***April** 2019*

DEPARTMENT OF AGRICULTURE

Summary of MDA Pesticide Bee Kill Complaint Investigations in 2018

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 2018 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 2018
- Terms and Definitions
- Pesticide Analyte Lists Used in Bee Kill Investigations

Program Contacts

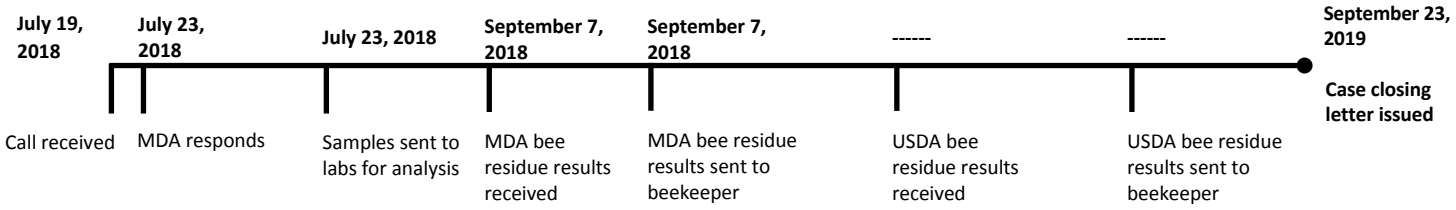
For misuse complaint information:
Andrew Murphy– (651) 201-6136
Christine Wicks – (651) 201-6390

For bee kill compensation information:
Raj Mann – (651) 201-6208
Gregg Regimbal – (651) 201-6671

Investigation Summary - Pesticide Bee Kill Complaint

Dodge County, near West Concord **Case File Number: CDP162002595**

Received date: July 19, 2018



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

- A hobby beekeeper started a new colony from packages in the middle of spring. The bees were fed sugar syrup weekly from establishment to date of inspection.
- The apiary with 2 colonies was located on private property next to a pasture used for horses. A corn field was across the road and a soybean field was on the other side of a tree line.
- The beekeeper noticed bees dropping to the ground on July 18, 2018 following a helicopter spraying the corn field across the road. A large number of bees were observed to be swarming above the hive prior to falling to the ground.
- A call was received by the MDA on July 19, 2018. MDA Agricultural Chemical Investigators (ACI) along with an MDA Pesticide Management Unit (PMU) staff entomologist responded on July 23, 2018. A delayed response occurred due to weather and work hours.
- On the day following the complaint, a large weather system moved through the area. Precipitation occurred for approximately half of the day.
- Investigators examined 1 colony considered affected by the beekeeper. There were not enough dead bees in front of the colony to constitute a dead bee sample. One affected live bee sample was collected from the affected colony for the MDA laboratory pesticide analysis. Sample was not collected for the USDA laboratory pesticide analysis because of inability to collect enough live bees.
- The second colony was not considered to be affected initially, but was reported as affected upon visiting the apiary. The other colony was not examined due to the beekeeper stating it was recently initiated and would not like the inspectors to collect the live bee samples. There were not enough dead bees in front of this colony.
- Using the colony evaluated, frames of bees, brood pattern and observations of disease were made. Samples were not collected for the Varroa/Nosema and viral analysis because of inability to collect enough live bees.
- A Vegetation sample was collected from plants approximately 10 feet from the colonies, adjacent to a small building.

The MDA obtained individual colony samples for pesticide residue analysis using the same colony selected to evaluate hive health. Individual colony samples consisted of live bees taken from frames consisting of nectar and pollen.

MDA Colony Health Findings

- The colony contained a mean of 5 frames of bees, indicating that a 500 dead bee threshold would be used as guidance to indicate an acute pesticide poisoning.
- Colonies had sustained a minimum quantifiable population loss 30 dead bees in and around hive entrances.
- Colonies had a brood pattern of 2 indicating a below average laying pattern.

- No diseases or symptoms of disease were observed in the colony.
- Varroa/Nosema samples were not collected due to an inability to collect enough live bees.
- Viral RNA was not quantified in colony evaluated due to an inability to collect enough live bees.

MDA Pesticide Findings

- 2,4-D was applied, by the homeowner, to pasture land near the hives in the spring.
- Pesticide analysis were carried out at the MDA laboratory.
- MDA laboratory pesticide results found prothioconazole des thio (a degredate of prothioconazole) (0.161 µg/kg) and tifloxystrobin (0.402 µg/kg) in the live bees.
- MDA laboratory pesticide results found prothioconazole des thio (a degredate of prothioconazole) (45.6 µg/kg), tifloxystrobin (0.0772 mg/kg), and lambda-cyhalothrin (24.6 µg/kg) in the vegetation samples taken from the property.
- The EPA's acute oral toxicity value for honey bees exposed to prothionconazole (parent compound) is >71 µg a.i./bee, and is considered practically non-toxic. The EPA's acute contact toxicity value for honey bees exposed to trifloxystrobin is > 200 µg/bee and is considered practically non-toxic. The EPA's acute contact toxicity value for honey bees exposed to lambda-cyhalothrin is 0.038 µg/bee and is considered highly toxic.
- An aerial applicator was identified during investigation follow-up. The applicator applied the fungicide Delaro (containing prothionconazole and tifloxystrobin) and the insecticide Willowood Lambda-Cy 1EC (containing lambda-cyhalothring) to a corn field. Conditions were reported as calm and 78°F.
- Many flowers were in bloom at the time of the investigation, including in the prairie patch the beekeeper planting consisting of native plants.

Laboratory Results

Laboratory	**Active Ingredient (Analytical Lab's Level of Detection)**	**Quantified sample concentration (µg/kg)**		Honey bee Acute LD50 (µg/kg = parts per billion [ppb])
		Affected live bees	Vegetation Sample	
		(% of acute oral benchmark)*		
MDA	Prothioconazole des thio[1]	0.161 ($5.7x10^{-4}$)	45.6 (0.16)	>71,000 (Oral)
MDA	Trifloxystrobin[2] (15.0 ppb)	0.402 ($1.4x10^{-3}$)	0.0772 mg/kg (9.7×10^{-5})	200,000 (Oral)
MDA	Lambda-cyhalothrin[3] (5 ppb)	---	24.6 (16.2)	380 (Contact)

* 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.

[1] Registration Review Preliminary Problem Formulation for Environmental Fate, Ecological Risk, Endangered Species, and Human Health Drinking Water Exposure Assessments for Prothioconazole

[2] Registration Review -Preliminary Problem Formulation for the Ecological Risk Assessment in Support of Registration Review for Trifloxystrobin

[3] Preliminary Comparative Environmental Fate and Ecological Risk Assessment for the Registration Review of Eight Synthetic Pyrethroids and the Pyrethrins

Investigation Conclusions

- The fungicides detected in the samples are considered practically non-toxic to honey bees, but the insecticide lambda-cyhalothrin is considered highly toxic to honey bees. The concentration of lambda-cyhalothrin detected is well below the acute toxicity value (maximum residue quantified 0.161 ppb or < 0.01% of EPA's level of concern; 0.402 ppb or < 0.00001% of EPA's level of concern). However, considerable degradation may have occurred due to a heavy rain event which occurred between the observed bee die-off and the MDA investigation/ sample collection and additional consideration should be given to the presence of residues on live bees from the affected colony and on vegetation.
- Applicator records indicate the fungicide and insecticide applied on July 18, 2018 are the same as the compounds detected in the live bee samples and are likely responsible for the bee death.
- No diseases or viruses were noted as possible contributors to the bee death.
- When the case was closed, results were reported to the EPA.

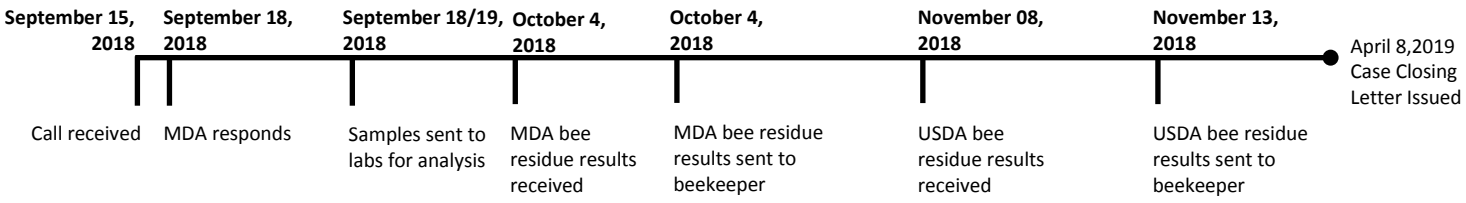
Compensation MDA's investigation concluded bee mortality is considered an acute pesticide poisoning (based on pesticide residues present on vegetation samples found on beekeeper's property). The residues detected did not meet the EPA's level of concern indicating an acute pesticide exposure event, however the insecticide exposure likely prevented some foraging bees from returning to the hive and rain degraded the dead bees around the hive prior to the investigation which affected investigator's ability to accurately assess colony mortality.

The beekeeper was not registered on beecheck.org, and is, therefore, not eligible for compensation.

Investigation Summary - Pesticide Bee Kill Complaint

Ramsey County, St. Paul **Case File Number: SRK175001270**

Received date: September 16th, 2018



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

- A hobby beekeeper maintained two colonies, one was overwintered (unaffected hive) and one was a swarm colony (affected) started in the spring. Each hive was topped with a feeding chamber containing ProSweet which was replaced weekly.
- The apiary was located in the backyard of the beekeeper's property with a garage behind the colonies and flowers in front of the hives.
- The beekeeper observed bees with an inability to fly, trembling with wings fluttering, and a large (1,000 bees) die-off on September 15th, 2018.
- MDA Agricultural Chemical Investigators (ACI) along with an MDA Pesticide Management Unit (PMU) staff entomologist responded on September 18th, 2018.
- At the time of the investigation, a large rain event was just ending with cool temperatures setting in.
- Investigators examined the colony considered affected by the beekeeper (one colony was considered not affected) and were able to confirm the symptoms observed by the beekeeper.
- Using the one examined colony, hive health samples were collected and used to evaluate colony stress from *Varroa*, *Nosema*, and common viruses.
- Using the same colony, frames of bees, brood pattern and observations of disease were made.

The MDA obtained individual colony samples for pesticide residue analysis using the same colonies selected to evaluate hive health. Individual colony samples included live affected and unaffected bees taken from frames consisting of nectar and pollen and dead bees located in front of the affected colony. Individual live colony samples for pesticide residue analysis were also collected from the hive considered unaffected.

MDA Colony Health Findings

- Colonies contained a mean of 3.5-5 frames of bees, indicating that a 350-500 dead bee threshold would be used as guidance to indicate an acute pesticide poisoning.
- Colonies had sustained a minimum quantifiable population loss of 900-1,100 dead bees in and around hive entrances.
- Colonies had a brood pattern of 4 indicating an above average laying pattern.
- No disease was observed at the time of the investigation, however, one mite was found on a bee in the unaffected hive.
- Results from the *Varroa* sample showed 2.38 *Varroa* mites/100 bees indicating a level of pressure nearing the recommended treatment threshold of 3 mites/100 bees.
- Individual bees tested for *Nosema* were found to be free from *Nosema* spores. 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 significantly higher than average for varroa destructor virus (60th percentile).

MDA Pesticide Findings

- The beekeeper applied Mite Away Quick Strips to the hive at the end of August 2018 to combat a mite issue within the hives. No other pesticides were applied to the property.
- Pesticide analysis were carried out at the MDA and USDA Labs.
- MDA laboratory pesticide results found residues of fipronil at 4.94 µg/kg (ppb) and ethiofencarb sulfoxide at 7.42 µg/kg (ppb) in dead bees; the live, affected bees showed residues of ethiofencarb sulfoxide at 1.42 µg/kg (ppb); the unaffected, live bee sample showed residues of ethiofencarb sulfoxide at 5.58 µg/kg (ppb). USDA laboratory pesticide results found residue of fipronil, fipronil Sulfide (fipronil breakdown product), and fipronil sulfone (fipronil breakdown product) in dead bees. The USDA did not analyze the sample of affected live bees because the sample was compromised during the process.
- MDA's analytical methods are more sensitive for detecting Fipronil (Level of Detection [LOD] = 5 ppb) than USDA analytical methods (LOD = 50 ppb), however the MDA laboratory does not screen for fipronil breakdown products and found lower levels of residue than the USDA laboratory.
- No applicator was located for either of the pesticides detected. Fipronil is a common pesticide product for use on and around structures. Due to the distance bees can travel, there are many places they may have come into contact with the insecticide.
- Many late season flowers were in bloom at the time of the investigation, but due to the location being residential, it is difficult to know which properties contained blooming flowers.

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	Affected live bees	Unaffected live bees	
		(% of acute oral benchmark)**			
MDA	Fipronil (5 ppb)	4.94 (31%)	----	----	(Oral: 40 ppb; Contact: 60 ppb)[1]
USDA	Fipronil (50 ppb)	229 (1,431%)	No Detection	----------	
MDA	Ethiofencarb sulfoxide	7.42	1.42	5.58	No established LD_{50}[1]
USDA	Ethiofencarb sulfoxide (Not Screened)***				
MDA	Fipronil sulfide (Not Screened)***				No established LD_{50}, refer to parent LD_{50}
USDA	Fipronil sulfide	52 (325%)	No Detection	----------	
MDA	Fipronil sulfone (Not Screened)***				No established LD_{50}, refer to parent LD_{50}
USDA	Fipronil sulfone	137(856%)	No Detection	----------	

* 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.

Investigation Conclusions

- 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.
- Fiproil, the pesticide detected in dead bees from both laboratories, was detected at concentrations ranging from 4.94- 229 ppb, considerably higher than the LD_{50}. Fipronil's lethal dose to 50% of a population (LD_{50}) is 40 ppb for an acute contact exposure and 16 ppb once EPA's level of concern is applied.
- The levels detected were from samples that may have undergone considerable degradation due to a rainfall event prior to sampling.
- No applicator or pesticide misuse was identified.
- Given the concentrations of Fipronil quantified in the dead bees and the associated LD_{50} value, it is likely the bees experienced adverse effects (such as mortality) due to the exposure. Levels of varroa mites and VDV may have added stress to the colony 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 beekeeper was not registered on beecheck.org, and, therefore, is not eligible for compensation. However, the incident is considered an acute pesticide poisoning, as defined by the MDA .

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	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

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

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