

Earth & Space

The Poisoned Oasis: Neonicotinoid Spillover Harms Bees Near Corn

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ABSTRACT

The by-effects of insecticides are a threat for pollinators and, in turn, for healthy ecosystems. The analysis of their impacts can lead to beneficial solutions, supporting simultaneously the environment and agricultural needs.

[Neonicotinoids](#) are a highly controversial class of insecticides that are often applied as seed coatings for crops such as corn, soy and, canola. Neonicotinoids are systemic and water soluble; once treated-seeds are planted, the insecticides are taken up by the growing plant through the roots and transported to all tissues, including the stem, leaves, pollen, and nectar. These properties make neonicotinoids very attractive to farmers who simply have to plant treated seeds to reap the benefits of pest control without the added cost of separate pesticide applications. But this seemingly cheap insurance against pests doesn't come without an environmental cost; neonicotinoids are highly toxic to beneficial insects, including the pollinating bees.

There is an ongoing debate about the role that neonicotinoids have played in declines of honey bees health in North America. On one hand, a growing number of studies have experimentally fed bees and bee colonies low doses of neonicotinoids and found a range of harmful effects. For example, neonicotinoids would suppress the bee's innate immune system and make it more difficult for them to find their way back to the hive. Critics would quickly point out that such studies used exposures that were not 'field-realistic' – that bee populations near crops would rarely, if ever, encounter the dose and duration of exposure used in the treatment experiments ([Carreck et al., 2015](#)). This 'field realistic' critique persisted given lack of high-resolution data on neonicotinoid levels and routes of exposure to bees; the data that existed were often derived from studies that sampled pesticides during a single snap shot of

time. This 'field-realistic' critique was made stronger by a few 'field' studies that placed bees in Corn and Canola during the crop's blooming or pollen shedding period (approximately 2 to 3 weeks) and found no ill effects on bees ([Pilling et al., 2013](#), [Cutler et al., 2014](#)). *But is 2 to 3 weeks an appropriate period of exposure?*

It is very clear that the debate on the safety of neonicotinoids must first be informed by high resolution exposure data from the field. We ([Tsvetkov et al., 2017](#)) carried out such a study. In the early spring of 2014, we placed honey bee colonies near corn fields and far from corn fields in Southern Ontario and Québec. These colonies were visited 7 times during the year (Early May to September), and our team sampled pollen, nectar, bees, and larvae and tested them for presence and quantity of over 200 agricultural chemicals.

We found that colonies near corn were exposed to sub-lethal levels of neonicotinoids for three to four months of the year – a much longer period of exposure that was used in typical treatment experiments, and is certainly longer than the period of exposure used in the 'field' studies (i.e. 3 weeks). Given that the average lifespan of a worker honey bee during the summer is about a month, our results indicate that many generations of workers were exposed to neonicotinoids throughout their entire life in Canada's corn growing regions.

The biggest route of exposure for colonies was pollen, so we examined the contaminated pollen

under a microscope to identify the source plants. We found that nearly all of the contaminated pollen in bee colonies originated from bee-friendly plants common in southern Ontario and Québec (e.g. [willow](#), [clover](#), [buckthorn](#)), not from neonicotinoid-treated corn, soy, or canola. Neonicotinoids are water soluble, making them highly mobile in agricultural environments. Our findings indicates that honey bees near corn are indirectly exposed to neonicotinoids that spill-over from agricultural fields into the surrounding landscapes that contain wild plants that naturally support pollinator populations. We call this phenomenon the ‘poisoned oasis’ representing bee-attractive plants that grow on the margins of the nutritional ‘desert’ that is corn monoculture.

Armed with high-resolution exposure data from the field, we carried out a controlled experiment to investigate the effects of ‘field-realistic’ neonicotinoids on bee health. We found that worker

honey bees exposed to neonicotinoids had a substantial reduction in adult life span. We also validated previously discovered negative effects of neonicotinoid exposure on the social immunity ([Wu-Smart et al., 2016](#)) and honey bee queen health ([Williams et al., 2015](#)).

Neonicotinoids are designed to protect crops against harmful insects, but our research clearly shows that neonicotinoids can spill over from crops and end up in the pollen and nectar of bee-attractive wild flowers. This process makes neonicotinoids readily available for consumption by pollinators for most of the active bee season in temperate environments. While neonicotinoids may be a cheap pest-control solution for farmers, our study shows that these insecticides impose an environmental cost in the form of declines in the health of honey bee colonies and likely other pollinators.