July 2021

Summary of MDA Pesticide Bee Kill Complaint Investigations in 2020

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 2020 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 2 pesticide bee kill complaints and the MDA's findings for 2020
- Terms and Definitions
- Pesticide Analyte Lists Used in Bee Kill Investigations

Program Contacts

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For bee kill compensation information:
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Investigation Summary – Pesticide Bee Kill Complaint

Wright County **Case File Number:** SRK175001484

Received date: September 21, 2020

Date	September 21, 2029	September 22, 2020	September 23, 2020	October 14, 2020	October 19, 2020	October 22, 2020	October 22, 2020	July 27, 2021
Action	Call received	MDA responds	Samples sent to labs for analysis	MDA bee residue results received	USDA bee residue results received	MDA bee residue results sent to beekeeper	USDA bee residue results sent to beekeeper	Case Closed

Background of Complaint and MDA Response

- A hobby beekeeper maintained and overwintered four colonies in this apiary. A miticide was applied on September 11th, 2020 in order to control Varroa mites.
- The apiary was located along a treeline, near a field. A tree nursery was located on the opposite side of the treeline from the colonies.
- The beekeepers first noticed dying bees on August 11, 2020. Upon inspecting on September 11th, the beekeeper reported two colonies were completely dead. One of the remaining colonies was considered failing, and the remaining colonies was still active.
- MDA Agricultural Chemical Investigators (ACI) responded on September 22nd, 2020.
- The dead bees collected for samples were dead for an undetermined length of time and may have been subjected to a variety of weather conditions.
- Investigators examined 3 colonies considered affected by the beekeeper. One colony in the apiary was deemed potentially unaffected due to continued activity and were able to corroborate the beekeeper's report of dead bees.
- Using the 3 examined colonies, hive health samples were collected and combined to form composite samples used to evaluate colony stress from *Varroa*, *Nosema*, and common viruses.
- Frames of bees, brood pattern and observations of disease were not made during this inspection due to the total loss of the colonies and the lack of an entomologist presence at the time of the investigaiton.

The MDA obtained composite samples of dead bees located in front of sampled colonies for pesticide residue analysis using the four colonies considered affected. An individual colony sample of live bees was taken from the only colony with surviving bees.

MDA Colony Heath Findings

- Three of the colonies did not contain frames of live bees, indicating that a minimum of 300 dead bees would be the threshold used as guidance to indicate an acute pesticide poisoning.

- Colonies had sustained a total population loss for two colonies and most bees were dead in the two remaining colonies. Total loss of bees was not reliably quantified due to decomposure of the dead bees.

- Results from the *Varroa* sample showed 13 *Varroa* mites/100 bees indicating a level of pressure exceeding the recommended treatment threshold of 3 mites/100 bees.
- Individual bees tested for *Nosema* were found to have an average of 0.15 million *Nosema* spores/bee. The threshold when *Nosema* is thought to cause damage to colonies is 1.0 million spores/bee.
- Viral RNA was quantified in colonies sampled and compared to national baselines. Result indicated virus levels were not significantly different for Deformed Wing Virus-A (26th percentile) and Sacbrood Virus (27th percentile), but were higher than average for Black Queen Cell Virus (63rd percentile) and Israili Acute paralysis Virus (69th percentile) and significantly higher for Deformed Wing Virus-B (89th percentile).

MDA Pesticide Findings

- The beekeeper applied Apiguard (thymol based miticide) to treat varroa mites in September, 2020.

- Pesticide analysis were carried out at the MDA and USDA Labs.

- MDA laboratory pesticide results found detectable levels of bifenthrin (an insecticide) at 7.83 and 28.6 ppb and metolachlor (a herbicide) at 5.31 ppb in dead bee samples. USDA laboratory pesticide results found trace amounts of diuron (a herbicide), boscalid (a fungicide), and flupyram (a fungicide) in dead bees and trace amounts of novaluron (an insecticide) in live bees . Detectable levels of chlorothalonil (a fungicide) at 27 ppb, boscalid (a fungicide) at 6 ppb, and thymol (a miticide) at 344 and 2850 ppb in dead bees and 4410 ppb in live bees. Chlorothalonil was not analyzed for by the MDA lab due to a pH issue.

- An application of Fanfare EC, active ingredient Bifenthrin, was made to the adjacent soybean field located west of the affected hives on 08/04/2020.

- Adjacent soybean field was in reproductive stage (R3), per application record.

Laboratory Results

Laboratory	**Active Ingredient** (Level of Detection)	**Affected dead bees** concentration in µg/kg (% acuted benchmark)**	**Affected live bees** concentration in µg/kg (% acuted benchmark)**	**Unaffected live bees** concentration in µg/kg (% acuted benchmark)**	**Affected Vegetation** concentration (mg/kg)	**Unaffected Vegetation** concentration (mg/kg)	**Honeybee Acute LD_{50}** (µg/kg=parts per billion [ppb])
MDA	Chlorothalonil[1]	Quantification issue	Quantification issue	Quanitfication issue	N.A****	N.A	Oral: > 1,400,000
USDA[ŧ]	Chlorothalonil (10ppb)	<LOQ-27 ppb (0.005%)	<LOQ	<LOQ	N.A	N.A	Oral: > 1,400,000
MDA	Diuron [2] (Not screened)				N.A	N.A	Contact: 1,160,240
USDA	Diuron (5ppb)	Trace[ǂ]	<LOQ	<LOQ	N.A	N.A	Contact: 1,160,240

Laboratory	**Active Ingredient** (Level of Detection)	**Affected dead bees** concentration in µg/kg (% acuted benchmark)**	**Affected live bees** concentration in µg/kg (% acuted benchmark)**	**Unaffected live bees** concentration in µg/kg (% acuted benchmark)**	**Affected Vegetation c**oncentration (mg/kg)	**Unaffected Vegetation** concentration (mg/kg)	**Honeybee Acute LD_{50}** (µg/kg=parts per billion [ppb])
MDA	Boscalid[3] (Not screened)				N.A	N.A	Contact: >1,600,000
USDA	Boscalid (5 ppb)	Trace - 6 (0.0009%)	<LOQ	<LOQ	N.A	N.A	Contact: >1,600,000
MDA	Thymol[4] (Not screened)				N.A	N.A	Not established by EPA
USDA	Thymol (25 ppb)	344 - 2850	4410	<LOQ	N.A	N.A	Not established by EPA
MDA	Novaluron[5] (Not screened)				N.A	N.A	Contact: >800,000 Oral: 800,000
USDA	Novaluron (5 ppb)	<LOQ	<LOQ	Trace	N.A	N.A	Contact: >800,000 Oral: 800,000
MDA	Fluopyram[6] (Not Screened)				N.A	N.A	Contact: >665,600 Oral: 712,000
USDA	Fluopyram (2 ppb)	<LOQ- Trace	<LOQ	<LOQ	N.A	N.A	Contact: >665,600 Oral: 712,000
MDA	Bifenthrin[7] (5 ppb)	7.83- 26.8 (15.7- 53.6%)	<LOD*	<LOD	0.00139	0.00904	Contact: 125
USDA	Bifenthrin (25 ppb)	<LOQ	<LOQ	<LOQ	N.A	N.A	Contact: 125
MDA	Metolachlor[8] (1 ppb)	<LOD- 5.31 (0.002%)	<LOD	<LOD	N.A	N.A	Contact: 880,000 Oral: 680,000
USDA	Metolachlor (25 ppb)	<LOQ	<LOQ	<LOQ	N.A	N.A	Contact: 880,000 Oral: 680,000

*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 (LD50) 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.

****Not Analyzed

ǂ Residues below 10 ppb are normally associated with a larger margin of error due to the currentanalytical techniques available to the scientific community which should be considered.

[1] Ecological Assessment for the IR-4 Registration of Chlorothalonil and the Degradation Product, 4-Hydroxy-2,5,6-trichloro- 1,3 -dicyanobenzene (SDS-3701) for the New Uses On: Bulb Vegetables, Bushberries, and Low Growing Berries. US Environmental Protection Agency. EPA-HQ-OPP02009-0081-0213. September 2011.

[2] Diuron: Registration Review Problem Formulation for the Environmental Fate, Ecological Risk, Endangered Species, and Drinking Water Assessments. US Environmental Protection Agency. EPA-HQ-OPP-2015-0077-0003. January 2016

[3] Boscalid: Draft Ecological Risk Assessment for Registration Review. US Environmental Protection Agency.EPA-HQ-OPP-2014-0199-0019. November 2019

[4] Registration Review Draft Risk Assessment for Thymol. US Environmental Protection Agency. EPA-HQ-OPP-2010-0002-0009. November 2019.

[5] Novaluron: Draft Ecological Risk Assessment for Registration Review. US Environmental Protection Agency. EPA-HQ-OPP-2015-0171-0025. May 2020.

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

[7] Environmental Fate and Effects Division: Registration Review Problem Formulation for Bifenthrin. US Environmental Protection Agency. EPA-HQ-OPP-2010-0384-0006. June 2010.

[8] Metolachlor/S-Metolachlor: Draft Ecological Risk Assessment for Registration Review. US Environmental Protection Agency. EPA-HQ-OPP- 2014-0772-0028. November 2019.

Investigation Conclusions

- Dead bees analyzed by the MDA and USDA were determined to contain pesticides below the acute benchmark, except for the insecticide bifenthrin. The concentration of the insecticide bifenthrin (7.83- 26.8 ppb) was detected at a concentration that is approximately 16 -54% of the acute benchmark. In addition, it should be noted that considerable degradation likely occurred due to rain and/or light exposure before samples were collected.
- Pesticide products containing active ingredient Bifenthrin, active ingredient found in bee samples, was applied by two separate entities in 2020.
- Bee samples indicated Varroa mite levels far exceeded the recommended threshold. Viral RNA present in the bees was found to be near average to above average levels. The varroa and virus loads may have acted as a stressor and therefore contributed either directly or indirectly to the observed bee mortality.
- Due to the presence of the insecticide in the dead bees, it is likely that the pesticide exposure contributed to colony mortality.
- When the case was closed, results were reported to the EPA.

Compensation – The investigation concluded the bee mortality was the result of an acute pesticide poisoning based on the residue present in the dead bees as well as the observed mortality. While the concentrations of the pesticides detected did not exceed the EPA's LOC, a month between the time of application and the investigation passed which likely resulted in considerable degredation.

The beekeeper was not registered with BeeCheck prior to the observed mortality and is, therefore, unable to be compensated. While the beekeeper does not qualify for compensation due to statutory requirements, the incident is considered an acute pesticide poisoning as defined by the MDA.

Investigation Summary – Pesticide Bee Kill Complaint

Hennepin County **Case File Number:** SRK175001410

Received date: May 24, 2020

Date	May 24, 2020	May 26, 2020	May 27, 2020	June 18, 2020	July 10, 2020	July 10, 2020	July 10, 2020	Oct. 2020
Action	Call received	MDA responds	Samples sent to labs for analysis	USDA bee residue results received	MDA bee residue results received	MDA bee residue results sent to beekeeper	USDA bee residue results sent to beekeeper	Case closing letter issued

Background of Complaint and MDA Response

- A hobby beekeeper split an overwintered colony on May 18, 2020. Prior to the split, bees were fed pollen in March and continued to receive syrup after being split.
- Both colonies were located adjacent to a house in a residential area.
- On May 24, 2020 the beekeeper observed twitching and disoriented bees with extended proboscises as well as a large number of dead bees in their own and their neighbor' yard.
- MDA Agricultural Chemical Investigators (ACI) along with an MDA Pesticide Technical Unit (PTU) staff entomologist responded on May 26, 2020.
- No weather events occurred between the observation and investigation, however, the beekeeper collected dead bees and stored them in the freezer. The MDA was unable to accept those bees as a part of the investigation as they are considered tampered with. This resulted in few dead bees available for sample analyses.
- Investigators examined two colonies considered affected by the beekeeper and were i able to corroborate disoriented bees with extended proboscises. No colonies were considered unaffected.
- Using the two examined colonies, live bees samples were collected and combined to form composite samples used for pesticide residure analysis and for evaluating hive health and colony stress from *Varroa*, *Nosema*, and common viruses. Composite samples included live bees collected from frames consisting of nectar and pollen. Using the same two colonies, frames of bees, brood pattern and observations of disease were made.

Dead bees samples for residue analysis were collected from the dead bees located in front of the sampled colonies.

MDA Colony Heath Findings

- Colonies contained a mean of six frames of bees, indicating that a 600 dead bee threshold would be used as guidance to indicate an acute pesticide poisoning.
- Colonies had sustained a minimum quantifiable population loss of approximately 270 dead bees in and around hive entrances.
- Colonies had a brood pattern of 1 indicating a below average laying pattern.
- No disease symptoms were observed.
- Results from the *Varroa* sample showed 5.55 *Varroa* mites/100 bees indicating a level of pressure exceeding the recommended treatment threshold of 3 mites/100 bees.

- Individual bees tested for Nosema were found to have an average of 2.85 million Nosema spores/bee. Thethreshold when Nosema is thought to cause damage to colonies is 1.0 million spores/bee.
- Viral RNA was quantified in the colonies sampled and compared to national baselines. Result indicatedcolonies were significantly higher than average for Black Cell Queen Virus, Deformed Wing – A virus,Deformed Wing- B virus, and Nosema ceranae (a fungus).

MDA Pesticide Findings

- The beekeeper did not report any pesticide use within the hive and stated their own property plus theiradjacent neighbors used strictly organic practices.
- Pesticide analysis were carried out at the MDA and USDA Labs.
- MDA laboratory pesticide results found permethrin at 75.9 ppb, phenothrin at 173 ppb, and tetramethrinat 18.3 ppb in the dead bee sample. All three are insecticides.
- USDA laboratory detected trace levels of atrazine in the dead bee samples and no pesticides in the livebee samples.
- A MDA ACI followed up by looking for applications in the surrounding area, but was unable to locate anycommercial applications.
- Many flowers were in bloom in this residential area.
- The beekeeper was not registered with BeeCheck prior to the observed mortality.

Laboratory Results

Laboratory	**Active Ingredient** (Level of Detection)	**Affected dead bees** concentration in µg/kg (% acuted benchmark)**	**Affected live bees** concentration in µg/kg (% acuted benchmark)**	**Honeybee Acute LD_{50}** (µg/kg=parts per billion [ppb])
MDA	Permethrin[1] (5 ppb)	75.9 (79)	No Detection	Oral: 1,300 ppb;
USDA[ŧ]	Permethrin (25 ppb)	No Detection	No Detection	Oral: 1,300 ppb;
MDA	Phenothrin[2] (10 ppb)	173 (65)	No Detection	Contact: 670 ppb[2]
USDA	Phenothrin (100 ppb)	No Detection	No Detection	Contact: 670 ppb[2]
MDA	Tetramethrin[3] (5 ppb)	18.3 (3)	No Detection	Contact: 1,550 ppb[3]
USDA	Tetramethrin (5 ppb)	No Detection	No Detection	Contact: 1,550 ppb
MDA	Atrazine[4] (5 ppb)	No Detection	No Detection	Contact: > 970,000[4]
USDA	Atrazine (1.2 ppb)	Trace (<LOQ)*	No Detection	Contact: > 970,000

*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 (LD50) 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] Environmental Fate and Ecological Risk Assessment Preliminary Problem Formulation in Support of the Registration Review of Permethrin. EPA-HQ-OPP-2011-0039-0004. USEPA. June 20, 2011.

[2] Environmental Fate and Ecological Risk Assessment for the Proposed New Use of d-Phenothrin in Outdoor Residential Misting Systems. EPA-HQ-OPP-2011-0539. USEPA. November 21, 2012.

[3] Preliminary Problem Formulation for Ecological Risk Assessment for Tetramethrin. EPA-HQ-OPP-2008-0014-0009. UPEPA. December 5, 2011.

[4] Addendum to the Problem Formulation for the Ecological Risk Assessment to be Conducted for the Registration Review of Atrazine. EPA-HQ-OPP-2013-0266-0002. USEPA. May 14, 2013.

Investigation Conclusions

- The insecticides detected in the dead bee samples are commonly used to control wasps. Given the residential setting, it is likely the exposure was due to homeowner use in the area.
- The concentrations of the insecticides detected were not above EPA's level of concern, however, they likely may have 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 - The insecticides detected were below EPA's LOC in dead bees and there were not enough quantifiable bees to meet the acute bee poisoning criteria, however, in addition to the bee keeper collecting many unusable bees, pesticide exposure likely prevented some portion of the affected colonies foraging population from returning to the hive and therefore affected investigators ability to accurately assess colony mortality.

The beekeeper was not registered with BeeCheck prior to 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.

USDA Pesticide Analyte List Used in Bee Kill Investigations

#	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

USDA Pesticide Analyte List Used in Bee Kill Investigations

#	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

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

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