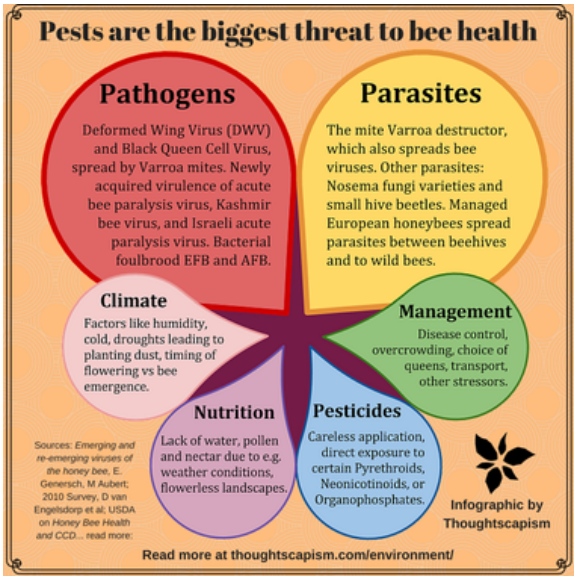
No, Glyphosate Is Not a Threat to Bees

Posted on June 11, 2018

> *Glyphosate is a herbicide, in other words, it is toxic to plants. Its target enzyme is not found in insects or other animals, so it is generally not very harmful to them – and as confirmed by a recent study, even direct sprays are not lethal to bees.*

This is what I said about bees in my series 17 Questions about Glyphosate. I thought that glyphosate having anything to do with bee welfare would be such a far-fetched idea that I needn't dedicate more time to that. But, time and again, when discussing glyphosate – usually in some completely different context – someone will pop up and go "it should be banned because it harms bees!" So let's talk about that in more detail.



If You Care About Bees, Look Past Neonicotionoids

I often try politely to inform the person that what they are probably thinking of are insecticides, particularly such groups of chemicals as pyrethroids or neonicotinoids, several of which can, if sprayed directly on the bees, prove lethal to them. Much research has also been conducted on sub-lethal levels of neonicotinoids on bee health, and although much of the time the effects in the field are small or non-existent (like in the whole of Australia, where CCD or higher bee losses have not been observed), in some cases small adverse effects are found. There are many larger concerns – like mites and disease – when it comes to pollinators, however. I wrote about this topic more in If You Care About Bees, Look Past Neonicotionoids, and about a recent large study here: New Study Finds Neonicotinoids May Have Harmful, Beneficial, or No Effects on Bees.

While many insecticides can indeed harm a variety of insects (though bees are not their intended target), the big difference, as I said earlier, is that glyphosate is not an insecticide, but a herbicide. (Both insecticides and herbicides, among many other -cides, by the way, fall under the umbrella of pesticides). Glyphosate's particular target enzyme does not exist in animals, which means that it does not interfere with our amino acid synthesis, and has generally very low toxicity outside of plants (or some bacteria).

Not toxic to bees, either

Lets look at the published research on toxicity regarding bees by searching Pubmed for 'glyphosate' and 'bees'. A large 2014 study sprayed bees' forage with glyphosate in series a glasshouse experiments, and also fed glyphosate-laced sucrose to their brood...

> *…at dose rates that reflect worst-case exposure scenarios. There were no significant effects from glyphosate observed in brood survival, development, and mean pupal weight. Additionally, there were no biologically significant levels of adult mortality observed in any glyphosate treatment group.*

A 2015 study, on the other hand, subjected bees to direct sprays of 42 insecticides, and one herbicide: glyphosate, in common usage concentrations. Their results not only confirm that being caught in a glyphosate spray demonstrated no acute toxicity from glyphosate within two weeks, but it also illustrates the point that demonising one class of pesticides is misleading at best. Entomology Today:

> *Using a modified spray tower to simulate field spray conditions, the researchers found that 26 pesticides, including many (but not all) neonicotinoids, organophosphates, and pyrethroids killed nearly all of the bees that came into contact with the test pesticide sprays. However, seven pesticides, including glyphosate and one neonicotinoid (acetamiprid), killed practically no bees in the tests.*

So, bees happily went on with their business after glyphosate spray. A 2017 study likewise found that:

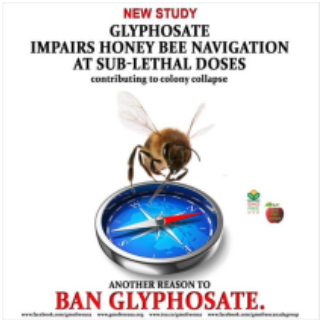
> *Our data demonstrated that residue levels of seven pesticide [including glyphosate] in pollens/hive may not adversely affect honey bees*

Well, that seems rather straightforward. Glyphosate shouldn't really be a problem for bees, there is no suggested mechanism of harm in bees, and… it does not show ill effects in bees.

But wait – groups like GMO-free USA actively peddle the idea that glyphosate would be 'contributing to colony collapse disorder' (see meme below). How, then?

What about bee behaviour?

This particular work on bee behaviour comes from one lab in Buenos Aires headed by Dr Walter Farina, where they have published three papers that claim glyphosate impairs bee learning in some ways. The study of bee cognition is certainly a fascinating area. The group's 2015 paper on bee navigation found that bees fed with a sucrose solution with 10 mg/l of glyphosate took longer time to fly home. Let's take a look at their experiment.



Hyperbolic anti-GMO campaigners' meme.

They trained bees to come collect sucrose solution at a feeder. They then captured them at the hive, tagged them and glued a radar transponder on them, fed them sucrose with or without glyphosate, released them at a new location, and recorded their flight back to the hive (or feeder). They then tried to catch the same bees again at the feeder after that, to drop them again at the same release location and see if they had learned something about finding their way home.

They had the bees divided into four treatment groups, and had between 8 and 22 bees in each group the first time around. During their first release, they found that the high treatment group (8 bees strong) took on average about 9 minutes to fly back (see figure A), while all the other 42 bees of the other 3 groups (control, 2.5,

and 5 mg/l treatment) flew home on average in about 4-5 minutes (one outlier in the control and largest group, with 22 bees, took the longest, 17 minutes, but they also had the fastest home-run, about 2 minutes).

There was no significant difference in flight times for those that flew *to the feeder first* (in grey, figure B) instead – if anything, the control group was slowest this time. This below, then, is their one core finding:

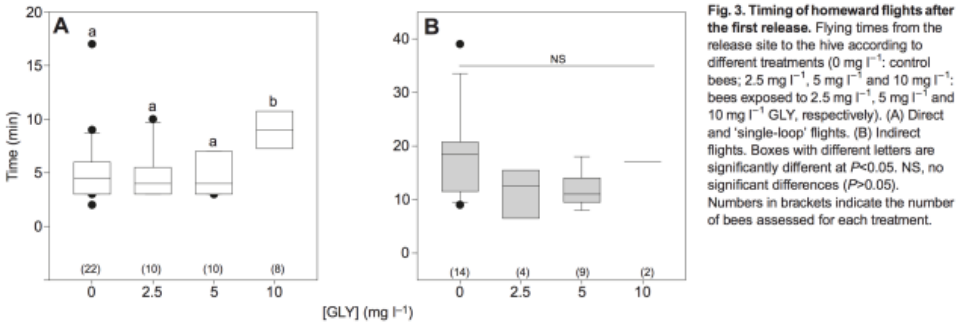
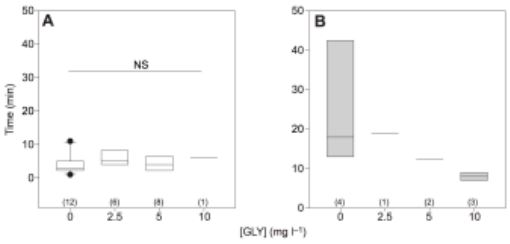


Fig. 3. Timing of homeward flights after the first release. Flying times from the release site to the hive according to different treatments (0 mg l^{-1}: control bees; 2.5 mg l^{-1}, 5 mg l^{-1} and 10 mg l^{-1}: bees exposed to 2.5 mg l^{-1}, 5 mg l^{-1} and 10 mg l^{-1} GLY, respectively). (A) Direct and 'single-loop' flights. (B) Indirect flights. Boxes with different letters are significantly different at $P<0.05$. NS, no significant differences ($P>0.05$). Numbers in brackets indicate the number of bees assessed for each treatment.

After this they tried to re-captured the bees, but only managed to get hold of four bees in the high treatment group. All four re-released groups flew back home at very similar times, between 3-11 minutes, which by the way is a range where the first high treatment flight-time falls in too (see A in the next figure below – why they have the scale so zoomed out this time, so that comparison to the first figure A is not as clear, I don't know). The range was similar between releases, with **no clear learning effect for any group**. The flight times to *the feeder* were similar too, apart from the high treatment group, which was actually faster. Of course, at this point each flight-group studied had between 1-4 or 1-12 bees (...), and so nothing was statistically significant.



Let that sink in. Yes, the paper claims to analyze 'long-term consequences' for bee learning – based on two flights, and with experiment 'groups' that are 1 bee strong.

To actually say anything meaningful about bee behaviour, it's not very radical to ask that we'd want to see clear differences in said behaviour of **actual groups** of bees, and in several repeat experiments. I am not alone in my thinking, either. I talked about this paper with an entomologist who does science outreach over at the blog The Mad Virologist, and he had this to say:

> *With that type of experiment, you really need large numbers of insects and many replicate flight experiments. With only two replicate experiments, this would be a hard sell in an entomology journal, especially given the low numbers used in each experiment.*

He went on to contrast this study with examples of robust studies instead: like one on bee foraging with three replicates of RFID-tagged bees – in each colony, they included *400 bees* per treatment condition (vs the 10-20 in Farina's); or an earlier study of bee flight of more than *two thousand bees* all in all, and with four replicate experiments.

What about confounding factors?

When you study something this subtle, with bees flying this way or that at 15 minute intervals, the situation is chock full of surprising and unaccounted variables – weather conditions? Other animals? Variations in the manual handling of the bees? What about parasites and disease? The nosema fungus, for instance, is specifically known to cause learning deficits in honeybees, and the Deformed Wing Virus has deleterious effects on foraging. The Mad Virologist has touched before on the shortcomings of bee-studies that make the mistake of not accounting for the variable of bee diseases.

To say anything about the real world, of course, this kind of research should preferably be presented with a connection to the overall wellbeing of the hives, following the pattern of actual glyphosate residues in the bees' environment. Otherwise all this is very hypothetical.

Consider that GMO-free USA claim once more: 'glyphosate impairs bee navigation and contributes to colony collapse disorder'. Wait, what? Eight bees were a few minutes tardier once – though their high-treatment buddies who flew straight to the feeder instead were not tardy. The second time around (the 'learning effects') they all flew back home just as fast, and to the feeder even faster than the other(s).

But wait – the study also lost a fourth of their bees

The paper also lists number of bees that did not return to the hive, period. In total 26 % of the bees never arrived back at the hive. That seems a rather alarming percentage. If at any one random time when four bees set out from a hive, only three return, it sounds like an untenable situation in the long run. Nowhere in their paper could I find discussion about what might have caused the large rate of non-arrivals.

The largest numbers of non-returning bees both times were found in the lowest treatment group, but the control group was no means well off, with 22 % and 16 % losses. In the second release, (the very small) intermediate and high treatment groups actually had zero losses. Should we draw the conclusion that high dose glyphosate has a protective effect then, guaranteeing that bees return to the hive?

Table 1. Data for control and GLY-treated bees released for the first time

GLY treatment	No. of bees released	No. arrived at hive	No. arrived at hive via feeder	No. not arrived
0 mg l^{-1}	46	36 (0.78)	6 (0.17)	10 (0.22)
2.5 mg l^{-1}	25	14 (0.56)	6 (0.42)	11 (0.44)
5 mg l^{-1}	22	19 (0.86)	2 (0.11)	3 (0.14)
10 mg l^{-1}	15	10 (0.67)	2 (0.2)	5 (0.33)

Numbers in parentheses indicate the proportion of bees for each treatment.

Table 2. Data for control and GLY-treated bees released for the second time

GLY treatment	No. of bees released	No. arrived at hive	No. not arrived
0 mg l^{-1}	19	16 (0.84)	3 (0.16)
2.5 mg l^{-1}	11	7 (0.64)	4 (0.36)
5 mg l^{-1}	10	10 (1)	0 (0)
10 mg l^{-1}	4	4 (1)	0 (0)

Numbers in parentheses indicate the proportion of bees for each treatment.

No. Just no. But the opposite claim, which Farina's paper makes,

> *exposure to levels of GLY commonly found in agricultural settings impairs the cognitive capacities needed to retrieve and integrate spatial information for a successful return to the hive, [...] with potential long-term negative consequences for colony foraging success*

is far from well supported by the evidence presented.

What this analysis hopefully shows, is that the more subtle the thing we are studying is, the more care we should take before drawing conclusions about its implications one way or another. With such tiny groups of bees and no other lab independently supporting these results, to think that this highly variable data shows anything with real-world meaning is incredibly far-fetched.

No real world connections

The group's earlier piece claims that glyphosate-dosed bees show decreased sucrose-responsiveness, that is, they are not as drawn to higher levels of sucrose (presumably applicable to choosing sweeter nectar in the field). So far the only connected paper I've found from another group found instead that bees showed a preference for sucrose with glyphosate residue as opposed to sucrose with other pesticide traces. The group Farina are alone to report their suggested subtle cognitive effects – and even their own paper states that effects outside of their limited experimental settings are lacking:

> *However, no effect on foraging-related behaviour was found.*

What about the realism of the dosing of the bees by Farina's group? Several studies report that glyphosate residues in the soil quite quickly decrease to micro and nanogram levels (vs the milligram level dosages in Farina's studies), and a very rapid breakdown is seen in pollen and nectar. The maximum residue limit in the US on most flowering crops, is also very low, often from a few milligrams to micrograms per kg – and these are the maximum limits, with 99.8 % of all produce tested below, and 80% tested 20 or even more times below – more about the residue data here by Steve Savage.

Canola/rapeseed in bloom. Photo by Myrabella, from Wikimedia commons, CC BY-SA 4.0.

The dosing of bees is made unlikelier again by the fact that glyphosate is commonly applied on weeds as they emerge, to eliminate them long before they can use up resources, flower, and go to seed. Later as the crop grows its shadowing effect will take care of most other weeds. It seems unrealistic that bees would commonly be exposed to concentrations of 10 mg/l in their feed. If that happened at some point, and we would take Farina's groups' suggestions at a face value, what might we expect? That the bees would fly home a few minutes later that time? This is very little to go on.

In fact, in the 2014 toxicity study from England which looked at twenty hives with more than 10,000 bees each, they directly sprayed the bees' forage and fed the brood with more than hundred-fold exposure to glyphosate (high treatments being 150 and 300 mg/l), and reported no ill effects on development. **Exposure to an order of magnitude higher doses of glyphosate than in Farina's experiment had no effect on bee health or survival**.

I have not even seen correlations suggesting a connection between glyphosate use and pollinator health, either temporally or geographically. This seems like a crucial link to present before we start talking about glyphosate actually having anything to do with bees.

If you care about bees, look elsewhere

We **do** know that habitat loss, disease, invasive species, climate, and many other factors have detrimental effects on not only bees, but most wild animals, whereas glyphosate is an important method in the toolkit to counteract many environmentally harmful effects of farming. As weed ecology professor Andrew Kniss writes, if farmers would be forced to forgo glyphosate, on top of consequences like increased soil erosion and fuel use, we could well see a return to less diverse rotations:

> *If we truly want to encourage crop diversity, then glyphosate use can be a powerful tool in allowing those diverse crop rotations while still managing weeds.*

Frankly, glyphosate wasn't brought into the public discussion because of a sincere concern for bees (although many who end up repeating the claims may do this without realizing the dishonesty). Anti-GMO groups are campaigning against glyphosate because they will grasp any straws to use as arguments against Genetically Engineered crops. They don't wait for solid support before making claims, either, because it is enough for them to be loud enough and sow doubt in the public perception (an example of the kind of striking anti-glyphosate bias among the French media here, or in French, here). This is an ideological and an emotional type of resistance, where evidence means little, unless it can be used to bolster one's pre-existing passionate dislike of the idea of biotech crops and pesticides to begin with.

Bumble bees I photographed in Finland. Diminishing wildflower habitats and invasive species can pose grave problems for wild bees, whose situation is largely unknown. In many parts of the world, the farmed European honeybee is an invasive species, which especially if left untreated can spread disease.

If we care about bees, however, let's remember the underlining principles about weighing scientific evidence – that we should rely on several converging lines of solid evidence to make sure we are not fooling ourselves – and try to focus on the big picture.

If you are interested in other environmental or health topics, you can find my other pieces on glyphosate over at 17 Questions about Glyphosate, and further resources under Farming and GMOs, The Environment, and Vaccines and Health. If you would like to have a discussion in the comments below, please take note of my Commenting policy. In a nutshell:

1. Be respectful.
2. Back up your claims with evidence.

About Thoughtscapism

Cell Biologist, volunteer science communicator, and fiction writer.

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9 Responses to *No, Glyphosate Is Not a Threat to Bees*

Pingback: *14.-16. Glyphosate and Field Ecosystems | Thoughtscapism*

Leonard Sugarman *says:*
June 11, 2018 at 1:16 pm

A very thorough and well argued article. I am afraid that the numb nuts will argue it's just a conspiracy and you are paid by the manufacturer to produce such a 'dishonest' article. As said I am persuaded by the clarity of your presentation.

★ Like

Reply

Chris *says:*
June 11, 2018 at 6:30 pm

I'd point out to said numb nuts that glyphosate isn't under patent anymore and you can get it from a large variety of manufacturers. Can't blame the Monsanto boogeyman for this one.

★ Like

Reply

Chuck *says:*
June 11, 2018 at 9:20 pm

Thanks. Sadly, too many people prefer some simple, easily-grasped "villain" to more complex realities.

★ Liked by 1 person

Reply

Jeff forbes *says:*

June 13, 2018 at 3:35 pm

Thank you for the well written article. I am a beekeeper and a biophysical chemist. I had no idea that some people were trying to associate glyphosate with bee loss. Glyphosate is simply not toxic at application levels to animals. The carrier detergents and other ingredients of the herbicide products are more toxic. Beekeepers are much more concerned with the overuse and misapplication of insecticides, especially neonicotinoids. Fungicides use may affect the honeybee microbiome, and affect their ability to process polysaccharides and pollen, but there has been little research in this area.

★ Like

Reply

Jarmo Mikkonen *says:*

June 18, 2018 at 11:37 am

The Farina study sounds like the ones carried out by Seralini on glyphosate effects on rats.

★ Like

Reply

Ariane *says:*

June 18, 2018 at 12:54 pm

This is a well-written and interesting article. However, the argument I'm now hearing a lot is a sort of fuzzy reasoning involving bee's food source being depleted by glyphosate and soil being polluted to the point that nothing grows anymore or if it does grow, becomes poisonous to bees. When one responds to the first part of the argument by saying that mechanical or hand weeding does the same job as glyphosate, just slower and at a higher cost, the other person immediately points out that glyphosate is a soil pollutant and the plants can't grow correctly or in sufficient quantity to sustain bee colonies, which get weaker and more prone to health issue. In a way, it is almost a never-ending dispute, because many people have decided point blank that glyphosate and any pesticide is evil. So, they will indeed catch any straw to keep denouncing these substance, which they see as a symbol of everything that goes wrong with our modern agriculture and industrial world as a whole.

★ Like

Reply

Thoughtscapism *says:*

June 18, 2018 at 1:33 pm

Hello Ariane!

Thank you for your kind words. I know exactly what you mean about fuzzy and ever-shifting reasoning around glyphosate, unfortunately!

As I wrote in the end of my 17 Questions series:

"We should always strive to honestly evaluate the evidence before forming our views on a topic. As the numerous examples of this series of 17 Questions About Glyphosate demonstrate, the greatest glyphosate-resistance around

may indeed be one of a more psychological kind: it has become a fix idea in many minds that glyphosate must be behind a whole host of ills in our world. Trying desperately to fit the evidence into the idea, rather than allowing our ideas to be shaped by the evidence, is what has resulted in this process of claim-whack-a-mole. I have no doubt that next month some new variation of glyphosate-sensationalist news will give wings to yet another far-fetched or misleading claim. The game might never come to a real conclusion, for it may be that for many, the only acceptable kind of world is one where glyphosate can only be a bad guy."

https://thoughtscapism.com/2016/09/13/17-can-glyphosate-research-be-trusted/

If you think the people you talk to, or anyone following your discussion, would sincerely be interested in finding out more, however, please feel free to send them over to read about Glyphosate and the Field Ecosystems, for info on soil environments, https://thoughtscapism.com/2016/09/11/14-16-glyphosate-and-field-ecosystems/

or to a comparison of glyphosate to other pesticides, and the situation now vs before, when no regulation existed and we used to use some truly nasty stuff for pest control! https://thoughtscapism.com/2016/09/08/5-glyphosate-and-the-precautionary-principle/

Thanks for stopping by,
Iida/Thoughtscapism

★ Like

Reply

Ariane *says:*

June 18, 2018 at 2:18 pm

Hello!
I agree with you and I have already posted a link to your article on my Facebook Page. I'll save it also in my bookmarks (I'm collecting them, so I don't have to google articles again, every time i need them). Also, has anyone from the French.speaking skeptic groups has contacted you to make a translation of your article in French? Because there are really loud opinions in French-speaking countries tbat are hell-bent on having their government ban glyphosate once and for all.

★ Like