

CATCH THE BUZZ

Corn Seed Treatment As Lethal As It Gets For Honey Bees All Season Long, And Long After The Season Is Gone. It Just Keeps On Killing.

Alan Harman

Frightening new research shows honey bees are being exposed to deadly neonicotinoid insecticides and several other agricultural pesticides throughout their foraging period. The research, published in the scientific journal *PLoS One* says extremely high levels of clothianidin and thiamethoxam were found in planter exhaust material produced during the planting of treated maize seed. The work, which could raise new questions about the long-term survival of the honey bee, was conducted by Christian H. Krupke of the Department of Entomology at Purdue University, Brian D. Eitzer of the Department of Analytical Chemistry at the Connecticut Agricultural Experiment Station and Krispn Given of Purdue.

neonicotinoids were found in the soil of each field we sampled, including unplanted fields, they report. Dandelions visited by foraging bees growing near these fields were found to contain neonicotinoids as well. "This indicates deposition of neonicotinoids on the flowers, uptake by the root system, or both," the report says. "Dead bees collected near hive entrances during the spring sampling period were found to contain clothianidin as well."

The researchers also detected the insecticide clothianidin in pollen collected by bees and stored in the hive. "When maize plants in our field reached anthesis, maize pollen from treated seed was found to contain clothianidin and other pesticides; and honey bees in our study readily collected maize pollen. "These results have implications for a wide range of large-scale annual cropping systems that utilize neonicotinoid seed treatments," the report says. The research was funded by grants from the North American Pollinator Protection Campaign and the Managed Pollinator Coordinated Agricultural Project.

There have been red flags about pesticide exposure for some time and of the many compounds detected, the neo-nicotinoid group has received the most attention. As a group, neonicotinoids possess several key attributes that have seen their heavy adoption in both agricultural and urban environments, including low vertebrate toxicity and the ability to be translocated by plants.

Neonicotinoids are also persistent, offering the potential for a large window of activity. The new report says the half-lives of these compounds in aerobic soil conditions can vary widely, but are best measured in months – 148 - 1,155 days for clothianidin.

Among the largest single uses of these compounds is application to maize seed. Production of maize for food, feed and ethanol production represents the largest single use of arable land in North America, reaching a record 35.7 million hectares (88,216,620 acres) in 2010 and is expected to increase. All of the maize seed planted in North America except for 0.2% used in organic production is coated with neonicotinoid insecticides.

Two major compounds are used – clothianidin and thiamethoxam, with the latter metabolized to clothianidin in the insect. The application rates for these compounds range from 0.25 to 1.25 mg/kernel. These compounds are highly toxic to honey bees – a single kernel contains several orders of magnitude of active ingredient more than the published LD50 values for honey bees – defined as the amount of material that will kill 50% of exposed individuals, which ranges from 22–44 ng/bee for clothianidin (contact toxicity).

In fact, the amount of clothianidin on a single maize seed at the rate of 0.5 mg/kernel contains enough active ingredient to kill more than 80,000 honey bees.

Maize seeds are typically planted at a rate of about 12,500 kernels/hectare (30,875 kernels/acre). The latest research was begun after reports of bee kills at Indiana apiaries in the spring of 2010 that coincided with the peak period of maize planting in the area. Analyses of these bees and pollen from the hives revealed that both clothianidin and thiamethoxam were present on dead bees and in pollen collected from a single hive. The compounds were also present in dead bees from other hives but not in bees from hives that did not show mortality. Also found was atrazine, a herbicide that is commonly used in maize production and is relatively non-toxic to honey bees.

The results prompted researchers to carry out more experiments to determine how honey bees may be gaining exposure to clothianidin and other pesticides commonly applied to either maize seed or to plants later in the season. They collected samples from a variety of potential exposure routes near agricultural fields and analyzed them to determine whether pesticides were present. They sampled soils, pollen both collected by honey bees and directly from plants, dandelion flowers, and dead and healthy bees. They even checked waste products produced during the planting of treated seed. Maize seed is sown with tractor-drawn planters that use a forced air/vacuum system and a perforated disc to pick up individual seeds and drop them into the planting furrow at the selected spacing. Maize kernels treated with neonicotinoids and other compounds such as fungicides do not flow readily and may stick to one another, causing uneven plant spacing. To overcome this, talc (a mineral composed of hydrated magnesium silicate) is added to seed boxes to reduce friction and stickiness and ensure the smooth flow of seed. Much of the talc is exhausted during planting, either down with the seed or behind the planter and into the air using an exhaust fan. Researchers sampled the waste talc after planting to determine whether this material was contaminated with pesticides abraded from treated seeds. The waste is a mixture of the talc that has been in contact with treated maize kernels and minute pieces of the seeds.

“Soil collected from areas near our test site revealed that neonicotinoid insecticide residues were present in all samples tested, with clothianidin occurring in each field sampled,” the research report says. “Herbicide residues were also found in these samples.”

Extremely high concentrations of clothianidin were found in talc exposed to treated seed along with fungicides applied to the seed. Analysis of talc used to plant untreated seed found low quantities of the same pesticides, likely due to contamination and reflecting the difficulties associated with thorough cleaning of equipment between plantings. Direct sampling of anthers revealed that many of the same compounds were present in maize grown from treated seed, but in far lower concentrations. Collection of pollen from traps in the field showed thiamethoxam was present in three of 20 samples, while pollen containing clothianidin was present in 10 of 20 samples. Fungicides were also frequently detected: azoxystrobin and propiconazole were found in all pollen samples, while trifloxystrobin was found in 12 of the 20 samples. Maize pollen is frequently collected by foraging honey bees while it was available and maize pollen made up more than 50% of the pollen collected by bees in 10 of 20 samples. Samples collected again last year revealed some similar trends.

“Clothianidin was found on all the dead and dying bees we sampled, while the apparently healthy bees we sampled from the same locations did not contain detectable levels of clothianidin,” the report says. “Atrazine and metolachlor were also found, providing further evidence that these bees were foraging near agricultural fields; as these herbicides are commonly applied prior to or during

maize planting.

When sampled, the contents of wax combs removed from two hives at the same apiary, researchers found both clothianidin and thiamethoxam in pollen removed from both hives. Nectar did not contain either compound. The miticide coumaphos was found at low levels in each nectar and pollen sample as well.

Both soil and dandelion flowers obtained from the fields closest to the affected apiary contained clothianidin and this could have resulted from translocation from the soil to the flower, from surface contamination of the flowers from dust, or a combination of these two mechanisms. Dandelion flowers growing far from agricultural areas served as controls and no neonicotinoids were detected.

“These results demonstrate that honey bees living and foraging near agricultural fields are exposed to neonicotinoids and other pesticides through **multiple mechanisms** throughout the spring and summer. The potential for greatest exposure (and the period when mortality was noted), occurs during planting time when there is potential for exposure to extremely high concentrations of neonicotinoids in waste talc that is exhausted to the environment during and after planting. Furthermore, we show that bees living in these environments will forage for maize pollen and transport pollen containing neonicotinoids to the hive. Pollen contaminated with levels of neonicotinoids similar to those shown in our results has been known to impair pollinator health,” researchers said.

The levels of clothianidin in bee-collected pollen the researchers found were about 10-fold higher than reported from experiments conducted in canola grown from clothianidin-treated seed. “Detection of clothianidin in pollen, both in stored pollen in cells and in pollen traps is a critical finding because clothianidin is even more toxic when administered to bees orally, with an LD50 of 2.8–3.7 ng/bee,” the report says. “Given an average weight of 80–100 mg/bee, some of our pollen sample concentrations exceed the oral LD50. This, combined with the result that our samples of dead and dying honey bees consistently demonstrated the presence of clothianidin, suggests that the levels of both clothianidin and thiamethoxam found in our sampling of stored pollen in May of 2011 may have contributed to the deaths of the bees we analyzed.”

The results also showed clothianidin present in the surface soil of fields long after treated seed has been planted. “All soil samples we collected contained clothianidin, even in cases where no treated seed had been planted for two growing seasons,” the report says.

During the spring planting period, dust that arises from this soil may land on flowers frequented by bees, or possibly on the insects themselves. Of potentially greater concern are the very high levels of neonicotinoids and fungicides found in the talc that has been exposed to treated seed. “The large areas being planted with neonicotinoid treated seeds, combined with the high persistence of these materials and the mobility of disturbed soil and talc dust, carry potential for effects over an area that may exceed the boundaries of the production fields themselves.”

“A key mechanism for honey bee exposure may occur during the period when maize is typically planted across much of the Midwest (mid-April through early May). At this time, the energetic requirements of honey bee colonies are increasing rapidly and pollen and nectar resources are being gathered for colony growth. Talc and soil dusts from planting are mobile and have the potential to contaminate any flowering plants that are commonly found in or near agricultural fields and are visited by honey bees, including dandelion. It is a preferred pollen and nectar source for honey bees during this period, when floral resources are relatively limited.”

Later in the season, when planting is largely complete, the researchers found bees collect maize pollen that contains translocated neonicotinoids and other pesticides from seed. Translocation of neonicotinoids into pollen has previously been reported for maize grown from imidacloprid-treated seed, but the researchers say the degree to which honey bees in their study gathered maize pollen was surprising. “The finding that bee-collected pollen contained neonicotinoids is of particular concern because of the risks to newly-emerged nurse bees, which must feed upon pollen reserves in the hive immediately following emergence,” they say.

“Lethal levels of insecticides in pollen are an obvious concern, but sub-lethal levels are also worthy of study as even slight behavioral effects may impact how affected bees carry out important tasks such as brood rearing, orientation and communication.” Also potentially important are the three fungicides found in bee-collected pollen samples – trifloxystrobin and azoxystrobin and propiconazole. Azoxystrobin and trifloxystrobin are frequently used in maize seed treatments as protectants and all three are widely applied to maize in North America, even in the absence of disease symptoms. These findings have implications both for honey bees located near these crops year-round, but also for migratory colonies such as almonds and other fruit and nut crops, the report says.

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