DEPARTMENT OF AGRICULTURE

Pesticide Bee Kill Complaint Investigations

Summary of investigations in 2023 and 2024

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Contents

Background

The Minnesota Department of Agriculture (MDA) is the state agency responsible for the investigation of bee kill incidents alleged to be caused by pesticides (MINN. STAT. 18D.201). The MDA's Pesticide and Fertilizer Management Division conducts the investigations.

In 2015, the Minnesota Legislature added a provision that requires a bee owner to be registered with a commonly utilized pesticide registry program (MINN. STAT. 18B.055), as designated by the commissioner in order to be eligible for compensation. The Commissioner of Agriculture has designated Beecheck, (https://beecheck.org/), a voluntary hive mapping registry administered by FieldWatch, as the required registry program.

In 2023, the maximum compensation rate for an individual bee kill incident were modified (MINN. STAT. 18B.055). Statute states that the MDA must compensate a bee owner for an acute pesticide poisoning resulting in the death of bees or loss of bee colonies owned by the bee owner. In any fiscal year, a bee owner must not be compensated for a claim that is less than $100 or compensated more than $10,000 for a bee kill incident. A bee owner must not be compensated more than $20,000 in a fiscal year for bee kill incidents.

Program Details

The MDA investigates alleged bee kills. To start a bee kill investigation, a complaint must be made in writing. See the Pesticide and Fertilizer Misuse Complaint webpage for more information.

Upon receipt of a written complaint, MDA staff will review the information to determine if there is sufficient evidence for a field investigation. If sufficient evidence is available, the MDA will send out a team of trained pesticide investigators. The team has expertise in bee handling/colony assessment.

During the investigation, samples of dead bees, live bees, and plant material, as available and appropriate, are collected to evaluate the presence of pesticides, colony pests, and overall colony health. In addition, the MDA attempts to determine the extent of pesticide use in areas adjacent to hive locations by contacting pesticide dealers, growers, and applicators in the area.

The MDA Laboratory Services Division is a state Federal Insecticide Fungicide Rodenticide Act (FIFRA) laboratory that analyzes MDA investigation samples for pesticide residues. The laboratory is accredited for ISO 17025 by A2LA. Samples may also be analyzed by the United States Department of Agriculture (USDA) Lab in Gastonia, North Carolina.

The University of Maryland evaluates MDA bee samples for *Varroa destructor*, a mite known to reduce bee longevity by vectoring viruses, and *Nosema spp*., a fungal pathogen that can infect a bee's gut. The Maryland lab also analyzes MDA bee samples for a set of common viruses that negatively affect colony health.

Once the MDA's Pesticide and Fertilizer Management Division receives analytical results for pesticides, mites, and viruses, staff confer internally to determine what likely contributed to bee mortality.

For bee kill investigations, the MDA uses a working definition of an "acute pesticide poisoning" to capture acute pesticide effects to honey bee colonies with different populations and developmental stages. The MDA evaluates an "acute pesticide poisoning" based on the presence of non-beekeeper applied pesticide residues in

dead bees, the number of frames of bees (a measure of a honey bee colony's living population), and a minimum number of dead bees present in and around the hive at the time of the investigation.

- For a pesticide-related bee kill to be considered an "acute pesticide poisoning," a colony with three or fewer frames of bees present in the hive at the time of investigation must have at least 300 total dead bees in and around the colony.
- Colonies with between 3.5 and 9.5 frames of bees at the time of investigation will need between 350 and 950 dead bees to be considered an "acute pesticide poisoning" (50 dead bees for every 0.5 frame of bees).
- If a colony has ten or more frames of bees at the time of investigation, a maximum of 1,000 dead bees must be quantified to be considered an "acute pesticide poisoning."

If it can be demonstrated that pesticides likely led to an "acute pesticide poisoning" and the apiary was registered on BeeCheck prior to the bee kill incident, the beekeeper may be eligible for compensation (MINN. STAT. 18B.055).

The MDA currently does not have a statewide apiary program for pollinator health and does not require the registration of apiaries with the state.

Program Contacts

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Summary of 2023 and 2024 Bee Kill Incidents

The MDA investigated two bee kill incidents in 2023 and zero bee kill incidents in 2024. One of the 2023 investigations was determined to be an acute pesticide poisoning and the beekeeper was compensated for two hives, the other was not determined to be an acute pesticide poisoning. See below for further details.

Investigation Summary

Hennepin County **Case File Number:** SRK141007309

Received date: May 04, 2023

Date	May 04, 2023	May 05, 2023	May 05, 2023	May 26, 2023	June 21, 2023	July 31, 2023	Aug. 25, 2023	March 01, 2024
Action	Call received	MDA responds	Samples sent to labs for analysis	USDA bee residue results received	MDA bee residue results received	Compensation claim request received from beekeeper	MDA/USDA bee residue results sent to beekeeper	Case closing letter issued

Background of Complaint and MDA Response

- An apiary of five honey bee colonies considered partially affected by the beekeeper was reported to the MDA on May 04, 2023. Two of the apiary's hives were completely dead while the other three were considered unaffected.
- Of the five colonies in the apiary, four were newly established hives installed on April 24, 2023 from three-pound package bees. The fifth colony had been overwintered and contained approximately twice the population of bees (6.5 frames, ≈15,000 bees) compared to newly installed hives. The two affected hives were newly established.
- Colonies were housed in modified hive boxes primarily consisting of new, undrawn frames that were 15 3/8" deep (a combined deep and medium frame). A few of the modified frames utilized drawn deep foundation as part of the combined frame design. Hive boxes were wrapped in permanent, ≥1" thick pink foam insulation. While the overwintered colony was housed in two, 9 1/8" deep hive boxes on drawn foundation without insulation.
- The incident was reported to the MDA on May 4, 2023 and an MDA Agricultural Chemical Investigator and MDA Pesticide Technical Unit staff entomologists visited the site on May 05, 2023.
- No rainfall occurred between the time of the complaint and the time of the on-site investigation.

MDA Colony Health Findings

- At the time of the inspection, packaged colony queens had not started laying eggs in the four new colonies. The overwintered colony had all ages of brood present and a brood pattern of 4 out of 5 indicating a healthy egg laying pattern.
- No disease symptoms were observed in affected or unaffected hives.
- The number of dead bees collected from each colony considered affected exceeded 1,000 individuals. No dead bees were available for collection from the unaffected hive.

Live bees were not sampled from newly established, unaffected hives because their queens had not started laying eggs, and because selecting an unaffected colony to sample with a larger foraging work force would likely

result in exposure to a wider portion of the surrounding environment. The following hive health results reflect the condition of the overwintered, unaffected colony.

- 0.45 *Varroa* mites/100 bees were found in the unaffected hive, which is below the recommended economic threshold of 3 mites/100 bees.
- 0.25 million *Nosema* spores/bee were found in the unafffective hive, which is below the 1.0 million *Nosema* spores/bee threshold at which negative effects from *Nosema* are thought to be observable in colonies.
- RNA for 11 honey bee viruses were quantified and compared to national prevalence rates. Percentiles, shown in parenthesis, allow for comparison of viral loads from sampled hives against nationally compiled prevalence rates, where smaller percentiles indicate less pressure from a particular virus. Black queen cell virus (18/100), and Deformed wing virus B (20/100) were found.

MDA Pesticide Findings

- Pesticide residue analyses were carried out at the MDA laboratory on dead bees from the affected hives and live bee samples from the overwintered, unaffected hive. The USDA laboratory analyzed analogous samples for pesticide residues in dead and live bees. No vegetation samples were collected for pesticide residue analysis because inspectors were not able to identify any pesticide point sources in the area surrounding the apiary as the apiary was located on a rooftop devoid of vegetation.
- The MDA laboratory analysis identified residues from amitraz DMPF, amitraz DMPMF, and buprofezin in dead bees, while live, unaffected bees had residues from amitraz DMPF, amitraz DMPMF, and clothianidin.
- The USDA laboratory pesticide residue results found amitraz 2,4-DMPF, atrazine, azoxystrobin, buprofezin, DDE p,p', fluopyram, fluxapyroxad, propiconazole, pyraclostrobin, tebuconazole, thymol, and trifloxystrobin in dead bees. While pesticide residue analysis for live, unaffected bees found amitraz 2,4-DMPF, atrazine, and thymol.
- The beekeeper did not apply any pesticide products to honey bee colonies within 12 months of the investigation for *Varroa* mite control.
- Differences in pesticide residue results between the MDA and USDA laboratories can be due to differences in sample composition, analytical methods and/or different levels of detection between laboratories. Laboratory results are displayed in the table below.

Laboratory Results – Pesticide Residue Analysis*

Lab	Analyte (Level of detection)	Type of pesticide	Concentration from affected dead bees Hive 1 (% acute benchmark^)	Concentration from affected dead bees Hive 2 (% acute benchmark^)	Concentration from unaffected live bees Hive 3 (% acute benchmark^)	Adult honey bee acute LD50	EPA ecotoxicity category (honey bee)
MDA	amitraz DMPF (0.2)	insecticide/ acaricide degradate	2.35 & 2.40 (<0.0008%)	4.02 & 4.46 (<0.001%)	9.48 & 10.6 (<0.003%)	Degradate LD_{50} unknown. Parent contact: >781,250 [1]	Practically non-toxic
USDA	amitraz 2,4-DMPF (25)	insecticide/ acaricide degradate	Trace (<0.008%)	No Detection	Trace (<0.008%)	Degradate LD_{50} unknown. Parent contact: >781,250 [1]	Practically non-toxic
MDA	amitraz DMPMF (0.4)	insecticide/ acaricide degradate	2.63 & 2.64 (<0.0008%)	25.7 & 32.5 (<0.008% & <0.01%)	25.3 & 25.8 (<0.008%)	Degradate LD_{50} unknown. Parent contact: >781,250 [1]	Practically non-toxic
USDA	amitraz DMPMF (NA)	insecticide/ acaricide degradate	Not Screened	Not Screened	Not Screened	Degradate LD_{50} unknown. Parent contact: >781,250 [1]	Practically non-toxic
MDA	atrazine (25)	herbicide	No Detection	No Detection	No Detection	Contact: >757,812 [2]	Practically non-toxic
USDA	atrazine (3)	herbicide	Trace (<0.001%)	Trace (<0.001%)	Trace (<0.001%)	Contact: >757,812 [2]	Practically non-toxic
MDA	azoxystrobin (NA)	fungicide	Not Screened	Not Screened	Not Screened	Oral: >195,313 [3]	Practically non-toxic
USDA	azoxystrobin (2)	fungicide	Trace (<0.003%)	Trace (<0.003%)	No Detection	Oral: >195,313 [3]	Practically non-toxic
MDA	buprofezin (0.4)	insect growth regulator / insecticide	15.1 & 17.9 (<0.002% & <0.003%)	6.93 & 9.93 (<0.001% & <0.002%)	No Detection	Contact: >1,562,500 [4]	Practically non-toxic
USDA	buprofezin (2)	insect growth regulator / insecticide	5 (<0.0008%)	16 (<0.003%)	No Detection	Contact: >1,562,500 [4]	Practically non-toxic
MDA	clothianidin (0.2)	insecticide	No Detection	No Detection	No Detection & 0.33 (NA & 2.8%)	Oral: 29 [5]	Highly toxic
USDA	clothianidin (8)	insecticide	No Detection	No Detection	No Detection	Oral: 29 [5]	Highly toxic
MDA	DDE p,p' (NA)	insecticide degradate	Not Screened	Not Screened	Not Screened	Degradate LD_{50} unknown. Parent contact: 210,937 [6]	Practically non-toxic
USDA	DDE p,p' (3)	insecticide degradate	Trace (<0.004%)	No Detection	No Detection	Degradate LD_{50} unknown. Parent contact: 210,937 [6]	Practically non-toxic
MDA	fluopyram (NA)	fungicide	Not Screened	Not Screened	Not Screened	Contact: >650,000 [7]	Practically non-toxic
USDA	fluopyram (2)	fungicide	No Detection	Trace (<0.0008%)	No Detection	Contact: >650,000 [7]	Practically non-toxic
MDA	fluxapyroxad (NA)	fungicide	Not Screened	Not Screened	Not Screened	Contact: 122,656 [8]	Practically non-toxic
USDA	fluxapyroxad (2)	fungicide	Trace (<0.004%)	Trace (<0.004%)	No Detection	Contact: 122,656 [8]	Practically non-toxic
MDA	propiconazole (NA)	fungicide	Not Screened	Not Screened	Not Screened	Contact: >781,250 [9]	Practically non-toxic

Lab	Active Ingredient (Level of detection)	Type of pesticide	Concentration from affected dead bees Hive 1 (% acute benchmark^)	Concentration from affected dead bees Hive 2 (% acute benchmark^)	Concentration from unaffected live bees Hive 3 (% acute benchmark^)	Adult honey bee acute LD50	EPA ecotoxicity category (honey bee)
USDA	propiconazole (5)	fungicide	16 (<0.005%)	28 (<0.009%)	No Detection	Contact: >781,250 [9]	Practically non-toxic
MDA	pyraclostrobin (NA)	fungicide	Not Screened	Not Screened	Not Screened	Oral: 21,093 [10]	Moderately toxic
USDA	pyraclostrobin (3)	fungicide	Trace (<0.04%)	Trace (<0.04%)	No Detection	Oral: 21,093 [10]	Moderately toxic
MDA	tebuconazole (NA)	fungicide	Not Screened	Not Screened	Not Screened	Oral: 648,828 [11]	Practically non-toxic
USDA	tebuconazole (25)	fungicide	Trace (<0.01%)	34 (0.01%)	No Detection	Oral: 648,828 [11]	Practically non-toxic
MDA	thymol (NA)	biopesticide	Not Screened	Not Screened	Not Screened	Contact: 400,390 [12]	Practically non-toxic
USDA	thymol (25)	biopesticide	1,190 (0.7%)	3,540 (2.2%)	402 (0.3%)	Contact: 400,390 [12]	Practically non-toxic
MDA	trifloxystrobin (NA)	fungicide	Not Screened	Not Screened	Not Screened	Contact: >1,562,500 [13]	Practically non-toxic
USDA	trifloxystrobin (1)	fungicide	1 (<0.0002%)	3 (<0.0005%)	No Detection	Contact: >1,562,500 [13]	Practically non-toxic

* All values are in µg active ingredient/kg which is equivalent to parts per billion (ppb).

^ Benchmark = EPA's toxicity value x EPA's acute Level of Concern (LOC) for adult honey bees. The EPA's toxicity value is the acute contact or oral Lethal Dose to 50% of a honey bee population (LD_{50}) in a standardized test (whichever value is lower) and the LOC is 0.4, a pre-determined threshold set for groups of organisms such as bees. Pesticide concentrations determined from the investigation's laboratory results are divided by the benchmark and expressed as a percentage.

[1] Amitraz Preliminary Ecological Risk Assessment and Endangered Species Assessment for Registration Review of the Conventional Use in Honey Bee Hives. 2018. DP Barcode: 435890

[2] Refined Ecological Risk Assessment for Atrazine. USEPA. 2016. EPA-HQ-OPP-2013-0266-0315

[3] Registration Review: Draft Risk Assessment of the Environmental Fate and Ecological Risk of Azoxystrobin. 2015. EPA-HQ-OPP-2009-0835-0024

[4] Preliminary Problem Formulation for the Ecological Risk and Drinking Water Exposure Assessments for the Registration Review of Buprofezin. USEPA. 2012. DP Barcode: D396408

[5] Preliminary Bee Risk Assessment to Support the Registration Review of Clothianidin and Thiamethoxam. USEPA. 2017. DP Barcode: 437097

[6] Environmental Health Criteria 83, DDT and its Derivatives Environmental Effect. World Health Organization, Geneva. 1989.

[7] Ecological Risk Assessment for Proposed Section 3 New Uses for Fluopyram. US Environmental Protection Agency. 2016. EPA-HQ-OPP-2015-0443-0006.

[8] Environmental Fate and Ecological Risk Assessment for Foliar and Seed Treatment Uses of the New Fungicide Fluxapyroxad (BAS 700F). USEPA. 2012. PC Code: 138009

[9] Propiconazole: Draft Ecological Risk Assessment for Registration Review. USEPA. 2020. EPA-HQ-OPP-2015-0459-0029

[10] Pyraclostrobin Data Evaluation Record Honey bee – Acute Contract & Oral LC50 Test '141-1. USEPA. 2019. DP Barcode: 444095

[11] Assessment of Side Effects of Tebuconazole a.i. to the Honey Bee, *Apis mellifera* L. in the Laboratory. 2021. DP Barcode: 447459

[12] Registration Review Draft Risk Assessment for Thymol. 2019. EPA-HQ-OPP-2010-0002

[13] Revised Ecological Risk Assessment for the Registration Review of Trifloxystrobin. 2018. EPA-HQ-OPP-2013-0074-0041

Investigation Conclusions

- Three insecticides, amitraz degradates DMPF, 2,4-DMPF or DMPMF, buprofezin, and DDE p,p' were found in dead bees. Residues identified are not likely to have been lethal on their own. The insecticide amitraz, typically applied by beekeepers, was found to have the highest percentage at <0.01% of the acute benchmark used to determine risk to honey bees.
- One herbicide, atrazine, was found in dead bees in trace amounts <0.001% of the acute benchmark used to determine risk to honey bees.
- Seven fungicides, azoxystrobin, fluopyram, fluxapyroxad, propiconazole, pyraclostrobin, tebuconazole, and trifloxystrobin were found in dead bees. The fungicide pyraclostrobin was found to have the highest percentage at <0.04% of the acute benchmark used to determine risk to honey bees.
- One biopesticide, thymol, typically applied by beekeepers to control *Varroa* mites, was found in dead bees in low levels ≈2.2% of the acute benchmark used to determine risk to honey bees.
- The lack of similar pesticide residues in unaffected live bees vs. affected dead bees recently purchased and shipped to MN but located in the same apiary suggests that exposure to pesticides may have occurred outside the MN apiary location. Sampled unaffected live bees from the overwintered population came from a stronger colony with a larger foraging workforce that should have, theoretically, been exposed to a larger subset of locations, resources, and pesticide residues within the apiary's surrounding landscape. However, the opposite occurred with the smaller, recently purchased packaged colonies, new to their MN apiary, showing nine additional pesticide compounds detected compared to bees sampled from the MN overwintered colony.
- While many of the detected pesticide active ingredients are registered for use in Minnesota in agricultural and non-agricultural settings, use of these products is not anticipated to occur in MN so early in the year.
- Two days passed between when the beekeeper noticed hive losses and when MDA staff collected samples for pesticide residue analysis. Due to the natural degradation processes of pesticides and the time that elapsed between bee death and sample collection, it is likely that pesticide residues degraded to some extent, and the quantity of pesticide detected is lower than initial exposure concentrations.
- Colony health measures could not be collected from affected colonies due to no live bees present and lack of drawn comb. However, given that the affected colonies had only been present in the apiary for 12 days, it is unlikely that pathogen loads would have been present at concerning levels. The unaffected colony evaluated appeared healthy with low *Varroa* mite, *Nosema*, and viral loads.
- Some concern exists for potential synergistic interactions between the 12 pesticide residues identified in dead bees, despite each pesticide being present at very low concentrations. It is possible that the combined pesticide residues had a greater effect on the bees than individual toxicity benchmarks would indicate and contributed to the observed bee mortality.
- The investigation concluded that the observed bee mortality qualifies as an acute pesticide poisoning based on the ratio of live to dead bees quantified and presence of non-beekeeper applied pesticide residues found in dead bees. Investigators quantified more than the minimum number of dead bees required (over 350 dead bees) and identified 10 non-beekeeper applied pesticide residues in dead bees.
- The beekeeper is eligible for compensation based on the acute pesticide poisoning determination and the beekeeper's participation in BeeCheck.

Compensation

- The beekeeper was registered with BeeCheck before the incident occured.
- Investigators concluded bee mortality could be considered an acute pesticide poisoning.
- Based on these findings, the investigation concluded that the observed bee mortality qualifies the beekeeper for compensation.
- The MDA received a completed Compensation Claim Form on July 31, 2023 and the beekeeper was compensated for the loss of two honey bee hives at the 2023 fair market value established at $220.00/hive.

Investigation Summary

Stearns County **Case File Number:** AJI131001042

Received date: October 17, 2023

Date	October 17, 2023	October 18, 2023	October 18, 2023	November 6, 2023	November 22, 2023	December 19, 2023	July 8, 2024
Action	Call received	MDA responds	Samples sent to labs for analysis	USDA bee residue results received	MDA bee residue results received	MDA/USDA bee residue results sent to beekeeper	Case closing letter issued

Background of Complaint and MDA Response

- The complainant visited the apiary on October 14, 2023, to modify hives for overwintering and observed the abnormally high mortality. Observed symptoms included lethargic, crawling, dead bees, and reduced colony populations.
- The apiary of 15 honey bee colonies considered affected by the beekeeper was reported to the MDA in writing on October 17, 2023 and an MDA Agricultural Chemical Investigator and MDA Pesticide Technical Unit staff entomologist visited the site the next day, October 18, 2023.
- Five of the apiary's hives were completely dead while the other colonies ranged in population with the strongest evaluated containing 23 frames of bees, >50,000 individuals. All colonies were housed in 2 – 3 deep hive boxes at the time of inspection and had been overwintered the previous year.
- Six colonies were opened, evaluated for colony health, and samples of dead and live bees collected when possible. Collected samples were combined into composite dead bee and composite live bee samples and screened for pesticide residues. Two colonies with live bees had foragers collected from food frames for viral analysis while nurse bees from brood frames were collected for *Varroa* and *Nosema* evaluation.
- The number of dead bees collected within each colony were relatively low, however, many dead bees were present outside of the hives and exceeded 1,000 individuals.
- Evaluated colonies with live populations appeared to be well resourced with greater than one box full of pollen and honey, while colonies considered dead had fine wax particles on the bottom board with many frames showing signs of robbing, indicating colonies had honey stores prior to dying.

MDA Colony Heath Findings

- Only two of the evaluated colonies had queens present. They were in the strongest hives, associated with large amounts of brood (7 – 10 frames), and contained brood of all ages. Dead colonies evaluated had between 7 - 14 frames of non-viable, capped brood indicating colonies had been strong prior to the mortality event.
- In the composite live bee sample, 23.22 *Varroa* mites/100 bees were found, which is above the recommended late summer economic threshold of 2-3 mites/100 bees.
- In the composite live bee sample, 0.0 *Nosema* spores/bee were found, which is below the 1.0 million *Nosema* spores/bee threshold at which negative effects from *Nosema* are thought to be observable in colonies.
- During colony inspections abnormal signs of adult and larvae disease were noted including sunken, discolored larvae and adult bees with shriveled wings indicating some pressure from deformed wing virus.
- RNA for 11 honey bee viruses were quantified from a composite sample of live bees. Analysis results utilize a ranking system to compare the relative viral pressure this apiary was under compared to viral pressure of other apiaries in the United States since 2013. A higher rank indicates higher virus pressure of the analyzed sample compared to the database. Results from this apiary identified four viruses, Acute Bee Paralysis Virus (ranking 88/100), Black Queen Cell Virus (ranking 96/100), Deformed Wing Virus A (ranking 90/100), and Deformed Wing Virus B (92/100).

MDA Pesticide Findings

- Pesticide residue analyses on dead and live bee samples was carried out at the MDA and USDA laboratories. No vegetation samples were collected for pesticide residue analysis because inspectors were not able to identify any pesticide point sources in the area surrounding the apiary and the incident occurred after agricultural spray events would likely have occurred.
- The MDA laboratory analysis showed dead bees contained residues from the insecticide tebufenozide at 0.12 parts per billion while live bees had no detectable pesticide residues present.
- The USDA laboratory pesticide residue results found carbendazim, diuron, and thymol in dead bees. While pesticide residue analysis for live bees found residues of fluridone, thymol, and trifloxystrobin.
- The beekeeper stated they applied oxalic acid in spring and in June for *Varroa* mite control.
- Differences in pesticide residue results between the MDA and USDA laboratories can be due to differences in sample composition, analytical methods and/or different levels of detection between laboratories. Laboratory results are displayed in the table below.

Laboratory Results – Pesticide Residue Analysis*

Lab	Analyte (Level of detection)	Type of pesticide	Concentration from affected dead bees (% acute benchmark^)	Concentration from affected live bees (% acute benchmark^)	Adult honey bee acute LD_{50} (EPA ecotoxicity category)
MDA	carbendazim (NA)	fungicide/ antimicrobial	Not Screened	Not Screened	Oral: >687,500 1 (Practically non-toxic)
USDA	carbendazim (25)	fungicide/ antimicrobial	42.2 (<0.02%)	Not Detected	Oral: >687,500 1 (Practically non-toxic)
MDA	diuron (NA)	herbicide/ antimicrobial	Not Screened	Not Screened	Contact: >1,133,047 [2] (Practically non-toxic)
USDA	diuron (5)	herbicide/ antimicrobial	Trace (<0.001%)	Not Detected	Contact: >1,133,047 [2] (Practically non-toxic)
MDA	fluridone (NA)	herbicide	Not Screened	Not Screened	Contact: >781,250 [3] (Practically non-toxic)
USDA	fluridone (1)	herbicide	Trace (<0.0003%)	Trace (<0.0003%)	Contact: >781,250 [3] (Practically non-toxic)
MDA	tebufenozide (0.04)	insect growth regulator	0.12 (<0.00002%)	Not Detected	Contact: >1,828,125 [4] (Practically non-toxic)
USDA	tebufenozide (1)	insect growth regulator	Not Detected	Not Detected	Contact: >1,828,125 [4] (Practically non-toxic)
MDA	thymol (NA)	biopesticide	Not Screened	Not Screened	Contact: 400,390 [5] (Practically non-toxic)
USDA	thymol (25)	biopesticide	74 (≈0.05%)	153 (≈0.1%)	Contact: 400,390 [5] (Practically non-toxic)
MDA	trifloxystrobin (NA)	fungicide	Not Screened	Not Screened	Contact: >1,562,500 [6] (Practically non-toxic)
USDA	trifloxystrobin (1)	fungicide	Not Detected	Trace (<0.0002%)	Contact: >1,562,500 [6] (Practically non-toxic)

* All values are in µg/kg (microgram per killogram) which is equivalent to parts per billion (ppb).

^ Benchmark = EPA's toxicity value x EPA's acute Level of Concern (LOC) for adult honey bees. The EPA's toxicity value is the acute contact or oral Lethal Dose to 50% of a honey bee population (LD_{50}) in a standardized test (whichever value is lower) and the LOC is 0.4, a pre-determined threshold set for groups of organisms such as bees. Pesticide concentrations determined from the investigation's laboratory results are divided by the benchmark and expressed as a percentage.

[1] Thiophanate Methyl and MBC (Carbendazim): Draft Ecological Risk Assessment for the Registration Review. 2020. DP Barcode: 453853

[2] Diuron: Registration Review Problem Formulation for the Environmental Fate, Ecological Risk, Endangered Species, and Drinking water Assessments. 2015. DP Barcode: 423230

[3] Fluridone: Preliminary Ecological Risk Assessment for Registration Review. 2017. DP Barcode: 440578

[4] Preliminary Environmental Fate and Ecological Risk Assessment for Registration Review of the Insect Growth Regulator, Tebufenozide. 2015. DP Barcode: D414537

[5] Registration Review Draft Risk Assessment for Thymol. 2019. DP Barcode: 452852

[6] Revised Ecological Risk Assessment for the Registration Review of Trifloxystrobin. 2018. DP Barcode: 446314

Investigation Conclusions

- Quantification of pesticide residues from live and dead bee samples found non-beekeeper applied pesticides. However, all pesticides quantified were found at relatively low concentrations and categorized by the EPA as “practically non-toxic” to honey bees.
- Thymol, was detected at the highest concentration, 153 parts per billion (ppb) or ≈0.1% of the EPA’s level of concern in live bees. However, thymol is a beekeeper applied pesticide. The highest non-beekeeper applied pesticide detected was carbendazim, a fungicide and antimicrobial, at a concentration of 42.2 ppb or <0.02% of the EPA’s level of concern in dead bees.
- Colony health measures were also evaluated for pest and disease pressure that could explain the observed mortality.
- Quantification of *Varroa* mite levels at 23.22 *Varroa* mites/100 bees were found to far exceed the recommended later summer economic threshold for *Varroa* mite of 2-3 mites/100 bees.
- Associated viral analysis detected four viruses. All viruses were detected at a rank of 88/100 or higher when compared to a national database of samples analyzed since 2013 and indicates colonies were experiencing significant viral pressure. The presence of Acute Bee Paralysis Virus is especially of note because symptoms of this virus can be very similar to the symptoms of a pesticide poisoning (trembling, inability to fly, and rapid death).
- Four days had passed, and a rain event occurred between the time the beekeeper noticed hive losses and MDA staff investigated.
- Even with some amount of pesticide degradation, the MDA does not expect the identified pesticides to account for the observed bee mortality and colony loss.

Compensation

- The beekeeper was registered with BeeCheck.
- Investigators concluded bee mortality was not due to an acute pesticide poisoning based on low levels of pesticide residues quantified and the classification of active ingredients found as practically non-toxic by the EPA.
- Colony health sample results indicate high *Varroa* populations and viral loads, better explaining the observed mortality.
- Based on these findings, the investigation concluded that the observed bee mortality does not qualify the beekeeper for compensation.

MDA and USDA Pesticide Analyte List Used in 2023 and 2024 Bee Kill Investigations

#	Analyte	MDA Limit of Detection*	USDA Limit of Detection*
1	1-Naphthol	Not Screened	500
2	2,4 Dimethylphenyl formamide (DMPF)	Not Screened	25
3	2, 6-Dichlorobenzamide (BAM)	Not Screened	5
4	3-Hydroxycarbofuran	Not Screened	5
5	Abamectin	16	Not Screened
6	Acephate	4.8	50
7	Acetamiprid	0.04	8
8	Acetochlor	25	100
9	Acrinathrin	Not Screened	100
10	Afidopyropen	1.2	Not Screened
11	Alachlor	25	100
12	Aldicarb	16	8
13	Aldicarb sulfone	0.04	13
14	Aldicarb sulfoxide	0.2	25
15	Allethrin	1.6	Not Screened
16	Ametoctradin	Not Screened	3
17	Amitraz DMPF	0.2	Not Screened
18	Amitraz DMPMF	0.4	Not Screened
19	Atrazine	25	3
20	Avermectin	Not Screened	63
21	Azinphos methyl	100	25
22	Azoxystrobin	Not Screened	2
23	Bensulide	Not Screened	5
24	Bentazone	Not Screened	38
25	Bifenazate	0.2	4
26	Bifenthrin	2.4	25
27	Boscalid	Not Screened	5
28	Broflanilide	0.4	Not Screened

#	Analyte	MDA Limit of Detection*	USDA Limit of Detection*
29	Broflanilide DM-8007	0.16	Not Screened
30	Bromacil	Not Screened	10
31	Bromophos-methyl	25	Not Screened
32	Bromopropylate	Not Screened	25
33	Bromuconazole	Not Screened	13
34	Buprofezin	0.4	2
35	Captan	Not Screened	125
36	Carbaryl	0.2	5
37	Carbendazim	Not Screened	25
38	Carbofuran	0.2	2
39	Carbofuran, 3-Keto	0.2	Not Screened
40	Carbofuran, 3-OH	0.4	Not Screened
41	Carfentrazone-ethyl	Not Screened	5
42	Chlorantraniliprole	0.4	13
43	Chlorfenopyr	Not Screened	13
44	Chlorfenvinphos	50	50
45	Chlorothalonil	50	10
46	Chlorpropham (CIPC)	Not Screened	15
47	Chlorpyrifos	25	5
48	Chlorpyrifos methyl	Not Screened	10
49	Chlorthal-dimethyl	Not Screened	3
50	Clofentezine	0.4	13
51	Clomazone	25	Not Screened
52	Clothianidin	0.2	8
53	Coumaphos	100	5
54	Coumaphos oxon	Not Screened	1
55	Cyanazine	50	Not Screened
56	Cyantraniliprole	1.2	13
57	Cyazofamid	Not Screened	2
58	Cyflufenamid	Not Screened	2
59	Cyflumetofen	Not Screened	10
60	Cyfluthrin	5	25

#	Analyte	MDA Limit of Detection*	USDA Limit of Detection*
61	Cyhalothrin (lambda)	5	25
62	Cymiazole	Not Screened	8
63	Cymoxanil	Not Screened	4
64	Cypermethrin	5	25
65	Cyphenothrin	5	1000
67	Cyprodinil	Not Screened	3
68	DDE, p, p’	Not Screened	3
69	DEET	Not Screened	13
70	Deisopropylatrazine	50	Not Screened
71	Deltamethrin/Tralomethrin	5	50
72	Desethylatrazine	25	Not Screened
73	Diazinon	25	25
74	Diazinon oxon	Not Screened	4
75	Dichlorvos (DDVP)	250	5
76	Dicloran	Not Screened	25
77	Dicofol	Not Screened	150
78	Difenoconazole	Not Screened	4
79	Diflubenzuron	Not Screened	3
80	Dimethenamid	25	4
81	Dimethoate	0.2	5
82	Dimethomorph	Not Screened	75
83	Dinotefuran	0.2	25
84	Dinotefuran UF	1.2	Not Screened
85	Diphenamid	Not Screened	3
86	Diphenylamine	Not Screened	3
87	Diuron	Not Screened	5
88	Emamectin Benzoate	1.2	Not Screened
89	Endosulfan I	Not Screened	25
90	Endosulfan II	Not Screened	25
91	Endosulfan sulfate	Not Screened	25
92	Epoxiconazole	Not Screened	4
93	EPTC	25	Not Screened

#	Analyte	MDA Limit of Detection*	USDA Limit of Detection*
94	Esfenvalerate/Fenvalerate	5	13
95	Ethalfluralin	25	Not Screened
96	Ethion	Not Screened	25
97	Ethofenprox	Not Screened	125
98	Ethofumesate	Not Screened	15
99	Etofenprox	0.2	Not Screened
100	Etoxazole	0.2	1
101	Famoxadone	Not Screened	8
102	Fenamidone	Not Screened	25
103	Fenarimol	Not Screened	25
104	Fenazaquin	Not Screened	1
105	Fenbuconazole	Not Screened	3
106	Fenhexamid	Not Screened	9
107	Fenoxaprop-ethyl	Not Screened	4
108	Fenpropathrin	1.2	25
109	Fenpyroximate	Not Screened	3
110	Fenthion	25	Not Screened
111	Fipronil	25	25
112	Fipronil sulfide	Not Screened	5
113	Fipronil sulfone	Not Screened	25
114	Flonicamid	Not Screened	38
115	Fludioxonil	Not Screened	10
116	Flumethrin	5	Not Screened
117	Flumeturon	Not Screened	2
118	Fluopicolide	Not Screened	3
119	Fluopyram	Not Screened	2
120	Fluoxastrobin	Not Screened	2
121	Flupyradifurone	0.2	5
122	Fluridone	Not Screened	1
123	Flutriafol	Not Screened	5
124	Fluvalinate (tau)	5	25
125	Fluxapyroxad	Not Screened	2

#	Analyte	MDA Limit of Detection*	USDA Limit of Detection*
126	Fonofos	25	Not Screened
127	Hexazinone	Not Screened	1
128	Hexythiazox	Not Screened	1
129	lmazalil	Not Screened	10
130	lmidacloprid	0.2	5
131	Imidacloprid des nitro olefin	0.4	Not Screened
132	Imidacloprid desnitro (HCl)	0.8	Not Screened
133	Imidacloprid olefin	4.8	Not Screened
134	Imidacloprid urea	0.2	Not Screened
135	Imidacloprid, 5-OH	1.6	Not Screened
136	Imidprothrin	5	Not Screened
137	lndoxacarb	Not Screened	5
138	lprodione	Not Screened	50
139	Kresoxim-methyl	Not Screened	3
140	Linuron	Not Screened	13
141	Malathion	25	25
142	Mandipropamide	Not Screened	2
143	Metalaxyl	Not Screened	2
144	Metazachlor	25	Not Screened
145	Metconazole	Not Screened	5
146	Methamidophos	0.4	25
147	Methidathion	25	2
148	Methiocarb	0.2	Not Screened
149	Methiocarb sulfone	0.04	Not Screened
150	Methiocarb sulfoxide	0.04	Not Screened
151	Methomyl	0.2	5
152	Methomyl oxime	0.2	Not Screened
153	Methomyl sulfoxide	4.8	Not Screened
154	Methoprene	Not Screened	25000
155	Methoxyfenozide	Not Screened	2
156	Methyl parathion	25	Not Screened
157	Metofluthrin	5	Not Screened

#	Analyte	MDA Limit of Detection*	USDA Limit of Detection*
158	Metolachlor	25	25
159	Metribuzin	25	13
160	Mevinphos	25	Not Screened
161	MGK-264	Not Screened	10
162	Momfluorothrin	Not Screened	25
163	Monocrotophos	0.2	Not Screened
164	Myclobutanil	Not Screened	8
165	Nithiazine	0.4	Not Screened
166	Norflurazon	Not Screened	5
167	Norflurazon desmethyl	Not Screened	5
168	Novaluron	4.8	5
169	Omethoate	0.2	50
170	Oxamyl	0.2	10
171	Oxamyl oxime	1.2	Not Screened
172	Oxyfluorfen	Not Screened	25
173	Parathion	Not Screened	25
174	Parathion methyl	Not Screened	25
175	Penconazole	Not Screened	2
176	Pendimethalin	25	25
177	Penthiopyrad	Not Screened	2
178	Permethrin	5	25
179	Phenothrin	2.5	100
180	Phophamidon-b	25	Not Screened
181	Phorate	25	50
182	Phosalone	Not Screened	25
183	Phosmet	25	50
184	Phosmet OA	Not Screened	1
185	Picoxystrobin	Not Screened	2
186	Piperonyl butoxide	Not Screened	3
187	Pirimiphos-ethyl	0.2	Not Screened
188	Pirimiphos-methyl	25	Not Screened
189	Prallethrin	10	13

#	Analyte	MDA Limit of Detection*	USDA Limit of Detection*
190	Prodiamine	Not Screened	20
191	Profenofos	Not Screened	5
192	Prometon	25	3
193	Prometryn	Not Screened	3
194	Pronamide	Not Screened	25
195	Propachlor	25	13
196	Propanil	Not Screened	5
197	Propargite	Not Screened	3
198	Propazine	25	5
199	Propetamphos	Not Screened	5
200	Propiconazole	Not Screened	5
201	Propoxur	0.4	Not Screened
202	Pymetrozine	Not Screened	250
203	Pyraclostrobin	Not Screened	3
204	Pyridaben	0.16	3
205	Pyrofluquinazon	0.2	Not Screened
206	Pyrimethanil	Not Screened	5
207	Pyriproxyfen	Not Screened	3
208	Quinoxyfen	Not Screened	2
209	Quintozine	Not Screened	5
210	Resmethrin	5	500
211	Sethoxydim	Not Screened	3
212	Simazine	25	20
213	Spinetoram J	1.2	Not Screened
214	Spinetoram L	4	Not Screened
215	Spinosad A	0.4	Not Screened
216	Spinosad D	4	Not Screened
217	Spirodiclofen	Not Screened	4
218	Spiromesifen	Not Screened	38
219	Spirotetramat	Not Screened	3
220	Sulfotep	25	Not Screened
221	Sulfoxaflor	0.2	10

#	Analyte	MDA Limit of Detection*	USDA Limit of Detection*
222	Tebuconazole	Not Screened	25
223	Tebufenozide	0.04	1
224	Tebuthiuron	Not Screened	3
225	Tefluthrin	5	5
226	Terbufos	25	Not Screened
227	Tetraconazole	Not Screened	5
228	Tetradifon	Not Screened	10
229	Tetramethrin	5	125
230	Thiabendazole	Not Screened	5
231	Thiacloprid	0.2	3
232	Thiamethoxam	0.2	10
233	THPI	Not Screened	125
234	Thymol	Not Screened	25
235	Tioxazafen	16	Not Screened
236	Tolfenpyrad	0.4	3
237	Triadimefon	Not Screened	8
238	Triadimenol	Not Screened	25
239	Triallate	25	Not Screened
240	Triazophos	Not Screened	2
241	Tribufos	Not Screened	13
242	Trifloxystrobin	Not Screened	1
243	Triflumizole	Not Screened	2
244	Trifluralin	25	13
245	Triticonazole	Not Screened	15
246	Vinclozolin	Not Screened	5

Detection limits are calculated based on the instrumental minimum detectable amount.

* The detection limit was estimated based on the spike response.