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In Support of: HB 229: Pesticides – Use of Chlorpyrifos - Prohibition
Submitted to: the House Environment and Transportation Committee
February 12, 2020

As a scientist/beekeeper, I support HB 229. I received a Ph.D. in chemistry from The Johns Hopkins University in 1992 and received a National Academy of Sciences award for Post-doctoral study at NASA in 1994. I have worked professionally as a chemist since 1982, and have authored and reviewed scientific papers for three decades. I have also been a beekeeper since 2009 and have experienced bee losses due to legal pesticide use, which lead to my study of the issue. I am vice president of the Central Maryland Beekeepers Association, have published articles in *American Bee Journal*, have been a panelist at a Congressional Briefing on the effect of pesticides on bees, and have spoken at the White House Council on Environmental Quality. I receive not one cent from either side on the issue of pollinators and pesticides.

THE SCIENCE of CHLORPYRIFOS and BEES

Chlorpyrifos harms pollinators. The EPA considers it "highly toxic to bees." Chlorpyrifos is the **third most prevalent and abundant pesticide detected in the hive and is among the top five pesticides of highest risk to bees** [Sanchez-Bayo and Goka, 2014]. Chlorpyrifos at hive-residue levels more than **doubles larval mortality compared to larvae not exposed to chlorpyrifos** [Zhu et al., 2014]. Another study **confirms of the ill effect** of chlorpyrifos on larval bees [Gregorc & Ellis, 2011]. Sublethal exposure of larvae to chlorpyrifos also **reduces queen emergence, with grave consequences for colony survival** [Degrandi-Hoffman et al. 2013].

Chlorpyrifos, when used as directed, is harming adult bees as well. In 2016 a ground-breaking peer-reviewed field study showed that not only does chlorpyrifos **cause colony threatening brain damage to honeybees**, it does so at the sub-lethal **concentrations found in the majority of fields sprayed as directed by the manufacturer** [Urlacher et al., 2016]. Learning and memory are of utmost importance for the behavior of foraging bees, and their impairment may result in negative consequences for colony health and survival [Henry et al., 2012]. A 2013 study noted that adult bees exposed to a sub-lethal dose of chlorpyrifos exhibited altered behaviors: less walking; more difficulty righting themselves; and unusual abdominal spasms [Williamson et al., 2013]. A three-year field study concluded just this year found **17% of pollen samples contained doses of chlorpyrifos higher than that required to cause sublethal effects on bees**, and concluded that **the prevalence of chlopyrifos in pollen is "of great concern for the health status of honey bees and other pollinators"** [Tosi, et al., 2018].

Especially troubling is the fact that current **EPA risk-assessment and regulation of chlorpyrifos does not address sub-lethal effects** [U.S. EPA, 2016]. In fact, current regulation does not even address lethal effects (the dose that kills bees immediately, LD50). A 1986 study found that exposure to chlorpyrifos-treated foliage induces **significant mortality for up to 7 days after chlorpyrifos is applied to a crop** [Lunden et al., 1986]. **Since chlorpyrifos is illegal to apply only if bees are present at the time of application** [EPA approved label, 2018], and it's ability to kill bees (LD50) persists for days, **chlorpyrifos likely kills bees outright, possibly on a large scale, with EPA approval.**

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PEER REVIEWED RESEARCH

Excerpts from recent research on the health impacts of chlorpyrifos on Pollinators. References appear in the order of citation.

Pesticide Residues and Bees – A Risk Assessment.

Sanchez-Bayo F, Goka K (2014). PLoS ONE 9(4): e94482. https://doi.org/10.1371/journal.pone.0094482

Peer-reviewed research proves chlorpyifos to be one of the top five pesticides of highest risk to bees, second only to neonicotinoids:

" … the large number of pesticide residues found in pollen and honey demand a thorough evaluation of all residual compounds so as to identify those of highest risk to bees. … **only five insecticides, namely thiamethoxam, phosmet, imidacloprid, chlorpyrifos and clothianidin, and four insecticide-fungicide mixtures pose risks with probabilities above 5%.**"

Four Common Pesticides, Their Mixtures and a Formulation Solvent in the Hive Environment Have High Oral Toxicity to Honey Bee Larvae.

Zhu W, Schmehl DR, Mullin CA, Frazier JL (2014). PLoS One. Jan 8;9(1):e77547. Doi10.1 371/journal.pone.0077547.

Peer-reviewed research has proven chlorpyrifos is especially toxic to larval bees:

"[Chlorpyrifos] at hive-residue levels **triggered a significant increase in larval mortality compared to untreated larvae by over two fold, with a strong increase after 3 days of exposure."**

"Our findings suggest that chronic dietary feeding at hive levels of common pesticide ingredients including … [the] insecticide **chloropyrifos, individually or in mixtures, have statistically significant impacts on honey bee larval survivorship**."

A 3-year survey of Italian honey bee-collected pollen reveals widespread contamination by agricultural pesticides.

Tosi, Simone & Costa, Cecilia & Vesco, Umberto & Quaglia, Giancarlo & Guido, Giovanni. (2018) Science of The Total Environment. 615. 208–218. 10.1016/j.scitotenv.2017.09.226.

A three year long, peer-reviewed study shows that chlorpyrifos is contaminating pollen and is of great concern for the health status of honey bees and other pollinators:

"Pesticides are considered to be a key factor [in honeybee colony losses], as a multitude of studies have demonstrated their detrimental effects at both individual and colony level...**exposure to low levels of pesticides can elicit sublethal effects on bees, not killing them outright but affecting their behaviour and immune system** … **The active ingredient with the highest frequency of residues (30%) was chlorpyrifos…** Learning and memory are of utmost importance for the behaviour of foraging bees, and their impairment may result in negative consequences for colony health and survival … The high proportion of samples containing chlorpyrifos found in this study, combined with the relatively high average level of residues and Hazard Quotient **are of great concern for the health status of honey bees and other pollinators, especially considering that the use of chlorpyrifos is globally widespread.**"

Cell death localization *in situ* in laboratory reared honey bee (*Apis mellifera* L.) larvae treated with pesticides.

Gregorc, Aleš & D. Ellis, James. (2011). Pesticide Biochemistry and Physiology - PESTIC BIOCHEM PHYSIOL. 99. . 10.1016/j.pestbp.2010.12.005.

This peer-reviewed study found that larva fed food containing chlorpyrifos at concentrations typically found in the hive kills larval cells and may outright kill or cripple bees:

"Collectively, our data indicate that the nine test pesticides can induce apoptosis in tissues of honey bee larvae reared in an incubator. … **tissue deletion and larval death is a potential development in these events.**"

The Effects of Pesticides on Queen Rearing and Virus Titers in Honey Bees (Apis mellifera L.).

Degrandi-Hoffman, Gloria & Chen, Yanping & Simonds, Roger. (2013). Insects. 4. 71-89. 10.3390/insects4010071.

Healthy queens are essential to hive survival. When a queen is failing, or dies, bees make new queens. Anything that effects the process by which queens are produced or causes compromised immunity in queens is likely detrimental to hive survival. This peer-reviewed study finds chlorpyrifos is a likely cause of fewer, and less healthy, queens:

"The effects of sublethal pesticide exposure on queen emergence and virus titers were examined. Queen rearing colonies were fed pollen with [hive-realistic, minute quantities, of] chlorpyrifos (CPF) ... **Fewer queens emerged when larvae from open foraging (*i.e.*, outside) colonies were reared in colonies fed [chlorpyrifos]** Deformed wing virus (DWV) and black queen cell virus were found in nurse bees [and queen larvae in colonies fed chlorpyrifos tainted pollen]…However, we did not detect virus in emerged queens grafted from and reared in outside colonies [colonies not feed chlorpyrifos contaminated pollen]. **The results suggest that sublethal exposure of CPF [chlorpyrifos] … reduces queen emergence possibly due to compromised immunity in developing queens.**"

Measurements of Chlorpyrifos Levels in Forager Bees and Comparison with Levels that Disrupt Honey Bee Odor-Mediated Learning Under Laboratory Conditions.

Urlacher, E., Monchanin, C., Rivière, C. et al. J Chem Ecol (2016) 42: 127. https://doi.org/10.1007/s10886-016-0672-4

This peer-reviewed field study proves that chlorpyrifos, applied as directed, is poisoning bees in a way might not kill them directly, but likely causes the colony to fail (collapse):

"Here, we **examined chlorpyrifos levels in bees** collected from 17 locations in Otago, New Zealand, and compared doses of this pesticide that cause sub-lethal effects on learning performance under laboratory conditions with amounts of chlorpyrifos detected in the bees in the field. …**the formation and retrieval of appetitive olfactory memories was severely affected**. Chlorpyrifos fed to bees in amounts several orders of magnitude lower than [what would kill bees outright], and also lower than levels detected in bees, **was found to slow appetitive learning and reduce the specificity of memory recall. As learning and memory play a central role in the behavioral ecology and communication of foraging bees, chlorpyrifos, even in sublethal doses, may threaten the success and survival of this important insect pollinator."**

A common pesticide decreases foraging success and survival in honey bees.

Henry, M., Béguin, M., Requier, F., Rollin, O., Odoux, J.-F., Aupinel, P., Aptel, J., Tchamitchian, S., Decourtye, A., (2012)

Science (80–) 336:348–350. https://doi.org/10.1126/science.1215039.

This, and other peer-reviewed studies, is typical of the overwhelming scientific evidence that sub-lethal doses of pesticides such as chlorpyrifos can no longer be ignored as a cause of the loss of honeybees and other pollinators.

"**Our study clearly demonstrates that exposure of foragers to nonlethal but commonly encountered doses … can affect forager survival, with potential contributions to collapse risk.** …, **impact studies are likely to severely underestimate sublethal pesticide effects** ...."

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Exposure to acetylcholinesterase inhibitors alters the physiology and motor function of honeybees.

Williamson, Sally M.; Moffat, Christopher; Gomersall, Martha A. E.; Saranzewa, Nastja; Connolly, Christopher N.; Wright, Geraldine A. (2013). Front. Physiol., 05 February 2013, DOI: 10.3389/fphys.2013.00013.

This peer-reviewed study proves that chlorpyrifos has profound effects on bees that could lead to colony collapse:

"Biochemical assays confirmed that … **chlorpyrifos** … **causes subtle yet profound effects on physiological effects on behavior that could lead to reduced survival**."

Chlorpyrifos Executive Summary for ESA Assessment.

United States Environmental Protection Agency, 2016. Downloaded from https://www.epa.gov/endangered-species/biological-evaluation-chapters-chlorpyrifos-esa-assessment#executivesummary, 11/3/17.

This document from the EPA proves that they do not consider sub-lethal effects in their determination of the risk of chlorpyrifos to bees. This is a decidedly unscientific approach. On page 229 of the document the EPA acknowledges a wide range of sub-lethal effects on pollinators and then simply states that sub-lethal effects "could not be converted to environmentally-relevant concentrations", and therefore are not included in the EPA evaluation of chlorpyrifos.

Effects of chlorpyrifos insecticide on pollinators.

Lunden J, Mayer D, Johansen C, Shanks C, Eves J (1986) Am Bee J 126:441–444

This industry-funded research (Dow, the makers of chlopryrifos funded the study) showed that long after the chlorpyrifos applicator has determined it is legal to apply the pesticide (by observing no bees were flying onto the crops), chlorpyrifos continues to kill bees:

"Chlorpyrifos is much too hazardous to bees to be used on blooming crops or in situations where it may drift onto blooming crops or weeds…Foraging honey bees captured in the chlorpyrifos plot (up to 3 days after application) had high mortality…California data indicate that chlorpyrifos residues up to 3.5 days old are highly hazardous to honey bees." And, from Table 1. **"Mortality of bees." 25% mortality for honeybees was reported for contact with foliage 7 days after application.**

EPA approved label.

For Cobalt insecticide (30% chlorpyrifos). downloaded from http://www.cdms.net/ldat/ld8AA016.pdf, January 24, 2018.

The EPA label offers no protection to pollinators. An applicator of chlorpyrifos only needs to say "I didn't see any bees when I applied the insecticide" to avoid prosecution:

"**…** This product is **highly toxic to bees** exposed to direct treatment or residues on blooming crops or weeds. **Do not apply** this product or allow it to drift to blooming crops or weeds **if bees are visiting the treatment area**."