Pollinator Protection Packet
Bee Aware. Be Safe.

GUIDE TO AVAILABLE RESOURCES for NPMA MEMBERS

For more info, visit pollinatorhealth.org
The National Pest Management Association understands the importance that all pollinators and specifically bees play in the nation’s food supply chain. Therefore we have made pollinator health an industry priority. With the help of our member companies we have worked diligently to develop training, resources, consumer fact sheets and educational materials to promote bee health in a variety of settings.

In addition, NPMA is working closely with numerous government agencies including U.S EPA state regulators, bee experts, and other stakeholders who are equally committed to ensuring bee health now and in the future.

This pollinator protection folder offers a summary of the resources available to you as a member of NPMA. In addition to the pieces that have been included, we have many more assets available to you on our website at www.npmapestworld.org under the policy tab. Should you ever have questions in regards to pollinator protection, efforts that NPMA has taken to date or would like to share thought and suggestion don’t hesitate to call us at 800.678.6722 or email us at npma@pestworld.org. We hope that you find these resources helpful in your understanding of bee health and encourage you to share copies with your colleagues.

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Pollinators: Past, Present and Prospective Future

Pollinator health, specifically as it relates to bees and colony collapse disorder has become a hot topic across the United States and around the world. In the last several years, when the pest management industry should be acutely aware of events that can and will impact professionals in their daily operations. The following document provides background on the connection between pesticide use and regulatory steps that have and may be taken in response to this important issue. As a member of NPMA, we strongly encourage you to read, review and share this information with your colleagues and industry associates.

Overview
The role of neonicotinoid pesticides in widespread bee die off in the last few years has catapulted the public policy forefront. EPA announced in mid-August that it would add language to the labels of some neonicotinoid pesticide products prohibiting use of the products where bees are present. Specifically, the changes apply to all products with outdoor non-agricultural foliar use directions (except granulars) containing the active ingredients imidacloprid, dinofeturan, clothianidin or thiamethoxam regardless of formulation, concentration, or intended use.

Public policy related to the possible connection between neonicotinoids and other pesticides and the decline in bee health intensified this summer as a flurry of significant action took place at the federal, state and local levels of government. Below is a recap of the most notable developments of the last 10 weeks.

President Obama’s Memo on Pollinators
President Barack Obama called off National Pollinator Week in late June by issuing a Presidential Memorandum expanding Federal efforts to reverse pollinator losses and helps restore populations to healthy levels. The Memorandum establishes a Pollinator Health Task Force chaired by the Secretary of Agriculture and the Administrator of U.S. EPA and charged with developing a National Pollinator Health Strategy within six months that includes an Action Plan.

EPA Reverses Course on PR Notice
Late last year, EPA indicated that it would issue a draft Pesticide Registration Notice sometime in 2014 proposing to add language similar to the pollinator protection wording it added to some neonicotinoid labels to all pesticide products. The issuance of this document was expected to be a significant summertime policy action related to pesticides and bee health. It appears, however, that those plans have been scrapped.

Instead, EPA is placing greater emphasis on state pollinator protection plans. While nothing has been finalized and the issue appears very fluid, U.S. EPA did write state regulatory officials in mid-August to express an interest in working together to develop state pollinator protection plans. The plans are a key byproduct of the Presidential Memo. NPMA has requested to be part of any group charged with developing a model state pollinator protection plan or establishing minimum standards for such plans.

EPA Blesses ASPCRO’s Guidance Document
The U.S. EPA wrote Association of Structural Pest Control Regulatory Officials (ASPCRO) President John Scott in late July endorsing ASPCRO’s Guidance Document for Bee Language for Neonictinoid Products in Outdoor Structural and Turf and Ornamental Settings that ASPCRO submitted to EPA in April. NPMA worked closely with ASPCRO on the guidance document to establish a common understanding of the pollinator protection label language and provide more clarity to the regulated community.

U.S. Fish & Wildlife Service Phase Out Neonicotinoid Use at Wildlife Refuges
The U.S. Fish and Wildlife Service announced in mid-July that the use of neonicotinoid pesticides at national wildlife refuges would be phased out by January 2016. According to a July 17 memo from the Chief of the National Wildlife Refuge System, the decision was “based on a precautionary approach to our wildlife management practices, and not on agricultural practices.” The memo also states “That there can be appropriate and specialized uses of neonicotinoid pesticides and decisions for the uses in the Service are subject to review through all applicable laws, regulations, and policies including, but not limited to, the National Environmental Policy Act.”

NRDC Petitions EPA to Commence Special Review for Neonicotinoid Pesticides
The Natural Resources Defense Council (NRDC) in early-July petitioned U.S. EPA to request that the Agency commence a Special Review for six specific neonicotinoid pesticides - dinofeturan, acetamiprid, clothianidin, thiacloprid, imidacloprid, and thiamethoxam - based on the risk that NRDC believes this class of pesticides poses to honey bees and native bees. The request effectively seeks to expedite EPA’s ongoing evaluation of neonicotinoid insecticides.

Also in early July, the Center for Food Safety, Beyond Pesticides and the Pesticide Action Network North America, filed a state lawsuit against the California Department of Pesticide Regulation (DPR), alleging that DPR violated the law by approving expanded use of neonicotinoid pesticides. The suit seeks to prohibit DPR from approving any new neonicotinoid products or new uses of those products until it completes required reevaluations of the pesticides.

Congressmen Circulate Neonictinoid Letter
In mid-August, Congressmen Earl Blumenauer of Oregon and John Conyers of Michigan circulated to fellow House colleagues a letter they had drafted to send to EPA Administrator Gina McCarthy, in hopes of getting other Members to sign on. The letter, which will likely be sent late this month, makes numerous recommendations, including that EPA restrict the use of neonicotinoids on bee attractive crops and ornamental applications, limit the times, methods of application, and locations of neonicotinoid use and, in instances where bees and other pollinators cannot be fully protected, suspend the use of neonicotinoid products. The letter also urges EPA to reclassify commercial neonicotinoid products as restricted use.

State Activity
The California Legislature in late August passed and sent to Governor Jerry Brown for his consideration legislation directing DPR to complete its reevaluation of neonicotinoid pesticides by July 1, 2018 and to adopt any control measures needed to protect pollinator health within two years of completing the reassessment.

The measure essentially synchronizes California’s reexamination of neonicotinoids with when U.S. EPA anticipates concluding its registration review of the chemistry.

Meanwhile, the Oregon Department of Agriculture in mid-July adopted emergency rulemaking prohibiting the use of products containing dinofeturan or imidacloprid to treat linden trees and other Tilia species. The measure, which will remain in effect until December 23, 2014, was adopted in response to several reports of bee kills involving the use of the aforementioned products. State officials and researchers are investigating the incidents and whether there may be some sort of synergistic effect between Tilia species trees and the two products.

In November of 2013, ODA decided to require as a condition of 2014 state registration that a label statement prohibiting use on Tilia species trees would be required, for certain products containing dinofeturan or imidacloprid. The emergency rule also covers older stocks of products that do not contain the new label restrictions.

Local Government Activity
In late June, the Spokane County Council voted 5-2 prohibiting the city from purchasing neonicotinoid pesticides or using the compounds on city property. In early August, the Shorewood (MN) City Council approved a resolution banning the use of neonicotinoid pesticides on city property.

NPMA Launches Pollinator Protection Training
As the activity described above well illustrates, the role neonicotinoids and other pesticides play in the decline in bee health is a hot button issue, often driven by emotion and well-funded activist groups. Nevertheless, it is important that PMPs and their technicians closely follow label directions and take steps to avoid inadvertently exposing honey bees to pesticides.

To that end, NPMA will soon unveil pollinator protection training as part of NPMA Online Learning Center. Training objectives include, enhanced awareness about pollinator health, neonicotinoid label changes and common sense techniques on how to avoid exposing beneficial pollinators to insecticides while performing exterior treatments. In addition, the training contains a section on how to identify beneficial pollinators while acknowledging the fact that PMPs are sometimes called on to control pollinators when they become a threat to public health.

NPMA Launches PollinatorsHealth.org, Marketing Materials
In August, NPMA launched PollinatorsHealth.org, a web site designed to serve as a comprehensive resource for consumers, media, educators and pest control professionals to better understand pollinator health, the issues that threaten pollinators and the importance of protecting them.

Also in August, NPMA created customizable marketing materials for its members to download and distribute to their customers. If you have any questions about these initiatives, please don’t hesitate to contact NPMA at 703-352-6762 or email npma@pestworld.org.
Recent EPA Action

What is the Buzz All About?

Section 1: Policy Efforts: What is the Buzz All About?

Without question, the hottest pest management regulatory issue these days is protecting bees from unintended exposure to pesticides. Recently adopted and future public policy will impact pesticide use patterns for all user groups including pest management professionals (PMPs), honeybees and other pollinators are vital to an abundant food supply. Over the last several years, however, honeybees have been plagued by the mysterious Colony Collapse Disorder (CCD), and beekeepers over the last several years, however, honeybees have been plagued by the mysterious Colony Collapse Disorder (CCD), and beekeepers have since lodged legal challenges against the suspensions. Soon after the European Commission approved the moratorium, USDA and EPA issued a report finding that multiple factors are at play, with pesticides being just one of the many issues affecting bee health. While this article is not intended to be an exhaustive review of the literature, it is important to note that there is strong evidence to support the claim that pesticides are a significant contributor to bee health decline.

In early March, EPA and the U.S. Department of Agriculture (USDA) hosted a Pollinator Summit to bring stakeholders together and to learn about current research, new technologies, best practices and other stewardship actions to protect bees from unnecessary pesticide exposure. The discussion focused almost exclusively on agricultural pesticide use, especially dust in agricultural planting operations in which pesticide-coated seeds are used.

The changes apply to all products that have outdoor foliar treatments in the foreseen future. Since few neonicotinoid pesticides are registered for PMP uses in Canada the recent announcement won't have much immediate impact on Canadian pesticides, although the recent action probably decreases the likelihood of the registration of neonicotinoid products for perimeter treatments in the foreseen future.

Activist groups have termed the recent decline in bee health "a second Silent Spring" and have lobbied officials from President Obama to Members of Congress to EPA officials about the issue. The groups have used EPA in federal district court alleging that the Agency failed to adequately protect pollinators from neonicotinoid pesticides and are also urging big box retailers to stop selling neonicotinoid pesticides.

NPMA Engagement

Since late June, NPMA staff has been deeply engaged in the bee health issue and has taken a number of steps to raise awareness of the issue within the professional pest management industry while also working with federal and state regulatory officials to educate them about the importance of retaining key PMP use patterns. Specific actions include:

- Meeting with senior EPA officials in early August to provide them with information on important PMP uses and suggestions for label language that is both protective of bees, while allowing critical PMP treatments in the foreseen future.
- Scheduling a webinar/conference call with the NPMA government affairs and technical committees and NPMA scientific advisory group for early September to further discuss the issue, partnering with the USDA and the National Pollinator Council to plan and co-host an October educational workshop for EPA employees that highlight PMP use patterns that target bees that threaten human health and property, and
- Working with ASPCRO and the American Association of Pesticide Control Officials to clarify the intent of the recent label revisions.

Scheduling a webinar/conference call with the NPMA government affairs and technical committees and NPMA scientific advisory group for early September to further discuss the issue, partnering with the USDA and the National Pollinator Council to plan and co-host an October educational workshop for EPA employees that highlight PMP use patterns that target bees that threaten human health and property, and
- Working with ASPCRO and the American Association of Pesticide Control Officials to clarify the intent of the recent label revisions.

Take Home Message

So what is the meaning of all of the efforts to limit unintended exposure to bees for PMPs? Below are a few take home messages:

1) The bee health issue is not a short-term issue and EPA recent label changes should be viewed as the first of what will likely be multiple steps to safeguard bees from pesticide exposure.

2) Regulatory action will eventually extend to non-neonicotinoid pesticides as well. In fact, in mid-July, the European Commission voted to restrict the use of imidacloprid. Expect the label language that will appear on neonicotinoid product labels early next year to eventually appear on other products as well.

3) The public is deeply interested and concerned about pollinator health, so the story is likely to continue to receive widespread media coverage. Pesticides role in declining bee health was the subject of an August 19 Time Magazine cover story.

4) Regardless of whether PMPs are using neonicotinoids or other pesticide products, they should avoid unnecessarily exposing bees to pesticides, unless the bees are the intended target for structural or public health reasons.

Section 2: Q&A: Understanding Changes to Neonicotinoid Labels with Outdoor Foliar Uses

For quick reference, new labels will have use directions that say: "Do not apply [insert name of product] while bees are foraging. Do not apply [insert name of product] to plants that are flowering. Only apply after all flower petals have fallen off." A bee icon to highlight the significance of the label change will accompany the new language.

A Pollinator Advisory Box containing voluntary best management practices will also appear on product labels. Registrants must submit the label changes to EPA by September 30 and the new labels will appear on products in early 2014. This label revision is likely the first in a series of label changes aimed at protecting bees.

What active ingredients are affected?

imidacloprid, dinofeturan, clothianidin, thiamethoxam

What uses are affected and what is NPMA doing about it?

EPA has said that the new language only applies to products that have "foliar" uses. Foliar generally refers to pesticide applications made to leaves. NPMA is working through SFIREG and ASPCRO, organizations comprised of state pesticide regulators, to obtain a guidance document from EPA, which will address some common questions and provide greater clarity to PMPs using these products, to include:

- Scheduling a webinar/conference call with the NPMA government affairs and technical committees and NPMA scientific advisory group for early September to further discuss the issue, partnering with the USDA and the National Pollinator Council to plan and co-host an October educational workshop for EPA employees that highlight PMP use patterns that target bees that threaten human health and property, and
- Working with ASPCRO and the American Association of Pesticide Control Officials to clarify the intent of the recent label revisions.
1. Clarification that this language does not prohibit or limit indoor, termite or perimeter treatments
2. That the new “bee box” is only advisory and not mandatory, enforceable label language
3. What “bees are foraging” means
4. That the term “bees” refers to honey bees, bumble bees and carpenter bees, but does not include wasps or Africanized honey bees

When will the new labels appear?
Products released for shipment after February 28th must bear the new labeling.

You should start seeing the first updated labels this spring, however since there is no way to know when the new language to protect pollinators will begin arriving on containers from your distributor, it is important to carefully review the label and any associated labeling material each time a new imidacloprid, dinotefuran, clothianidin, thiamethoxam container is opened for use.

In addition, EPA recently informed us that some manufacturers have removed uses from their labels due to the new restrictions. Thus, it is critical that in addition to looking for the new label restrictions, you also need to ensure the Directions for Use still includes the site to which you will be applying the product.

Are any of the labels I use changing?
If the product has outdoor foliar uses on the label, yes, changes will be made to the directions for use. The directions will now read:

As long are you are not treating plants that are flowering while you treat, however look for flowering plants in the area to be treated.

Do not apply [insert name of product] while bees are foraging. Do not apply [insert name of product] to plants that are flowering.

This language will be accompanied by a bee icon in a red diamond to alert you to the label change. The icon should also remind you to consider any foraging bees before choosing the product if there are flowering plants in the area to be treated.

When do I have to start complying with the new labels?
The label is the law. So, as soon as the product container you are using displays the updated language, you are required to comply with the new directions for use.

Can I use neonicotinoids for a perimeter treatment?
Yes, you may apply a perimeter treatment using neonics. Before you treat, however, look for flowering plants that could indicate foraging bees may be present. Bees are present, be sure to take steps to minimize exposure of the product to bees and other insect pollinators.

Bee boxes are important to my family and me. Are there actions I can take to protect bees beyond what is on the label?
There are lots of things you can do:

- Continue to use integrated pest management techniques for control of pests
- Practice good product and bee stewardship
- Be more aware if bees are in or near the area requiring treatment.

If bees are present, and you don’t need to treat plants that are flowering, but you feel a neonicotinoid is the best product choice for control of the pest, consider making the application during the early morning hours or late evening when bees are less likely to come in contact with or be affected by your treatment.

- Educate homeowners about the benefits of pollinators and the proactive steps your company is taking to reduce risk to pollinators

What steps do you recommend for my company?
- Review the new product labels
- Review and revise service protocols as necessary
- Provide training to technicians regarding the changes in labels and service protocols others

What does science actually say about neonicotinoids and their impact on bees?
EPA and USDA issued a report in 2012 that suggested factors influencing bee health may include “disease, arthropod pests [parasitic mites]; pesticides, poor nutrition and beekeeping practices.” They identified the varroa mite as “the single most detrimental pest of honey bees and can magnify the role of viruses.” Most scientists agree that declining bee health is a result of multiple factors.

A Pollinator Advisory Box was mentioned in the article. Do you know what this will look like?

Protection of Pollinators
APPLICATION RESTRICTIONS EXIST FOR THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER INSECT POLLINATORS.
FOLLOW APPLICATION RESTRICTIONS FOUND IN THE DIRECTIONS FOR USE TO PROTECT POLLINATORS.

Look for the bee hazard icon in the directions for use for each application site for specific use restrictions and instructions to protect bees and other insect pollinators.

This product can kill bees and other insect pollinators.

Bees and other insect pollinators will forage on plants when they flower, shed pollen, or produce nectar. Bees and other insect pollinators can be exposed to this product from:

- Direct contact during foliar applications, or contact with residues on plant surfaces after foliar applications
- Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, soil, tree injection, as well as foliar applications.

When Using This Product Take Steps To:

- Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site.
- Minimize drift of this product on to beehives or off-site to pollinator attractive habitat. Drift of this product onto beehives or off-site to pollinator attractive habitat can result in bee kills.
- Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewardship website.
- Pesticide incidents (for example, bee kills) should immediately be reported to the state/tribal lead agency.

For contact information for your state, go to: http://www.apsn.org/officials.html. Pesticide incidents should also be reported to the National Pesticide Information Center.

Section 3: ASPCRO Guidance Document for Bee Language for Neonicotinoid Products in Outdoor Structural and Turf and Ornamental Settings

This document, developed by the Association of Structural Pest Control Regulatory Officials (ASPCRO), provides interpretation for pesticide state lead agencies (SLAs) of the pollinator protection and non-agricultural language required by the US EPA August 15, 2013 letter to registrants of nitrogenamide neonicotinoid products. This applies to outdoor, non-agricultural foliar applications of products containing clothianidin, dinotefuran, imidacloprid, and thiamethoxam (excluding granules). The attached Pollinator Protection Box must be placed on the label following the Environmental Hazards section, and the new language indicated below must be added to the Direction for Use section of each label.

Pollinator Protection Box

It is ASPCRO’s interpretation that the box is considered advisory information. The text is not written in directive sentences and does not include clearly enforceable statements. The term “enforceable” is based on the EPA Label Review Manual, Chapter 3, General Labeling Requirements, Section III(A).

PROTECTION OF POLLINATORS

APPLICATION RESTRICTIONS: ENSURE THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER INSECT POLLINATORS. FOLLOW APPLICATION RESTRICTIONS FOUND IN THE DIRECTIONS FOR USE TO PROTECT POLLINATORS.

Look for the bee hazard icon in the directions for use for each application site for specific use restrictions and instructions to protect bees and other insect pollinators.

This product can kill bees and other insect pollinators.

Bees and other insect pollinators will forage on plants when they flower, shed pollen, or produce nectar. Bees and other insect pollinators can be exposed to this product from:

- Direct contact during foliar applications, or contact with residues on plant surfaces after foliar applications
- Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, soil, tree injection, as well as foliar applications.

When Using This Product Take Steps To:

- Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site.
- Minimize drift of this product on to beehives or off-site to pollinator attractive habitat. Drift of this product onto beehives or off-site to pollinator attractive habitat can result in bee kills.
- Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewardship website.
- Pesticide incidents (for example, bee kills) should immediately be reported to the state/tribal lead agency.

For contact information for your state, go to: http://www.apsn.org/officials.html. Pesticide incidents should also be reported to the National Pesticide Information Center.
Language required for Non-Agricultural Products:

Do not apply (insert name of product) while bees are foraging.
Do not apply (insert name of product) to plants that are flowering.

Only apply after all flower petals have fallen off.

**Interpretation:**

*Note: For all of the following interpretations of the non-agricultural bee language, if other pollinator protection label statements found on the product label are more restrictive, those statements would take precedence.*

- Unless otherwise specified on the label, the above statements for non-agricultural products apply to honey bees and wild bees that forage for pollen or nectar. They do not apply to control of wasps, Africanized honey bees or bees which are the target pest.
- The non-agricultural use direction statements must be followed when bees are foraging in the area of an application site with flowering plants, when blooms are present.
- Bees are foraging when they are actively visiting a site collecting pollen or nectar.
- “In the area” is interpreted to mean the area immediately adjacent to the application site where blooming plants onto which deposition from the application will come into contact with blooms. The distance will vary and should be based on variables of the application including: weather, type of equipment, and application method.
- Application is prohibited to the blooms and foliage of flowering plants which are in the treatment area at the time of the application when bees are foraging. Application to other parts of the plant is permissible if contact of the pesticide to the blooms and foliage can be prevented. It does not apply to adjacent areas and plants out of the treatment area where bees are foraging.
- “After all petals have fallen off” is interpreted to mean when flowering has completed to the extent bees are no longer foraging. For plants that may not drop all petals, flowering is interpreted to be complete when bees are no longer foraging (e.g. Sunflowers). Application can occur pre-bloom.
- For outdoor applications made directly on or around the structure (e.g.: residential lawns, commercial landscapes, parks, etc.) for pests including applications for plant pest insect control, flea, tick, and other animal/human pests; and adulticiding for mosquitoes and other disease vectors:
  - when flowering plants (including weeds) are in the area of application: Allowing the product being applied to contact blooms is a violation of the label if bees are foraging at the time of the application.
  - when flowering plants (including weeds) with blooms are not in the area (including when blooms have been removed e.g.: trimming or mowing) where application will occur: Application can be made to the ornamental plants and turf.

**Section 4: Official Response from EPA to ASPCRO Guidance Document**

**July 29, 2014**

Mr. John W. Scott ASPCRO President
Colorado Department of Agriculture
700 Kipling Street, Suite 4000, Lakewood, CO 80215-8000
Subject: ASPCRO Guidance for Bee Language for Neonicotinoid Products Draft Document Dated June 4, 2014

Dear Mr. Scott:

We have reviewed the document developed by the Association of Structural Pest Control Regulatory Officials (ASPCRO) that provides interpretation for pesticide state lead agencies (SLAs) of the pollinator protection labeling required by the Agency’s August 15, 2013 letter to registrants of nitroguanidine neonicotinoid products. The required labeling applies solely to those products that may be applied as foliar applications. As you know, the intent of the labeling was to more effectively communicate to applicators the potential risk these products pose to pollinators, especially honey bees, and to protect them by limiting exposure to the extent possible. We appreciate the support the SLAs have provided us in this effort.

The ASPCRO Guidance Document reflects the appropriate interpretation of the pollinator protective labeling for the products used in structural and non-agricultural pest control and we concur on the Document.

If you have any further questions, feel free to contact me.

Sincerely,

Meredith F. Laws
Chief Insecticide-Rodenticide Branch Registration Division (7505P) Office of Pesticide Programs
Training & Technical Resources

This section covers the various training resources and technical aspects related to pollinators. Although there have been numerous articles published and studies conducted we have included a few of the pieces we feel most informative in the following section. These include:

Section 1: NPMA Online Pollinator Training

In an effort to lead the industry and better educate those individuals that may make applications in environments where pollinators are present, NPMA has developed free online training to all member companies. Everyone that completes this training will receive a certificate of completion.

To get started visit: www.pestworld.learningzen.com

Section 2: Risks of Neonicotinoid Insecticides to Honeybees. Environmental Toxicology and Chemistry.

Section 3: Bee Health and Pollinator Problems

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**Introduction**

The European honey bee, Apis mellifera, plays an important role as a pollinator for major agricultural crops, pollinating $15 billion to $20 billion worth of crops in the United States alone and more than $200 billion worldwide [1]. In 2006, unexpectedly high colony losses reported by 6 commercial beekeeping operations in the United States were investigated and attributed to “fall dwindle disease” [2]. These operations lost 30% to 90% of their colonies in the fall, and some of the remaining colonies were considered too weak to survive overwintering [2]. This new syndrome was dubbed “colony collapse disorder.” Colony collapse disorder is characterized by the sudden loss of a colony’s adult worker bees, while the queen and live brood are present in surviving colonies. The latter part of the description often has been ignored when characterizing a colony as affected by colony collapse disorder, and the diagnosis can be difficult to apply because the entire colony may be dead at the time of inspection. No specific pathogen was identified in affected colonies, but the condition was considered distinct from previously known afflictions of beehives [2]. After the initial report by vanEngelsdorp et al. [2], a colony collapse disorder working group was formed by the US Department of Agriculture (USDA), and a survey was conducted to investigate overwintering losses of bees [3]. However, the survey was based on respondents’ opinions; no baseline was established for comparison of losses prior to the survey, and no programs were in place to ensure proper diagnosis of colony collapse disorder or other honeybee diseases [3]. Overriding economic factors, such as chronically low return on investment and cheap imported honey, were not considered but could have contributed to inadequate hive maintenance. Thus, the global occurrence of colony collapse disorder remains unproven.

In fact, a report by the United Nations Environment Programme (UNEP) [4], among others, indicates that the number of managed colonies—bees kept in human-made hives—has declined for either honey production or pollination—is increasing worldwide, albeit with localized declines in some areas. In Europe, an overall decrease in managed honeybee colony numbers began in 1985 but was reversed in 2001, and numbers are now increasing. Records from the United States show a nearly constant rate of decline in the number of managed colonies since 1950, except for a slight increase in the late 1970s, followed by a steep decline after the arrival of the parasitic mite Varroa destructor in 1987 [5]. In the European Union, this trend reversed in 2005 when the number of managed colonies in the United States began to increase, in spite of higher overwintering losses. The long term trend of managed colonies in Canada since 1990 is distinctly different from that in the United States (Figure 1).

Aside from a decrease in the number of colonies following the arrival of Varroa mites in 1987, there has been an increasing trend from 1950 to the present. The number of managed colonies has decreased from 7.6 million hives in 1950 to 3.5 million hives in 2021. This is a decrease of 55% in 71 years. The number of managed colonies has decreased in all major honey beekeeping countries. The primary reason for the decrease is the increased use of pesticides to control Varroa mites. Other factors include a decrease in beekeeping revenue, increase in production costs, and increased environmental concerns.

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**The European Honeybee (Apis mellifera)**

The European honeybee is a semidomesticated colonial bee species and one of the most economically important pollinators in the world. It is native to Europe and was brought to North America in the early 1800s to be used in the production of honey and beeswax. Today, honeybees are found throughout the world, and they play a critical role in pollinating crops and providing a source of honey for human consumption.

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**Keywords**

Neonicotinoid; Honeybee; Risk assessment; Insecticide

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**Article Information**

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Environ. Toxicol. Chem. 2014; 33:719-731. © 2014 The Authors. Environmental Toxicology and Chemistry published by Wiley Periodicals, Inc., on behalf of SEATC. This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution, and reproduction in any medium, provided the original work is properly cited.

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**Notes**

1. To whom correspondence may be addressed.

2. whipleyonhnelibrary.com. DOI 10.1002/etc.2527

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[2] vanEngelsdorp, D., et al. (2011). Colony collapse disorder. Environ Toxicol Chem 2014;33:719-731. © 2014 The Authors. Environmental Toxicology and Chemistry published by Wiley Periodicals, Inc., on behalf of SEATC. This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution, and reproduction in any medium, provided the original work is properly cited.

[3] Environmental Toxicology and Chemistry, published by Wiley Periodicals, Inc., on behalf of SEATC. This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution, and reproduction in any medium, provided the original work is properly cited.

[4] The European honeybee is a semidomesticated colonial bee species and one of the most economically important pollinators in the world. It is native to Europe and was brought to North America in the early 1800s to be used in the production of honey and beeswax. Today, honeybees are found throughout the world, and they play a critical role in pollinating crops and providing a source of honey for human consumption.

[5] Harris, D. (2013). The decline of honey bees: a review of current and proposed guidance in the United States and Europe for assessing the risks of pesticides to honeybees. Environ Toxicol Chem 2014;33:719-731. © 2014 The Authors. Environmental Toxicology and Chemistry published by Wiley Periodicals, Inc., on behalf of SEATC. This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution, and reproduction in any medium, provided the original work is properly cited.
have reduced the interest in honey production. Today, more than 65% of commercial bee colonies in the United States are managed for honey production. This is due to factors such as the high demand for honey and the fact that honeybees are essential pollinators for many crops. Yet, the rate of colony losses as a result of weakening and mortality is a serious concern for beekeepers and the honey industry.

### Possible Causes of Colony Loss

Articles have proliferated in the popular press suggesting a range of possible causes for colony collapse disorder and the general decline of bees, such as the heavy use of pesticides, habitat fragmentation, and the introduction of new bee diseases and pests (Figure 2) [7]. Poor bee husbandry, causing bees to go into winter in poor condition, has also been targeted as a possible cause of honeybee decline in the United States and Canada [5].

The U.S. Department of Agriculture (USDA) in the United States has been tracking the movement of bee colonies for many years, and at least 24 of the known viruses are transmitted by the Varroa mite. These mites are highly efficient vectors, transmitting viruses to brood or adult bees through the cuticle as well as through the normal routes of feeding or sex, and virus virulence increases during transmission within the mite vector, resulting in death within days after inoculation [9]. Dead and dying mites are removed from the hive, reducing the hive population sometimes quite dramatically. The visible symptoms of viral infection are unreliable, and multiple viruses may be present at the same time [6]. New molecular techniques have shown that viruses may cause latent infections, living in the bees with no apparent signs of disease and suddenly transitioning to virulence, possibly caused by high mite population levels [6]. It has also been established that genes responsible for the immune response are downregulated during mite feeding [10], which may increase bee susceptibility to viral infection as the result of a compromised immune system.

The difficulty in correctly identifying the cause(s) of widespread bee mortality was illustrated by Neumann and Carreck [5], who have drawn parallels between the experiment ences with Isle of Wight disease that occurred in the United Kingdom more than 100 yr ago and the current issue with colony collapse disorder. Isle of Wight disease resulted in large-scale mortality, and there was a time when every colony lost in the United Kingdom was attributed to Isle of Wight disease; for a long time, the underlying cause was unknown. Many cases were misdiagnosed as tracheal mites, and man y still believe that they are the cause, although recent studies have shown that Isle of Wight disease was actually a combined effect of acute bee paralysis virus, bad weather that inhibited foraging, and an excess of honeybee colonies compared with the amount of forage available [5]. For most viruses, visual diagnosis of infection is unreliable. Symptoms in many cases are not specific, and multiple viruses are usually present in a colony, and a definitive diagnosis is possible only through genetic analysis.

### Pesticides

While there is a growing consensus among scientists that the primary concern for beekeepers is Varroa mites, nutrition, and diseases, many investigators and regulators have focused on the possible role that insecticides, particularly the neonicotinoids, may be playing in bee health. Direct mortality from pesticides is considered to be limited to isolated incidents of catastrophic circumstances [4,11]. However, there remains a high level of concern among the public, many regulators, and some scientists, that pesticides may be responsible for weakening honey bees and making them more susceptible to viral infection as the result of a compromised immune system.

Neonicotinoid insecticides are neurotoxicants and therefore have been of particular concern for sublethal effects in honey bees. This class of insecticides was considered a major milestone for integrated pest- and resistance-management programs at the time of their development, combining features such as broad-spectrum activity, low application rates, low mammalian toxicity, target specificity, and rapid systemic movement in plants, and versatile application methods. The neonicotinoid insecticides include imidacloprid, acetamiprid, clothianidin, thiamethoxam, and thiacloprid, and are marketed under a variety of trade names. Of particular concern for pollinators is their use as seed coatings, and the potential exposure that results from subsequent distribution of the insecticide throughout the plant, including g pollen, nectar, and guttation fluids. There also is a concern for exposure to dust from treated seed in the exhaust air emitted by certain types of planters. In January 2013, the European Food Safety Authority (EFSA) released reports assessing the risks to honeybees of 3 neonicotinoid insecticides (imidacloprid, clothianidin, and thiamethoxam), explicitly acknowledging areas where data required to follow the current risk-assessment approach were unavailable [12]. This was followed in April 2013 by the European Union placing a 2-yr moratorium on the use of neonicotinoid insecticides in an effort to reduce bee losses while the data needed for more accurate characterization of risks from these chemicals are developed. While sublethal effects of neonicotinoids on the foraging behavior of bees have been documented in many laboratory studies, similar effects have not been observed in field studies at field realistic dosages [11], causing many regulators and scientists to question the application of the laboratory findings in a risk-assessment context. Not only are free foraging bees difficult to monitor but the measurement of quantifiable effects at the colony level from altered foraging behavior has not been possible. Consequently, the decision to suspend the use of these products was not unanimously supported by the European countries. The U.S. Environmental Protection Agency (USEPA) has accelerated the schedule for registration review of the neonicotinoid insecticides and added a warning about honey bees and other pollinators to the labels of these products but, at the time of this writing, has declined to ban or suspend registration of these products.

A comprehensive review of more than 100 publications relating to neonicotinoids and honey bees has been published by Blaquer et al. [13]. We summarize the information that describes how neonicotinoids interact with the nervous system of honeybees and what is known about their effects on individual honeybees in laboratory situations. Because honey bees are social insects, the aggregate effect of the colony changes how individual bees are exposed and how they protect themselves from toxicants; therefore, we have included a discussion of what is known about neonicotinoid exposure in semitropical and field conditions. We conclude with a review of the current and proposed methods for assessing the risks of pesticides to honey bees to highlight the evolution of our understanding of the interactions of chemicals and honeybees in commercial agriculture and insecticide production.

**Neonicotinoid Insecticides**

Neonicotinoid insecticides were developed in the 1990s as an alternative to broad-spectrum pesticides. They are a synthetic class of compounds, which is a naturally occurring neonicotinoid, and target the same receptors in the insect nervous system. They are registered for use on a variety of crops and are effective against a wide range of sucking insects as well as chewing insects such as
beetles and some Lepidoptera, particularly cutworms. Neonicotinoid insecticides can be applied as either a foliar spray or a seed coating. Labeling instructions specifically warn against applying the foliar spray times that are too frequent, as this can increase the risk of pest resistance. When seeds are coated with the product, the plant incorporates the pesticide into its tissues as it emerges and grows, including transferring some of the product to pollen, nectar and guttation fluid (guttation fluid is water that is transported by the roots and excreted at the base of the leaves in early morning when humidity is high). To coat the seed, the insecticide and other substances (e.g., fungicides, nitrates, rhizobium) are mixed with various materials such as polymers, talc and lime. Heating is used to anneal the coating to the seed. Seed coating is done in large, automated rotary coaters that can rapidly coat very large quantities of seed. There are 8 active ingredients registered in the United States, of which imidacloprid is the most widely used. The European Union instituted a 2-year ban (2013-2015) on the use of these products while Directive 2009/128/EC, which establishes the rules for the authorisation of plant protection products, prohibits the use of neonicotinoids in indoor environments. Insecticides can be applied as either a foliar spray or a seed coating. Effective against a wide variety of turf and sucking insects, including flies, beetles, moths and true bugs.

Thiamethoxam – Registered in 2001 for a wide range of vegetables. Thiamethoxam – Registered in 2003 for use on cotton and pome fruits. Thiamethoxam – Registered in 2011 for house fly control in animal facilities (poultry, feedlots, dairy, stables) and industrial locations. The European Union has instituted a 2-year ban (2013-2015) on the use of these products while Directive 2009/128/EC, which establishes the rules for the authorisation of plant protection products, prohibits the use of neonicotinoids in indoor environments. Insecticides can be applied as either a foliar spray or a seed coating. Effective against a wide variety of turf and sucking insects, including flies, beetles, moths and true bugs.

Acetamiprid – Registered in 2002 for use on leafy and fruiting vegetables, citrus, cotton, and fruits and ornamentals. Effective against ants, beetles, boxelder bugs, centipedes, chiggers, cockroaches, crickets, earwigs, firebrats, fleas, gnats, flies, millipedes, mosquitoes, moths, pillbugs, scorpions, silverfish, spiders, snails, stink bugs, ticks, termites and weevils.

Clothiamedin – Registered in 2003 for corn, canola, grapes, pome fruit, nee, tobacco, turf and ornamentals. Effective against a wide variety of turf and sucking insects, including flies, beetles, moths and true bugs.

Dicofol – Registered in 2012 for cotton, mustard, turf, lawn, and garden use, vegetable crops and residential indoor use. Effective on a broad spectrum of insects, including aphids, whiteflies, thrips, leafhopper, leafminer, sawfly and white grubs, lacebugs, pillbugs, beetles, mealybugs, sawfly larvae, and leafminers.

Imidacloprid – Registered in 1992 for cotton, rice, cereals, potatoes, tobacco, vegetables, pome fruit, peaches and tur. Effective against sucking and solenostomus, whiteflies, termites, tur insects and sucking, white potato beetle.

Nitpenyram – Registered as a veterinary product for use on dogs for flea control.

Nithiazine – Registered in 2011 for house fly control in animal facilities (poultry, feedlots, dairy, stables) and industrial locations.

Thiacloprid – Registered in 2003 for use on cotton and pome fruits. Effective against a variety of insects, including aphids and whiteflies, and capable of being sprayed directly on plants. Hair conditioner, soft powder, rinsed dry, talcum powders.

Thiamethoxam – Registered in 2001 for a wide range of vegetables. Organic, citrus, cotton, and rice. Effective against sucking and solenostomus, whiteflies, thrips, beetles, centipedes, millipedes, sawflies, lepidoptera, stink bugs and termites. Clothiamedin is a transformation product of the compound, method unknown. However, reported that increased Nosema infections in caged, newly emerged bees taken from colonies that had been fed either 5 ppb or 20 ppb imidacloprid in protein patties for 6 wk to 8 wk. Thiamethoxam had continued living in the experimental and control colonies were tested for Nosema, however, there was no relationship between the amount of Nosema infection and imidacloprid treatment. In a more recent study, Pettis et al. [24] found that the consumption of pollen containing neonicotinoid residues (acetamiprid, imidacloprid and thiacloprid) was associated with a reduced risk of Nosema infection. The studies by Pettis et al. [23,24] illustrate the difficulty in extrapolating laboratory effects to field conditions when investigating susceptibility to gut pathogens. Honeybees harbor a characteristic bacterial complex in the gut that plays an important role in nutrient processing, degradation of toxic compounds, and detoxifying pathogens. Newly emerged workers possess few bacteria, and their primary food, bee bread, does not provide a adequate source for the development of the normal gut bacterial community [25]. The establishment of a normal microbiota requires contact with the colony and food exchange with older nestmates [25]. The isolation of newly emerged workers in cages for testing may lead to increased susceptibility to pesticides and pathogens because of impaired gut microbiota. Differences in physiology, stress levels, and the bacterial complex in the gut may explain why the standard practice of collecting newly emerged workers from brood frames placed in incubators for use in laboratory pesticide tests may lead to misleading and/or inaccurate results.

Behavior, learning, and memory. Honeybees rely on innate behaviors to locate flowers and return nectar and pollen to the colony. Additionally, they forage for food within the colony for nurturing and raising young, as well as other labor activities. Therefore, because neonicotinoids are neurotoxins, there has been considerable concern and research on how they may affect bee behavior, including learning and memory [26]. Locomotor ability is critical to foraging success and is also affected by environmental factors. The isolation of a colony and food exchange with older nestmates [25]. The isolation of newly emerged workers in cages for testing may lead to increased susceptibility to pesticides and pathogens because of impaired gut microbiota. Differences in physiology, stress levels, and the bacterial complex in the gut may explain why the standard practice of collecting newly emerged workers from brood frames placed in incubators for use in laboratory pesticide tests may lead to misleading and/or inaccurate results.

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and Wright [29] also used the proboscis extension reflex assay to examine the effects of imidacloprid on adult honeybees of foraging age. Caged bees were fed approximately 1.3 μg of imidacloprid (field-realistic levels) reduced the rate of learning only in spaced conditioning trials. Further studies with high levels of mortality in a large group during toxicity testing (>50%) raises questions about the health and stress levels of the bees during testing.

Effects on learning and memory have yet to be demonstrated under field conditions [30], further emphasizing the difficulty of extrapolating from laboratory studies to the field level responses. Field trials with imidacloprid have shown delays in homing behavior and foraging behavior but only at food concentrations of 100 ppb [31], a level 50 times higher than average nectar concentrations. Similar effects on homing behavior were found with thiamethoxam but only at concentrations of 67 ppb [32]. Clothianidin has also been shown to affect homing flight behavior at concentrations higher than expected from field exposure (>1.09 μg/bee) [33].

Physiology and stress. Although there currently are no standardized laboratory tests to study either chronic or sublethal effects of pesticides on honeybees, the maintenance of bees under laboratory conditions prior to and during experimentation is viewed as a means to provide better control of extraneous variables. However, the caging of adult honeybees, whether individually or in groups, may not provide an accurate indication of how pesticides affect behavior or colony health under natural conditions. Caging not only increases stress but also limits interactions and behaviors that can affect both development and physiology. Access to dietary protein, for example, plays a key role in adult worker development. Young workers feed on bee bread, which provides the proteins, lipids, vitamins, and minerals required for normal growth. Inadequate diets not only affect growth but can also affect development of the hypopharyngeal glands, the ovaries, the fat body, and immune responses, all factors that have been implicated as sublethal effects of neonicotinoid insecticide exposure [18]. Despite this caution, results from laboratory studies often provide the basis for conclusions about chronic and sublethal effects of neonicotinoid insecticides on honeybees and are extrapolated by inference to field conditions.

Field and semifield tests. The variability of results in laboratory tests with individual bees makes it difficult to extrapolate to the more complex interactions that occur under field conditions. Experiments under the aegis of the Agricultural Research Service in 14 laboratory and semifield studies by Cress et al. [28] suggested that dietary intake of imidacloprid at field realistic levels could have sublethal effects and reduce honeybee performance by 6% to 20%. However, field studies by Maus et al. [20], Stadler et al. [34], and Cress et al. [18] demonstrated that pesticides that are not evaluated according to the label directions result in contamination of nectar and pollen; they do not cause acute toxic effects on foraging honeybees or significant health effects to colonies. Monitoring studies by Blacquiere et al. [11] and others conclude that residue concentrations in crops following application of neonicotinoids at recommended rates are too low to cause significant sublethal effects to honeybees. Cutler et al. [35] reviewed the Incident Reporting Program of the Canadian Pest Management Regulatory Agency and 111 incidents involving field mortality of bees in Canada since 2007, only 6 of which occurred prior to 2012. Although the neonicotinoids were suspected in a majority of incidents, including a large number in Ontario and Quebec in 2012, more than 90% of these were classified as “minor” meaning that less than 10% of honeybees in the colony were affected; most of the “major” incidents were attributable to other insecticide classes. It is significant that in Alberta, Canada, where beekeepers rely most heavily on canola (sized seed rape) for honeybee foraging, colony numbers and productivity have increased steadily in the time since neonicotinoid canola seed treatments were introduced, and productivity per colony exceeds 100 kg honey/yr. It also has been shown that the use of cloothianin-din treated seed of canola has had no significant impact on honeybee colonies [36].

In a major study of honeybee losses in Germany [37], the main factors that had a statistically significant association with colony loss were age of colony, calendar month of incident, foraging area (agricultural or urban), defoliated press seed – and acute bee paralysis virus – in autumn, (ii) queen age, and (iv) weakness of the colonies in autumn. No effects could be observed for Nosema sp. or pesticides. As in Canada, there was no association of high colony losses with access to oilseed rape. Neonicotinoid seeds were approved for agricultural use in the United States in 1994, and their use worldwide has increased significantly since then, except in France where their use was banned in 1999. However, reduced rates of colony survival were not reported even in states with the highest application of clothianidin, with no mortality being detected in a field study during which the ban was in France. These results suggest that the loss of a large number of honeybees can be tolerated by a colony during spring and summer. Mortality of forager bees is a frequent and natural occurrence during this time, which coincides with foraging behavior. As a result of the increasing concern over honeybee colony losses in higher-tiered studies that may be required on a case-by-case basis. These higher-tier studies are particularly complex because individual bees interact within the colony in a manner that can either increase or decrease the colony’s exposure, and the severity of the response can differ across ages and life stages. The EFSA’s guidance [42] acknowledges a level of conservatism because the highest tier tested is at the field level, whereas bees may be exposed to dust from施用 pesticides on plants and dust from treated seeds during planting. For exposure pathways from foliar sprays, external contact and diet. Dietary exposure also occurs from products incorporated into plant tissues through seed treatments or, occasionally, direct injection into the plant. To contact foliage products can include residues on exposed leaves and stems, which may be ingested. For contact exposure estimates of foliar products, standard methods for determining residues on plant leaves as a function of concentration, spray volume, nozzle size, and drift can be used [e.g., USEPA’s T-Rex model [42], and results can be compared directly to the contact LD50 or other test end points.

Tiered risk-assessment frameworks

The protection goals described by the Pellston workshop [41] and the USEPA [42] are protection of pollination services, honey production and other bee products, and biodiversity (i.e., protection of wild bees and other bee-keepers). The key goals of the risk assessment include assessing the effects of pesticides on colony strength (population size and demo grams) and colony survival (persistence). The EFSA risk assessment goals [43] are similar; that is, to protect colony strength by protecting survival, reproduction, and development of colonies, as well as behavior of larvae and adult bees. The EFSA (43) operationally defines “colony strength” as the number of honeybees a colony contains and has determined that the magnitude of effects on colonies should not exceed 7% reduction in colony strength due to the mortality of forager bees should not be increased more than 1.5-fold compared with control over a 6-d time period, or a factor of 2 for 3 d, or a factor of 3 for 2 d. Because the protection goal is at the colony level, it is particularly important for the emergent properties associated with the colony behaviors to be taken into account. For example, forage dust exposure to a neurotoxic pesticide may not return to the hive or may improperly communicate the location of forage plants. If this occurs, other worker bees will not know the location of the contaminated plants, so the probability of exposure is greatly reduced. All of the proposed risk-assessment frameworks follow a tiered approach, with initial toxicity tests conducted by exposing individual honeybees in the laboratory, followed by more realistic exposures of whole colonies under semfield conditions (or “tunnel” studies) and large-scale field tests. The protection goals (e.g., the EFSA’s target) is to infer from tests that bees that, assess the potential for the chemical to cause a toxic response so without explicit consideration of exposure scenarios. The more comprehensive studies or models assess the probability of encountering real-world exposures. These higher-tier studies are particularly complex because individual bees interact within the colony in a manner that can either increase or decrease the colony’s exposure, and the severity of the response can differ across ages and life stages. The EFSA’s guidance [43] acknowledges a level of conservatism because the highest tier tested is at the field level, whereas bees may be exposed to dust from planted seeds or exposed crops or weeds along field edges. Furthermore, the EFSA [43] specifically states that the assessment is conducted using a worst-case exposure scenario (e.g., 90th percentile of possible exposure scenarios), to ensure protection of pollinator s in over 90% of all treated fields.
Pollination dynamics and pesticide exposure for honey bees

Adult honeybees potentially can be exposed to systemic pesticides from several sources: seed coatings or soil, or through pollen, nectar, or guttation fluid (Figure 3). Brood and queens are exposed via processed pollen (brood food or royal jelly, respectively) and processed nectar (i.e., honey). Because different plant species take up and distribute chemicals differently, it can be difficult to accurately model concentrations in pollen, nectar, or guttation fluid based solely on application rate. Therefore, default values for dietary concentrations (i.e., pollen, nectar, and guttation fluid) have been proposed for tier 1 screening studies. Fischer and Moritany [41] proposed adopting a default value of 1mg/kg for systemic compound s and noted the lack of any information for foliar applied products. The EFSA [43] also uses the 1 mg/kg default value for systemic compounds but additionally provides a set of default values for foliar applications, depending on whether the assessment is for exposures up- or downwind from the application event. These values are 7.6 mg/kg (downwind) to 10.6 mg/kg (upwind) for adults and 4.4 mg/kg (downwind) to 6.1 mg/kg (upwind) for larvae.

Exposure values can be refined through measurements of pollen and nectar during semifield studies (see below). Pesticide concentrations in guttation water are estimated according to EFSA [43] based on their water solubility (100% soluble in the screening assessment, with reduced solubility estimates in the higher-tier assessments).

For higher-tier risk assessments of foliar pesticides (including dust from seed drilling), exposure is expressed as the total exposure from foraging on the crop, weeds within the field, the weeds at the field margin, and adjacent crops. Carrying over to subsequent years may also be examined. Thus, the relative proportion of the applied chemical that is in the various plant types needs to be calculated. Additionally, the proportion of time that bees spend foraging on each plant type is included in the exposure estimate for all types of applications, including systemic products. These parameters can result in large uncertainties in the final exposure estimate, partly due to the pesticide itself may alter foraging behaviors. The time of day that bees are foraging can also alter exposure (e.g., guttation fluid is present only in the early morning when it is still too cool for foraging activity) [42]. Therefore, for chemicals with high intrinsic toxicity, field studies would be needed to measure concentrations in and on the plants, pollen, nectar, other hive products and to look for compensatory changes in honey bee behaviors.

Effects

At present, the only end point with standardized protocols is mortality, although behavior is included in a semiquantitative manner. There are 2 standard protocols for quantifying pesticide-induced mortality: the contact and oral toxicity tests. Both are short-term studies, at 48 h and 72 h, respectively. Tests are conducted on individual worker bees at the cleaning/feeding stage of their life cycle. It has been proposed that these tests be extended to 96 h or 10 d for chronic exposure assessment (e.g., immobilization, incoordination, and hyper- or hyperrresponsiveness), although additional research is needed to develop repeatable protocols [43]. Additional tests for sublethal effects have been proposed, such as neurophysiology (with the proboscis extension reflex test), learning behavior (with a maze test) [43], and effects on hypopharyngal glands [43]. Tests for additional life stages are also available and have been proposed for situations in which exposure via pollen and nectar is considered [43]. This includes a honeybee first-instar larva dietary toxicity test being prepared as an Organizational for Economic Co-operation and Development standard test, in which survival, pupal weight, duration of development, adult morphology, and behavior are recorded [6]. Effects on bee hives can be investigated with colony exposure to pesticide in sugar solutions and monitoring brood mortality at 7 d and just prior to emergence, as well as pupal deformities just prior to emergence. However, these test methods have not yet been standardized [43].

Semifield studies where entire colonies are exposed to the crop or a mix of crop and weeds, either in cages, tunnels, or tents, have been standardized [6] as a means of assessing changes in behaviors under worst-case scenarios. The EFSA [43] recommends increased replication when conducting these tests to enhance statistical sensitivity. The use of a bee attractive crop such as oilseed rape (Brassica napus), mustard (Sinapis hirta), or buckwheat (family Polygonaceae) is recommended to ensure high-percentile exposure and allow sufficient quantification of the pesticide in pollen and honey [41]. Along with mortality at the front of the hive, behavioral end points include flight activity, foraging behavior on the treated crop (e.g., repellency), ability to return to the hive, and other behavioral abnormalities. Accurately measuring in-hive exposure (beyond concentrations in honey and royal jelly) can be difficult. Full field studies are rarely conducted. The primary assessment end points of field studies are forager returns and mortality, colony strength (number of bees), hive weight, overwintering success, presence of the same queen, and honey production. Secondary-effect end points are behavioral abnormalities, including behavior of foragers on flowers and of guard bees at the colony entrance, and disease resistance [6,41].

Risk characterization

There is no harmonized approach to a tiered risk assessment to bees, although there is general agreement that early tiers should be more conservative, to minimize the potential for false negatives, and higher tiers should become more realistic. Current and proposed schemes begin with the study of effects to individual bees exposed to high pesticide concentrations under worst-case conditions and conclude with long-term, full-scale field assessments that are more reflective of realistic exposure levels. However, there is disagreement on whether behavioral end points (e.g., proboscis extension reflex) can be included in a standardized test because of the lack of guidance on interpreting ecological endpoints at various levels of effect. The USEPA [42] states, “Until there are sufficient data to establish plausible adverse outcome pathways with consistent and reproducible linkages between molecular initiating events and key events across multiple levels of biological organization to an adverse effect at the whole organism/ colony/ population level, it is difficult to make use of sublethal al effects other than in qualitatively describing potential adverse effects.”

There is no agreement on what triggers a conclusion of unacceptable risk at the tier 1 screening level or whether to include assessment factors at a lower tier due to low exposure levels. For chemicals that do not pass the tier 1 screen, the risk-management approaches suggest putting mitigation measures into place to reduce chemical exposure below the screening level or conducting higher-tier study s to develop more accurate exposure metrics and to measure colony-level end points. Bees have become an important property that makes it very difficult to extrapolate colony-level exposures from honey and bee bread and colony-level responses to field applications of chemicals.

Conclusions and Summary

While it is undeniable that overwintering losses of commercial honey bee colonies are higher than they were in the recent past, there is no clear indication that pesticides are the root cause of such losses. The USDA survey shed light on the pattern of honeybee losses across the United States and concluded that such losses were unrelated to the patterns of agricultural pesticide use, in general, or neonicotinoid use, in particular. While beekeepers may have difficulty diagnosing a new phenomenon such as colony collapse disorder, they are familiar with other causes of colony loss, and pesticides ranked 8th on the list of possible causes of colony loss in the USDA survey [3]. Additionally, the epidemiological evidence from Europe shows no correlation of honeybee losses to pesticide use and indicates the presence of causative factors other than pesticides, although it is not yet possible to completely discount potential interactive effects of neonicotinoids with other stressors. Finally, the timeframe for increased mortality of honeybees is the late fall and over the winter, whereas the highest pesticide use occurs in the spring and early summer. The life span of forager bees is very short (approximately 1 mo), so the bees that may be exposed to the insecticide in the spring and early summer are not the same bees that overwinter in the hive. Additionally, it has been shown that neonicotinoids do not accumulate over time in the environment, the colony, or the honeybee. Given these 2 attributes, it is possible that some latent effects are expressed months after application.

All of the neonicotinoid insecticides have been reviewed and approved in many jurisdictions around the world, including Europe, Australia, Japan, Canada, and the United States, and they have been used for more than 15 y on a variety of crops. Therefore,
a significant body of data from both laboratory and field studies is available to assess the risks to honeybee colonies. The available data indicate that there may be effects to individual honeybees and a significant body of data from both laboratory and field studies is available to assess the risks to colonies of honeybees. The available data indicate that there may be effects to individual honeybees and a significant body of data from both laboratory and field studies is available to assess the risks to colonies of honeybees.

The commercial honeybee industry involves toward a pollinator-based economy, with fewer but larger companies and greater aggregations of bees, beekeepers are learning to manage their bees in a manner similar to other livestock operators. Herbicides and fungicides used to control agricultural weeds and pests, but the effects of pesticides on behavior, learning, and immunity are subtle and may not be measurable at realistic exposure concentrations. The more robust risk assessment frameworks being proposed and recently adopted in Europe provide guidance for a more initial analysis of possible effects of pesticides, but higher-tier assessments must be implemented to determine the realistically probable consequences of chemical use under field conditions. Assessing risks only under worst-case conditions with individual honeybees, diversified from properties provided by colony interactions, serves only to understand potential mechanisms of action of different chemicals but not their aggregated effect. Sublethal effects on pesticides on behavior, learning, and immunity are subtle and may not be measurable at realistic exposure concentrations. The most robust risk assessment frameworks being proposed and recently adopted in Europe provide guidance for a more initial analysis of possible effects of pesticides, but higher-tier assessments must be implemented to determine the realistically probable consequences of chemical use under field conditions. Assessing risks only under worst-case conditions with individual honeybees, diversified from properties provided by colony interactions, serves only to understand potential mechanisms of action of different chemicals but not their aggregated effect.

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Section 1: Links to Resources & State Plans
A) www.pollinator.org - this website is hosted by the Pollinator Partnership of which NPMA is a member.  
B) http://www2.epa.gov/pollinator-protection - EPA’s site with resources and information from the agency on pollinators.  
C) Per the directive of the President, EPA and USDA must work to develop a comprehensive plan in regards to pollinator protection. As NPMA has learned, this will include state pollinator protection plans. To date a handful of states have these plans in place. To view existing state plans visit the sites below:  
  b. California: http://www.cdpr.ca.gov/docs/legbills/calcodel/032032.htm  
  c. Mississippi: http://www.mdad.state.ms.us/departments/bpi/index.html  
  d. Florida: http://www.freshfromflorida.com/Consumer-Resources/Florida-Bee-Protection  
  e. Colorado: http://www.ceep.colostate.edu/Pollinator%20Protection/index.html

Section 2: Forbes article, The Dreaded 'Green Blob' Is The Most Dire Threat To Bees

The Dreaded 'Green Blob' Is The Most Dire Threat To Bees

If neonicotinoid pesticides were banned—as activists are demanding—U.S. farmers' productivity would drop and they would resort to more toxic chemicals, the nation's agricultural economy would be damaged, food prices would increase, and bees would be much worse off.

Magazine editor and satirist H.L. Mencken was right that there is an easy solution to every human problem—and that it is invariably neat, plausible, and wrong. In that category is the insistence of anti-pesticide crusaders and the organic food industry that federal regulators should ban neonicotinoids (“neons”) for short, the mostly widely used class of pesticides.

Activists commonly cite two justifications for such a ban: the presence of pesticide residues in food and the supposedly detrimental effect of the chemicals on bees.

Neither of these rationales is valid. Apparently the activists don’t know much about the sources of pesticidal substances found in our diet. The vast majority that we consume occur “naturally,” and they are present in organic foods as well as those that are produced with conventional methods.

In a landmark research article published in the Proceedings of the National Academy of Sciences, University of California, Berkeley, biochemist Bruce Ames and his colleagues found that “99.99 percent (by weight) of the pesticides in the American diet are chemicals that plants produce to defend themselves. Only 0.01 percent of natural pesticides have been tested in high-dose animal cancer tests, and about half (27) are rodent carcinogens; these 27 are shown to be present in many common foods.”

The bottom line of Ames’ experiments: “Natural and synthetic chemicals are equally likely to be positive in animal cancer tests. We also conclude that at the low doses of most human exposures the comparative hazards of synthetic pesticide residues are insignificant.”

In other words, consumers who buy organic foods in order to avoid pesticide exposure are focusing their attention on 0.01% of the pesticides they consume—and paying a huge price premium.

The anti-pesticide activists also seem neither to know nor to care about the role of neonicotinoids in American agriculture and the nation’s economy.

The neonicotinoids were derived from a naturally-occurring plant substance, nicotine, about 20 years ago. They act on the nicotinic receptors in insects’ nervous system, which are critical to insects’ functioning but are almost insignificant in vertebrate and mammalian— including human—physiology. Consequently, these compounds are much safer for humans and other vertebrates than previous generations of pesticides, such as carbamates and organophosphates.

Neonics are also more selective in their action than earlier pesticides. Commonly applied as a seed treatment or to the soil at the plant’s roots, the pesticide is taken up into the plant, becoming more dilute as the plant grows, so that it is present at very low levels in the plant’s flowers and fruits. By far the highest concentrations of neonics are in the stems and leaves of plants— where predatory insects most often feed— rather than in the flowers, where pollinators feed.

The result is that especially in the crops vulnerable seedling stage, the neonics in the plant control only the insects that actually feed on the crop— quite an improvement over earlier pesticides that killed insects indiscriminately, often with disruption of the wider ecology. Moreover, a single neonic seed treatment, sometimes supplemented by a single sprayed application, is usually enough for the whole season for many crops— another advance over previous compounds that required multiple sprayed applications throughout the growing season.

In spite of having been derived from a natural plant substance (not unlike many organically-approved pesticides), the safety for humans and other vertebrates, high specificity for the pests that feed on the crop, and the reduction of the amount of pesticides applied during the crop’s growing season, the banning of neonics has become a high priority for anti-pesticide activists. Their primary rationale is that the chemicals are bad for bees, but bee populations in the U.S. and Europe remain at healthy levels for reproduction and critical pollination of food crops and trees. Contrary to oft-repeated claims, honeybee populations are not declining.

According to U.N. Food and Agriculture Organization statistics, the world’s honeybee population rose to 80 million colonies in 2011 from 50 million in 1960. In the U.S. and Europe, honeybee populations have been stable (or even rising slightly over the last couple of years) during the two decades since neonics were introduced, according to U.N. and USDA data. Statistics Canada reports an increase to 672,000 honeybee colonies in Canada, up from 501,000, over the same two decades.

In February, the Australian government issued a report on bee health from the cattle industry. The Varroa destructor mite, a pathogen of bees. It found that “Australian honeybee populations are not in decline, despite the increased use of [neonicotinoids] in agriculture and horticulture since the mid-1990s.”

In April, the EU released the first continent-wide epidemiological study of bee health in Europe, which encompassed 2011 data before any continent-wide ban went into effect. Seventy-five percent of the EU’s bee population (located in 11 of the countries surveyed) experienced overwinter losses of 15% or less— levels considered normal in the U.S. Only 5% of the EU’s bee population (located in six northern countries) experienced losses over 20%, and that was after a long, severe winter.
California and the Pacific Northwest would be imperiled. If whitely infestations weren’t kept in check with neonic, a huge portion of U.S. winter vegetable production would be lost.

Grape-growing in California and the Pacific Northwest could be devastated by the viral scourges of leaf-roll and red blotch without neonic pesticides to control the leafhoppers that spread them. Similarly, in the mid-South, without neonic protection against thrips in cotton, water weevil in rice and grape coliasis in soybeans, yields could be so adversely affected that farmers would either go out of business or turn to already abundant crops like corn.

The ripple effect of such losses would be devastating. The production of citrus and tomatoes in Florida and rice and cotton in the mid-South and elsewhere is tied to processing plants, refrigerated warehouses, packing houses, cotton gins, rice mills, and a transportation and shipping infrastructure that supports the region’s agriculture. If the crops processed by these support industries were to become economically unviable in the absence of effective crop protection, rural counties across the southeastern U.S. would be decimated. We would see a kind of Community Collapse.

Radical environmental activists are anything but benevolent or constructive. The courageous former UK Environment Minister Owen Paterson on July 20 wrote about what he dubbed the “Green Blob,” “the mutually supportive network of environmental pressure groups, renewable energy companies and some public officials who keep each other well supplied with lavish funds, scare stories and green tape.” He blasted it as a “tangled triangle of unelected busybodies [who claim] to have the interests of the planet and the countryside at heart,” but while serving in the ministerial post, Paterson found it to be “increasingly clear that [the Blob] is focusing on the wrong issues and doing real harm while profiting handsomely.”

I found this passage in Paterson’s op-ed particularly poignant. “I received more death threats in a few months at [the Department for Environment, Food and Rural Affairs] than I ever did as secretary of state for Northern Ireland. My home address was circulated worldwide with an incitement to trash it; I was burnt in effigy of state for Northern Ireland. My home address was circulated worldwide with an incitement to trash it; I was burnt in effigy of state for Northern Ireland. My home address was circulated worldwide with an incitement to trash it; I was burnt in effigy of state for Northern Ireland. My home address was circulated worldwide with an incitement to trash it; I was burnt in effigy of state for Northern Ireland.” In other words, these environmental activists are far from the image of earnest, benign, channel-shirt-wearing, tree-huggers they like to project.

A ban on neonic in the name of protecting bees would be a travesty. It would not benefit bees, but it would make life harder for farmers and painful for consumers, who would see their food costs rise significantly, and by making farm exports more expensive and less competitive, it would damage the U.S. economy. It would, however, delight the Green Blob.

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