September 2018

DEPARTMENT OF AGRICULTURE

Summary of MDA Pesticide Bee Kill Complaint Investigations in 2017

Background

Under Minnesota Statutes, Chapter 18D.201, the Minnesota Department of Agriculture (MDA) is the state agency responsible for the investigation of bee kills alleged to be caused by pesticides. The MDA's Pesticide and Fertilizer Management Division conducts the investigations.

Effective July 01, 2014, the Minnesota Legislature appropriated $150,000 per fiscal year from the pesticide regulatory account to pay compensation claims for bees killed by pesticide. In any fiscal year, a bee owner must not be compensated for a claim that is less than $100 or compensated more than $20,000 for all eligible claims.

Effective August 01, 2015, the Minnesota Legislature added a provision that requires a bee owner to be registered with a commonly utilized pesticide registry program, as designated by the commissioner. The Commissioner of Agriculture has designated Beecheck, https://beecheck.org/, a voluntary hive mapping registry administered by FieldWatch.

Details

In order for the MDA to respond to an alleged pesticide bee kill, complaints must be reported in writing to the Pesticide and Fertilizer Management Division. A written complaint can be completed and submitted online at http://www.mda.state.mn.us/chemicals/pesticides/complaints/misusecomplaints.aspx

Upon receipt of a written complaint, the MDA sends a team of pesticide investigators with training in pesticide investigations, bee handling/colony assessment to the site where the dead bees are located.

Samples of live/dead bees and other materials are taken to determine 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 through contacting pesticide dealers, growers and applicators in the area.

The MDA Laboratory Services Division is a State Federal Insecticide Fungicide Rodenticide Act (FIFRA) laboratory and analyzes MDA samples for pesticide residues. Samples may also be analyzed by the USDA Lab in Gastonia, Maryland lab under contract to the MDA.

The University of Maryland evaluates honey bee samples for the mite, *Varroa destructor*, known to vector viruses, reduce bee longevity, and the fungal pathogen *Nosema* spp. that invades a bee's gut causing adverse effects. The Maryland lab also analyzes honey bees for a set of viruses that cause adverse effects.

Once analytical results are received by the Pesticide and Fertilizer Management Division, the MDA confers internally regarding all evidence collected and attempts to determine the cause of the bee kill as well as provide an underlying assessment of colony health. Individual investigation summaries are created for each bee kill.

For 2017 bee kill investigations, the MDA used a working definition of an "acute pesticide poisoning" intended to capture acute pesticide effects to honey bee colonies at different developmental stages. The MDA evaluates an "acute pesticide poisoning" based on the presence of non-beekeeper applied pesticide residues present in dead bees, the number of frames of bees (a measure of a honey bee colonies 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 3 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 quantified 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 10 or more frames of bees at the time of investigation, a maximum of 1,000 dead bees need to be quantified to be considered an "acute pesticide poisoning".

If it can be demonstrated that pesticides are likely to have caused an "acute pesticide poisoning" and the apiary is in compliance with the pesticide registry program requirements, the MDA considers the following compensation options:

- If the person who applied the pesticide can be identified, and did so in a manner inconsistent with the pesticide product's label or labeling, the MDA may issue an enforcement action against the applicator that includes a financial penalty sufficient to compensate the beekeeper;

- If the person who applied the pesticide can be identified, and did so in a manner consistent with the pesticide product's label or labeling, then compensation to the beekeeper may be made from the pesticide regulatory account; or

- If an applicator cannot be identified, the MDA may compensate the beekeeper from the pesticide regulatory account.

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

Attachments

- Summaries for the 5 pesticide bee kill complaints and the MDA's findings for 2017
- Terms and Definitions
- Pesticide Analyte Lists Used in Bee Kill Investigations

Program Contacts

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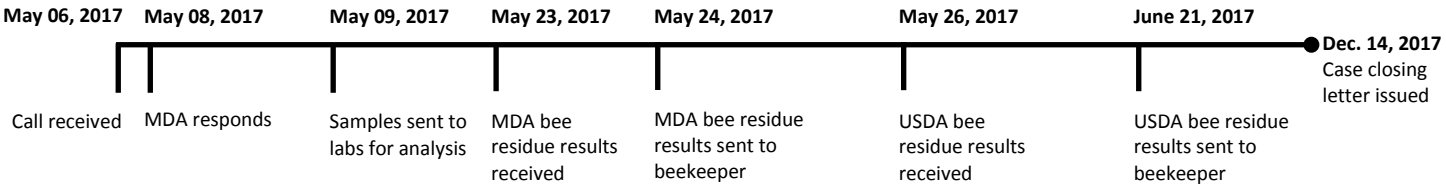
Grant County, Barrett **Case File Number: PTH101077775**

Received date: May 06, 2017



Background of Complaint and Minnesota Department of Agriculture (MDA) Response

- On April 25, 2017, a commercial beekeeper brought colonies overwintered out-of-state back to an apiary in Minnesota where colonies were fed 1 gallon of sucrose solution.
- The apiary was recessed into a stand of trees with one side open and near two agricultural fields planted to corn and soybean.
- On May 06, 2017, the beekeeper observed dead bees being removed from hives and bees in front of the hives on their backs with legs frantically moving.
- MDA Agricultural Chemical Investigators (ACI) along with an MDA Pesticide Technical Unit (PTU) staff entomologist responded on May 08, 2017.
- Investigators examined 4 colonies in the apiary and corroborated abnormally high mortality in front of all colonies, uncoordinated movement of bees, and the removal/ejection of larvae and dead bees from colonies.
- Using the 4 examined colonies, hive health samples were collected and combined to form composite samples used to evaluate colony stress from *Varroa*, *Nosema*, and common viruses.
- Using the same 4 colonies, frames of bees, brood pattern, and observations of disease were made.

The MDA obtained composite samples for pesticide residue analysis using the same colonies selected to evaluate hive health. Composite samples included live bees taken from frames consisting of nectar and pollen, and dead bees located in front of sampled colonies.

MDA Colony Health Findings

- Colonies contained a mean of 16.5 to 17 frames of bees, indicating that a 1,000 dead bee threshold would be used as guidance to indicate an acute pesticide poisoning.
- Colonies had sustained an estimated population loss of 405 to 540 dead bees in and around hive entrances.
- Colonies had a brood pattern of either 2 or 3 out of a possible score of 5.
- No signs of disease were present in any of the colonies evaluated.
- Results from the *Varroa* samples showed 0.29 and 0.33 *Varroa* mites/100 bees indicating a level of pressure below the recommended treatment threshold of 3 mites/100 bees.
- Individual bees tested for *Nosema* were found to have between 0.55 and 1.5 million *Nosema* spores/bee.
- Viral RNA was quantified in colonies sampled and compared to national baselines. Result indicated viral pathogens Black Queen Cell Virus, Lake Sinai Virus, and *Nosema* spp. were prevalent at high levels in comparison to baseline averages.

MDA Pesticide Findings

- In April 2017, colonies were treated with the active ingredient formic acid, formulated as Mite Away Quick Strips for control of *Varroa* mites.
- Pesticide analyses were carried out at the MDA and USDA Labs.
- MDA laboratory pesticide results found detectable residues of thiamethoxam (an insecticide) at 0.24 ppb in one dead bee sample and at 0.48 ppb in one live bee sample. Clothianidin residues (an insecticide and primary breakdown product of thiamethoxam) were present in both dead bee samples at 0.79 and 1.02 ppb.
- USDA laboratory pesticide results found trace amounts of clothianidin (an insecticide) indicating that clothianidin was present below 15 ppb, USDA's level of quantification. This result corroborates MDA findings of clothianidin at relatively low levels, near or below 1 ppb. All live and dead bee samples analyzed by USDA were found to contain thymol (a miticide) between 57 and 206 ppb.
- Investigation follow-up determined that the soybean field had been planted with seed treated with a Gaucho product containing an insecticide, imidacloprid, not detected in/on live or dead bees. The farmer planting the corn field denied investigators request for information related to seed treatment products applied.
- The beekeeper stated that dandelion, wild plum, elderberry and creeping charlie were all in bloom at the time the incident occurred. Investigators collected foliage samples at the apiaries edge and from flowers (one sample dandelion and one sample wild plum) between the apiary and the two fields planted with row crops. However, because treated seed is exempt from pesticide requirements under FIFRA, alleged fugitive seed dust containing an active ingredient and moving onto flowering plants or into apiaries is not considered illegal. For this reason foliage samples were not analyzed.

Laboratory Results

Laboratory	Active Ingredient (Analytical Lab's Level of Detection)	Quantified sample concentration (µg/kg)				Honey bee Acute LD_{50} (µg/kg = parts per billion [ppb])
		Affected dead bees (set 1)	Affected dead bees (set 2)	Affected live bees (set 1)	Affected live bees (set 2)	
		(Percent of acute oral benchmark)**				
MDA	Clothianidin (0.08 ppb)	1.02 (6.9%)	0.79 (5.3%)	<LOD*	<LOD*	(Oral: 37.0 ppb; Contact: 275 ppb)[1]
USDA	Clothianidin (15.0 ppb)	Trace <LOQ*	<LOQ*	<LOQ*	<LOQ*	(Oral: 37.0 ppb; Contact: 275 ppb)[1]
MDA	Thiamethoxam (0.16 ppb)	<LOD*	0.24 (2.3%)	0.48 (4.5%)	<LOD*	(Oral: 26.5 ppb; Contact: 160 ppb)[1]
USDA	Thiamethoxam (10.0 ppb)	<LOQ*	<LOQ*	<LOQ*	<LOQ*	(Oral: 26.5 ppb; Contact: 160 ppb)[1]
MDA	Thymol (Not Screened***)					(Not established by EPA)[2]
USDA	Thymol (50.0 ppb)	75 (NA)	206 (NA)	57 (NA)	190 (NA)	(Not established by EPA)[2]

* If USDA laboratory sample, analyte is not present at the level of quantification (LOQ); if MDA laboratory sample, analyte is not present at the level of detection (LOD).

** Benchmark = EPA's toxicity value x the Level of Concern (LOC). Where 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 is lower, and the LOC is 0.4. Laboratory results are divided by the benchmark and expressed as a percentage.

*** A term used to denote a difference in laboratory analytical methodologies which limit a laboratories ability to search for a particular pesticide.

[1] Preliminary Bee Risk Assessment to Support the Registration Review of Clothianidin and Thiamethoxam. DP Barcode: 437097. USEPA. January 05, 2017.

[2] Thymol Summary Document: Registration Review. March 2010.

Investigation Conclusions

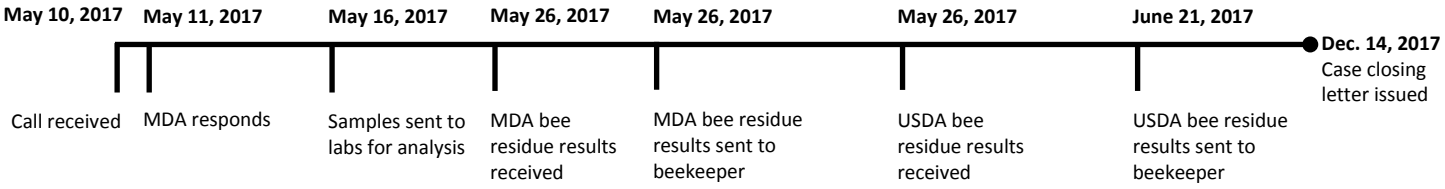
- Two insecticides, thiamethoxam and clothianidin, were found in dead bees at relatively low levels (maximum residue quantified 1.02 ppb or 6.9% of EPA's level of concern). However, additional consideration should be given to residues quantified below 10 ppb, as these values are normally associated with a larger margin of error due to the current analytical techniques available to the scientific community.
- Pesticide treatments made to soybean seed and planted in a nearby field were not detected in the analyzed live or dead bees from the affected apiary. While the pesticide application history for the nearby corn field was not made available to investigators, pesticide application to corn seed is a common practice and often includes the application of either insecticide, thiamethoxam or clothianidin, which were detected in the affected bees.
- Despite the relatively low residues of two insecticides, thiamethoxam and clothianidin, found on/in dead bees it is likely that these insecticides acted as a stressor and therefore contributed either directly or indirectly to the observed bee mortality.
- When the case was closed, results were reported to the EPA.

Compensation

Because the beekeeper was not registered with BeeCheck before the observed mortality and due to an insufficient number of dead bees quantified by investigators, this incident is not considered an acute pesticide poisoning as defined by the MDA and is not eligible for compensation.

Grant County, Barrett **Case File Number: PTH101077817**

Received date: May 10, 2017



Background of Complaint and Minnesota Department of Agriculture (MDA) Response

- On May 01, 2017, a commercial beekeeper brought colonies overwintered out-of-state back to an apiary in Minnesota where colonies were fed 1 gallon of sucrose solution.
- The apiary was located along two hedgerows of small trees and buffered on the east and west side by fields planted to grass. However, fields located to the north and south were planted to soybean.
- On May 10, 2017 the beekeeper observed large piles of dead bees in front of all 40 colonies, dead bees being carried away from colonies, and a few live bees outside colonies displaying abnormal behavior.
- MDA Agricultural Chemical Investigators (ACI) along with an MDA Pesticide Technical Unit (PTU) staff entomologist responded on May 11, 2017.
- Investigators examined 4 colonies and corroborated abnormally high mortality in front of all colonies, uncoordinated movement of bees, and the removal of dead bees from colonies.
- Using the 4 examined colonies, hive health samples were collected and combined to form composite samples used to evaluate colony stress from *Varroa*, *Nosema*, and common viruses.
- Using the same 4 colonies, frames of bees, brood pattern, and observations of disease were made.

The MDA obtained composite samples for pesticide residue analysis using the same colonies selected to evaluate hive health. Composite samples included live bees taken from frames consisting of nectar and pollen, and dead bees located in front of sampled colonies.

MDA Colony Health Findings

- Colonies evaluated contained between 7 and 21 frames of bees, indicating that a 700 to 1,000 dead bee threshold would be used as guidance to indicate an acute pesticide poisoning depending on the colony being evaluated.
- Colonies had sustained a minimum quantifiable population loss of >1,000 dead bees in and around hive entrances.
- Colonies had a brood pattern of either 2 or 3 out of a possible 5.
- No signs of disease were present in any of the colonies evaluated.
- Results from *Varroa* samples showed 0.33 and 0.64 mites/100 bees indicating a level of pressure below the recommended treatment threshold of 3 mites/100 bees.
- Individual bees tested for *Nosema* were found to have 4.2 and 5.7 million *Nosema* spores/bee.
- Viral RNA was quantified in colonies sampled and compared to national baselines. Result indicated the viral pathogens Lake Sinai Virus, and *Nosema* spp. were prevalent at high levels in comparison to baseline averages.

MDA Pesticide Findings

- Colonies had been treated in April, 2017 with formic acid formulated as Mite Away Quick Strips.
- Pesticide analyses were carried out at the MDA and USDA Labs.
- MDA laboratory pesticide results found one insecticide, clothianidin, in dead bees at concentrations up to 2.53 ppb and in one live bee sample at a concentration of 0.20 ppb. Clothianidin is a systemic insecticide registered for the control of a wide range of insects in field crops and is registered for use as seed treatment product.
- USDA laboratory pesticide results corroborated the presence of clothianidin residues in dead bee samples finding concentrations of 16 and 18 ppb. Cyprodinil, difenoconazole, iprodione, carbendazim, and methoxyfenozide are all fungicides registered for use in almond and were either found in live or dead bees at low levels ranging from <5 ppb to 618 ppb with the most sensitive endpoint being carbendazim with an LD_{50} of 500,000 ppb. All live and dead bee samples analyzed by USDA were found to contain thymol (a miticide) between 87 and 1,830 ppb. Thymol is a registered active ingredient used for control of *Varroa* mite by beekeepers and is not expected to contribute to the observed mortality at the concentrations quantified.
- Investigators identified the farmer who planted the nearby soybean fields. The farmer stated that the soybean seed was not treated with any pesticide before planting.
- Because nearby fields were found not to be treated with pesticides before planting and given that treated seed is exempt from pesticide requirements under FIFRA, alleged fugitive seed dust containing an active ingredient and moving onto flowering plants or into apiaries is not considered illegal. For these reasons foliage samples were not analyzed.

Laboratory Results

Laboratory	Active Ingredient (Analytical Lab's Level of Detection)	Quantified sample concentration (µg/kg)				Honey bee Acute LD_{50} (µg/kg = parts per billion [ppb])
		Affected dead bees (set 1)	Affected dead bees (set 2)	Affected live bees (set 1)	Affected live bees (set 2)	
		(Percent of acute benchmark)**				
MDA	Clothianidin (0.08 ppb)	1.79 (12.1%)	2.53 (17.1%)	0.20 (1.4%)	<LOD*	(Oral: 37.0 ppb; Contact: 275 ppb)[1]
USDA	Clothianidin (15.0 ppb)	16 (108.1%)	18 (121.6%)	<LOQ*	<LOQ*	(Oral: 37.0 ppb; Contact: 275 ppb)[1]
MDA	Carbendazim (Not Screened***)					(Oral: NA; Contact: >500,000 ppb)[2]
USDA	Carbendazim (5.0 ppb)	<LOQ*	Trace <LOQ*	<LOQ*	<LOQ*	(Oral: NA; Contact: >500,000 ppb)[2]
MDA	Cyprodinil (Not Screened***)					(Oral: NA; Contact: >7,840,000 ppb)[3]
USDA	Cyprodinil (10.0 ppb)	<LOQ*	34 (<0.00001%)	<LOQ*	13 (<0.000004%)	(Oral: NA; Contact: >7,840,000 ppb)[3]
MDA	Difenoconazole (Not Screened***)					(Oral: NA; Contact: >1,000,000 ppb)[4]
USDA	Difenoconazole (10.0 ppb)	<LOQ*	Trace <LOQ*	<LOQ*	Trace <LOQ*	(Oral: NA; Contact: >1,000,000 ppb)[4]
MDA	Iprodione (Not Screened***)					(No acceptable studies available)[5]
USDA	Iprodione (50.0 ppb)	618 (NA)	349 (NA)	218 (NA)	162 (NA)	(No acceptable studies available)[5]
MDA	Methoxyfenozide (Not Screened***)					(Oral: NA; Contact: >1,000,000 ppb)[6]
USDA	Methoxyfenozide (5.0 ppb)	Trace <LOQ*	<LOQ*	<LOQ*	<LOQ*	(Oral: NA; Contact: >1,000,000 ppb)[6]
MDA	Thymol (Not Screened***)					(Not established)[7]
USDA	Thymol (50.0 ppb)	87 (NA)	447 (NA)	188 (NA)	1,830 (NA)	(Not established)[7]

* If USDA laboratory sample, analyte is not present at the level of quantification (LOQ); if MDA laboratory sample, analyte is not present at the level of detection (LOD).

** Benchmark = EPA's toxicity value x the Level of Concern (LOC). Where 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 is lower, and the LOC is 0.4. Laboratory results are divided by the benchmark and expressed as a percentage.

*** A term used to denote a difference in laboratory analytical methodologies which limit a laboratories ability to search for a particular pesticide.

1 Preliminary Bee Risk Assessment to Support the Registration Review of Clothianidin and Thiamethoxam. DP Barcode: 437097. USEPA. January 05, 2017.

2 Preliminary Problem Formulation for the Environmental Fate, Ecological Risk, Endangered Species, and Human Health Drinking Water Exposure Assessments in Support of the Registration Review of Thiphanate Methyl and Carbendazim. DP Barcode: D480778. USEPA. March 18, 2014.

3 Preliminary Environmental Fate, Ecological Risk, for the Registration Review of Cyprodinil. DP Barcode: 426740. USEPA. December 20, 2016.

4 Difenoconazole: Preliminary Problem Formulation for Environmental Fate, Ecological Risk, Endangered Species, and Drinking Water Exposure Assessments in Support of Registration Review. DP Barcode: 428500. USEPA. November 5, 2015.

5 Registration Review: Preliminary Problem Formulation for Ecological Risk and Environmental Fate, Endangered Species, and Drinking Water Assessments for Iprodione. DP Barcode: D402502. USEPA. Decemeber 6, 2012.

6 Registration Review: Preliminary Problem Formulation for Environmental Fate, Ecological Risk, Endangered Species, and Human Health Drinking Water Exposure Assessments for Methoxyfenoxide. DP Barcode: D404482. April 25, 2013.

7 Thymol Summary Document: Registration Review. March 2010.

Investigation Conclusions

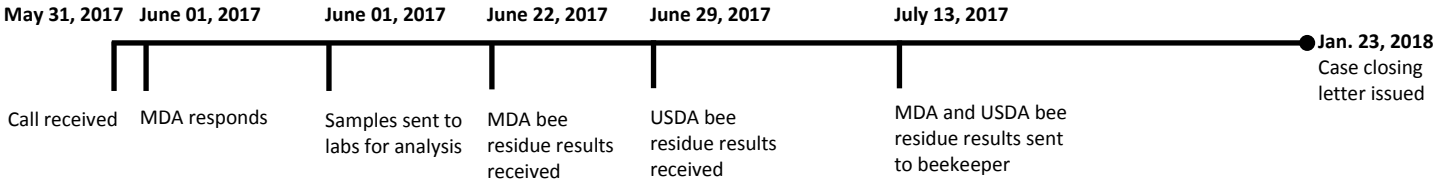
- In early May, clothianidin is known to be associated with the planting of some treated seeds. However, given that the closest fields had not been treated with clothianidin, exposure is presumed to have occurred at some unidentified site further away from the apiary.
- Clothianidin was found in all dead bee samples and was quantified at relatively high levels, maximum concentration 18 ppb or 121.6% of EPA's level of concern.
- Because clothianidin exceeded EPA's level of concern and investigators quantified over 1,000 dead bees per colony it is likely that clothianidin acted as a stressor and therefore contributed either directly or indirectly to the observed bee mortality. These criteria meet MDA's definition for an acute pesticide poisoning.
- When the case was closed, results were reported to the EPA.

Compensation

Because the beekeeper was not registered with BeeCheck before the incident, the beekeeper did not qualify for compensation. While the beekeeper does not qualify for compensation due to statutory requirements, the incident is considered an acute pesticide poisoning both because of the number of dead bees present in front of hives as well as pesticide concentrations in dead bees exceeding EPA's level of concern.

Carver County, Chaska **Case File Number: AJM101078372**

Received date: May 31, 2017



Background of Complaint and Minnesota Department of Agriculture (MDA) Response

- A hobby beekeeper had overwintered 26 colonies and installed 12 colonies from packages in the affected apiary in early spring. The newly installed colonies were fed sugar syrup throughout the spring.
- The apiary was located on private property across the road from a field planted to corn and adjacent to a pasture which was bordered by a stand of trees.
- On May 31, 2017, the beekeeper noticed lots of dead bees on the ground in front of the 2 hives, estimating a population loss of approximately 10% of each hive and a few twitching bees outside hive entrances.
- MDA Agricultural Chemical Investigators (ACI) along with an MDA Pesticide Management Unit (PMU) staff entomologist responded on June 01, 2017.
- Investigators examined 4 colonies and confirmed the reported mortality in front of colonies considered most affected. Colonies evaluated were separated by level of mortality observed with two considered less affected and two considered more affected.
- Using the 4 examined colonies, hive health samples were collected and combined by level affected (less or more) to form composite samples used to evaluate colony stress from *Varroa*, *Nosema*, and common viruses.
- Using the same 4 colonies, frames of bees, brood pattern, and observations of disease were made.

The MDA obtained composite samples for pesticide residue analysis using the same colonies selected to evaluate hive health. Composite samples included live bees taken from frames consisting of nectar and pollen, and dead bees located in front of colonies considered more or less affected.

MDA Colony Health Findings

- Colonies contained a mean of 3 to 10 frames of bees indicating that, depending on the colony, a range of 300 to 1,000 dead bees in or near hive entrances would be used as guidance to indicate an acute pesticide poisoning.
- Colonies considered more affected sustained a minimum quantifiable population loss of 270 dead bees in and around hive entrances (cumulative loss of 1,350 dead bees in front of the 5 most affected colonies). For colonies considered less affected, a loss of 400 dead bees was quantified from the rest of the apiary.
- Both colonies considered more affected and less affected had a colony with a brood pattern of 1 and 3 out of a possible 5.
- One of the less affected colonies was observed to have chalk brood, a common spring fungal pathogen, and a small number of hive beetles, while the remaining colonies evaluated appeared to be free from disease.
- Results from the *Varroa* samples showed 0 and 1.9 *Varroa* mites/100 bees indicating a level of pressure below the recommended treatment threshold of 3 mites/100 bees.
- Individual bees tested for *Nosema* were found to have an average of 0.8 and 1.4 million *Nosema* spores/bee.
- Viral RNA was quantified in colonies sampled and compared to national baselines. Result indicated that viruses were not present at levels considered high when compared to baseline averages.

MDA Pesticide Findings

- Colonies in the apiary were treated with an oxalic acid product, not formulated for use in honey bee hives, every 5-7 days in April for control of *Varroa* mite over the course of 4 weeks.
- Pesticide analyses were carried out at the MDA and USDA Labs.
- MDA laboratory pesticide results found detectable residues of two insecticides clothianidin and carbaryl at low levels in dead bees. The colonies considered more affected had clothianidin present at 0.2 ppb while colonies considered less affected had clothianidin present at 0.08 ppb. For carbaryl, colonies considered less affected had insecticide present at 0.08 ppb while colonies considered more affected had residues below the level of detection indicating the insecticide was present <0.08 ppb. Less affected colonies also had quantifiable levels of a miticide used to treat *Varroa* mite in honey bee colonies. The miticide amitraz had two common degradates, DMPF and DMPMF, present at 2.12 and 2.32 ppb, respectively.
- USDA laboratory pesticide results found no quantifiable levels of any pesticide screened in dead or live bees. Given the low concentrations quantified by MDA's lab, the differences observed are likely due to different analytical methods used by the USDA lab resulting in different limits of detections.
- Neighboring landowners, two golf courses, and the Minnesota Landscape Arboretum were interviewed regarding pesticide applications made in 2017 and while pesticides had been used, none matched the active ingredients identified by the laboratory analysis. The field planted to corn was at the 2-leaf stage, indicating that planting had occurred several weeks earlier.
- A foliage sample was taken near the most affected colonies; however, the plant foliage was not analyzed due to follow-up with applicators which showed the pesticides of concern had not recently been used as part of a pesticide application.

Laboratory Results

Laboratory	Active Ingredient (Analytical Lab's Level of Detection)	Quantified sample concentration (µg/kg)				Honey bee Acute LD_{50} (µg/kg = parts per billion [ppb])
		Most affected hives dead bees	Less affected hives dead bees	Most affected hives live bees	Less affected hives live bees	
		(Percent of acute oral benchmark)**				
MDA	Amitraz DMPF (0.8 ppb)	<LOD	2.12 (<0.0005%)	<LOD	<LOD	(Metabolite LD_{50} unknown; Parent > 1,000,000 ppb)[1]
USDA	Amitraz DMPF (5.0 ppb)	<LOQ	<LOQ	<LOQ	<LOQ	
MDA	Amitraz DMPMF (1.2 ppb)	<LOD	2.32 (<0.0006%)	<LOD	<LOD	(Metabolite LD_{50} unknown; Parent > 1,000,000 ppb)[1]
USDA	Amitraz DMPMF (Not Screened)***					
MDA	Carbaryl (0.08 ppb)	<LOD	0.08 (0.02%)	<LOD	<LOD	(Oral: 1,000 ppb; Contact: 11,000)[2]
USDA	Carbaryl (2.0 ppb)	<LOQ	<LOQ	<LOQ	<LOQ	(Oral: 1,000 ppb; Contact: 11,000)[2]
MDA	Clothianidin (0.08 ppb)	0.2 (1.3%)	0.08 (0.5%)	<LOD	<LOD	(Oral: 37.0 ppb; Contact: 275 ppb)[3]
USDA	Clothianidin (15.0 ppb)	<LOQ	<LOQ	<LOQ	<LOQ	(Oral: 37.0 ppb; Contact: 275 ppb)[3]

* If USDA laboratory sample, analyte is not present at the level of quantification (LOQ); if MDA laboratory sample, analyte is not present at the level of detection (LOD).

** Benchmark = EPA's toxicity value x the Level of Concern (LOC). Where 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 is lower, and the LOC is 0.4. Laboratory results are divided by the benchmark and expressed as a percentage.

*** A term used to denote a difference in laboratory analytical methodologies which limit a laboratories ability to search for a particular pesticide.

[1] Registration Review – Preliminary Problem Formulation for Ecological Risk and Environmental Fate, Endangered Species, and Drinking Water assessment for Amitraz. USEPA. January 7, 2010.

[2] Revised EFED Risk Assessment of Carbaryl in Support of the Reregistration Eligibility Decision. DP Barcode: D288451. USEPA. March 18, 2003.

[3] Preliminary Bee Risk Assessment to Support the Registration Review of Clothianidin and Thiamethoxam. DP Barcode: 437097. USEPA. January 05,2017.

Investigation Conclusions

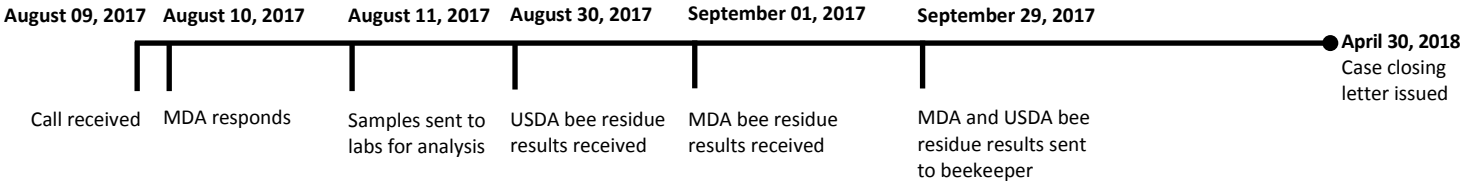
- Two highly toxic bee insecticides were detected at relatively low levels, clothianidin present up to 0.2 ppb (1.3% of EPA's level of concern), and carbaryl present at even lower levels, 0.08 ppb (0.02% of EPA's level of concern). However, some amount of degradation may have occurred since the exposure began and before samples were collected and additional considerations should be given to residues quantified below 10 ppb, as these values are normally associated with a larger margin of error due to the current analytical techniques available to the scientific community.
- While surrounding landowners were interviewed and determined to have made pesticide applications, none related to the active ingredients detected in dead bees from the affected apiary.
- Despite the low residues of clothianidin and carbaryl found on/in dead bees and presence of chalk brood and hive beetles observed in one colony, the apiary in general appeared to be in relatively good health (low *Varroa* and viruses). It is possible that clothianidin and carbaryl may have acted as a stressor toward colonies and therefore contributed either directly or indirectly to the observed bee mortality.
- When the case was closed, results were reported to the EPA.

Compensation **–**

Because an insufficient number of dead bees were quantified per colony and because pesticide residues detected did not reach EPA's level of concern this case was not considered an acute pesticide poisoning and is therefore not eligible for compensation.

Pope County, near Forada **Case File Number: PTH101079130**

Received date: August 09, 2017



Background of Complaint and Minnesota Department of Agriculture (MDA) Response

- On June 01, 2017 a commercial beekeeper brought colonies overwintered in California back to an apiary in Minnesota and fed sugar syrup upon becoming established.
- The apiary was recessed on three sides into a densely wooded area and bordered a gravel road toward the South.
- On August 08, 2017, the beekeeper observed two aerial applications taking place to the NE and SE of the apiary and a ground rig refueling ¼ mile away. When the beekeeper arrived at the apiary they noticed dead and twitching bees in front of colonies, extreme agitation of workers, and a large decrease in colony populations.
- MDA Agricultural Chemical Investigators (ACI) along with an MDA Pesticide Technical Unit (PTU) staff entomologist responded on August 10, 2017.
- Investigators examined 4 colonies considered affected by the beekeeper and confirmed symptoms and mortality reported by the beekeeper.
- Using the 4 examined colonies, hive health samples were collected and combined to form composite samples used to evaluate colony stress from *Varroa*, *Nosema*, and common viruses.
- Using the same 4 colonies, frames of bees, brood pattern, and observations of disease were made.

The MDA obtained composite samples for pesticide residue analysis using the same colonies selected to evaluate hive health. Composite samples included live bees taken from frames consisting of nectar and pollen, and dead bees located in front of sampled colonies.

MDA Colony Health Findings

- Colonies contained a mean of either 10 or 15 frames of bees, indicating that a 1,000 dead bee threshold would be used as guidance to indicate an acute pesticide poisoning.
- Colonies had sustained a minimum quantifiable population loss between 567 and 837 dead bees in and around hive entrances.
- Three of the colonies evaluated had a brood pattern of either 3 or 4 out of a possible 5, while one colony had a brood pattern of 0 indicating no brood was present in the colony.
- No signs of disease were present in evaluated colonies.
- Results from the *Varroa* samples showed 1.4 mites/100 bees and 2.52 mites/100 bees indicating a level of pressure below or nearing the recommended treatment threshold of 3 mites/100 bees.
- Individual bees tested for *Nosema* were found to have an average of between 0.0 and 0.15 million *Nosema* spores/bee.
- Viral RNA was quantified in colonies sampled and compared to national baselines. Results indicated that viruses were not present at levels considered high when compared to baseline averages.

MDA Pesticide Findings

- Upon becoming established in the Minnesota apiary, colonies were treated with thymol for control of *Varroa* mite.
- Pesticide analyses were carried out at the MDA and USDA Labs.
- MDA laboratory pesticide results found two insecticides, bifenthrin and chlorpyrifos at high levels up to 351 ppb in dead bees while chlorpyrifos was found at lower concentrations up to 14 ppb in dead bees and up to 8.9 ppb in live bees. Miticide degradates were detected in dead and live bees at 26.3 ppb while amitraz DMPMF was detected up to 16 ppb. Amitraz, used for control of varroa mites, is not expected to contribute to the observed bee mortality at the levels detected.
- USDA laboratory pesticide results corroborated the presence of the same two insecticides (bifenthrin and chlorpyrifos) and another amitraz degradate (amitraz DMPF). The insecticide bifenthrin was found at high levels up to 510 ppb in dead bees while chlorpyrifos was found at a concentration of 46 ppb in dead bees. The miticide degradate amitraz DMPF was detected at a trace amount, below the level of quantification.
- Due to the close proximity of the soybean field, a foliage sample was collected at the edge of the apiary. However, inspector follow up with the 3 known commercial applicator operations working in the area only found applications of bifenthrin made as close as 4.5 miles away from the apiary at around the time of the observed mortality. Foliage analysis was not conducted because no responsible party could be identified and analysis of dead bees provided enough information to conclude the reason for mortality.

Laboratory Results

Laboratory	Active Ingredient (Analytical Lab's Level of Detection)	Quantified sample concentration (µg/kg)				Honey bee Acute LD_{50} (µg/kg = parts per billion [ppb])
		Affected dead bees (set 1)	Affected dead bees (set 2)	Affected live bees (set 1)	Affected live bees (set 2)	
		(Percent of acute contact benchmark)**				
MDA	Amitraz 2,4-DMA (12.0 ppb)	<LOD*	26.3 (<0.007%)	<LOD*	<LOD*	(Metabolite LD_{50} unknown; Parent > 1,000,000 ppb)[1]
USDA	Amitraz 2,4-DMA (Not Screened***)					
MDA	Amitraz DMPF (0.8 ppb)	<LOD*	<LOD*	<LOD*	<LOD*	(Metabolite LD_{50} unknown; Parent > 1,000,000 ppb)[1]
USDA	Amitraz DMPF (5.0 ppb)	<LOQ*	Trace <LOQ*	<LOQ*	<LOQ*	
MDA	Amitraz DMPMF (1.2 ppb)	4.9 (<0.001%)	16 (<0.004%)	1.4 (<0.0004%)	0.2 (<0.00005%)	(Metabolite LD_{50} unknown; Parent > 1,000,000 ppb)[1]
USDA	Amitraz DMPMF (Not Screened***)					
MDA	Bifenthrin (5.0 ppb)	351 (585%)	150 (250%)	<LOD*	<LOD*	(Oral: Not Required; Contact: 150)[2]
USDA	Bifenthrin (10.0 ppb)	390 (650%)	510 (850%)	<LOQ*	<LOQ*	(Oral: Not Required; Contact: 150)[2]
MDA	Chlorpyrifos (10.0 ppb)	14 (5.9%)	<LOD*	7.8 (3.3%)	8.9 (3.8%)	(Oral: Not Required; Contact: 590)[3]
USDA	Chlorpyrifos (20.0 ppb)	46 (19.5%)	<LOQ*	<LOQ*	<LOQ*	(Oral: Not Required; Contact: 590)[3]

* If USDA laboratory sample, analyte is not present at the level of quantification (LOQ); if MDA laboratory sample, analyte is not present at the level of detection (LOD).

** Benchmark = EPA's toxicity value x the Level of Concern (LOC). Where 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 is lower, and the LOC is 0.4. Laboratory results are divided by the benchmark and expressed as a percentage.

*** A term used to denote a difference in laboratory analytical methodologies which limit a laboratories ability to search for a particular pesticide.

[1] Registration Review – Preliminary Problem Formulation for Ecological Risk and Environmental Fate, Endangered Species, and Drinking Water assessment for Amitraz. USEPA. January 7, 2010

[2] Environmental Fate and Ecological Risk Assessment Problem Formulation in Support of Registration Review for Bifenthrin; June 09, 2010

[3] Preliminary Problem Formulation for Ecological Risk and Environmental Fate, Endangered species and Drinking Water Assessments for Chlorpyrifos. USEPA. November 25, 2008.

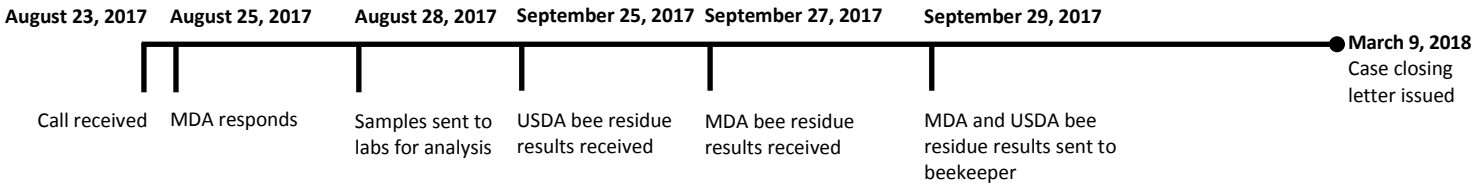
Investigation Conclusions

- Bifenthrin was detected in all dead bee samples at levels that met or exceeded EPA's acute contact LD_{50} value of 150 ppb and exceeded EPA's level of concern by as much as 850%. Another insecticide, chlorpyrifos, was also detected in dead bee samples at a concentration up to 46 ppb or 19.5% of EPA's level of concern.
- The 3 known commercial applicator operations working in the area were interviewed to determine if spraying had occurred around the time of the reported bee kill and while bifenthrin spraying had occurred, the closest identified application made was 4.5 miles away from the affected apiary.
- Colony health appeared good with levels of *Varroa*, *Nosema*, and viruses at levels considered low.
- Because bifenthrin exceeded EPA's level of concern, by as much as 8.5 times, and chlorpyrifos was found at relatively high levels (19.5% of EPA's level of concern), it is expected that bifenthrin and chlorpyrifos acted as a stressors and directly contributed to the observed bee mortality.
- When the case was closed, results were reported to the EPA.

Compensation **–** The investigation concluded that bee mortality is considered an acute pesticide poisoning based on pesticide residues exceeding EPA's level of concern in dead bees and because the beekeeper was registered with BeeCheck, the incident was eligible for compensation.

Wadena County, Aldrich **Case File Number: MWF185000089**

Received date: August 23, 2017



Background of Complaint and Minnesota Department of Agriculture (MDA) Response

- On May 20, 2017, a commercial beekeeper brought colonies overwintered in California back to an apiary in Minnesota. It was determined no supplemental feeding of syrup or pollen was needed at the time of establishment.
- The apiary was located near a stand of trees with a grass field along the south and west sides and a wheat field to the north and east.
- On August 23, 2017, the beekeeper observed colonies without queens, irregular brood patters, and up to 50% loss of colony populations.
- MDA Agricultural Chemical Investigators (ACI) along with an MDA Pesticide Technical Unit (PTU) staff entomologist responded on August 25, 2017.
- The beekeeper stated that the apiary was last visited July 15, 2017. Given that nearly 6 weeks had elapsed since the last visit, it is likely that pesticide residues and bees had degraded to some extent since the incident occurred.
- Investigators examined 2 colonies considered affected by the beekeeper and corroborated the elevated numbers of dead bees in front of some hives.
- Using the 2 examined colonies, hive health samples were collected and combined to form composite samples used to evaluate colony stress from *Varroa*, *Nosema*, and common viruses.
- Using the same 2 colonies, frames of bees, brood pattern, and observations of disease were made.

  The MDA obtained composite samples for pesticide residue analysis using the same colonies selected to evaluate hive health. Composite samples included live bees taken from frames consisting of nectar and pollen, and dead bees located in front of sampled colonies.

MDA Colony Health Findings

- Colonies contained a mean of 16.5 or 17 frames of bees, indicating that a 1,000 dead bee threshold would be used as guidance to indicate an acute pesticide poisoning.
- Colonies had sustained a minimum quantifiable population loss of between 270 and 540 dead bees in and around hive entrances.
- Colonies had a brood pattern of either 2 or 4 out of a possible 5.
- No signs of disease were present in evaluated colonies.
- Results from the *Varroa* sample showed 1.09 *Varroa* mites/100 bees indicating a level of pressure below the recommended treatment threshold of 3 mites/100 bees.
- Individual bees tested for the presence of *Nosema* were found to be free from *Nosema* spores.
- Viral RNA was quantified in colonies sampled and compared to national baselines. Results indicated that Black Queen Cell Virus and Israeli Acute Paralysis Virus were present at levels considered high when compared to baseline averages.

MDA Pesticide Findings

- Upon becoming established in the Minnesota apiary, colonies were treated with thymol for control of *Varroa* mite.
- Pesticide analyses were carried out at the MDA and USDA Labs.
- MDA laboratory pesticide results found detectable levels of an amitraz degradate in live and dead bees. The miticide degradate amitraz DMPMF was detected in dead bees at a concentration of 1.6 ppb and in live bees at a concentration 9.9 ppb. Amitraz is a registered miticide used by beekeepers to treat *Varroa* mite.
- USDA laboratory pesticide results found trace amounts of chlorpyrifos, an insecticide, at levels that could not be quantified in dead bees.
- A farmer was identified and questioned in relationship to sunflower fields in the vicinity, however no insecticides or fungicides had been used for the 2017 growing season.
- The apiary was located on untreated land planted to grass and wheat and sufficiently far from other agricultural actives to rule out drift into the apiary.

Laboratory Results

Laboratory	Active Ingredient (Analytical Lab's Level of Detection)	Quantified sample concentration (µg/kg)		Honey bee Acute LD_{50} (µg/kg = parts per billion [ppb])
		Affected dead bees (Percent of acute oral benchmark)**	Affected live bees (Percent of acute oral benchmark)**	
MDA	Amitraz DMPMF (1.2 ppb)	1.6 ppb (<0.0004%)	9.9 ppb (<0.0025%)	(Metabolite LD50 unknown; Parent > 1,000,000 ppb)[1]
USDA	Amitraz DMPMF (Not Screened***)			
MDA	Chlorpyrifos (10.0 ppb)	<LOD*	<LOD*	(Oral: Not Required; Contact: 590)[2]
USDA	Chlorpyrifos (20.0 ppb)	Trace <LOQ*	<LOQ*	(Oral: Not Required; Contact: 590)[2]

* If USDA laboratory sample, analyte is not present at the level of quantification (LOQ); if MDA laboratory sample, analyte is not present at the level of detection (LOD).

** Benchmark = EPA's toxicity value x the Level of Concern (LOC). Where 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 is lower, and the LOC is 0.4. Laboratory results are divided by the benchmark and expressed as a percentage.

*** A term used to denote a difference in laboratory analytical methodologies which limit a laboratories ability to search for a particular pesticide.

[1] Registration Review – Preliminary Problem Formulation for Ecological Risk and Environmental Fate, Endangered Species, and Drinking Water assessment for Amitraz. USEPA. January 7, 2010.

[2] Preliminary Problem Formulation for Ecological Risk and Environmental Fate, Endangered species and Drinking Water Assessments for Chlorpyrifos. USEPA. November 25, 2008.

Investigation Conclusions

- Chlorpyrifos, an insecticide, was found at trace amounts that could not be quantified. However, because there was a 6 week period between observation dates of the apiary, considerable degradation may have occurred due to rain and/or light exposure before samples were collected.
- Despite the low residues of chlorpyrifos found on/in dead bees, and given that colonies appeared to be in relatively good health (low *Varroa* and *Nosema*), it is likely that chlorpyrifos acted as a stressor and therefore contributed either directly or indirectly in the observed bee mortality.
- When the case was closed, results were reported to the EPA.

Compensation

Because an insufficient number of dead bees were quantified per colony and because pesticide residues detected did not reach EPA's level of concern, this case was not considered an acute pesticide poisoning and is therefore not eligible for compensation.

Acute Pesticide Kill – Short term exposure to a bee toxic pesticide resulting in bee death. See page 2 for how the MDA evaluates an "acute pesticide poisoning" for purposes of compensation.

Aerial Application – Fixed wing (plane) or helicopter applications of pesticides. Pilots are required to be licensed by the FAA and the MDA.

Analyte – Samples collected during an investigation for pesticide residue analysis undergo a process to identify and measure chemical constituents. The specific chemicals being looked for during this process are considered analytes.

Bee Kill Complaint – The initial information received by the MDA by a complainant who believes that the death of their bees is due to pesticides.

Brood Pattern – The distribution of a queen's egg laying and immature bees in the frames of a hive. A greater concentration of brood, immature bees, indicates less brood disease, a healthier queen, and is correlated with a higher brood pattern score (1 to 5).

Colony – The collection of a queen and all offspring (foragers, nurse bees, and drones) who co-inhabit an individual hive.

Commercial Beekeeper – Beekeepers who have hundreds to several thousand colonies. They are generally migratory and conduct pollination services for hire. Commercial beekeepers generally move their colonies out of Minnesota in winter and bring them back in late April/early May each year.

Compensation – Hive owners may receive monetary reimbursement for "acute pesticide poisonings" under Minnesota state law.

Composite Sample – A sample consisting of like material collected from multiple sources. The analytical output obtained from a composite sample are considered representative results from the multiple, like sample sources.

Enforcement Action – The MDA issues both written warnings and financial penalties to persons who the MDA alleges violated state/federal pesticide law. Financial penalties are referred to as a "Notice of Intent to Sue".

EPA – Environmental Protection Agency. The federal agency that approves the registration of pesticides.

FIFRA – The Federal Insecticide Fungicide Rodenticide Act. Pesticides are only registered by EPA when there will be no unreasonable adverse effects from the legal use of the pesticide according to label instructions.

Frames of bees – An indirect measurement of the number of bees in a colony. Frames of bees can be estimated by the number of frames, in a brood box, that are completely covered with bees on both sides. The estimate is performed by looking at the top and bottom of a brood box and averaging the number of frames covered in bees together before multiplying by an average number of bees known to cover a frame, approximately 2,400.

Hive – The unit in which a honey bee colony lives. Often, beekeepers use a Langstroth hive consisting of stackable hive boxes that are filled with removable frames.

Hobby Beekeeper – Non-migratory beekeepers that may have a single hive or up to dozens of hives who keep bees primarily for honey, pollen and other bee products.

Lethal dose to 50% of a population (LD_{50}) – Amount of pesticide (the Lethal Dose) required to kill one-half (50%) of the test organisms (e.g., bees) in controlled studies. Findings of pesticide residues at less than the LD_{50} may contribute to the death of some, but less than half of the bees that have been exposed to the pesticide.

Level of Concern (LOC) – A value used to assess the risk of an environmental exposure. For honey bees, an EPA LOC of 0.4 is used to compare the acute contact or oral risk from exposure to a pesticide.

Nosema spp. – A microsporidia, fungal, pathogen that infects the gut of honey bees resulting in accelerated behavioral development, alters feeding behavior, and can lead to other adverse effects.

Pesticide – A pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. For compensation, a bee kill resulting from use of a bee toxic pesticide is considered an acute pesticide poisoning. There are General Use pesticides which do not require a license to apply and Restricted Use pesticides which may only be applied by a licensed/certified applicator.

Pesticide Applicator – The person who applies the pesticide. The MDA maintains databases of all licensed applicators in the state.

Pesticide Dealer – A business that has a license to sell pesticides.

Pesticide Label – Any text or images printed directly on, or attached to, the product or its packaging. Pesticide product labels provide critical information about how to safely handle and use pesticide products. Many insecticide products contain directions for use which prohibit the products use when applying in areas where pollinators are present. Pesticide labels are legally enforceable under state law.

Seed Treatments – An insecticide, fungicide, or microbial treatment coating individual plant seeds to protect them against pests or impart other characteristics. A significant number of crop seeds are treated with insecticides and/or fungicides. Seeds treated with pesticides are considered treated articles and exempt from regulation under the Federal Insecticide, Fungicide, and Rodenticide Act, 7 U.S.C. §136-136y.

Treated Articles – An article or substance treated with, or containing, a pesticide to protect the treated article or substance. Articles that fall into this categorization, such as pesticide treated seeds, are exempt from all requirements of FIFRA.

Varroa destructor – A common parasitic mite of the honey bee. High numbers result in reduced vigor of honeybees/colony health. Many beekeepers treat their colonies one to four times per year for varroa mite.

Virus – An agent that causes infectious disease. Honey bees can be infected by a variety of viruses including 7 of which are analyzed for during MDA investigations.

A Note on Public Data

MDA bee kill files contain investigation details. Most information is public with the exception of information that identifies the complainant and information about pesticide applications. All requests to see investigation files must be submitted to the MDA in writing. To request a copy of an MDA investigation, contact the Data Practices and Records Manager at 651-201-6435, or fax at 651-201-6118.

#	Analyte	Limit of Detection (ppb)
1	3-OH Carbofuran	0.8
2	5-hydroxy Imidacloprid	60
3	Acephate	1.6
4	Acetamiprid	0.8
5	Acetochlor	2
6	Alachlor	5
7	Aldicarb	4
8	Aldicarb Sulfone	1.6
9	Aldicarb Sulfoxide	0.8
10	Allethrin	25
11	Amitraz 2,4-DMA	12
12	Amitraz DMPF	0.8
13	Amitraz DMPMF	1.2
14	Atrazine	2
15	Azinphos	10
16	Bendiocarb	0.8
17	Bifenazate	1.2
18	Bifenthrin	5
19	Bromophos	50
20	Carbaryl	0.08
21	Carbofuran	0.4
22	Chlorantraniliprole	1.2
23	Chlorfenvinphos	2
24	Chlorothalonil	50
25	Chlorpyrifos	10
26	Clomazone	2
27	Clothianidin	0.08
28	Coumaphos	2
29	Cyanazine	2
30	Cyantraniliprole IN-J9Z38	20
31	Cyfluthrin	5
32	Cyhalothrin	5
33	Cypermethrin	25
34	Cyphenothrin	100
35	Deltamethrin/Traloemthrin	10
36	Desethylatrazine	2
37	Desisopropylatrazine	5
38	Diazinon	2
39	Dichlorvos	5
40	Dimethenamid	2
41	Dinotefuran	0.4
42	Dinotefuran DN	1.6
43	Dinotefuran UF	1.6
44	Emamectin benzoate	1.6
45	EPTC	10

#	Analyte	Limit of Detection (ppb)
46	Esfenvalerate	10
47	Ethafluralin	100
48	Fenpropathrin	10
49	Fenthion	10
50	Fipronil	50
51	Flubendamide	2.4
52	Flumethrin	10
53	Flupyradifurone	1.6
54	Fluvalinate (tau)	10
55	Fonofos	5
56	Formatamate	1.2
57	Imidacloprid	0.8
58	Imidacloprid des nitro olefin	1.6
59	Imidacloprid HCl desnitro	1.2
60	Imidacloprid olefin	1.6
61	Imidacloprid urea	1.2
62	Imiprothrin	25
63	Malathion	2
64	Metazachlor	2
65	Methamidophos	2
66	Methidathion	10
1	Methiocarb	0.32
68	Methomyl	0.8
69	Methomyl Sulfone	1.6
70	Methomyl Sulfoxide	4
71	Methyl Parathion	50
72	Metofluthrin	10
73	Metolachlor	2
74	Metolcarb	1.2
75	Metribuzin	2
76	Mevinphos	5
77	Monocrotophos	2
78	Nithiazine	1.6
79	Omethoate	0.8
80	Oxamyl	1.2
81	Oxamyl Oxime	2
82	Pendimethalin	10
83	Permethrin	5
84	Phenothrin	5
85	Phorate	50
86	Phosmet	2
87	Phosphamidon	2
88	Pirimiphos-ethyl	2
89	Pirimiphos-methyl	2
90	Prallethrin	50*

#	Analyte	Limit of Detection (ppb)*
91	Prometon	2
92	Propachlor	2
93	Propazine	2
94	Propoxur	0.8
95	Pyrifluquinazon	1.2
96	Resmethrin	5
97	Simazine	2
98	Spinetoram J	4.8
99	Spinetoram L	24
100	Spinosad A	1.6
101	Spinosad D	4.8
102	Spirotetramat	0.4
103	Sulfotep	2
104	Sulfoxaflor Alcohol	2
105	Sulfoxaflor Sulfonyl	2
106	Sulfoxaflor Urea	2
107	Tefluthrin	5
108	Terbufos	50
109	Tetramethrin	5
110	Thiacloprid	1.2
111	Thiamethoxam	0.16
112	Thiodicarb	0.8
113	Triallate	10
114	Trifluralin	50
115	Vinclozolin	50

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

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

#	Analyte	Limit of Detection (ppb)
1	1-Naphthol	50
2	2,4 Dimethylphenyl formamide (DMPF)	5
3	2, 6-Dichlorobenzamide (BAM)	10
4	3-Hydroxycarbofuran	10
5	4-Hydroxychlorothalonil	10
6	Abamectin	100
7	Acephate	50
8	Acequinocyl	100
9	Acetamiprid	4
10	Acetochlor	15
11	Acrinathrin	20
12	Alachlor	15
13	Aldicarb	25
14	Aldicarb sulfone	15
15	Aldicarb sulfoxide	25
16	Ametoctradin	10
17	Atrazine	4
18	Azinphos methyl	50
19	Azoxystrobin	10
20	Bensulide	10
21	Bentazon	10
22	Bifenazate	10
23	Bifenthrin	10
24	Boscalid	10
25	Bromacil	20
26	Bromopropylate	20
27	Bromuconazole	10
28	Buprofezin	10
29	Captan	50
30	Carbaryl	2
31	Carbendazim	5
32	Carbofuran	10
33	Carfentrazone-ethyl	20
34	Chlorantraniliprole	15
35	Chlorfenopyr	20
36	Chlorfenvinphos	10
37	Chlorothalonil	20
38	Chlorpropham (CIPC)	10
39	Chlorpyrifos	20
40	Chlorpyrifos methyl	20
41	Clofentezine	6
42	Clothianidin	15
43	Coumaphos	3
44	Coumaphos oxon	2
45	Cyantraniliprole	25

#	Analyte	Limit of Detection (ppb)
46	Cyazofamid	30
47	Cyflufenamid	10
48	Cyflumetofen	10
49	Cyfluthrin	10
50	Cyhalothrin	10
51	Cymiazole	10
52	Cymoxanil	10
53	Cypermethrin	10
54	Cyphenothrin	100
55	Cyprodinil	10
56	Cyromazine	25
57	DCPA	20
58	DDE, p, p’	5
59	DEET	10
60	Deltamethrin	50
61	Diazinon	15
62	Diazinon oxon	5
63	Dichlorvos (DDVP)	15
64	Dicloran	20
65	Dicofol	5
66	Difenoconazole	10
67	Diflubenzuron	5
68	Dimethenamid	10
69	Dimethoate	15
70	Dimethomorph	25
71	Dinotefuran	10
72	Diphenamid	3
73	Diphenylamine	20
74	Diuron	6
75	Emamectin Benzoate	5
76	Endosulfan I	20
77	Endosulfan II	20
78	Endosulfan sulfate	20
79	Epoxiconazole	10
80	Esfenvalerate/Fenvalerate	10
81	Ethion	15
82	Ethofumesate	20
83	Ethoxyquin	10
84	Etofenprox	5
85	Etoxazole	5
86	Famoxadone	25
87	Fenamidone	30
88	Fenarimol	10
89	Fenazaquin	5
90	Fenbuconazole	15

#	Analyte	Limit of Detection (ppb)
91	Fenhexamid	10
92	Fenoxaprop-ethyl	15
93	Fenpropathrin	10
94	Fenpyroximate	4
95	Fipronil	20
96	Fipronil sulfide	5
97	Fipronil sulfone	5
98	Flonicamid	15
99	Fludioxonil	60
100	Flumethrin	100
101	Fluometuron	40
102	Fluopicolide	10
103	Fluopyram	5
104	Fluoxastrobin	5
105	Flupyradifurone	25
106	Fluridone	5
107	Flutriafol	10
108	Fluvalinate	10
109	Fluxapyroxad	10
110	Formetanate	25
111	Hexazinone	10
112	Hexythiazox	15
113	Imazalil	20
114	Imidacloprid	6
115	Indoxacarb	30
116	Iprodione	20
117	Kresoxim-methyl	10
118	Linuron	15
119	Malathion	10
120	Mandipropamide	10
121	Metalaxyl Total	5
122	Metconazole	10
123	Methamidophos	40
124	Methidathion	5
125	Methomyl	25
126	Methoprene	80
127	Methoxyfenozide	5
128	Metolachlor	5
129	Metribuzin	10
130	MGK-264	25
131	Momfluorothrin	20
132	Myclobutanil	15
133	Naled	50
134	Norflurazon	15
135	Norflurazon desmethyl	25

#	Analyte	Limit of Detection (ppb)
136	Novaluron	30
137	Omethoate	50
138	Oxamyl	15
139	Oxamyl oxime	10
140	Oxyfluorfen	10
141	Parathion	10
142	Parathion methyl	10
143	Penconazole	10
144	Pendimethalin	10
145	Penthiopyrad	10
146	Permethrin	30
147	Phenothrin	30
148	Phorate	10
149	Phosalone	10
150	Phosmet	20
151	Phosmet OA	10
152	Picoxystrobin	10
153	Piperonyl butoxide	15
154	Prallethrin	50
155	Prodiamine	100
156	Profenofos	10
157	Prometon	10
158	Prometryn	10
159	Pronamide	10
160	Propachlor	25
161	Propamocarb hydrochloride	10
162	Propanil	5
163	Propargite	15
164	Propazine	10
165	Propetamphos	20
166	Propiconazole	15
167	Prothioconazole	125
168	Pymetrozine	30
169	Pyraclostrobin	5
170	Pyridaben	5
171	Pyrimethanil	15
172	Pyriproxyfen	5
173	Quinoxyfen	10
174	Quintozene	10
175	Resmethrin	30
176	Sethoxydim	10
177	Simazine	50
178	Spinetoram	100
179	Spinosad	15
180	Spirodiclofen	10

#	Analyte	Limit of Detection (ppb)
181	Spiromesifen	10
182	Spirotetramat	30
183	Sulfoxaflor	25
184	Tebuconazole	15
185	Tebufenozide	5
186	Tebuthiuron	15
187	Tefluthrin	10
188	Tetraconazole	15
189	Tetradifon	10
190	Tetramethrin	30
191	Thiabendazole	5
192	Thiacloprid	5
193	Thiamethoxam	10
194	THPI	15
195	Thymol	10
196	Tolfenpyrad	10
197	Triadimefon	10
198	Triadimenol	25
199	Triazophos	10
200	Tribufos	10
201	Trifloxystrobin	10
202	Triflumizole	10
203	Trifluralin	10
204	Triticonazole	30
205	Vinclozolin	10