Pesticides – the silent killer?

Taste detection of common pesticides in Honeybees

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Introduction:

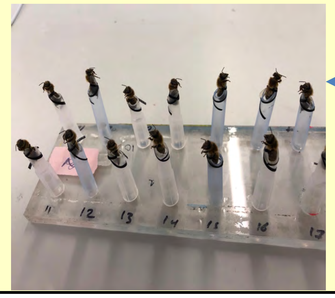
- Bees are non-target organisms, exposed to chemical pesticides intended to control insect herbivores (they are not the 'pests' of the crop plants)
- We need to know if bees are able to detect pesticides in their natural diet (e.g. pollen, nectar)
- If bees can taste pesticides, will they avoid contaminated (treated) food?

Hypothesis

I hypothesise that the bees can taste the pesticides, but that they are sweet. Bees like sweet tastes and this would explain why they continue to eat the harmful compounds

Methods:

the antennae of honeybees (*Apis mellifera*) were stimulated with 1M sucrose to initiate a proboscis extension reflex (PER) response. 1M sucrose was used as it is phagostimulatory (stimulates feeding) to bees and will initiate a PER response. Once a positive PER was shown, the test solution (pesticide in 1M sucrose) was placed onto the mouthparts of the individual. If the bee consumed the solution it was scored 1, if it did not consume it but kept its tongue out (the way they behave when assay is performed with water) it was scored as 0. Each individual can only be tested with one substance (i.e. 100µm pesticide one **OR** 1mM pesticide 2)



Harnessing rack of bees

Positive PER response

Results:

90-100% of individuals consumed each of the pesticides, at each of the concentrations (figure. 1) just as they did with the 1M sucrose control. Pesticide type had no significant influence on the proportion of bees responding (lreg pesticide: $\chi 26 = 4.35$, $P = 0.629$) and neither did pesticide concentration (lreg concentration $\chi 22 = 0.261$, $P = 0.877$).

However, the bees responded differently to the known toxic, bitter substance quinine (used as the negative control) – with less than 10% of individuals consuming. This implies that the bees cannot taste the pesticides, as it could possibly be masked by the sucrose, or that they like the taste (i.e. pesticides taste sweet). If the pesticides tasted bitter the bees would retract their proboscis after contact with the mouthparts, as they did with the negative control.

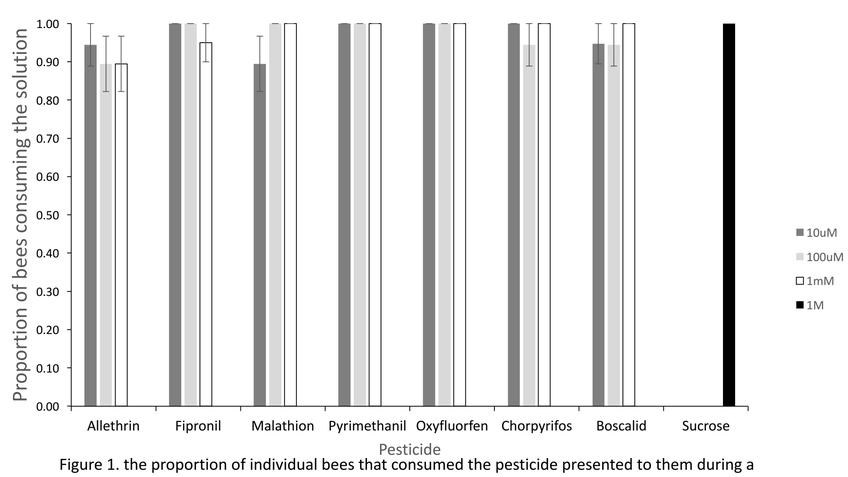


Figure 1. the proportion of individual bees that consumed the pesticide presented to them during a mouthpart assay. Only one concentration (10uM, 100uM or 1mM) of one pesticide was used on any single individual. n= 20 for each concentration of each pesticide and n= 40 for the 1M sucrose control. ± SEM

Discussion:

To determine whether the bees like the taste, or if they cannot detect the pesticide, another experiment would have to be performed. In this experiment, the pesticide concentration would be maintained constant (i.e. 100uM) and the sucrose concentration would be altered (a series: 0.3, 0.5, 0.7 and 1M). Changing the sucrose concentration could eliminate the potential of sucrose masking the taste of the pesticide. If the bees consume the pesticide diluted with a lower sucrose concentration, more often than the sucrose concentration alone, it can be concluded that the bees can taste the pesticide and like the taste. If the bees consume It significantly less often, it can be concluded that the sweet taste of the sucrose masks the taste of the pesticide.

One potential outcome is 'bees can, and like the, taste of pesticides'. I presumed that pesticides would have a butter taste, since known toxins (e.g. quinine) activate bitter taste receptors. It is possible that the pesticides do not cause this response. i.e they are sweet to attract pests and then kill them

It is also possible that the bees cannot taste but aren't repelled by it. Studies have been done using neonicotinoid pesticides (a different class, that wasn't used in this experiment) and shown that although the bees cannot taste the neonicotinoids used, they are not repelled and even eat the pesticide laced food preferentially (Kessler et al., 2015)

In conclusion, without further research it is impossible to understand why bees consume crops treated with these pesticides. They could either like the taste, or they could not be able to detect them (the sweetness of pollen masks the pesticides, or the pesticides do not have the bitter taste that was presumed).

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References:

- Kessler, S., Tiedeken, E., Simcock, K., Derveau, S., Mitchell, J., Softley, S., Stout, J. and Wright, G. (2015). Bees prefer foods containing neonicotinoid pesticides. *Nature*, 521(7550), pp.74-76.