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Science for Environment Policy

# Bumblebee survival and reproduction impaired by pesticide azadirachtin even at recommended concentrations

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**Issue 316**



**Source:** Barbosa, W.F., De Meyer, L., Guedes, R. N. C. & Smagghe, G. (2015) Lethal and sublethal effects of azadirachtin on the bumblebee *Bombus terrestris* (Hymenoptera: Apidae). *Ecotoxicology* 24:130–142. DOI:10.1007/s10646-014-1365-9.

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**Read more about:** Biodiversity, Environmental technologies

**Bumblebees are negatively affected by the insecticide azadirachtin** even at concentrations 50 times lower than the recommended levels used by farmers, recent laboratory experiments have revealed. No males hatched in laboratory colonies that were fed on recommended levels of the pesticide and, even at concentrations 50 times lower, the males that did hatch were deformed, and there were significantly fewer compared to an untreated colony.

Azadirachtin is a bioinsecticide — produced from natural sources — found in the seed of the Indian neem tree (*Azadirachta indica*). With its low toxicity towards mammals and rapid degradation in the environment, it is one of the most widely used bioinsecticides available. There is, however, no research on how safe it is for bumblebees, as previous work has focused on its effects on the honey bee (*Apis mellifera*). This is a concern as bumblebees also play an important role as pollinators of wildflowers and crops.

For this study, researchers investigated how azadirachtin affects the survival, reproduction and foraging behaviour of the buff-tailed bumblebee (*Bombus terrestris*). It is important to examine sublethal affects as well as impacts on survival as these can affect the long-term extinction risk of populations.

To investigate whether the bumblebees will actively avoid azadirachtin-contaminated pollen when foraging, researchers fed individual bumblebees azadirachtin-treated sugar water in one of five concentrations ranging from 32 to 1600 mg/ L. Only seven percent of workers were repelled by azadirachtin-sugar water treated at 32 mg/L which is the maximum recommended application to be used by farmers, or 'maximum field recommended concentration'. Furthermore, the researchers calculated that it would take a concentration of 504 mg/L to repel half of the bumblebees. This is about 16 times higher than maximum field recommended concentration, implying that the bumblebees were not very sensitive to the taste of azadirachtin. This suggests that bumblebees might not be deterred by the taste of contaminated pollen and nectar and could potentially gather these food sources for their colonies in the wild.

To see if azadirachtin affected the normal growth and development of bumblebees, the researchers established laboratory microcolonies of bumblebees and, over 11 weeks, fed them azadirachtin-treated sugar water at concentrations ranging from 3.2 to 320 mg/L. The researchers compared the biopesticide treatments with a plain sugar water 'control' and 0.02 mg/L solution of imidacloprid, a neonicotinoid pesticide known to adversely affect bumblebees at this concentration.

Less than 30% of the bumblebees survived exposure to any concentration of azadirachtin greater than 6.4 mg/L. Only bumblebees exposed to the 3.2 mg/L concentration of azadirachtin, as well as to the plain sugar water and imidacloprid controls had survival rates above 50%.

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Apart from these lethal effects, sublethal effects of the pesticide on reproduction were also evident. Over the 11 weeks no drones (males) were produced in microcolonies given azadirachtin-treated sugar water in concentrations above 6.4 mg/L. In microcolonies treated with azadirachtin at 3.2 mg/L the number of drones that hatched was reduced compared with those fed plain sugar water.

Furthermore, the bodies of the hatched drones exposed to any concentration of azadirachtin within the range 3.2–320 mg/L weighed less than those fed on uncontaminated sugar water. In females, ovary development was affected — those exposed to higher azadirachtin concentrations had shorter ovaries and, in females exposed to azadirachtin at concentrations above 16 mg/L, no egg cells developed. Taken together, these results suggest that bumblebee survival, reproduction and development were all impaired by exposure to azadirachtin at concentrations lower than the maximum recommended dose to be used by farmers.

The impacts of pesticides on bees may vary depending on foraging behaviour. To investigate this, the researchers also set up microcolonies that allowed the bumblebees to forage and supplied azadirachtin-treated sugar water at concentrations ranging from 0.064 to 32 mg/L for 11 weeks.

Compared with the effects of azadirachtin on bumblebee colonies where no foraging took place, foraging increased the lethal and sublethal effects of azadirachtin. For example, no males hatched in microcolonies exposed to azadirachtin concentrations of 3.2 mg/L. Even at concentrations as low as 0.64 mg/L, which is 50 times lower than the recommended dose that farmers use, significantly fewer males hatched compared with microcolonies exposed to just plain sugar water. At this concentration males also had deformed wings, mouthparts, legs and antennae. The researchers suggest that, in addition to the direct effects of azadirachtin, feeding contaminated food to larvae in their nests negatively affects bumblebee development.

The researchers recommend that experiments to determine the risks of pesticides on bumblebees should include foraging behaviour, as already recommended by the European Food Safety Authority in their guidance document[1].

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1. Guidance on the risk assessment of plant protection products on bees http://www.efsa.europa.eu/en/efsajournal/pub/3295.htm