less available for uptake (and systemic transport).	*20.5-586.9 g a.i./ha.* **Potentially Relevant for Other Labelled Crop(s):** **Potato:** *Registered at 1x 100-480 g a.i./ha* **CG 1B: Root vegetables (except sugar beet); CG 1D: Tuberous and corm vegetables (except potatoes)** and; **CG 2: Leaves of root and tuber vegetables:** *Registered at1x 100-408 g a.i./ha.* **CG4A: Leafy greens subgroup; CG4B: Leafy petioles subgroup** and; **CG19: Herbs:** *Registered at 1x 79.92-480 g a.i./ha.* **CG5: Brassica leafy vegetables:** *Registered at 1x*
Melon (heavy soil [fine soil]) Drip irrigation at 1 x 404 g a.i./ha sampled at 118 DALA	8.3 pollen from bees	2.7 nectar from in-hive	No (0.21)	No (0.12)	The rate yielding the highest residues in the melon study that were used in the risk assessment (1 x 404 g a.i./ha) is within rates for CG9 (slightly lower than maximum rate of 1 x 586 g a.i./ha). Application was made early in the season, which is relevant to typical agricultural practices. The timing between application and sampling (>100 DALA) was longer in melon compared to the pumpkin study described below and is thought to have resulted in lower residues. Residues from the pumpkin study will also be considered in the risk assessment to provide a range of relevant residues.		

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)		Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**			
Pumpkin Transplant water at 1 x 422 g a.i./ha; sampled approx. 35 DALA	86.6 pollen from flowers	11.9 nectar from flowers	**Yes (0.92)**	**Yes (0.66)**	The rate in the study (1 x 422 g a.i./ha) is lower than the maximum rate in CG9 (586 g a.i./ha) and comparable to the maximum rate for most labelled crops (400 to 520 g a.i./ha). Applications in both the pumpkin and the melon study were made early in growing season which is considered applicable. However, sampling was made at 35 DALA in the pumpkin study compared to >100 DALA in the melon study, which resulted in higher residues in pumpkin. Residues from the pumpkin study were sampled from the plant which is expected to result in conservative (higher) residues compared to residues sampled from the hive.	There is a potential for acute dietary risk for adult bees from soil applications in pumpkin.	*86.6-520 g a.i./ha.* **CG6: Legume vegetables (except dry soybean)**; **Peanut:** *Registered at1x 100-400 g a.i./ha.* **CG8: Fruiting vegetables:** R*egistered at1x 93-560 g a.i./ha.* **CG13F: Berry and small fruit vines, including grapes and; CG13G: Low growing berry:** *Registered at1x 100-480 g a.i./ha.* **Tobacco:** *Registered at1x 113-453 g a.i./ha.*
Pumpkin Transplant water at 1x 211 g a.i./ha followed by drip irrigation at 1 x 211 g a.i./ha; sampled 14 DALA	101 pollen from flowers	16 nectar from flowers	**Yes (1.2)**	**Yes (0.84)**	The total amount applied to pumpkins is comparable to the above scenario. Higher residues are thought to be related to the shorter interval between last application and sampling. To have two seasonal soil applications is however not permitted in Canada.		

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)		Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees			
Pumpkin Transplant water at 1x 280 g a.i./ha; sampled 35 DALA	40.1 pollen from flowers	7.3 nectar from flowers	**Yes (0.56)**	No (0.37)	Studied rate within range of rates for CG9 even though lower than the maximum rate. Studied rate is similar to the rate for CG13, cranberry, bushberry, turf and ornamentals (288 g/ha).	There is a potential for acute dietary risk for adult forager bees from soil applications in pumpkin at a mid-range application rate.	**Crop Group 9: Cucurbit vegetables** *Registered at 1x 20.5-586.9 g a.i./ha.* **Potentially Relevant for Other Labelled Crop(s):** **Cranberry** and; **CG13A: Caneberry:** *Registered at1x 288 g a.i./ha* **CG 13B: Bushberry:** R*egistered at1x 65.1-288 g a.i./ha* **Turf** and; **Ornamentals (herbaceous species):** *Registered at 1x 280 g a.i./ha*
Pumpkin Soil drench 1x 30 g a.i./ha; sampled 35 DALA	6.7 pollen from flowers	0.5 nectar from flowers	No (0.04)	No (0.04)	The studied rate is similar to the minimum single application rate in CG9.	No acute dietary risk from soil applications in pumpkin at lower application rate.	**Crop Group 9: Cucurbit vegetables** *Registered at 1x 20.5-586.9 g a.i./ha.*
Strawberry (light soil [coarse soil]) Soil treatment at 1 x 560 g a.i./ha	260.2 pollen from plant	n/a	No (0.0028)	**Yes (0.66)**	The rate in the study (560 g ai/ha) is slightly higher than the maximum rate for CG13 (480 g ai/ha). Only pollen was collected, and thus there are no nectar residues for consideration. Risk quotients would be higher if residues in nectar were also considered.	Potential for acute dietary risk for nurse bees when strawberry is grown in coarse/light soil. Risk in coarse/light soil is greater than in medium soil. It is postulated that higher organic matter in the soil may bind imidacloprid and thus make it less available for uptake (and systemic transport). The potential risk associated with	**Strawberry from Crop Group 13G: Low growing berry** *Registered at 100-480 g a.i./ha.*
Strawberry (medium soil) Soil treatment at 1 x 560 g a.i./ha	6.5 pollen from plant	n/a	No (0.0001)	No (0.016)			

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)		Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees			
						nurse bees is attributed to the higher consumption of pollen (and high pollen residues in strawberry). If nectar residues are also considered a risk would likely also be identified for forager bees.	
Blueberry Post-bloom band application at 1 x 561 g a.i./ha; post-harvest; sampled 200 DALA	38.5 pollen from bees	13.8 nectar from hive	**Yes (1.06)**	**Yes (0.61)**	The rate in the study (561 g ai/ha) is much higher than the rates in CG13B (288 g/ha). However, the timing of application (post-bloom) is consistent with Canadian use pattern for blueberries. Thus residues are representative of the following year residues (sampling occurred DALA > 200 days). Residues were sampled from the hive which is expected to result in less conservative (lower) residues compared to residues sampled from the plant. Blueberry plants may be relevant to other woody plants such as ornamental trees and shrubs.	There is a potential for acute dietary risk for adult bees from soil applications in blueberry.	**Crop Group 13B: Bushberry** *Registered at 1x 65.1-288 g a.i./ha.* **Potentially Relevant for Other Labelled Crop(s):** **Cranberry and; CG13A: Caneberry** *Registered at1x288 g a.i./ha* **Ornamental trees and shrubs:** *Registered at1x280 g a.i./ha* **CG13F: Berry and small fruit vines including grapes [e.g. kiwi, grape]:** *Registered at1x100-480g a.i./ha*
Citrus Various application scenarios including soil drench at 1 x 280 or 1 x 560 g a.i./ha. Samples taken following year 200-233	6.58 pollen from in-hive	54.1 nectar from hive	**Yes (4.16)**	**Yes (2.01)**	Application rates (280 and 560 g a.i./ha) are comparable to some labelled uses. Citrus was considered for other labelled woody species. The post-bloom application timing in citrus is relevant to blueberry but not to ornamental plants; higher residues would be expected for	There is a potential for acute dietary risk for adult bees from soil application in citrus.	**Not a registered crop in Canada.** **Potentially Relevant for Other Labelled Crop(s):** **Crop Group 13B: Bushberry** *Registered at 1x 65.1-288 g a.i./ha.*

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)		Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees			
DALA.					applications during or before bloom. Citrus morphology may not be relevant to labelled woody crops. Pollen and nectar were sampled in hive. Thus residues collected from hives may be lower than that of plants.		**Ornamental trees and shrubs:** *Registered at1x280 g a.i./ha*
Cotton (coarse soil) In-furrow application at 1x 370 g a.i./ha. Sampling at 70-95 DALA	42.5 pollen from flower	123.4 nectar from hive	**Yes (9.5)**	**Yes (4.7)**	Nectar sampled from both the flower and extrafloral nectaries. Nectar residues in this table are only from floral nectar; extrafloral nectaries are unique to cotton, which is not grown in Canada. Floral nectar generally showed the highest concentrations after the in-furrow application. Studied rate similar to registered rate for Crop Groups 1B (root vegetables except sugar beet), 1D (tuberous and corm vegetables except potatoes), 2 (leaves of root and tuber vegetables, 6 (legume vegetables except soybeans), and for peanuts. However, the cotton plant biology is unique which may influence the uptake and distribution of residues; cotton less relevant to Canadian crops.	There is a potential for acute dietary risk to adult bees from soil applications in cotton. Risk to adult bees was indicated in coarse soil for nectar foragers and nurse bee and in medium soil for nectar foragers only. No risk to adult bees was indicated in fine soil. It is postulated that higher organic matter in the soil may bind imidacloprid and thus make it less available for uptake (and systemic transport).	**Not a registered crop in Canada** **See considerations**
Cotton (medium soil) In-furrow application at 1x 370 g a.i./ha. Sampling at 70-95 DALA	1.0 pollen from flower	17.1 nectar from flower	**Yes (1.3)**	No (0.6)			
Cotton (fine soil) In-furrow application at 1x 370 g a.i./ha. Sampling at 70-95 DALA	1.3 pollen from flower	1.5 nectar from hive	No (0.12)	No (0.059)			
Rotational crops (phacelia, mustard or corn; mustard had highest residues which	1.0 pollen from in-hive	0.63 nectar from bees	No (0.048)	No (0.026)	Rates within range of labelled rates, but lower than maximum rates. Residues sampled from the plant may have been higher.	No acute dietary risk to adult bees or bee brood indicated in rotational crops.	**Rotational crops**

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)		Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees			
are reported) Soil application at 95.4 g a.i./ha or 173.4 g a.i./ha + winter barley seed treatment at 0.014 - 0.023 mg a.i./seed (62.5 - 63.2 g a.i./ha)					LOQ in clover rotation and in wildflowers: 2 ppb.		
Melon (untreated planted after treated as below) Seed-line soil drench in cantaloupe in 2009 at 1 x 258 g a.i/ha + 1 x 314 g a.i./ha and 2010 at 1 x 314 g a.i./ha. No imidacloprid use in 2011. Sampling in 2011 at 199 DALA	9.6 pollen from traps	0.3 nectar in-hive	No (0.023)	No (0.035)			
Clover In-furrow treatment in potato in 1999 at 204 g a.i./ha sampling in 2001	<LOQ 1[2] pollen from bees	<LOQ 1[2] nectar from bees	No (0.077)	No (0.047)			
Wildflowers (off-field) In-furrow treatment in potato 2000 at 204 g a.i./ha sampling in 2001	<LOQ 1[2] wildflower		No (0.077)	No (0.039)	Studied rate within registered rates, but lower than all maximum seasonal rates.	No acute dietary risk to adult bees or bee brood indicated from run-off.	**Considered for Run-off**

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)		Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees			
+ in-furrow treatment in potato in 2001 at 204 g a.i./ha sampling in 2001							

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

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
Note: adult acute oral LD_{50} = 0.0038 µg a.i./bee for TGAI

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

Table 4 Soil Application: Chronic Dietary Risk to Different Bee Castes Based on Highest Mean Residues of Imidacloprid

Sampled Crop	EEC - highest mean residue value in ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
Tomato (coarse soil) In-furrow at 1 x 422 g a.i./ha sampled 31-77 DALA	185 pollen from bees	n/a	No (0.047)	**Yes (11.1)**	No (0.37)	Tomato plants provide mainly pollen and only pollen was sampled. Tomato plants are not an important source of nectar. To have only pollen residues is a limitation when expanding to fruiting vegetables other than tomato and to other crop groups. Therefore information	There is a potential for chronic dietary risk to adult nurse bees from soil applications in tomato. No risk to nectar foragers or bee brood was indicated. Risk was highest in coarse soil followed by medium then heavy/fine soil. Studied rates in the chemigation study were lower and a soil containing more sand (such as a coarse soil) was	**Crops that mainly produce pollen from Crop Group 8: Fruiting vegetables** (except cucurbits) *Registered at 1x 93.36 - 560g a.i./ha for single application*
Tomato (medium soil) In-furrow at 1 x 422 g a.i./ha sampled 31-77 DALA	103.7 pollen from bees	n/a	No (0.027)	**Yes (6.22)**	No (0.21)			
Tomato (fine soil) In-furrow at 1 x 422 g a.i./ha sampled 31-77 DALA	101 pollen from bees	n/a	No (0.026)	**Yes (6.06)**	No (0.21)			

Sampled Crop	EEC - highest mean residue value in ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
Tomato (medium soil) Chemigation at 1 x 202 g a.i./ha sampled 79-102 DALA	41.3 pollen from anther	n/a	No (0.011)	**Yes (2.48)**	No (0.083)	from other residue studies where nectar was sampled is further considered for crops in CG8 that provide both pollen and nectar. The two tomato studies were at different rates. Studied rates are within registered rates for fruiting vegetables (although slightly lower than maximum rate) and other crops. The timing between application and sampling was considered applicable for other crops in CG8. Pollen sampled from bees may have lower residues compared to samples taken from the anther.	not included in the study design and therefore results were not completely comparable to the in-furrow study. It is postulated that higher organic matter in the soil may bind imidacloprid and thus make it less available for uptake (and systemic transport). The relationship with soil type is less pronounced in the tomato studies than in other studies (such as strawberry).	
Tomato (heavy soil [fine soil]) Chemigation at 2 x 140 g a.i./ha sampled 79-102 DALA	23.8 pollen from anther	n/a	No (0.006)	**Yes (1.4)**	No (0.048)			
Melon (medium soil) Drip irrigation at 1 x 404 g a.i./ha sampled 125 DALA	14.95 pollen from hive	3.65 nectar from hive	**Yes (6.67)**	**Yes (4.09)**	No (0.27)	Both pollen and nectar were sampled in the hive, which may result in lower residues compared to collection from the plant. Residues in the hive may be diluted. The rate yielding the highest residues in the melon study and that were used in	There is a potential for chronic dietary risk for adult bees in melon. No risk estimated for bee brood. Risk in medium soil texture is greater than in heavy/fine soil. It is postulated that higher organic matter in the soil may bind imidacloprid and thus make it less available for	**Crop Group 9: Cucurbit vegetables** *Registered at 1x 20.5-586.9 g a.i./ha.* **Potentially Relevant for Other Labelled Crop(s):** **Potato:** *Registered at 1x 100-480 g a.i./ha*
Melon (heavy soil [fine soil]) Drip irrigation at 1 x 404 g a.i./ha sampled at 118 DALA	7.5 pollen from in-hive	1.85 nectar from in-hive	**Yes (3.38)**	**Yes (2.07)**	No (0.14)			

Sampled Crop	EEC - highest mean residue value in ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	**Nectar**	**Nectar forager**	**Nurse bees**	**Bee larvae**			
						the risk assessment (1 x 404 g a.i./ha) is within rates for CG9 (slightly lower than maximum rate of 1 x 586 g a.i./ha). Application was made early in the season, which is relevant to typical agricultural practices. The timing between application and sampling (>100 DALA) was longer in melon compared to the pumpkin study described below and is thought to have resulted in lower residues. Residues from the pumpkin study will also be considered in the risk assessment to provide a range of relevant residues.	uptake (and systemic transport).	**CG 1B: Root vegetables (except sugar beet); CG 1D: Tuberous and corm vegetables (except potatoes)** and; **CG 2: Leaves of root and tuber vegetables:** *Registered at1x 100-408 g a.i./ha.* **CG4A: Leafy greens subgroup; CG4B: Leafy petioles subgroup and; CG19: Herbs:** *Registered at1x 79.92-480 g a.i./ha.* **CG5: Brassica leafy vegetables:** *Registered at 1x 86.6-520 g a.i./ha.* **CG6: Legume vegetables (except dry soybean)**; **Peanut:** *Registered at 1x 100-400 g a.i./ha.* **CG8: Fruiting vegetables (FOR nectar only):** R*egistered at 1x 93-560 g a.i./ha.* **CG13F: Berry and small fruit vines, including grapes** and; **CG13G: Low**
Pumpkin Transplant water at 1x 422 g a.i./ha; sampled 35 DALA	60.9 pollen from flowers	7.4 nectar from flowers	**Yes (13.5)**	**Yes (10.1)**	No (0.62)	The rate in the study (1 x 422 g a.i./ha) is lower than the maximum rate in CG9 (586 g a.i./ha) and comparable to the maximum rate for most labelled crops (400 to 520 g a.i./ha). Applications in both the pumpkin and the melon study were made	There is a potential for chronic dietary risk for adult bees from soil applications in pumpkin. No risk estimated for bee brood.	

Sampled Crop	EEC - highest mean residue value in ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
						early in growing season which is considered applicable. However, sampling was made at 35 DALA in the pumpkin study compared to >100 DALA in the melon study, which resulted in higher residues in pumpkin. Residues from the pumpkin study were sampled from the plant which is expected to result in conservative (higher) residues compared to residues sampled from the hive.		**growing berry (FOR nectar only):** *Registered at1x 100-480 g a.i./ha.* **Tobacco:** *Registered at 1x 113-453 g a.i./ha.*
Pumpkin Transplant water at 1 x 211 g a.i./ha followed by drip irrigation at 1 x 211 g a.i./ha; sampled 14 DALA	80.2 pollen from flowers	11.2 nectar from flowers	**Yes (20)**	**Yes (15)**	No (0.91)	The total amount applied to pumpkins is comparable to the above scenario. Higher residues are thought to be related to the shorter interval between last application and sampling. To have two seasonal soil applications is however not permitted in Canada.		

Sampled Crop	EEC - highest mean residue value in ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
Pumpkin Transplant water at 1x 280 g a.i./ha; sampled 35 DALA	36.7 pollen from flowers	6.1 nectar from flowers	**Yes (11.1)**	**Yes (7.54)**	No (0.48)	Studied rate within range of rates for CG9 even though lower than the maximum rate. Studied rate is similar to the rate for CG13, cranberry, bushberry, turf and ornamentals (288 g/ha).	There is a potential for chronic dietary risk for adult bees from soil applications in pumpkin at a mid-range application rate. No risk estimated for bee brood.	**Crop Group 9: Cucurbit vegetables** *Registered at 1x 20.5-586.9 g a.i./ha.* **Potentially Relevant for Other Labelled Crop(s):** **Cranberry** and; **CG13A: Caneberry:** *Registered at1x 288 g a.i./ha* **CG 13B: Bushberry:** R*egistered at1x 65.1-288 g a.i./ha* **Turf and; Ornamentals (herbaceous species):** *Registered at 1x 280 g a.i./ha*
Pumpkin Soil drench 1x 30 g a.i./ha; sampled 35 DALA	4.9 pollen from flowers	0.4 nectar from flowers	No (0.73)	No (0.64)	No (0.04)	The studied rate is similar to the minimum single application rate in CG9.	No chronic dietary risk from soil applications in pumpkin at lower application rate.	**Crop Group 9: Cucurbit vegetables** *Registered at 1x 20.5-586.9 g a.i./ha.*
Strawberry (light soil [coarse soil]) Soil treatment at 1 x 560 g a.i./ha	231 pollen from plant	n/a	No (0.059)	**Yes (13.9)**	No (0.46)	The rate in the study (560 g ai/ha) is slightly higher than the maximum rate for CG13 (480 g ai/ha). Only pollen was collected, and thus there are no nectar residues for consideration. Risk quotients would be	Potential for chronic dietary risk for nurse bees when strawberry is grown in coarse/light soil. No risk estimated for nectar foragers or bee brood. Risk in coarse/light soil is greater than in medium soil. It is	**Strawberry from Crop Group 13G: Low growing berry** *Registered at 1x 100-480 g a.i./ha.*
Strawberry (medium soil) Soil treatment at 1 x 560 g a.i./ha	6.35 pollen from plant	n/a	No (0.0017)	No (0.38)	No (0.013)			

Sampled Crop	EEC - highest mean residue value in ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
						higher if residues in nectar were also considered.	postulated that higher organic matter in the soil may bind imidacloprid and thus make it less available for uptake (and systemic transport). The potential risk associated with nurse bees is attributed to the higher consumption of pollen (and high pollen residues in strawberry). If nectar residues are also considered a risk would likely also be identified for forager bees.	
Blueberry Post-bloom band application at 1 x 561 g a.i./ha; post harvest; sampled 200 DALA	14.78 pollen from bees	7.53 nectar from hive	**Yes (13.7)**	**Yes (7.5)**	No (0.53)	The rate in the study (561 g ai/ha) is much higher than the rates in CG13B (288 g/ha). However, the timing of application (post-bloom) is consistent with Canadian use pattern for blueberries. Thus residues are representative of the following year residues (sampling occurred DALA > 200 days). Residues were sampled from the hive which is expected to result in less conservative (lower) residues	There is a potential for chronic dietary risk to adult bees from post-bloom soil applications in blueberry. No risk estimated for bee brood.	**Crop Group 13B: Bushberry** *Registered at 1x 65.1-288 g a.i./ha.* **Potentially Relevant for Other Labelled Crop(s):** **Cranberry and; CG13A: Caneberry** *Registered at1x288 g a.i./ha* **Ornamental trees and shrubs:** *Registered at1x280 g a.i./ha* **CG13F: Berry and small fruit vines including**

Sampled Crop	EEC - highest mean residue value in ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
						compared to residues sampled from the plant. Blueberry plants may be relevant to other woody plants such as ornamental trees and shrubs.		**grapes [e.g. kiwi, grape]:** *Registered at1x100-480g a.i./ha*
Citrus Various application scenarios Soil drench at 1x280 or 1x560 g a.i./ha Samples taken following year 200-233 DALA.	6.21 pollen from hive	29.9 nectar from flowers	**Yes (55)**	**Yes (27)**	**Yes (2.01)**	Application rates (280 and 560 g a.i./ha) are comparable to some labelled uses. Citrus was considered for other labelled woody species. The post-bloom application timing in citrus is relevant to blueberry but not to ornamental plants; higher residues would be expected for applications during or before bloom. Citrus morphology may not be relevant to labelled woody crops. Pollen and nectar were sampled in hive. Thus residues collected from hives may be lower than that of plants.	There is a potential for chronic dietary risk for adult bees and bee brood from soil applications in citrus.	**Not a registered crop in Canada.** **Potentially Relevant for Other Labelled Crop(s):** **Crop Group 13B: Bushberry** *Registered at 1x 65.1-288 g a.i./ha* **Ornamental trees and shrubs** *Registered at1x280 g a.i./ha*

Sampled Crop	EEC - highest mean residue value in ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
Cotton (coarse soil) In-furrow application at 1x 370 g a.i./ha. Sampling at 70-95 DALA	40.2 pollen from in-hive	80.9 nectar from hive	**Yes (148)**	**Yes (73)**	**Yes (5.5)**	Nectar sampled from both the flower and extrafloral nectaries. Nectar residues in this table are only from floral nectar; extrafloral nectaries are unique to cotton, which is not grown in Canada. Floral nectar generally showed the highest concentrations after the in-furrow application. Studied rate similar to registered rate for Crop Groups 1B (root vegetables except sugar beet), 1D (tuberous and corm vegetables except potatoes), 2 (leaves of root and tuber vegetables, 6 (legume vegetables except soybeans), and for peanuts. However, the cotton plant biology is unique which may influence the uptake and distribution of residues; cotton less relevant to Canadian crops.	There is a potential for chronic dietary risk for adult bees and bee brood from soil applications in cotton. No risk to bee brood was indicated in fine soil. Risk to bees was greatest in coarse soil followed by medium then fine soil. It is postulated that higher organic matter in the soil may bind imidacloprid and thus make it less available for uptake (and systemic transport).	**Not a registered crop in Canada** **See considerations**
Cotton (medium soil) In-furrow application at 1x 370 g a.i./ha. Sampling at 70-95 DALA	0.6 pollen from in-hive	17.1 nectar from hive	**Yes (31)**	**Yes (15)**	**Yes (1.14)**			
Cotton (fine soil) In-furrow application at 1x 370 g a.i./ha. Sampling at 70-95 DALA	0.8 pollen from in-hive	1.5 nectar from hive	**Yes (2.74)**	**Yes (1.36)**	No (0.10)			

Sampled Crop	EEC - highest mean residue value in ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
Rotational crops (phacelia, mustard or corn; mustard had highest residues which are reported) Soil application at 95.4 g a.i./ha or 173.4 g a.i./ha + winter barley seed treatment at 0.014 - 0.023 mg a.i./seed (62.5 - 63.2 g a.i./ha)	0.79 pollen from in-hive	0.53 nectar from bees	No (0.97)	No (0.51)	No (0.037)	Rates within range of labelled rates, but lower than maximum rates. Residues sampled from the plant may have been higher. LOQ in clover rotation and in wildflowers: 2 ppb.	Risk estimates in a clover rotation study using standardized residue values and the most sensitive chronic endpoint value indicate a potential chronic risk to adult forager bees. No risk to nurse bees or bee brood was indicated.	**Rotational crops**
Melon (untreated planted after treated as below) Seed-line soil drench in cantaloupe in 2009 at 1 x 258 g a.i/ha + 1 x 314 g a.i./ha and 2010 at 1 x 314 g a.i./ha. No imidaclo-prid use in 2011. Sampling in 2011 199 DALA	9.2 pollen from traps	0.25 nectar in-hive	No (0.46)	No (0.77)	No (0.035)			
Clover In-furrow treatment in potato in 1999 at 204 g a.i./ha sampling in 2001	<LOQ 1[2] pollen from bees	<LOQ 1[2] nectar from bees	**Yes (1.83)**	No (0.94)	No (0.069)			
Wildflowers (off-field) In-furrow treatment in potato 2000 at 204 g a.i./ha sampling in 2001 +	<LOQ 1[2] wildflower	<LOQ 1[2] wildflower	**Yes (1.83)**	No (0.94)	No (0.069)	Studied rate within registered rates, but lower than all maximum seasonal rates.	Risk estimates in a clover rotation study using standardized residue values and the most sensitive chronic endpoint indicate a potential chronic risk to adult forager bees from field run off.	**Considered for Run-off**

Sampled Crop	EEC - highest mean residue value in ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
in-furrow treatment in potato in 2001 at 204 g a.i./ha sampling in 2001							No risk to nurse bees or bee brood was indicated.	

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

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

[1] 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 = 0.00016 µg a.i./bee/day for adult worker bees for TGAI; 21-d NOEL = 0.0018 µg a.i./larvae/day for bee larvae for TGAI

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

Table 5 Seed Treatment: Acute Dietary Risk to Different Bee Castes Based on Maximum Residues of Imidacloprid

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)		Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees			
Canola Applied at 50 and 78 g a.i./ha, 0.02 to 0.05 mg a.i./seeds. Sampled 55 to 65 DAP	7.6 pollen from hive	0.81 nectar from hive	No (0.06)	No (0.05)	A single value was reported in this study explaining why the mean and max concentrations are the same. Pollen and nectar sampled from hives. The registered rates are similar to the rates used in the residue studies.	No acute dietary risk to adult bees is indicated from seed treatment applications in canola.	**Canola, Rapeseed, Mustard** *Registered at 0.008 to 0.047 mg a.i./seed and 16 to 89.6 g a.i./ha*

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)		Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees			
Corn Applied at 133.28 g a.i./ha, 1.34 mg a.i./seed. Year 1 (Y1) applied in 2012 sampled 58-68 DAP Year 2 (Y2) applied in 2012 and 2013: sampled in 2013 59 to 72 DAP	Y1: 19.46 pollen from plant	n/a	No (0.0002)	No (0.05)	Residues were found in control. Pollen sampled from plant. Seed treatment rate higher than Canadian registered rate (0.63 mg a.i./seed). In separate studies, corn treated at rates more similar to registered rates had lower resides (less than LOQs of 5 ppb or 1 ppb).	No acute dietary risk to adult bees is indicated from seed treatment application in corn.	**Corn** *Registered at 0.084 to 0.630 mg a.i./seed, and 3.5 to 56.8 g a.i./ha*
	Y2: 38.5 pollen from plant	n/a	No (0.0004)	No (0.10)			
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 (0.18)	No (0.09)	Pollen and nectar not sampled.	No acute dietary risk to adult bees is indicated from seed treatment application in sweet pepper.	**Crop Group 8: Fruiting vegetables** (except cucurbits) *Registered at 0.013 to 0.083 mg a.i./seed, and 0.2 to 2.5 g a.i.//ha* **Potentially Relevant for Other Labelled Crop(s):** CG1B: root vegetables (carrot only); CG3: Bulb vegetables (leek, bulb onion, bunching onion) **Low end estimate for**: CG6: Legume vegetables (except dry soybean); CG6A Edible-podded legume vegetable subgroup (except peas) and 6C Succulent shelled pea and bean subgroup *Refer to summary of imidacloprid application rates table for use pattern*

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)		Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees			
Melon Applied at 50 and 78 g a.i./ha, 0.02 to 0.05 mg a.i./seed. Sampled 55 to 65 DAP.	7.9 whole flower	7.9 whole flower	**Yes (0.61)**	No (0.31)	Even though no measurable residues were found in pollen or nectar, it is noted that residues were found in the flower. Both pollen and nectar were sampled from hives.	There is a potential for acute dietary risk to adult bees following seed treatment application in melon.	**Crop Group 9: Cucurbit vegetables** *Registered at 0.250 mg a.i./seed, 0.56 to 6.9 g a.i./ha.* **Potentially Relevant for Other Labelled Crop(s):** CG4A: Leafy greens subgroup (lettuce); CG5: Brassica leafy vegetables (cabbage and broccoli) **High end estimate for**: CG6: Legume vegetables (except dry soybean); CG6A Edible-podded legume vegetable subgroup (except peas) and 6C Succulent shelled pea and bean subgroup *Refer to summary of imidacloprid application rates table for use pattern*
Clover Treated corn seed planted in 2012 at 133.28 g a.i./ha or 1.34 mg a.i./seed. Clover sampled >400 DALA in corn.	3.4 pollen from plant	0.9 nectar from plant	No (0.070)	No (0.042)	In clover, highest imidacloprid residues in pollen and nectar were 36.8 and 0.9 ppb, respectively. The 36.8 ppb concentration in pollen is much higher than any other imidacloprid residue concentration found in clover pollen. To illustrate this, the second highest imidacloprid concentration in clover pollen	No acute dietary risk to adult bees was indicated in rotational crops grown in soil where a seed treatment application of imidacloprid was made the preceding year.	**Rotational forage crops**

Sampled Crop	EEC - maximum residue value in ppb		Did the Acute RQ[1] exceed LOC (0.4)? (RQ)		Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees			
					was 3.4 ppb and the 90th percentile of imidacloprid concentrations in clover pollen, as reported in the study, was 2.9 ppb. The high residue value was excluded as it was considered an outlier.		

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

Bold values indicate that acute LOC (RQ ≥0.4) 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

Note: adult acute oral LD_{50} = 0.0038 µg a.i./bee for TGAI

Table 6 Seed Treatment: Chronic Dietary Risk to Different Bee Castes Based on Highest Mean Residues

Sampled Crop	EEC - highest mean residue value in ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
Canola Applied at 50 and 78 g a.i./ha, 0.02 to 0.05 mg a.i./seeds. Sampled 55 to 65 DAP	7.6 pollen from hive	0.81 nectar from hive	**Yes (1.48)**	**Yes (1.16)**	No (0.069)	A single value was reported in this study explaining why the mean and max concentrations are the same. Pollen and nectar are sampled from hives. The registered rates are similar to the rates used in the residue studies.	There is a potential for chronic dietary risk to adult bees following seed treatment applications in canola. No chronic dietary risk to bee brood was indicated.	**Canola, Rapeseed, Mustard** *Registered at 0.008 to 0.047 mg a.i./seed and 16 to 89.6 g a.i./ha*

Sampled Crop	EEC - highest mean residue value in ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
Corn Applied at 133.28 g a.i./ha, 1.34 mg a.i./seed. Year 1 (Y1) applied in 2012 sampled 58-68 DAP Year 2 (Y2) applied in 2012 and 2013: sampled in 2013 59 to 72 DAP	Y1: 11.28 pollen from plant	n/a	No (0.0029)	No (0.68)	No (0.023)	Residues were found in control. Pollen sampled from plant. Seed treatment rate higher than Canadian registered rate (0.63 mg a.i./seed). The mean concentration of 21.88 ppb was observed in the second year of treatment and is associated with a plot that shows a wider variation in residue concentrations and higher residues in general. In separate studies, corn treated at rates more similar to registered rates had lower residues (less than LOQs of 5 ppb or 1 ppb).	No chronic dietary risk to adult bees or bee brood is indicated from seed treatment applications in corn (see considerations).	**Corn** *Registered at 0.084 to 0.630 mg a.i./seed, and 3.5 to 56.8 g a.i./ha*
	Y2: 21.9 pollen from plant	n/a	No (0.0056)	**Yes (1.31)**	No (0.044)			
Sweet Pepper Applied at 12 g a.i./ha, 0.17 mg a.i./seed. Sampled 99 to 124 DAP.	<LOQ 0.5[2] whole flower	<LOQ 0.5[2] whole flower	No (0.91)	No (0.47)	No (0.03)	Pollen and nectar not sampled.	No chronic dietary risk to adult bees or bee brood was indicated from seed treatment applications in sweet pepper.	**Crop Group 8: Fruiting vegetables** (except cucurbits) *Registered at 0.013 to 0.083 mg a.i./seed, and 0.2 to 2.5 g a.i.//ha* **Potentially Relevant for Other Labelled Crop(s):** CG1B: root vegetables (carrot only);

Sampled Crop	EEC - highest mean residue value in ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
								CG3: Bulb vegetables (leek, bulb onion, bunching onion) **Low end estimate for**: CG6: Legume vegetables (except dry soybean); CG6A: Edible-podded legume vegetable subgroup (except peas) and 6C: Succulent shelled pea and bean subgroup
Melon Applied at 50 and 78 g a.i./ha, 0.02 to 0.05 mg a.i./seed. Sampled 55 to 65 DAP.	3.4 whole flower	3.4 whole flower	**Yes (6.21)**	**Yes (3.18)**	No (0.23)	Even though no measurable residues were found in pollen or nectar, it is noted that residues were found in the flower. Both pollen and nectar were sampled from hives.	There is a potential for chronic dietary risk to adult bees from seed treatment applications in melon. No risk to bee brood was indicated.	**Crop Group 9: Cucurbit vegetables** *Registered at 0.250 mg a.i./seed, 0.56 to 6.9 g a.i./ha.* **Potentially Relevant for Other Labelled Crop(s):** CG4A: Leafy greens subgroup (lettuce); CG5: Brassica leafy vegetables (cabbage and broccoli) **High end estimate for**: CG6: Legume

Sampled Crop	EEC - highest mean residue value in ppb		Did the Chronic RQ[1] exceed LOC (1.0)? (RQ)			Considerations	Risk Characterization	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Nectar forager	Nurse bees	Bee larvae			
								vegetables (except dry soybean); CG6A: Edible-podded legume vegetable subgroup (except peas) and 6C: Succulent shelled pea and bean subgroup
Clover Treated corn seed planted in 2012 at 133.28 g a.i./ha or 1.34 mg a.i./seed. Clover sampled >400 DALA in corn.	1.95 pollen from plant	0.37 nectar from plant	No (0.68)	No (0.44)	No (0.029)	In clover, highest imidacloprid residues in pollen and nectar were 36.8 and 0.9 ppb, respectively. The 36.8 ppb concentration in pollen is much higher than any other imidacloprid residue concentration found in clover pollen. To illustrate this, the second highest imidacloprid concentration in clover pollen was 3.4 ppb and the 90th percentile of imidacloprid concentrations in clover pollen, as reported in the study, was 2.9 ppb. The high residue value was excluded as it was considered an outlier.	No chronic dietary risk to adult bees or bee brood was indicated in rotational crops grown in soil where a seed treatment application of imidacloprid was made the preceding year.	**Rotational forage crops**

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

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

[1] 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 = 0.00016 µg a.i./bee/day for adult worker bees for TGAI; 21-d NOEL = 0.0018 µg a.i./larvae/day for bee larvae for TGAI

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

Appendix VI Tier I: Refined Risk Assessment for Imidacloprid Transformation Products

Table 1 Foliar Application: Acute Risk to Different Bee Castes Based on Maximum Residues of Imidacloprid Transformation Products

Compound	Matrix	EEC - maximum resiude value	Acute RQ		Did the acute RQ exceed the acute LOC for the most sensitive bee caste? (LOC=0.4)	Risk Characterization
			Nectar forager	Nurse bees		
Hydroxy-imidacloprid	Cherry Pollen	22.7	0.009	0.006	No RQ≤0.009	No acute risk to adult bees is indicated from hydroxy-imidacloprid following foliar applications with imidacloprid.
	Cherry Nectar	4.4				
	Cotton Pollen	2.1	0.003	0.002	No RQ≤0.003	
	Cotton Nectar	1.7				
	Orange Pollen	210	0.04	0.03	No RQ≤0.04	
	Orange Nectar	20				
	Clover Pollen	<LOD (0.25)	0.002	0.0009	No RQ≤0.002	
	Clover Nectar	0.9				
Olefin-imidacloprid	Cherry Pollen	32.4	0.02	0.02	No RQ≤0.02	No acute risk to adult bees is indicated from olefin-imidacloprid following foliar applications with imidacloprid.
	Cherry Nectar	1.5				
	Cotton Pollen	1.6	0.03	0.01	No RQ≤0.03	
	Cotton Nectar	2.4				
	Orange Pollen	253	0.13	0.17	No RQ≤0.17	
	Orange Nectar	10				
	Clover Pollen	5.4	0.008	0.006	No RQ≤0.008	
	Clover Nectar	0.6				

EEC = estimated environmental concentration, RQ = risk quotient
Bold values indicate that acute LOC (RQ ≥0.4) is exceeded.
Acute RQ = Acute Estimated Daily Dose/acute toxicity endpoint
Acute Estimated Daily Dose = 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
Note: adult acute oral LD_{50} = 0.151 µg a.i./bee for hydroxy-imidacloprid; 0.023 µg a.i./bee for olefin-imidacloprid

Table 2 Soil Application: Acute Risk to Different Bee Castes Based on the Maximum Residues of Imidacloprid Transformation Products

Compound	Matrix	EEC - maximum resiude value	Acute RQ		Did the acute RQ exceed the acute LOC for the most sensitive bee caste? (LOC=0.4)	Risk Characterization
			Nectar forager	Nurse bees		
Hydroxy-imidacloprid	Strawberry Pollen (light soil [coarse soil])	41.5	0.0054	0.0052	No RQ≤0.0054	No acute risk to adult bees indicated from hydroxy-imidacloprid following soil applications with imidacloprid.
	Melon Nectar (heavy soil [fine soil])	2.8				
Olefin-imidacloprid	Strawberry Pollen (light soil [coarse soil])	16.9	0.020	0.017	No RQ≤0.017	No acute risk to adult bees indicated from olefin-imidacloprid following soil applications with imidacloprid.
	Melon Nectar (medium soil)	1.6				

EEC = estimated environmental concentration, RQ = risk quotient

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

Acute RQ is equal to the acute Estimated Daily Dose/acute toxicity endpoint. Note: adult acute oral LD_{50} = 0.151 µg a.i./bee for hydroxy-imidacloprid; 0.023 µg a.i./bee for olefin-imidacloprid

Acute Estimated Daily Dose is equal to the nectar dose [(nectar consumption rate (mg/day) x maximum nectar residue (µg/kg)/ 1.0×10^6)] + pollen dose [(pollen consumption rate (mg/day) x maximum pollen residue (µg/kg)/1.0×10^6)]

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

Table 3 Seed Treatment: Acute Risk to Different Bee Castes Based on Maximum Residues of Imidacloprid Transformation Products

Compound	Matrix	EEC - maximum resiude value	Acute RQ		Did the acute RQ exceed the acute LOC for the most sensitive bee caste? (LOC=0.4)	Risk Characterization
			Nectar forager	Nurse bees		
Hydroxy-imidacloprid	Canola Pollen	<LOQ 0.5	0.001	0.0005	No RQ≤0.001	No acute risk to adult bees is indicated from hydroxy-imidacloprid following seed treatment applications with imidacloprid.
	Canola Nectar	<LOQ 0.5				
	Corn Pollen	0.9	<<0.0001	0.0001	No RQ≤0.0001	
	Pepper Pollen	<LOD 0.15	0.0003	0.0001	No RQ≤0.0003	
	Pepper Nectar	<LOD 0.15				
	Melon Pollen	1.0	0.002	0.001	No RQ≤0.002	
	Melon Nectar	1.0				
	Clover Pollen	<LOD	0.0005	0.0002	No	

Compound	Matrix	EEC - maximum residue value	Acute RQ		Did the acute RQ exceed the acute LOC for the most sensitive bee caste? (LOC=0.4)	Risk Characterization
			Nectar forager	Nurse bees		
		0.25			RQ≤0.0005	
	Clover Nectar	<LOD 0.25				
Olefin-imidacloprid	Canola Pollen	<LOQ 0.5	0.006	0.003	No RQ≤0.006	No acute risk to adult bees is indicated from olefin-imidacloprid following seed treatment applications with imidacloprid.
	Canola Nectar	<LOQ 0.5				
	Corn Pollen	0.9	<<0.0001	0.0004	No RQ≤0.0004	
	Pepper Pollen	<LOD 0.15	0.002	0.001	No RQ≤0.002	
	Pepper Nectar	<LOD 0.15				
	Melon Pollen	1.0	0.01	0.007	No RQ≤0.01	
	Melon Nectar	1.0				
	Clover Pollen	<LOD 0.25	0.003	0.002	No RQ≤0.003	
	Clover Nectar	<LOD 0.25				

EEC = estimated environmental concentration, RQ = risk quotient

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

Acute RQ is equal to the acute Estimated Daily Dose/acute toxicity endpoint. Note: adult acute oral LD_{50} = 0.151 µg a.i./bee for hydroxy-imidacloprid; 0.023 µg a.i./bee for olefin-imidacloprid

Acute Estimated Daily Dose is equal to the 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

Appendix VII Tier II: Risk Assessment for Imidacloprid

Table 1 Foliar Application: Chronic Risk Assessment for Honey Bee Hives Based on the Comparison of Measured Imidacloprid Residues and Colony Feeding Study Effects Values[a]

Sampled Crop	EEC - highest mean residue value in ppb [b]		Potential for risk from pollen or nectar? [c]		Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Pollen	Nectar			
Cherry Applied at 5 x112 g a.i./ha post-bloom at intervals of 8-10 days. (seasonal rate 560 g a.i./ha) Year1 (Y1) applied in fall after cherry harvest: sampled 205-219 DALA Year 2 (Y2) applied in summer before cherry harvest: sampled 274 – 303 DALA	Y1: 509 pollen from flowers	Y1: 3.4 nectar from flowers	Yes	No	Single application rate in study higher than registered single rate on cherries and other orchard/tree crops. Seasonal rate exceeds registered seasonal rates on cherries and other orchard/tree crops. Post-bloom scenario consistent with labelled use on cherries and other orchard/tree crops. Pre-bloom scenario not represented. Two post-bloom application timings are represented: pre-harvest or post-harvest application. For crops that are not bee-attractive, exposure is not expected.	YI: Yes When applied after cherry harvest Note: use rate greater than Canadian use rate Y2: No When applied earlier in summer before cherry harvest	**CG 12: Stone fruit** [e.g. peach, plum, cherries] *Registered at 2-5 x 48-55 g a.i./ha (seasonal rate 276 g a.i./ha)* *(post-bloom)* **Potentially Relevant for Other Labelled Crop(s):** **CG 11: Pome fruit**: *Registered at 2 x 48-91 g a.i./ha (seasonal rate 182 g a.i./ha)* *(post-bloom)* **CG 14: Tree nuts:** *Registered at 2 x 48-55 g a.i./ha (seasonal rate 110 g a.i./ha)* *(pre-bloom and post-bloom)*
	Y2: 20.3 pollen from flowers	Y2: 1.0 nectar from flowers	No	No			

Sampled Crop	EEC - highest mean residue value in ppb [b]		Potential for risk from pollen or nectar? [c]		Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Pollen	Nectar			
Cotton Various application scenarios at bloom (1 x 71 g a.i./ha) and pre-bloom (5 x 68 g a.i./ha at intervals of 5-8 days). Sampled 6-50 DALA.	24.8 pollen from cotton	52.2 nectar from flowers	No	Yes	Residue levels may be representative of one application during bloom or several pre-bloom applications. However, multiple applications during bloom and pollen/nectar residue levels on directly sprayed flowers may not be represented and might result in higher residues. The cotton residues also have additional imidacloprid treatments (seed treatment or soil applications in previous years), but contribution of these additional treatments to residue levels is relatively low. For crops harvested before bloom, pollinator exposure is not expected. For crops that are not bee-attractive, exposure is not expected.	Yes Note: cotton is expected to represent a low-end estimate of residues resulting from during bloom application.	**Not a registered crop in Canada**. **Potentially Relevant for Other Labelled Crop(s):** Turf; Potatoes; CG1B: Root vegetables (except sugar beet); CG1D: Tuberous & corm vegetables; CG2: Leaves of root & tuber vegetables; CG4A: Leafy greens; Globe artichoke; CG5: Brassica leafy vegetables; CG6: Legume vegetables; Soybeans; CG8: Fruiting vegetables; G13A: Caneberry; CG13B: Bushberry; CG13F: Berry & small fruit vines; CG 13G: Low growing berry; CG19: Herbs; Hops; Peanut; Tobacco *Refer to summary of imidacloprid application rates table for use pattern*

Sampled Crop	EEC - highest mean residue value in ppb [b]		Potential for risk from pollen or nectar? [c]		Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Pollen	Nectar			
Orange Foliar spray pre-bloom (2 x 280.5 g a.i./ha). Sampled 3-44 DALA.	2878 pollen from flower	301 nectar from flower	Yes	Yes	Studied single and seasonal application rates are higher than registered rates. Pre-bloom applications are not permitted in orchard crops, but permitted in tree nuts and pistachio. Even though pre-bloom applications are of interest for some tree crops, the single application rate in orange is higher than registered rates and crop type may not be similar to tree crops in Canada.	Yes	**Not a registered crop in Canada** **Potentially Relevant for Other Labelled Crop(s):** **CG 14: Tree nuts** (pre-bloom) *Registered at 2 x 48-55 g a.i./ha (seasonal rate 110 g a.i./ha) (pre-bloom and post-bloom)* [may not be relevant - see considerations]
Clover Treated cotton seed planted in 2012 (54 g a.i./ha) followed by foliar applications in 2012 (5 x 68 g a.i./ha). Sampled clover in 2013 at 405-447 DALA.	1.57 pollen from bees	1 nectar from flowers	No	No	Foliar applications in cotton within range of registered single and seasonal rates for other agricultural crops. Residues in rotational crops (clover) were examined based on a previous seasonal rate of 394 g a.i./ha. [Foliar applications at 5x68 g a.i/ha (total 340 g a.i./ha) plus seed treatment at 54 g a.i./ha.] Higher soil residues potentially resulting from higher foliar use rates may not be represented. For rotational crops that are not bee-attractive, exposure is not expected.	No	**Rotational forage crop**

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

[a] Colony feeding study critical effects values considered include:

Pollen: 20 ppb (NOEL) and 100 ppb (LOEL); values greater than the LOEL are considered to pose potential risk; the wide spacing between the NOEL and LOEL doses and the inconsistent effects at the LOEL result in uncertainty regarding potential effects at the LOEL; thus the LOEL will be used in the pollen risk characterization.

Nectar: 23.3 ppb (NOEL) and 47.6 ppb (LOEL); values greater than the NOEL are considered to pose potential risk.

[b] Chronic residue value is the highest mean residue value among all the scenarios within a study.

[c] Measured imidacloprid concentrations in pollen and nectar are compared with the critical colony feeding study effects values for pollen and nectar. “Yes” indicates the measured residue level is greater than the critical effects value and poses potential risk to honey bees; “No” indicates that measured residue level is less than the critical value and 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 or nectar exposure route indicates a potential risk.

Table 2 Soil Application: Chronic Risk Assessment for Honey Bee Hives Based on the Comparison of Measured Imidacloprid Residues and Colony Feeding Study Effects Values[a]

<table>
<tr><th rowspan="2">Sampled Crop</th><th colspan="2">EEC - highest mean residue value in ppb [b]</th><th colspan="2">Potential for risk from pollen or nectar? [c]</th><th rowspan="2">Considerations</th><th rowspan="2">Overall potential for risk?</th><th rowspan="2">Residue Data is Related to Registered Crop Group</th></tr>
<tr><th>Pollen</th><th>Nectar</th><th>Pollen</th><th>Nectar</th></tr>
<tr><td>Tomato
(coarse soil)

In-furrow at 1 x 422 g a.i./ha sampled 31-77 DALA</td><td>185
pollen from bees</td><td>n/a</td><td>Yes</td><td>n/a</td><td rowspan="5">Tomato plants provide mainly pollen and only pollen was sampled. Tomato plants are not an important source of nectar. To have only pollen residues is a limitation when expanding to fruiting vegetables other than tomato and to other crop groups. Therefore information from other residue studies where nectar was sampled is further considered for crops in CG8 that provide both pollen and nectar.
The two tomato studies were at different rates. Studied rates are within registered rates for fruiting vegetables (although slightly lower than maximum rate) and other crops.
The timing between application and sampling was considered applicable for other crops in CG8.
Pollen sampled from bees may have lower residues compared to samples taken from</td><td>Yes</td><td rowspan="5">Crops that mainly produce pollen from Group 8: Fruiting vegetables (except cucurbits)
Registered at 93.36 - 560g a.i./ha for single application</td></tr>
<tr><td>Tomato
(medium soil)

In-furrow at 1 x 422 g a.i./ha sampled 31-77 DALA</td><td>103.7
pollen from bees</td><td>n/a</td><td>Yes</td><td>n/a</td><td>Yes</td></tr>
<tr><td>Tomato
(fine soil)

In-furrow at 1 x 422 g a.i./ha sampled 31-77 DALA</td><td>101
pollen from bees</td><td>n/a</td><td>Yes</td><td>n/a</td><td>Yes</td></tr>
<tr><td>Tomato
(medium soil)

Chemigation at 1 x 202 g a.i./ha sampled 79-102 DALA</td><td>41.3
pollen from anther</td><td>n/a</td><td>No</td><td>n/a</td><td>No</td></tr>
<tr><td>Tomato
(heavy soil [fine soil])

Chemigation at 2 x 140 g a.i./ha sampled 79-102 DALA</td><td>23.8
pollen from anther</td><td>n/a</td><td>No</td><td>No</td><td>No</td></tr>
</table>

Sampled Crop	EEC - highest mean residue value in ppb [b]		Potential for risk from pollen or nectar? [c]		Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Pollen	Nectar			
					the anther.		
Melon (medium soil) Drip irrigation at 1 x 404 g a.i./ha sampled 125 DALA	14.95 pollen from hive	3.65 nectar from hive	No	No	Both pollen and nectar were sampled in the hive, which may result in lower residues compared to collection from the plant. Residues in the hive may be diluted. The rate yielding the highest residues in the melon study and that were used in the risk assessment (1 x 404 g a.i./ha) is within rates for CG9 (slightly lower than maximum rate of 1 x 586 g a.i./ha). Application was made early in the season, which is relevant to typical agricultural practices. The timing between application and sampling (>100 DALA) was longer in melon compared to the pumpkin study described below and is thought to have resulted in lower residues. Residues from the pumpkin study will also be considered in the risk assessment to provide a range of relevant residues.	No	**Crop Group 9: Cucurbit vegetables** *Registered at 1x 20.5-586.9 g a.i./ha.* **Potentially Relevant for Other Labelled Crop(s):** **Potato:** *Registered at 1x 100-480 g a.i./ha* **CG 1B: Root vegetables (except sugar beet); CG 1D: Tuberous and corm vegetables (except potatoes) and; CG 2: Leaves of root and tuber vegetables:** *Registered at1x 100-408 g a.i./ha.* **CG4A: Leafy greens subgroup; CG4B: Leafy petioles subgroup and; CG19: Herbs:** *Registered at1x 79.92-480 g a.i./ha.* **CG5: Brassica leafy vegetables:** *Registered at1x 86.6-520 g a.i./ha.*
Melon (heavy soil [fine soil]) Drip irrigation at 1 x 404 g a.i./ha sampled at 118 DALA	7.5 pollen from in-hive	1.85 nectar from in-hive	No	No		No	
Pumpkin Transplant water at 422 g a.i./ha; sampled 35 DALA	60.9 pollen from flowers	7.4 nectar from flowers	No	No	The rate in the study (1 x 422 g a.i./ha) is lower than the maximum rate in CG9 (586 g a.i./ha) and comparable to the maximum rate for most labelled crops (400 to 520 g	No	

Sampled Crop	EEC - highest mean residue value in ppb [b]		Potential for risk from pollen or nectar? [c]		Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Pollen	Nectar			
					a.i./ha). Applications in both the pumpkin and the melon study were made early in growing season which is considered applicable. However, sampling was made at 35 DALA in the pumpkin study compared to >100 DALA in the melon study, which resulted in higher residues in pumpkin. Residues from the pumpkin study were sampled from the plant which is expected to result in conservative (higher) residues compared to residues sampled from the hive.		**CG6: Legume vegetables (except dry soybean); Peanut:** *Registered at1x 100-400 g a.i./ha.* **CG8: Fruiting vegetables (FOR nectar only):** *Registered at1x 93-560 g a.i./ha.* **CG13F: Berry and small fruit vines, including grapes and; CG13G: Low growing berry (FOR nectar only):** *Registered at1x 100-480 g a.i./ha.* **Tobacco:** *Registered at1x 113-453 g a.i./ha.*
Pumpkin Transplant water at 1x 211 g a.i./ha followed by drip irrigation at 1 x 211 g a.i./ha; sampled 14 DALA	80.2 pollen from flowers	11.2 nectar from flowers	No	No	The total amount applied to pumpkins is comparable to the above scenario. Higher residues are thought to be related to the shorter interval between last application and sampling. To have two seasonal soil applications is however not permitted in Canada.	No	
Pumpkin Transplant water at 280 g a.i./ha Sampling was made at 35 DALA	36.7 pollen from flowers	6.1 nectar from flowers	No	No	Studied rate within range of rates for CG9 even though lower than the maximum rate. Studied rate is similar to the rate for CG13, cranberry, bushberry, turf and ornamentals (288 g/ha).	No	**Crop Group 9: Cucurbit vegetables** *Registered at 1x 20.5-586.9 g a.i./ha.* **Potentially Relevant for Other Labelled Crop(s):** **-Cranberry and; CG13A:**

Sampled Crop	EEC - highest mean residue value in ppb [b]		Potential for risk from pollen or nectar? [c]		Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Pollen	Nectar			
							Caneberry: *Registered at1x 288 g a.i./ha* **-CG 13B: Bushberry:** *Registered at1x 65.1-288 g a.i./ha* **-Turf and; Ornamentals (herbaceous species):** *Registered at 1x 280 g a.i./ha*
Pumpkin Soil drench 1x 30 g a.i./ha; sampled 35 DALA	4.9 pollen from flowers	0.4 nectar from flowers	No	No	The studied rate is similar to the minimum single application rate in CG9.	No	**Crop Group 9: Cucurbit vegetables** *Registered at 1x 20.5-586.9 g a.i./ha.*
Strawberry (light soil [coarse soil]) Soil treatment at 1 x 560 g a.i./ha	231	n/a	Yes	n/a	The rate in the study (560 g ai/ha) is slightly higher than the maximum rate for CG13 (480 g ai/ha). Only pollen was collected, and thus there are no nectar residues for consideration. Risk quotients would be higher if residues in nectar were also considered.	Yes	**Strawberry from Crop Group 13G: Low growing berry** *Registered at 100-480 g a.i./ha.*
Strawberry (medium soil) Soil treatment at 1 x 560 g a.i./ha	6.35 pollen from flowers	n/a	No	n/a		No	
Blueberry Post-bloom band application at 1 x 561 g a.i./ha; post harvest; sampled 200 DALA	14.78 pollen from bees	7.53 nectar from hive	No	No	The rate in the study (561 g ai/ha) is much higher than the rates in CG13B (288 g/ha). However, the timing of application (post bloom) is consistent with Canadian use pattern for blueberries. Thus residues are representative of the	No	**Crop Group 13B: Bushberry** *Registered at 1 x 65.1-288 g a.i./ha.* **Potentially Relevant for Other Labelled Crop(s):**

Sampled Crop	EEC - highest mean residue value in ppb [b]		Potential for risk from pollen or nectar? [c]		Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Pollen	Nectar			
					following year residues (sampling occurred DALA > 200 days). Residues were sampled from the hive which is expected to result in less conservative (lower) residues compared to residues sampled from the plant. Blueberry plants may be relevant to other woody plants such as ornamental trees and shrubs.		**Cranberry and; CG13A: Caneberry** *Registered at 1 x 288 g a.i./ha* **Ornamental trees and shrubs:** *Registered at 1 x 280 g a.i./ha* **CG13F: Berry and small fruit vines including grapes [e.g. kiwi, grape]:** *Registered at 1 x 100-480g a.i./ha*
Citrus Various application scenarios Soil drench at 1x280 or 1x560 g a.i./ha Samples taken following year 200-233 DALA.	6.21 pollen from hive	29.9 nectar from flowers	No	No	Application rates (280 and 560 g a.i./ha) are comparable to some labelled uses. Citrus was considered for other labelled woody species. The post-bloom application timing in citrus is relevant to blueberry but not to ornamental plants; higher residues would be expected for applications during or before bloom. Citrus morphology may not be relevant to labelled woody crops. Pollen and nectar were sampled in hive. Thus residues collected from hives may be lower than that of plants.	No	**Not a registered crop in Canada.** **Potentially Relevant for Other Labelled Crop(s):** **Crop Group 13B: Bushberry** *Registered at 1x 65.1-288 g a.i./ha* **Ornamental trees and shrubs:** *Registered at1x280 g a.i./ha*
Cotton (coarse soil) In-furrow application at 1 x 370 g a.i./ha. Sampling at 70-95 DALA	40.2 pollen from in-hive	80.9 nectar from hive	No	No	Nectar sampled from both the flower and extrafloral nectaries. Nectar residues in this table are only from floral nectar; extrafloral nectaries are unique to cotton,	No	**Not a registered crop** **See considerations**

Sampled Crop	EEC - highest mean residue value in ppb [b]		Potential for risk from pollen or nectar? [c]		Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Pollen	Nectar			
Cotton (medium soil) In-furrow application at 1x 370 g a.i./ha. Sampling at 70-95 DALA	0.6 pollen from in-hive	17.1 nectar from hive	No	No	which is not grown in Canada. Floral nectar generally showed the highest concentrations after the in-furrow application. Studied rate similar to registered rate for Crop Groups 1B (root vegetables except sugar beet), 1D (tuberous and corm vegetables except potatoes), 2 (leaves of root and tuber vegetables, 6 (legume vegetables except soybeans), and for peanuts. However, the cotton plant biology is unique which may influence the uptake and distribution of residues; cotton less relevant to Canadian crops.		
Cotton (fine soil) In-furrow application at 1x 370 g a.i./ha. Sampling at 70-95 DALA	0.8 pollen from in-hive	1.5 nectar from hive	No	No			
Rotational crops (phacelia, mustard or corn; mustard had highest residues which are reported) Soil application at 95.4 g a.i./ha or 173.4 g a.i./ha + winter barley seed treatment at 0.014 - 0.023 mg a.i./seed (62.5 - 63.2 g a.i./ha).	0.79 pollen from in-hive	0.53 nectar from bees	No	No	Rates within range of labelled rates, but lower than maximum rates. Residues sampled from the plant may have been higher. LOQ in clover rotation and in wildflowers: 2 ppb.	No	**Rotational crops**
Melon (untreated planted after treated as below) Seed-line soil drench in cantaloupe in 2009 at 1 x 258 g a.i/ha + 1 x 314 g a.i./ha and 2010 at 1 x 314 g a.i./ha. No	9.2 pollen from traps	0.25 nectar in-hive	No	No		No	

Sampled Crop	EEC - highest mean residue value in ppb [b]		Potential for risk from pollen or nectar? [c]		Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Pollen	Nectar			
imidaclo-prid use in 2011. Sampling in 2011 199 DALA							
Clover In-furrow treatment in potato in 1999 at 204 g a.i./ha sampling in 2001	<LOQ 1 [2] pollen from bees	<LOQ 1 [2] nectar from bees	No	No		No	
Wildflowers (off-field) In-furrow treatment in potato 2000 at 204 g a.i./ha sampling in 2001 + in-furrow treatment in potato in 2001 at 204 g a.i./ha sampling in 2001	<LOQ 1 [2] wildflo wer	n/a	No	n/a	Studied rate within registered rates, but lower than all maximum seasonal rates.	No	**Considered for Run-off**

CG = crop group, DALA = days after last application, LOQ = limit of quantification, EEC = estimated environmental concentration, Y = year

[a] Colony feeding study critical effects values considered include:

Pollen: 20 ppb (NOEL) and 100 ppb (LOEL); values greater than the LOEL are considered to pose potential risk; the wide spacing between the NOEL and LOEL doses and the inconsistent effects at the LOEL result in uncertainty regarding potential effects at the LOEL; thus the LOEL will be used in the pollen risk characterization.

Nectar: 23.3 ppb (NOEL) and 47.6 ppb (LOEL); values greater than the NOEL are considered to pose potential risk.

[b] Chronic residue value is the highest mean residue value among all the scenarios within a study.

[c] Measured imidacloprid concentrations in pollen and nectar are compared with the critical colony feeding study effects values for pollen and nectar. “Yes” indicates the measured residue level is greater than the critical effects value and poses potential risk to honey bees; “No” indicates that measured residue level is less than the critical value and 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 or nectar exposure route indicates a potential risk.

Table 3 Seed Treatment: Chronic Risk Assessment for Honey Bee Hives Based on the Comparison of Measured Imidacloprid Residues and Colony Feeding Study Effects Values[a]

Sampled Crop	EEC - highest mean residue value in ppb [b]		Potential for risk from pollen or nectar? [c]		Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Pollen	Nectar			
Canola Applied at 50 and 78 g a.i./ha, 0.02 to 0.05 mg a.i./seeds. Sampled 55 to 65 DAP	7.6 pollen from hive	0.81 nectar from hive	No	No	A single value was reported in this study explaining why the mean and max concentrations are the same. Pollen and nectar are sampled from hives. The registered rates are similar to the rates used in the residue studies.	No	**Canola, Rapeseed, Mustard** *Registered at 0.008 to 0.047 mg a.i./seed and 16 to 89.6 g a.i./ha*
Corn Applied at 133.28 g a.i./ha, 1.34 mg a.i./seed. Year 1 (Y1) applied in 2012 sampled 58-68 DAP Year 2 (Y2) applied in 2012 and 2013: sampled in 2013 59 to 72 DAP	Y1: 11.28 pollen from plant	NA	No	No	Residues were found in control. Pollen sampled from plant. Seed treatment rate higher than Canadian registered rate (0.63 mg a.i./seed). The mean concentration of 21.9 ppb observed in the second year of treatment was unusually high and associated with a plot that showed a wider variation in residue concentrations. In separate studies, corn treated at rates more similar to registered rates had lower residues (less than LOQs of 5 ppb or 1 ppb)	No	**Corn** *Registered at 0.084 to 0.630 mg a.i./seed, and 3.5 to 56.8 g a.i./ha*
	Y2: 21.9 pollen from plant	NA	No	No		No	

Sampled Crop	EEC - highest mean residue value in ppb [b]		Potential for risk from pollen or nectar? [c]		Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Pollen	Nectar			
Sweet Pepper Applied at 12 g a.i./ha, 0.17 mg a.i./seed. Sampled 99 to 124 DAP.	<LOQ (LOQ 1; ½ LOQ 0.5) whole flower	<LOQ (LOQ 1; ½ LOQ 0.5) whole flower	No	No	Pollen and nectar not sampled. Whole flower sampled.	No	**Crop Group 8: Fruiting vegetables** (except cucurbits) *Registered at 0.013 to 0.083 mg a.i./seed, and 0.2 to 2.5 g a.i.//ha* **Potentially Relevant for Other Labelled Crop(s):** CG1B: root vegetables (carrot only); CG3: Bulb vegetables (leek, bulb onion, bunching onion) **Low end estimate for**: CG6: Legume vegetables (except dry soybean); CG6A: Edible-podded legume vegetable subgroup (except peas) and 6C: Succulent shelled pea and bean subgroup
Melon Applied at 50 and 78 g a.i./ha, 0.02 to 0.05 mg a.i./seed. Sampled 55 to 65 DAP.	3.4 whole flower	3.4 whole flower	No	No	Even though no measurable residues were found in pollen or nectar, it is noted that residues were found in the flower. Both pollen and nectar were sampled from hives, therefore flower was used as a conservative estimate.	No	**Crop Group 9: Cucurbit vegetables** *Registered at 0.250 mg a.i./seed, 0.56 to 6.9 g a.i./ha.* **Potentially Relevant for Other Labelled Crop(s):** CG4A: Leafy greens subgroup (lettuce); CG5: Brassica leafy vegetables (cabbage and broccoli) **High end estimate for**: CG6: Legume vegetables (except dry soybean); CG6A: Edible-podded legume vegetable subgroup (except peas) and 6C: Succulent shelled pea and bean subgroup

Sampled Crop	EEC - highest mean residue value in ppb [b]		Potential for risk from pollen or nectar? [c]		Considerations	Overall potential for risk?	Residue Data is Related to Registered Crop Group
	Pollen	Nectar	Pollen	Nectar			
Clover Treated corn seed planted in 2012 at 133.28 g a.i./ha or 1.34 mg a.i./seed. Clover sampled >400 DALA in corn.	1.95 pollen from plant	0.37 nectar from plant	No	No	In clover, highest imidacloprid residues in pollen and nectar were 36.8 and 0.9 ppb, respectively. The 36.8 ppb concentration in pollen is much higher than any other imidacloprid residue concentration found in clover pollen. To illustrate this, the second highest imidacloprid concentration in clover pollen was 3.4 ppb and the 90th percentile of imidacloprid concentrations in clover pollen, as reported in the study, was 2.9 ppb. The high residue value was excluded as it was considered an outlier.	No	**Rotational forage crops**

CG = crop group, DALA = days after last application, DAP = days after planting, LOQ = limit of quantification, EEC = estimated environmental concentration, Y = year

[a] Colony feeding study critical effects values considered include:

Pollen: 20 ppb (NOEL) and 100 ppb (LOEL); values greater than the LOEL are considered to pose potential risk; the wide spacing between the NOEL and LOEL doses and the inconsistent effects at the LOEL result in uncertainty regarding potential effects at the LOEL; thus the LOEL will be used in the pollen risk characterization.

Nectar: 23.3 ppb (NOEL) and 47.6 ppb (LOEL); values greater than the NOEL are considered to pose potential risk.

[b] Chronic residue value is the highest mean residue value among all the scenarios within a study.

[c] Measured imidacloprid concentrations in pollen and nectar are compared with the critical colony feeding study effects values for pollen and nectar. “Yes” indicates the measured residue level is greater than the critical effects value and poses potential risk to honey bees; “No” indicates that measured residue level is less than the critical value and 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 or nectar exposure route indicates a potential risk.

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A. Information Considered in the Pollinator Assessment

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