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MDAR MASSACHUSETTS DEPARTMENT OF AGRICULTURAL RESOURCES

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Overview: The purpose of this summary is to outline the topic of neonicotinoid pesticides and their use. Over the last decade, there has been a considerable amount of attention regarding the possible effects on pollinator health from this class of widely used insecticides known as neonicotinoids (neonicotinoids). The original version of this document was provided to the Subcommittee in November 2019. The current version includes some updates relative to EPA registration review of the neonicotinoids.

Neonicotinoid pesticides are modeled after the natural insecticide, nicotine. They act on the central nervous system of insects and causes excitation of the nerves and eventual paralysis, which leads to death. In the US, neonicotinoids were first registered by the EPA in the 1990s. The neonicotinoid family includes Acetamiprid, Clothianidin, Dinotefuran, Imidacloprid, Nitenpyram, Nithiazine, Thiacloprid and Thiamethoxam.

EPA is currently conducting a registration review of this class of chemicals. The conclusion of this review may result in the following:

- Changes made to application methods;
- Changes to use patterns;
- Sites applied to; or
- No changes at all

EPA has currently stopped registering any new outdoor uses (such as; new crops or new use sites) with neonicotinoids until this review has been completed. Draft risk assessments were issued for public comment during 2016-2018. Updated risk assessments and proposed interim decisions were issued in January 2020. Final Interim Decision documents are expected to be issued during 2021. The accompanying document entitled "*Summary of EPA Registration Review of Neonicotinoids*" provides more detail on risk characterization and proposed mitigation measures for neonicotinoids.

To date, MDAR has been consistent in its messaging about this class of chemicals. Through MDAR's Division of Crop and Pest Services, the Department regularly provides education to licensed applicators on the use of neonicotinoids and all pesticides relative to their safe use and impacts on pollinator health. MDAR continues to stress that applicators use an Integrated Pest Management (IPM) approach to manage pests. Education and training is a key component to IPM. IPM itself is a common sense approach to manage pests using a variety of methods including: preventing pest problems by controlling conditions which may attract and support pests, along with chemical and non-chemical treatments.

In 2017, MDAR staff conducted a more in-depth review of existing research for the purpose of developing a summary/living document. The objective of this document is to assist in the assessment of neonicotinoids to identify if toxicity and risk issues exists or not, and if the science is still inconclusive.

[1] This version includes updated product registration information, see p. 2 and 3.

KEY FACTS AND UNDERSTANDING:

Massachusetts Neonicotinoid Use: Neonicotinoids are widely used by agriculture, horticulture, non-agriculture, various industries and homeowners. Areas where the application of neonicotinoids are found include:

- Ornamental and shade trees, Christmas trees, shrubs, greenhouses, fruits and vegetables, fruit trees, golf courses, lawns, structural pest control, electrical utilities, forestry, wood treatments, and mosquitoes.

- Collars and topicals (K9 Advantix® II. Advantage® II) for domestic animals such as dogs and cats contain neonicotinoids for flea and tick control.

- Neonicotinoids have been/are used to battle invasive pests such as the Emerald Ash Borer (EAB), Asian Long Horn Beetle (ALB). Hemlock Woolly Adelgid (HWA) and the Spotted Lantern Fly (SLF).

- Massachusetts has approximately 9,800 pesticide licensed individuals that encompass all the industries and types of businesses listed above that use neonicotinoids. There are also a number of farmers that do not have a pesticide license (as they only use general use pesticides) but MAY use neonicotinoids.

MA Product Registration Information: Use patterns of registered neonicotinoid products in MA include:

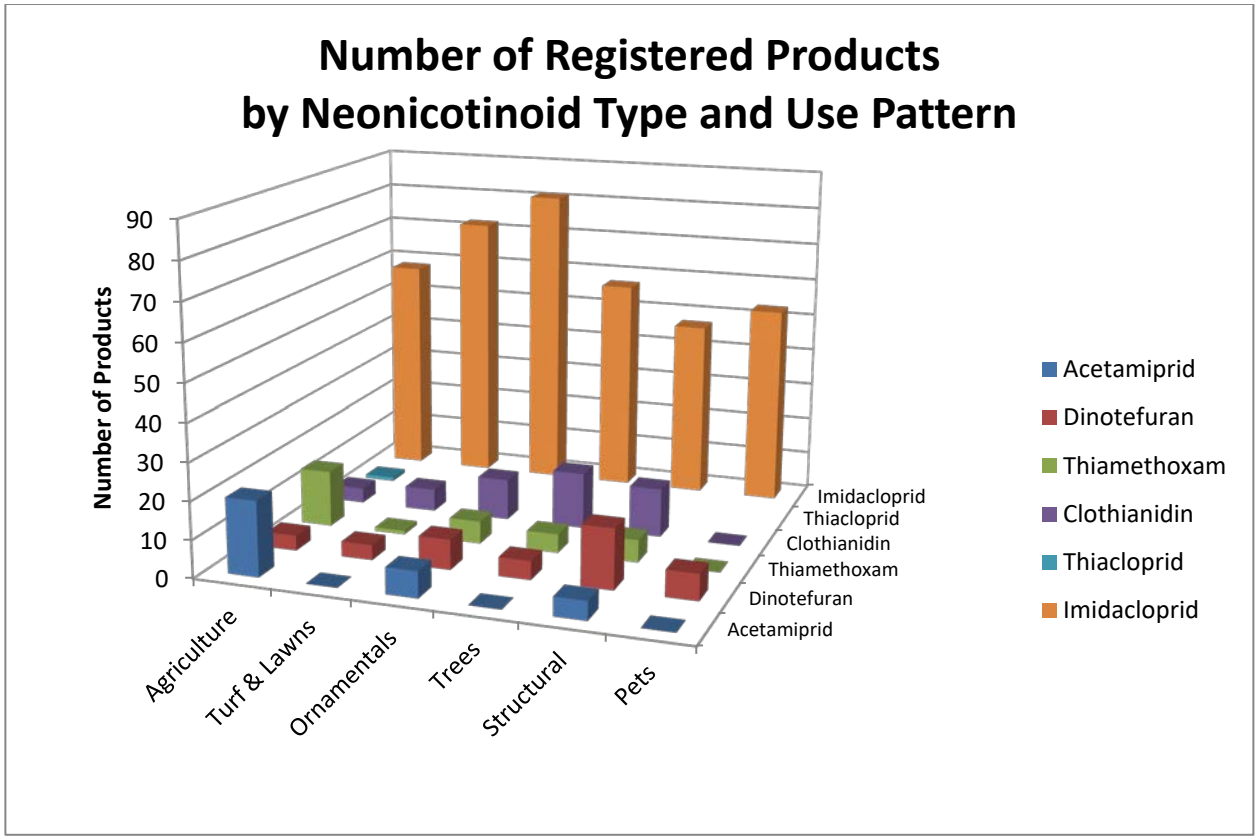
1. Acetamiprid: agricultural crops, garden vegetables, fruit and flower use
2. Clothianidin: agricultural crops, garden vegetables, fruit, flowers, turf & lawn, ornamentals
3. Dinotefuran: non-agricultural garden vegetable, fruit, flower, ornamental, turf & lawn, structural uses, pet products
4. Imidacloprid: agricultural crops, garden vegetable, fruit, flower, turf & lawn, structural uses, pet products
5. Thiacloprid: orchard fruit
6. Thiamethoxam: agricultural crops, garden vegetable, fruit, flower, turf & lawn, structural uses

MA Number of Registered Products (UPDATED for 2021)[2]

1. Acetamiprid: 29
2. Clothianidin: 36
3. Dinotefuran: 31
4. Imidacloprid: 223
5. Thiacloprid: 1
6. Thiamethoxam: 32

It should also be noted that Thiamethoxam and Dinotefuran based products[3] are classified as state-restricted use (SRU) because of concerns for potential impacts to groundwater resources. The graph below shows the number of registered products by neonicotinoid type and use pattern.

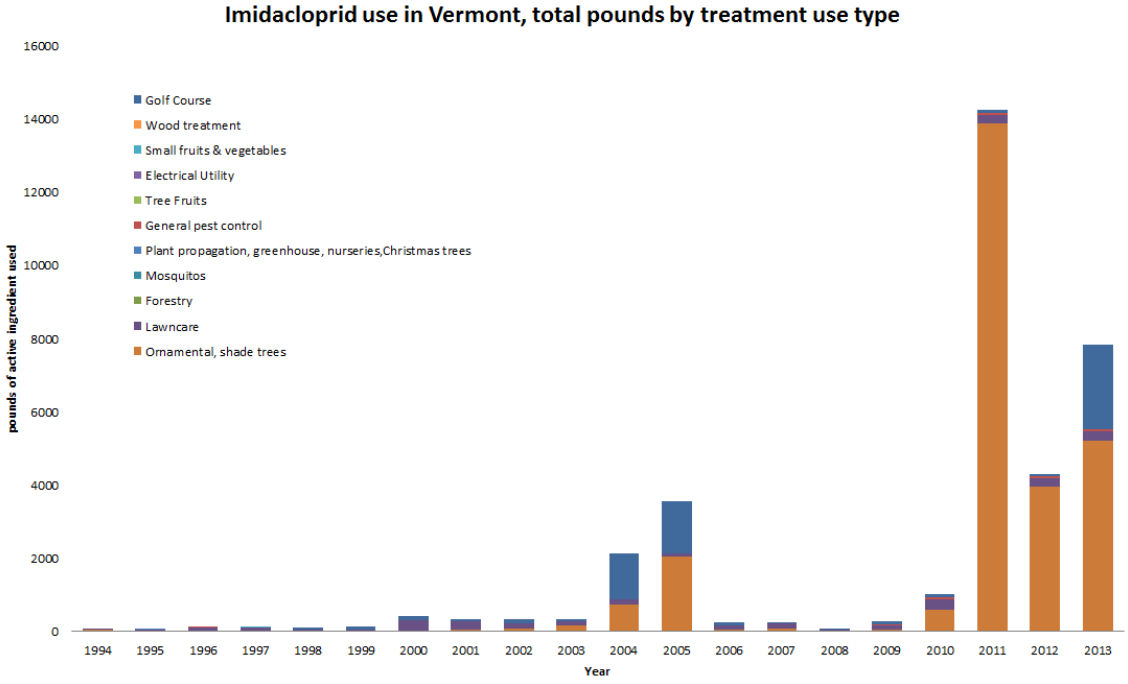
[2] Product registration data were accessed through the Kelly Solutions database: http://www.kellysolutions.com/ma/
[3] For products with a wide-area use pattern, such as agriculture and turf.



This graph shows that Imidacloprid-based products are the most common registered products in MA. The use pattern on trees appears on the largest number of registered Imidacloprid products.

For comparison, below is a neonicotinoid use perspective for Vermont showing the use of Imidacloprid across various use patterns.

Imidacloprid commercial use reported as a percent of usage type in VT: 1994-2013



Application of Neonicotinoid Pesticides:

- Neonicotinoids are different in that they are systemic in the plant; meaning – after they are applied, they enter the plant and can be moved throughout it. These pesticides may remain in varying concentrations throughout the plant after its application. Staying within the plant provides extended protection against pests – thus potentially reducing the need for additional insecticide applications.

- Neonicotinoids may be applied through foliar applications, through soil applications, as a seed coating and through tree trunk direct injections and/or applications.

- After neonicotinoids are applied the plant's roots, leaves, tissues, and other parts of the plant system will contain the pesticide. This makes neonicotinoids particularly effective against sucking insects as they feed on the plant and ingest the pesticide.

Toxicity of Neonicotinoids:

- The EPA classifies neonicotinoids as both toxicity class II and class III agents labeled with the signal word "Warning" or "Caution." They are not classified by EPA as a class I agent which requires the descriptive term "Danger".

- Neonicotinoids are less toxic to mammals and birds, and were developed to replaces organophosphates and other more toxic chemistries of insecticides. Neonicotinoids block a specific neuron pathway that is more abundant in insects than warm-blooded animals, these insecticides are more selectively toxic to insects than mammals.

- Neonicotinoids can be found in pollen and the nectar of plants or as a residue on the outside of a plant. They may also persist in the soil.

- The method and timing of application of neonicotinoids can significantly impact the potential exposure to pollinators, mammals and birds that come in direct contact with them. Incidental exposure can occur through contact with wind-blown soil or dust particles that land on pollinator forage or other environmental media.

- It can be argued that using neonicotinoids is an Integrated Pest Management (IPM) technique as the pesticide is taken up throughout the plant which possibly reduces the amount of pesticides and number of applications that need to be used to treat the plant once initially treated.

- EPA is currently conducting a registration review of neonicotinoids. At this point the assessments for clothianidin and thiamethoxam, similar to the preliminary pollinator assessment for imidacloprid showed most approved uses do not pose significant risks to bee colonies. Additional residue data will be considered in refined final risk assessments. Assessment for dinotefuran indicated potential risk to individual bees from on-field exposure for all crops and application methods.

Pollinator Health: Pollinator health is in decline and there are many complex factors that affect pollinators No single factor has been identified as the cause of pollinator health causes or bee losses. Rather, beekeeping practices (for managed pollinators), loss of habitat and forage resources, parasites such as; Varroa Mites, diseases, virus, pests, and pesticides are all factors impacting pollinator health.

- There has been substantial attention given to neonicotinoids regarding the possible effects on pollinator health. Over the years, considerable research has been conducted to further characterize what kind of effect neonicotinoids have on pollinator health. To date, the science is still unclear. While many studies have identified possible effects of neonicotinoids on pollinators, few studies have

characterized the actual risk to pollinators under true field conditions. The challenge is to transfer findings from lab studies to field situations. Results from field studies, including longer-term studies, are part of the risk assessment that EPA conducts for registration review.

- There is still a lot of science that is looking at sub lethal doses of neonicotinoids on bees and how bee health is impacted. The science is not consistent and there are many different conclusions.

- Neonicotinoids like any insecticide are toxic to insects and to bees and acute effect can occur at certain doses. Clothianidin, dinotefuran, imidacloprid and thiamethoxam have higher toxicity to bees than acetamiprid. The principal unanswered issue is the cumulative effect of sub lethal exposures.

- According to the Minnesota review, dust created from planting seeds treated with neonicotinoids which are contacted by bees may pose a problem. Thiamethoxam and clothianidin are the two neonicotinoids that are used for seed treatments. The treated seed planting exposure is reviewed in the Minnesota review. EPA's most recent risk assessment concludes that seed treatments are associated with low risk concern to bees.

Federal and States Actions to Mitigate Exposure of Pollinators to Pesticides: In addition, to conducting a registration review of neonicotinoids by the EPA as indicated above at the federal level the following actions have been/are being taken at the federal level to protect pollinators.

- In June 2014, President Obama directed federal agencies to increase efforts to protect pollinator health in the United States. One focus of the directive was specific to reduce pesticide exposures.

- The EPA has already required new labeling in the form of a "bee box", on all neonicotinoid pesticides, alerting the applicator to the potential risks from the pesticides. This may be particularly helpful in increasing the general public's awareness, as they may actually be applying at rates significantly higher than agricultural or commercial applicators. Increased pesticide label restrictions for contracted pollinator services will also occur.

- Pesticide labels have been changed to include more language directing applicators when and where they can use the product in relation to pollinators.

- Current pesticide labels (not just neonicotinoids) do include bee toxicity language as well. Such things as;
    - *'BEE CAUTION: This product is highly toxic to honeybees and other bees exposed to direct treatment or residues on crops or weeds in bloom. This product may show residual toxicity to honeybee, especially in humid climates and under slow drying condition. Notifying beekeepers within 1 mile of treatment area at least 48 hours before product is applied will allow them to take additional steps to protect their bees. Limiting applications to times when bees are least active, e.g. within 2 hours of sunrise or sunset, will minimize risk to bees."* are listed on the label.

  The applicators must read and follow label directions.

- Additionally, the EPA with input from state and federal agencies developed a guidance policy for states to create their own "Managed Pollinator Protection Plan". Using this guidance each state may develop a managed pollinator protection plan that reflects the state's usage pattern (pesticide type, treatment types) for pesticides as well as the types of managed pollinator activities in the state.

- In Massachusetts, MDAR, in addition to providing continuing education to pesticide applicators, has taken steps to protect pollinator health including but not limited to:
    - Release of Pollinator Protection Plan 4/21/17; the Plan is designed to improve the overall health of pollinator populations by providing stakeholders with a set of voluntary guidelines that facilitate communication, collaboration, and recommendations of best management practices.
    - Scale up of the Apiary Program to promote and sustain apiculture in MA. The Program provides: support to honey beekeepers, farmers, land managers and pesticide applicators.

  Apiary Services include:
    - Formalized hive inspections, registration of apiaries and colonies for beekeepers, best practices and prevention methods for the establishment of new pests and pathogens.
    - Investigate and sample suspected honey bee kills from pesticides and pathogens.
    - Provide technical assistance, continuing education and outreach to all audiences. The opening of two new state apiaries to promote awareness, education and demonstration projects.
    - Issue permits for the movement of honey bees and hive equipment.
    - Conduct honey bee surveys and research projects as funding allows.

Honey Bee Mortality Directly Associated with Neonicotinoid Pesticide Use in MA:

I. National USDA-APHIS Honey Bee Health Survey: MDAR and UMass-Amherst participated in the National USDA-APHIS Honey Bee Health Survey funded from the Farm Bill in 2012, 2016, 2017 and 2018. This survey consists of visiting beekeepers with apiaries containing at least 10 honey bee colonies from which 8 colonies were sampled by taking composite samples of pollen/bee bread or wax for pesticide analysis (1 apiary = 1 pollen/bee bread sample). In 2017, USDA issued a series of changes in sampling protocol of which the most impactful was a change in sampling 5 apiaries longitudinally by taking wax instead of pollen/bee bread (1 apiary = 2 wax samples). A total of 240 samples were either collected by MDAR or UMass and then analyzed each year by the USDA-AMS lab for a total of 302 pesticides.

The results specific to Massachusetts Data was as follows as it relates to data collected from MA Beekeepers:

- 2018 (wax): no samples contained neonicotinoids; this represents a total of 40 colonies sampled across the state; colonies sampled were in both agricultural and residential areas during the months of June/July and August/September 2018.

- 2017 (wax): no samples contained neonicotinoids; this represents a total of 40 colonies sampled across the state; colonies sampled were in both agricultural and residential areas during the months of July/August and September/October 2017.

- 2016 (pollen/bee bread): 1 sample contained a neonicotinoid (clothianidin= trace amounts); this represents a total of 80 colonies sampled across the state; colonies sampled were both in agricultural and residential areas during the months of July and August 2016.

- 2012 (pollen/bee bread): only 1 sample of bee bread pollen contained a neonicotinoid (thiamethoxam=24.2ppb); this represents a total of 80 colonies sampled across the state; colonies sampled were both in agricultural and residential areas during the months of July and August 2012.

II. UMass Hobby Beekeeper Health Survey: In 2018, MDAR utilized appropriated ear-mark budget funds to collaborate with UMass-Amherst to conduct a state-wide Hobby Beekeeper Health Survey. This survey was considered vitally important given the gap in knowledge of samples taken from hobby beekeepers in Massachusetts, which consist of a diverse subset of honey bee colonies that are not sampled since they

do not meet the minimum apiary size criteria to be included in the National USDA-APHIS Honey Bee Health Survey. A total of 40 beekeepers located in 12 counties in both agricultural and residential areas were selected based on response to MDAR solicited notice about survey. Beekeepers were sampled twice per season (June/July – early and August/September - late) during which time composite samples of pollen and wax were taken from hives (1 apiary = 2 samples of pollen and 2 samples of wax). A total of 160 samples were collected by UMass and analyzed by the Cornell Pesticide Analysis Lab for a total of 266 pesticides.

- A total of 52 samples tested positive for at minimum trace amounts of at least one neonicotinoid (33% of all samples). The most common neonicotinoid found in these positive samples were imidacloprid (19.4%), acetamiprid (6.9%), clothianidin (3.1%), thiamethoxam (2.5%), and dinotefuran (0.6%).

Prevalence of pesticides found in all pollen samples (n=160) analyzed statewide 2018.

Neonicotinoid Insecticide	Prevalence (%)	LOD (ppb)	Detection Level Range (ppb)
Acetamiprid	3.1	0.05	0.21-5.21
Clothianidin	3.1	0.23	Trace-1.04
Dinotefuran	0.6	0.70	10.38
Imidacloprid	11.3	0.23	Trace-4.40
Thiamethoxam	1.9	0.19	Trace

Prevalence of pesticides found in all wax samples (n=160) analyzed statewide 2018.

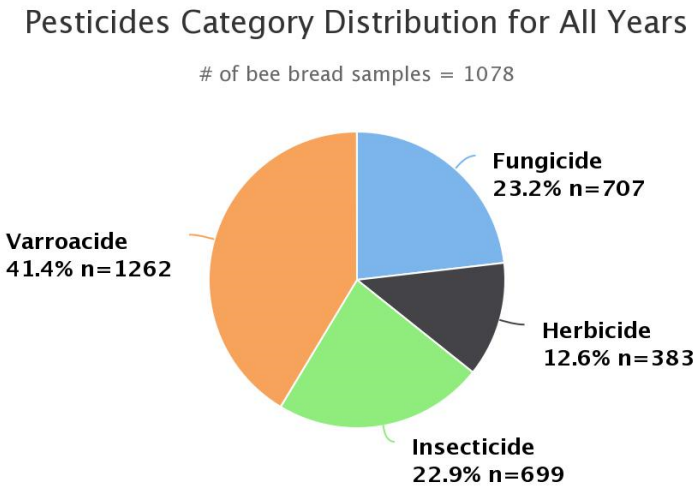
Neonicotinoid Insecticide	Prevalence (%)	LOD (ppb)	Detection Level Range (ppb)
Acetamiprid	3.8	0.04	Trace-0.11
Imidacloprid	8.1	0.18	Trace-6.47
Thiamethoxam	0.6	0.14	Trace

III. MDAR Bee Kill Investigations: The Department has investigated 34 bee kill complaints relative to pesticides over the past four years. To date, neonicotinoids have not been found during the sample screening process. Samples collected include bees, honey/nectar, wax, and pollen/bee bread.

National Prevalence of Neonicotinoids and Other Pesticides in Pollen:
A major concern for pollinator exposure to pesticides, including neonicotinoids, is their presence in pollen. For honey bees, this pollen is collected and brought back to the hive. Pesticides measured in hive pollen/bee bread can be used as a surrogate for pollinator exposure. Nationally, pesticides are routinely found in honey bee pollen/bee bread. The National USDA-APHIS Honey Bee Health Survey conducted in 2011-2016 found the most prevalent pesticides (% of samples) in hive pollen/bee bread were miticides used to treat parasitic mites: 2, 4-dimethylphenyl formamide (an amitraz derivative) (44.5%), fluvalinate (37.4%), coumaphos (31.2%), and thymol (21.5%).

However, pesticides from other classes were also found in the pollen samples and often times more than one pesticide was found in each pollen sample. The pesticides most often found in pollen (>5% of samples) were the miticides (Varroacide), non-neonicotinoid insecticides (chlorpyrifos, fenproximate), fungicides (azoxystrobin, boscalid, chlorothalonil, cyprodinil, pyraclostrobin and herbicides (atrazine, pendimethalin). The neonicotinoids detected were only found in 0.4-1.9% of samples.

Pesticide class distribution in pollen/bee bread samples collected nationally 2011-2016.



Prevalence of pesticides found in all pollen/bee bread samples (n=1078) analyzed nationally 2011-2016.

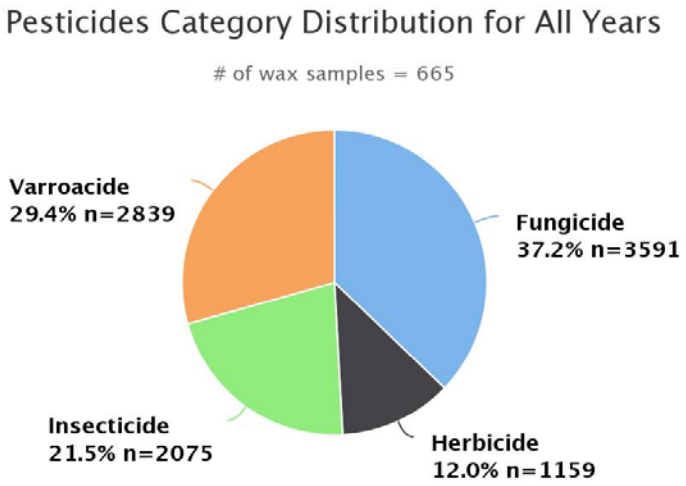
Neonicotinoid Insecticide	Prevalence (%)	LOD (ppb)	Detection Level Range (ppb)
Acetamiprid	0.9	4.0	Trace-81.0
Clothianidin	1.2	15.0	Trace-62.8
Imidacloprid	1.9	6.0	Trace-216.0
Thiacloprid	0.4	5.0	29.0-362.0
Thiamethoxam	1.2	10.0	Trace-39.6

National Prevalence of Neonicotinoids and Other Pesticides in Wax:

Another potential area of concern for pesticide exposure is in wax. For honey bees, wax is secreted by workers and used as components for housing stored floral resources (i.e. pollen, bee bread, nectar, honey and brood – non-adult bees). Pesticides measured in wax can illustrate long term exposure and persistent chemical build up within the hive. Nationally, pesticides are routinely found in wax. The National USDA-APHIS Honey Bee Health Survey conducted in 2017-2018 found the most prevalent pesticides (>50% of samples) in wax were miticides used to treat parasitic mites: coumaphos (89.8%), fluvalinate (74.1%), thymol (77.4%), 2, 4-dimethylphenyl formamide (an amitraz derivative) (72.7%), fungicides: carbendazim (83.3%), azoxystrobin (51.9%), and a synergist: piperonyl butoxide (68%).

However, pesticides from other classes were also found in the wax samples, and often more than one pesticide was found in each wax sample. The few neonicotinoids detected were only found in 0.6-3.0% of samples.

Pesticide class distribution in pollen samples collected nationally 2017-2018.



Prevalence of pesticides found in all wax samples (n=665) analyzed nationally 2017-2018.

Neonicotinoid Insecticide	Prevalence (%)	LOD (ppb)	Detection Level Range (ppb)
Acetamiprid	3.0	2.5-8.0	Trace-19.0
Imidacloprid	1.1	5.0-6.0	Trace-24.0
Thiacloprid	0.6	2.0-5.0	Trace-15.0

<u>Other States and Countries</u>:

Connecticut: New law, Reclassification of Neonicotinoid Pesticides, Public Act 16-17 requires that, not later than 01/01/18, the Commissioner (of Energy and Environmental Protection) classify all neonicotinoids (as defined by the Act) that are labeled for treating plants, as restricted use.

- The classification of products currently registered in Connecticut which contain clothianidin, dinotefuran, imidacloprid and thiamethoxam will be changed from general use to restricted use effective January 1, 2017.
- Essentially this new law restricts the product, taking it off the shelves for homeowner use, but allows for its use in agriculture.

Maryland: Similar to CT, a state ban on consumer use of neonicotinoids is slated to take effect on 01/01/18. The legislation includes exceptions for certified applicators, farmers and veterinarians.

Minnesota and California: Pesticide regulator agencies in Minnesota and California conducted special reviews to further assess pollinator risks. These reviews resulted in recommendations and action steps to minimize the impact of neonics on pollinators, including training and education efforts, stewardship programs, stakeholder interactions to review label requirements and potentially modify application rates and timing.

European Union Use Restrictions: In 2013, the EU restricted the use of some neonicotinoid insecticides. With the exception of seed treatments, the restrictions were similar to those that have been implemented by the US EPA (i.e., prohibition of pesticide application when crops are in bloom). Evaluation of additional data collected since the implementation of the 2013 restrictions resulted in a ban implemented in 2018 for all outdoor uses of imidacloprid, clothianindin and thiamethoxam; only the use is permanent greenhouses

remains possible. In the light of these restrictions, the registration of these active ingredients will expire of January 31st, 2019 and April 30th, 2019 respectively. The expiration date for imidacloprid is July 31st, 2022. For acetamiprid, a low risk to bees was established and further restrictions of this substance were not issued. Regarding thiacloprid, it was proposed to not renew the approval which will expire on April 30th, 2020.

Resources:

Bee Informed Partnership APHIS Honey Bee Survey Reports. https://bip2.beeinformed.org/state_reports/

https://www.epa.gov/pollinator-protection/schedule-review-neonicotinoid-pesticides

https://www.epa.gov/pollinator-protection/epa-actions-protect-pollinators

http://www.umass.edu/pested/index.htm

Vermont: http://pss.uvm.edu/beeclover/Articles/NEONICOTINOID_PESTICIDES_Report_Final.pdf

Minnesota Extension: http://www.extension.umn.edu/garden/plant-nursery-health/toxicity-to-pollinators/

Oregon Dept of Agriculture: https://www.oregon.gov/ODA/shared/Documents/Publications/PesticidesPARC/NeonicotinoidAlternativesNurseries.pdf