# The Role of Pesticides in Bee Decline

*Pollinator decline has accelerated rapidly in the last decade, with many populations at critically low levels. Scientists are increasingly linking these and other signs of biodiversity collapse with low-level exposure to pesticide 'cocktails' in the environment — especially to a relatively new class of systemic insecticides called neonicotinoids.*

## Introduction

Honey bee populations have steadily declined in the U.S. since 1947 at a gradual rate averaging 1% per year. Steeper declines have been recorded since 1987, but since the emergence of "Colony Collapse Disorder" in 2006 commercial beekeepers have reported extraordinary losses averaging 29 to 36% per year. Such losses are unprecedented, more than double what is considered normal.

Most scientists agree that there is no single cause of CCD. Rather, recent population declines are likely caused by a combination of factors acting in concert to weaken bee colonies to the point of collapse; and emerging science points specifically to impaired immunity. Lead suspects in this causal complex include: nutritional stress, pathogens (including parasites) and pesticides.

## Key suspect: Neonicotinoids

Neonicotinoid pesticides (or neonics) were implicated early on by beekeepers in France and then the U.S. as their bee populations began rapidly declining. Commercial beekeepers report especially heavy losses after having pollinated or allowed their bees near crops treated with neonics.

Neonics are the fastest growing class of insecticides in the history of synthetic pesticides and are "blockbuster" products for makers Bayer and Syngenta, in part because these chemicals are used in 77% (as of 2005) of the emerging, highly profitable seed treatment sector. Although used in a variety of settings, neonics are most notably used on nearly all of the 92+ million acres of corn planted in the U.S. Corn does not depend on bees for pollination, but bees do rely on corn's abundant, neonic-laced pollen as a pervasive nutrition source.

### Neonicotinoid pesticides

Neonicotinoids (neonics) are the most widely used class of insecticides. Introduced in the early 1990s in response to widespread pest resistance and public health concerns arising from older pesticides, they have come into focus as problematic largely because of their harmful effects on bees.

Neonics are typically applied as systemics, used as seed coatings or soil drenches and taken up through the plant's vascular system. They are then transmitted to all parts of the plant, including pollen and nectar.

Neonics are very persistent, accumulating over time in the environment. Most neonics are acutely toxic to bees, but single, high-dose (i.e. acute) exposures are likely less common than chronic, sub-lethal exposure levels faced by bees over time as they forage in the field.

Researchers have found a range of sub-lethal effects caused by neonics: altered foraging and feeding behavior, impaired orientation and social communication, undermined immunity and delayed larval development.

**TABLE 1** Economic value of pollination to U.S. agriculture

| CROP | CROP VALUE | POLLINATION DEPENDENCY | HONEY BEE POLLINATION VALUE |
|---|---|---|---|
| Almonds | $2.84 billion | 100% | $2.84 billion |
| Apples | $2.2 billion | 90% | $1.98 billion |
| Oranges | $1.93 billion | 30% | $522 million |
| Cherries (sweet) | $721 million | 80% | $584 million |
| Blueberries | $593 million | 90% | $534 million |

***Source: :*** Calderone NW (2012) Insect Pollinated Crops, Insect Pollinators and US Agriculture: Trend Analysis of Aggregate Data for the Period 1992–2009. PLoS ONE 7(5): e37235.

## What's at stake?

According to a recent U.N. report, of the 100 crops that provide 90% of the world's food, over 70 are pollinated by bees. Wild pollinators like bats, butterflies and bumble bees are also facing catastrophic declines. Managed honey bees, however, remain the most economically important pollinator, contributing over $19 billion annually to the U.S. economy.

Rapid declines in pollinator populations put additional stress on an already-unstable food supply by depressing yields and agricultural efficiency. While pollination biologists do not foresee imminent food system collapse without honey bees, we do know that agriculture quickly becomes unrecognizable.

Bees are responsible for one in every three bites of food: from almonds to berries and the alfalfa that feeds dairy cows, our diets and agricultural economy hinge in largely invisible ways on a healthy bee population. For example, the cost of almond pollination has nearly tripled since colonies began collapsing in 2004, costing that industry over $83 million per year.

In addition to their agricultural value as pollinators, honey bees are a keystone, indicator species. Their decline points to (and will likely accelerate) broader environmental degradation. Pollinator population declines are thus a disproportionately important piece of the current collapse in biodiversity.

However, bees' critical role as pollinators means that attending to their health and intervening on their behalf presents a unique opportunity for bolstering the health and resilience of our environment and agricultural economy alike.

### WHAT BEEKEEPERS ARE SAYING

U.S. commercial beekeepers report that their industry is on the verge of collapse.

"Bee-toxic pesticides in dozens of widely used products, on top of many other stresses our industry faces, are killing our bees and threatening our livelihoods."
—Steve Ellis, MN & CA beekeeper

"Another winter of 'more studies are needed' so Bayer can keep their blockbuster products on the market, and EPA can avoid a difficult decision, is unacceptable."
—David Hackenberg, PA beekeeper

# The Science

### What we know

The causes behind recent bee declines are not a "mystery." After having tried and failed to link CCD with a particular parasite, virus, fungus or other pathogen, scientists now largely concur that CCD is caused by a combination of increased overall pathogen loads, poor nutrition and pesticide exposure. Recent debates have hinged on which of these three co-factors is driving losses most directly.

In the last few years neonicotinoid pesticides—both alone and in combination with other pesticides—have emerged the leading suspects both because of their direct toxicity to bees and because of their indirect and cascading effects. For example, individual bees can be acutely poisoned while flying through pesticide-contaminated planter dust in a recently planted corn field; or chronically poisoned at sub-lethal levels by eating and drinking contaminated pollen, nectar and/or water over time. (Neonics are water soluble and persist for months in the environment). Bees are then more likely to get sick, less able to forage effectively, and so on. Colonies experience these poisonings at the population level as a hive's highly interdependent generational cycles, immune system functions and social communication abilities are disrupted.

### Recent science

A review of recent research on the effects of neonics' environmental impact reveals that 94% (31/34) of methodologically sound, published studies since 2009 found that these pesticides were even more toxic than had been previously known. (The majority of these studies concerned bees as environmental indicators.)

Since 2010 three separate studies have found a synergistic effect between neonics and the common gut pathogen, *Nosema*. One found increased susceptibility to infection in bees exposed to imidacloprid as larva at levels so low as to be "undetectable" in adults (Pettis, 2012).

In early 2012 three more strong studies were released linking neonics to declining bee populations. One of these established contaminated corn planter dust as a significant exposure route (Krupke, 2012), finding 10x levels of clothianidin as were found in the industry-sponsored study on the basis of which clothianidin was originally approved for use in corn and canola in the U.S.

### Industry bias

Industry-sponsored studies have been proven to be systematically biased. Such studies never-the-less provide much of the basis for regulatory decisionmaking in the U.S. One consequence of this arrangement is that products such as neonics are rushed to market and remain there without rigorous toxicity tests having been conducted.

At present, there are no valid field studies establishing the safety of nitroguanidine neonics for bees. To the contrary, the weight of evidence from independent, peer-reviewed studies clearly indicates that this relatively new, long-lasting and widely used class of pesticides is a key driver behind recent bee declines.

As is the case with most environmental diseases, the likelihood that a definitive study will determine singular causality is very low. We must instead rely upon the weight of the evidence established by unbiased science. Especially in field-relevant studies where the effects of low-level, combined pesticide exposures are tracked over time periods exceeding the common 24-48 hr window, science shows that the nitroguanidine neonics—both alone and in combination with other pesticides—are poisoning bees and beehives in a number of different ways that lead to colony collapse.

**Neonic impacts on honey bees**

- Compromised immune response > increased pathogen load
- Shortened adult life-cycles > disruption of brood cycle
- Impaired memory & learning
- Reduced social communication > reduced foraging efficacy
- Disorientation > reduced foraging efficacy
- Delayed larval development > longer *Varroa* mite reproduction cycles & a disruption of brood cycle
- "Gut" microbe disruption > malnutrition
- Acute poisonings in the field

***Sources:*** See page four for a list of resources cited directly. See *Bees & Pesticides: State of the Science,* for a full list of relevant studies.

## Steps taken in other countries to protect honey bees from pesticides

European governments are heeding the science and taking action to protect bees from harmful pesticides.

Based on bee-monitoring studies, neonicotinoid seed treatments were banned in Italy in 2008.

In Germany, corn seeds treated with clothianidin, thiamethoxam and imidacloprid were pulled from market in 2008. Sunflower and corn seeds treated with imidacloprid were suspended in France in 1999. After restrictions were imposed on neonic-treated seeds, European beekeepers report improved hive health.

In 2013, the European Food Safety Authority released a report concluding that neonics pose an "unnacceptable risk" to bees. This report prompted a two year ban of neonics in the European Union, which was implemented in December 2013.

## Policy options

**1)** ***Conduct evaluations of neonicotinoids in a timely manner, using independent and field-relevant data.*** EPA's current review of neonics already on the market is due to complete in 2018, with an action plan developed at that point.

**2)** ***Restrict the use of neonicotinoids as a seed treatment on bee forage and pollinator-dependent crops (e.g. corn, almonds, sunflowers).*** The prophylactic use of insecticidal seed treatments is unnecessary with basic Integrated Pest Management practices such as multi-year crop rotations. Up until the mid-1990s U.S. corn farmers used insecticides on just 30-35% of corn acreage. In 2012, 94% of the 92 million acres of corn seed planted in the U.S. were treated with neonicotinoids (primarily clothianidin or thiamethoxam).

**3)** ***Close the conditional registration loophole.*** Conditional registration (CR) allows a new active ingredient to enter the market for an unspecified period of time while the registrant gathers safety data requested by EPA. Despite Congressional intention that it only be used in rare instances, CR is a regularly abused loophole; registrants rarely complete required studies on time and EPA fails to track. Roughly 65% of the 16,000 currently registered pesticide products – including clothianidin and other neonics — have been rushed to market before basic toxicity testing through conditional registration.

EPA's own analysis of the program between 2004–2010 confirms that this process has been misused in 98% of cases. As such, EPA should: Cancel registration for all products with overdue or non-compliant studies, ensure transparency by documenting CR actions and allowing for public participation and oversight of this process.

**4)** ***Support the "Save America's Pollinators Act."*** Introduced by Representatives Conyers (D-MI) and Blumenauer (D-OR), H.R. 2692 would ensure neonics are taken off the market until EPA concludes its review.

## Resources cited


Calderone, NW (2012) "Insect Pollinated Crops, Insect Pollinators and US Agriculture: Trend Analysis of Aggregate Data for the Period 1992–2009." PLoS ONE 7(5): e37235.

Carman, H (2011) "The Estimated Impact of Bee Colony Collapse Disorder on Almond Pollination Fees." ARE Update 14(5): 9-11. University of California Giannini Foundation of Agricultural Economics.

Cox-Foster, D and D. vanEngelsdorp (2009) "Solving the mystery of the disappearing bees." *Sci Am*. Apr; 40-47.

Krupke , C et al. (2012) "Multiple routes of pesticide exposure for honey bees living near agricultural fields." PLoS ONE 7(1).

McGarity and Wagner (2008) "Bending Science: How Special Interests Corrupt Public Health Research 24." Harvard U. Press.

Pilatic, H (2012) "Pesticides and Honey Bees: State of the Science." Pesticide Action Network North America.

Sass, J and M. Wu (2013) " Superficial Safeguards." National Resources Defense Council.

Shardlow, M (2012). "A review of recent research relating to the impact of neonicotinoids on the environment." Buglife.

Steinzor, R and W. Radin (2012) "Cozying Up: How the Manufacturers of Toxic Chemcicals Seek to Co-opt Their Regulators." Center for Progressive Reform.

USDA National Agricultural Statistics Service (www.nass.usda.gov)

vanEngelsdorp, D et al. (2010) "Weighing risk factors associated with bee colony collapse disorder by classification and regression tree analysis." J Econ Entomol 103(5): 1517-1523.


**Pesticide Action Network North America** works to replace the use of hazardous pesticides with ecologically sound and socially just alternatives. To learn more about the impact of pesticides on bees, visit www.panna.org/bees.