Requiem for the Honeybee

Neoniccotinoid insecticides used in seed dressing may be responsible for the collapse of honeybee colonies

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Neonicotinoid insecticides are harmful to the honeybee

There has been a great deal of concern over the decline of the honeybee across the US, Europe and Australia [1] (The Mystery of Disappearing Honeybees, this series). The United States National Research Council (USNRC) Committee of the Status of Pollinators in North America report [2] focused on the impact of parasites, fungi, bacteria and viruses, but did not pay much attention on the impact of pesticides and genetically modified (GM) crops, which may have lethal or sub-lethal effects on the bee's behaviour or resistance to infection. There have been strong responses to the report on that account. On the other hand, any suggestion that GM crops and pesticides may be causing the decline of honeybees is met with heated denial from the proponents.

Certainly, honeybees are declining both in areas where GM crops are widely grown, and in other areas where GM crops are released in small test plots. Is there a common thread that links both areas? Yes there is, the universal use of systemic pesticide seed dressing in GM crops and conventional crops; in particular, the widespread application of a relatively new class of systemic insecticides - the neonicotinoids - that are highly toxic to insects including bees at very low concentrations. Systemic pesticide seed dressings protect the newly sprouted seed at a vulnerable time in the plant's development. Seed dressings include systemic insecticides and fungicides, which often act synergistically in controlling early seedling pests.

The neonicotinoid insecticides include imidacloprid, thiamethoxam, clothianidin, and several others. Imidacloprid is used extensively in seed dressing for field and horticultural crops, and particularly for maize, sunflower and rapeseed (canola). Imidacloprid was detected in soils, plant tissues and pollen using HPLC coupled to a mass spectrometer. The levels of the insecticide found in pollen suggested probable delirious effects on honeybees [3]. For several years since 2000, French and Italian beekeepers have been noticing that imidacloprid is lethal to bees, and the insecticide is suspected to be causing the decline of hive populations by affecting the bee's orientation and ability to return to the hive.

Confused and disoriented bees

A team of scientist led by the National Institute of Beekeeping in Bologna, Italy, found that pollen obtained from seeds dressed with imidacloprid contains significant levels of the insesticide, and suggested that the polluted pollen was one of the main causes of honeybee colony collapse [4]. Analysis of maize and sunflower crops originating from seeds dressed with imidacloprid indicated that large amounts of the insecticide will be carried back to honey bee colonies [5]. Sub-lethal doses of imidacloprid in sucrose solution affected homing and foraging activity of honeybees. Bees fed with 500 or 1 000 ppb (parts per billion) of the insecticide in sucrose solutions failed to return to the hive and disappeared altogether, while bees that had imbibed 100 ppb solutions were delayed for 24 h compared with controls. [6]. Imidacloprid in sucrose solution fed to the bees in the laboratory impaired their communication for a few hours [7]. Sub-lethal doses of imidacloprid in laboratory and field experiment decreased flight activity and olfactory discrimination, and olfactory learning performance was impaired [8]..

Bayer corporation scientists reported that neither honeybees exposed to imidacloprid in sunflower seeds dressed with the insecticide [9] nor maize seeds dressed with the insecticide or released from the seeds during planting [10] were detrimental to honeybees. The Bayer studies did not deal with sub-lethal behaviour of intoxicated bees. An independent study found that imidacloprid was released to the environment from treated maize seeds during seed planting [11]. Bayer eco-toxicologists directed harsh criticisms at reports showing lethal or sub-lethal toxic effects of imidicloprid seed dressing and concluded that imidacloprid does not pose any significant risk to honeybees in the field [12], without, however, disproving the findings. It is simply yet another case of the anti-precaution principle being applied [13] (Use and Abuse of the Precautionary Principle, *ISIS News* 6)

Turning to GM crops such as maize, canola, cotton and soybean it is clear that all of these GM crops, with or without Bt genes, use seeds most of which are coated with neonicotinoid pesticides highly toxic to honey bees. For example, Herculex maize with Bt genes to control rootworm, like Yieldgard corn borer resistant maize, is planted with seeds dressed with a neonicotinoid insecticide and a fungicide. Furthermore, the GM planting requires setting aside plots of non-GM maize making up 20 percent of the planted area as a "refuge" to discourage the evolution of resistant insects. But the "refuge" is sprayed with neonicotinoid pesticide to protect its yield [14], and is more like a death camp for insects. Monsanto's US Patent 6,660,690 provides for coating GM seeds with chemical pesticides [15].

Toxicology known

The toxicology of neonicotinoid insecticides is well known. The insecticides are inhibitors of acetycholine receptors (i.e., they are nerve poisons). They have low toxicity for mammals, birds and fish, and are used to control fleas on dogs and cats [16]. The nicotinic acetylcholine receptor gene family of the honeybee has been studied; it has 11 subunit members, a larger number than the fruit fly or mosquito. The genes for the subunits employ alternatively spliced transcripts to increase receptor diversity, and the messenger RNAs are edited to replace specific A bases with I bases. Information on the receptor should allow for development of insecticides that are not harmful to bees [17].

In conclusion, the US NRC Committee did not deal with the heated debate over neonicotinoid pesticides and honeybee decline. Instead, that it seemed to suffer from tunnel vision and to be overcautious about matters that threaten large corporations.

We urgently need a thoroughly independent committee to consider the full range of factors that may be contributing to the decline of bees, including pesticides, GM crops and electronic devices, before the bees become extinct.

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