Canadian Section of The Wildlife Society
Conservations Affairs Committee
"Canada Proposes to Phase-out the Use of Nicotine Based (Neonicotinoid) Pesticides"
Briefing Document – November 2018

Overview

Declines in honeybee and other pollinator populations have generated considerable scientific and public concern. A number of factors are seen as potential contributors to these declines and no single factor has been identified as the main cause including loss of habitat and food sources, disease, viruses as well as pesticide exposure.

Neonicotinoids are a popular class of pesticides used by the agriculture industry as a foliar spray and as a seed treatment. They are also used for other purposes including killing insects in homes and other domestic uses. There are three main neonicotinoid pesticides currently approved for use by the agriculture industry: imidacloprid, thiamethoxam and clothianidin. Canada's Pest Management Regulatory Agency (PMRA) has proposed a ban on all outdoor uses, including seed treatments, of all three.

In November 2016, amid concerns about the health of mayflies and midges, the PMRA proposed a ban on outdoor uses of imidacloprid. This phase-out is proposed to take place over three to five years. The comment period on this proposed ban is now closed and a final decision is expected in December 2018. PMRA also started its review of the two other neonicotinoids, thiamethoxam and clothianidin, in November 2016. The phasing out of these neonicotinoids is proposed to take place over a three to five-year period once the ban was approved. The comment period on this proposal ends November 13, 2018 and a decision on whether to ban these is expected to occur in 2019 and will consider whether other products are available.

The province of Ontario has already brought in regulatory restrictions to reduce the use of neonicotinoids out of concern for pollinators. This decision is based on concerns regarding levels of the insecticide found in aquatic habitats and potential negative impacts on non-target aquatic invertebrates. Although there has been considerable concern about the implications of the use of these pesticides on bees and aquatic insects, there is also increasing concern and scientific evidence that there are potential impacts on fish and other vertebrate wildlife.

Purpose of this Brief

The purpose of this brief is to provide background, science-based information, guidance and recommendations to the CSTWS in order to develop a response to the Federal Government's plans to phase out the use of neonicotinoid pesticides. The current comment period includes the proposal to phase out thiamethoxam and clothianidin. The comment period for phasing out imidacloprid has closed.

What are Neonicotinoid Pesticides?

Neonicotinoids are a class of insecticides that target nicotinic acetylcholine receptors (nAChRs). In insects, binding at the receptor level elicits a biological response that can ultimately impact cognitive ability and nervous system processing or, at high doses, can lead to neurotoxicity and mortality. Though the pesticides do not bioaccumulate, they are time-cumulative depending on exposure frequency.

First synthesized as nithiazine in the 1970s, which lead to further research and development to establish an effective insecticide, that exhibited low toxicity to mammals. This led to the wide-spread distribution of imidacloprid after introduction to market in 1991 and the later availability of thiamethoxam and its metabolite clothianidin in 1999. Though many neonicotinoids have since been synthesized, 7 neonicotinoids are commonly used including imidacloprid, clothianidin, thiamethoxam, acetamiprid, thiacloprid, dinotefuran, and nitenpyram

The high water solubility of neonicotinoids facilitates a wide variety of application methods. Crops may be treated directly by spraying, injection of the chemical in irrigation water or by soil treatment and seeds and plants may be coated with insecticide or have the chemical applied at specified times during growth (e.g., brushing on stems, dipping seedlings). However, foliar spraying and seed coating constitute 60% of applications worldwide.

Neonicotinoids are used principally against larvae and/or adult insects, including species of moths, beetles, flies, and sap-feeding and wood-boring pests. Many beneficial insects (e.g., honey bee (*Apis mellifera*)) may also be affected through consumption or direct exposure to the insecticide present in bee products (e.g., honey, bee bread, royal jelly, wax), pollen, nectar, leaves, and water (e.g., guttation drops from plants and groundwater). Exposure risk will depend on life history, timing of insecticide application, conditions affecting distribution (e.g., leaching, runoff), and the capacity for plants to uptake the chemical (i.e., maximum uptake of 20% after planting of coated seeds).

How widely are these pesticides used in Canada?

Imidacloprid constitutes up to 41.5% of the global market, with application on more than 140 crops worldwide, while use of clothianidin makes up another 46 million acres (approximately 146 registered crops). The three principal neonicotinoid insecticides (imidacloprid, thiamethoxam, and clothianidin) are registered for use on nearly all crops in Canada, including corn, soybean, winter wheat, and canola, and are predominantly used in southwestern Ontario. In the prairies, over 40% of croplands are treated with neonicotinoids, an estimated 11 million acres in 2012, and at least one neonicotinoid was detected in 36% of samples from Saskatchewan wetlands.

What are the Issues?

Despite pervasive use, a 2013 study (Cutler et al. 2013) found that the Pest Management Regulatory Agency (PMRA) assessed 110 reported incidents of potential neonicotinoid exposure resulting in bee mortality, but 91% of cases were classified as minor such that <10% of the colony suffered loss or sublethal effects. However, in 2012, clothianidin was detected in approximately 70% of samples of dead bees from Ontario and thiamethoxam was present in samples originating in Québec.

Neonicotinoids have a long half-life, which can range from months to years (e.g., 28–1250 days for imidacloprid) and therefore can have a high degree of environmental persistence.

Bees

Studies are predominantly focused on honeybees and bumblebees due to their intensive management and economic significance. Studies have found effects on mobility, spatial memory, postural control, reproduction and development.

Aquatic invertebrates and fish

The US Environmental Protection Agency lists 57 aquatic species spanning 6 orders of magnitude that are affected by neonicotinoids, with the most sensitive to the chemical being the mayfly and the least sensitive being select species of fish.

Neonicotinoids have been shown to cause feeding inhibition, impaired movement, and reduced fecundity and body size in invertebrates.

Fish are most sensitive during embryonic and larval stages due to extent of tissue differentiation at these stages. Neonicotinoids can result in oxidative damage to DNA (i.e., cellular-level stress response) in short-term exposures and can lead to immunosuppression. Though some studies have shown an effect on body size, others (Engelking 2018) have found no effect on growth. In sockeye salmon (*Oncorhynchus nerka*), however, no impacts were seen on development, hatching, and survival.

Studies are currently looking at how pulse exposures (i.e., short-term with high concentration, then a period of exposure to low concentrations of the chemical) contribute to the effects of neonicotinoids in aquatic environments.

Birds

American eared doves (*Zenaida auriculata*) administered imidacloprid, clothianidin, and thiamethoxam administered at the median lethal dose (i.e., LD50, the amount of material required that results in mortality in 50% of the test population), resulted in a decline in feeding and loss of body weight. Based on these results, an average-sized bird could be exposed to the equivalent of an LD50 of imidacloprid by consuming 1.7 g of treated sorghum seeds.

Decline in body mass and effect on orientation in white-crowned sparrow (*Zonotrichia leucophrys*) has been documented at low (4.1 µg imidacloprid/g bw/day) and high (10.25 µg imidacloprid/g bw/day) doses of imidacloprid.

Neonicotinoids, particularly thiacloprid, have been detected in the blood of European honey buzzard (*Pernis apivorus*) and detections mirrored the spatial distribution of treated oilseed plant fields in Finland. In the Netherlands, bird populations declined 3.5% per year on average in correlation with the introduction of imidacloprid.

Neonicotinoids (i.e., clothianidin and thiamethoxam) have been detected in wild turkeys (*Meleagris gallopavo silvestris*), a game bird, in southern Ontario.

Take Home Points, Suggested Response and Proposed Recommendations to the CSTWS

- Neonicotinoids play an important role in agriculture production in Canada
- Due to the economic importance of ecosystem services provided by bees (primarily honeybees and bumblebees) scientific studies have primarily focused on these species.
- Recent research has highlighted potential impacts on aquatic invertebrates (e.g., mollusks, mayflies, dragonflies, earthworms).
- There is increasing concern about potential implications on other non-target wildlife species including fish and birds.
- Neonicotinoids can accumulate in soils and groundwater with potential input into aquatic systems.
- Neonicotinoids can persist within the environment for several years, depending on environmental conditions due to their long half-life (i.e. the amount of time it takes for chemical to breakdown and dissipate). This has raised concerns about the potential impacts on wildlife and ecosystem function.

Suggested Response to the Federal Government

- Given the scientific evidence of the implications of the use of these pesticides on non-target insects and aquatic invertebrates, and growing body of science supported information on the potential impacts on other wildlife species, it is appropriate for CSTWS to send a letter to Canada's Pest Management Regulatory Agency on this issue.
- Support the efforts by the Pest Management Regulatory Agency to phase out the use of these pesticides.
- Acknowledge the import role that Neonicotinoids play in Agriculture production in Canada.

Proposed Recommendations to Canada's Pest Management Regulatory Agency:

- Invest in monitoring and evaluation current impacts of existing neonicotinoid pesticides to increase understanding of potential factors (e.g., topography, soil, field conditions) that may influence chemical dissipation and potential mitigation measures to limit risk.
- Ensure short-term and long-term scientific studies that includes a thorough analysis of the potential time-variable exposure profiles (e.g., acute, long-term, and pulsed exposures) in different environmental conditions. This should include studies on the interactions with other chemicals, and for different life-history stages of a representative selection of target and non-target species, with consideration of potential sublethal effects and shifts in community interactions.
- Support for the development and evaluation of alternative target-specific compounds with a proven efficacy in pest control that have minimum impact on non-target species and low environmental risk
- Work with the scientific community, industry, and stakeholders to establish a precautionary approach that maintains evidence-based decisions in regulatory development of new compounds and alternate methods of pests control including Best Management Practices, while phasing out use of neonicotinoids in Canada.
- Increase public awareness of scientifically-accurate information on neonicotinoids and the potential benefits and risks posed by alternative methods

Final November 11, 2018

References

Addy-Orduna, L. M., J. C. Brodeur, and R. Mateo. 2019. Oral acute toxicity of imidacloprid, thiamethoxam and clothianidin in eared doves: A contribution for the risk assessment of neonicotinoids in birds. *Science of The Total Environment*, 650, 1216-1223.

Bonmatin, J.-M., C. Giorio, V. Girolami, D. Goulson, D. P. Kreutzweiser, C. Krupke, M. Liess, E. Long, M. Marzaro, E. A. D. Mitchell, D. A. Noome, N. Simon-Delso, and A. Tapparo. 2014. Environmental fate and exposure; neonicotinoids and fipronil. *Environmental Science and Pollution Research*, 22, 35–67.

Byholm, P., S. Mäkeläinen, A. Santangeli, and D. Goulson. 2018. First evidence of neonicotinoid residues in a long-distance migratory raptor, the European honey buzzard (*Pernis apivorus*). *Science of The Total Environment*, 639, 929-933.

Cutler, G. C., C. D. Scott-Dupree, and D. M. Drexler. 2013. Honey bees, neonicotinoids and bee incident reports: the Canadian situation. *Pest Management Science*, 70, 779-783.

Eng, M. L., B. J. M. Stutchbury, and C. A. Morrissey. 2017. Imidacloprid and chlorpyrifos insecticides impair migratory ability in a seed-eating songbird. *Scientific Reports*, 7, 15176.

Engelking, S. 2018. Viability, growth, development, and performance of juvenile sockeye salmon (Oncorhynchus nerka) exposed to neonicotinoid pesticides. M. E. T. Thesis, Biological Sciences Department, Simon Fraser University, British Columbia, Canada.

Fahrenkamp-Uppenbrink, J. 2018. Wildflower contamination with neonicotinoids. *Science*, 360, 167-168.

Goulson, D. 2013. REVIEW: An overview of the environmental risks posed by neonicotinoid insecticides. *Journal of Applied Ecology*, 50, 977-987.

Government of Canada. 2017. Update on the Neonicotinoid Pesticides. Retrieved from: https://www.canada.ca/en/health-canada/services/consumer-product-safety/reports-publications/pesticides-pest-management/fact-sheets-other-resources/update-neonicotinoid-pesticides.html

Government of Canada. 2018. Proposed Special Review Decision PSRD2018-02, Special Review of Thiamethoxam Risk to Aquatic Invertebrates: Proposed Decision Consultation. Retrieved from: https://www.canada.ca/en/health-canada/services/consumer-product-safety/reports-publications/pesticides- pesticides-pest-management/public/consultations/proposed-special-review-decision/2018/thiamethoxam-risk-aquatic-invertebrates/document.html

Government of Canada. 2018. Proposed Special Review Decision PSRD2018-02, Special Review of Thiamethoxam Risk to Aquatic Invertebrates: Proposed Decision Consultation. Retrieved from: https://www.canada.ca/en/health-canada/services/consumer-product-safety/reports-publications/pesticides- pesticides-pest-management/public/consultations/proposed-special-review-decision/2018/clothianidin/document.htm

Hallmann, C. A., R. P. B. Foppen, C. A. M. van Turnhout, H. de Kroon, and E. Jongejans. 2014. Declines in insectivorous birds are associated with high neonicotinoid concentrations. *Nature*, 511, 341–343.

iPolitics. 2018. Health Canada says popular nicotine-based pesticides pose rrisk to aquatic insects. Retrieved from: https:// ipolitics.ca/2018/08/15/health-canada-says-popular-nicotine-based-pesticides-pose-risk-to-aquatic-insects/.

Iturburu, G. B., M. F. Simoniello, S. Medici, A. M. Panzeri, and M. L. Menone. 2018. Imidacloprid causes DNA damage in fish: clastogenesis as a mechanism of genotoxicity. *Bulletin of Environmental Contamination and Toxicology*, 100, 760–764.

Jeschke, P., R. Nauen, M. Schindler, and A. Elbert. 2010. Overview of the Status and Global Strategy for Neonicotinoids. *Journal of Agricultural and Food Chemistry*, 59, 2897–2908.

Jones, A., P. Harrington, and G. Turnbull. 2014. Neonicotinoid concentrations in arable soils after seed treatment applications in preceding years. *Pest Management Science*, 70, 1780-1784.

Laycock, I., K. M. Lenthall, A. T. Barratt, and J. E. Cresswell. 2012. Effects of imidacloprid, a neonicotinoid pesticide, on reproduction in worker bumble bees (*Bombus terrestris*). *Exotoxicology*, 21, 1937-1945.

MacDonald, A. M., C. M. Jardine, and P. J. Thomas. 2018. Neonicotinoid detection in wild turkeys (*Meleagris gallopavo silvestris*) in Ontario, Canada. *Environmental Science and Pollution Research*, 25, 16254–16260.

Main, A. R., J. V. Headley, K. M. Peru, N. L. Michel, A. J. Cessna, and C. A. Morrissey. 2014. Widespread use and frequent detection of neonicotinoid insecticides in wetlands of Canada's prairie pothole region. *PLoS ONE*, 9, e92821.

Meikle, W. G., J. J. Adamczyk, M. Weiss, A. Gregorc, D. R. Johnson, S. D. Stewart, J. Zawislak, M. J. Carroll, and G. M. Lorenz. 2016. Sublethal effects of imidacloprid on honey bee colony growth and activity at three sites in the U.S. *PLoS ONE*, 11, e0168603.

National Post. 2018. Pesticides linked to bee deaths will be phased out in Canada starting in 2012. Retrieved from: https://nationalpost.com/news/canada/pesticides-linked-to-bee-deaths-will-be-phased-out-in-canada-sources-say.

Public Health Ontario. 2015. Case study: neonicotinoids. Retrieved from: https://www.publichealthontario.ca/en/eRepository/Case_Study_Neonicotinoids_2015.pdf

van der Sluijs, J. P., N. Simon-Delso, D. Goulson, L. Maxim, J. Bonmatin, and L. P. Belzunces. 2013. Neonicotinoids, bee disorders and the sustainability of pollinator services. *Current Opinion in Environmental Sustainability*, 5, 293-305.

Raby, M., X. Zhao, C. Hao, D. G. Poirier, and P. K. Sibley. 2018. Chronic effects of an environmentally-relevant, short-term neonicotinoid insecticide pulse on four aquatic invertebrates. *Science of the Total Environment*, 639, 1543-1552.

Samuelson, E. E. W., Z. P. Chen-Wishart, R. J. Gill, and E. Leadbeater. 2016. Effect of acute pesticide exposure on bee spatial working memory using an analogue of the radial-arm maze. *Scientific Reports*, 6, 38957.

Sánchez-Bayo1, F., K. Goka, and D. Hayasaka. 2016. Contamination of the aquatic environment with neonicotinoids and its implication for ecosystems. *Frontiers in Environmental Science*, 4, 71.

Schaafsma, A., V. Limay-Rios, Y. Xue, J. Smith, and T. Baute. 2015. Field-scale examination of neonicotinoid insecticide persistence in soil as a result of seed treatment use in commercial maize (corn) fields in southwestern Ontario. *Environmental Toxicology and Chemistry*, 35, 295-302.

Simon-Delso, N., V. Amaral-Rogers, L. P. Belzunces, J. M. Bonmatin, M. Chagnon, and C. Downs, and L. Furlan. 2015. Systemic insecticides (neonicotinoids and fipronil): trends, uses, mode of action and metabolites. *Environmental Science and Pollution Research*, 22, 5-34.

Xan, X., W. Yang, D. Wang, Y. Zhao, R. Yao, L. Ma, C. Ge, X. Li, Z. Huang, L. He, W. Jiao, and A. Lin. 2018. Chronic brain toxicity response of juvenile Chinese rare minnows (*Gobiocypris rarus*) to the neonicotinoid insecticides imidacloprid and nitenpyram. *Chemosphere*, 210, 1006-1012.

Tosi, S., G. Burgio, and J. C. Nieh. 2017. A common neonicotinoid pesticide, thiamethoxam, impairs honey bee flight ability. *Scientific Reports*, 7, 1201.

Williamson, S., S. Willis, and G. Wright. 2014. Exposure to neonicotinoids influences the motor function of adult worker honeybees. *Ecotoxicology*, 8, 1409-1418.