DEPARTMENT OF AGRICULTURE

Pesticide Bee Kill Complaint Investigations

Summary of investigations submitted in 2019

February 2020

Contents

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 2019 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.

Program Contacts

For misuse complaint information:
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For bee kill compensation information:
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Appendix A
Investigation Summary – Pesticide Bee Kill Complaint

Grant County, Elbow Lake **Case File Number:** MWF114000327
Received date: May 17, 2019

Date	May 17, 2019	May 20, 2019	May 21, 2019	June 19, 2019	July 15, 2019	July 15, 2020	July 19, 2020	Feb 19,2020
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

- In early May, a commercial beekeeper transferred colonies which overwintered in California back to a stagingyard in Minnesota where colonies were fed sucrose solution and mite-away strips were applied.
- The temporary apiary was described as a staging yard where all bees for this beekeeper are transferred to aftertheir time out-of-state prior to going to their seasonal apiary. The staging yard contained trees and grassy areason three sides with a corn field to the east, just beyond another grassy area.
- On May 17, 2019, the beekeeper noticed dead and twitching/dying bees located in front of hives which had beenin the staging yard for approximately two weeks.
- MDA Agricultural Chemical Investigators (ACI) along with a MDA Pesticide Management Unit (PMU) staffentomologist responded on May 20, 2019.
- Heavy rainfall and storms occurred between the time of the complaint and the investigation. This resulted in beeswhich may have deteriorated due to rainfall being used for samples.
- The beekeeper initially placed hive covers over the dead bees to preserve them, however, upon furtherdiscussion, it was determined the covers could be contaminated and could interfere with the samples.
- Investigators examined 18 colonies considered affected by the beekeeper and 3 control colonies (i.e., controlcolonies arrived at the holding yard the night prior to the complaint and were considered unaffected) and wereable to corroborate the beekeeper reported symptoms.
- Using the 18 affected colonies, hive health samples were collected and combined to form 6 composite samplesused to evaluate colony stress from *Varroa*, *Nosema*, and common viruses.
- Using the same 18 colonies, frames of bees, brood pattern and observations of disease were made.
- The 3 unaffected control colonies were sampled for pesticides in live bees. The MDA obtained composite samplesfor pesticide residue analysis using the same colonies selected to evaluate hive health. Composite samplesincluded live bees taken from frames consisting of nectar and pollen and dead bees located in front of sampledcolonies.

MDA Colony Heath Findings

- Colonies contained a mean of 2.5-7 frames of bees, indicating that a 250-700 dead bee threshold would be used as guidance to indicate an acute pesticide poisoning.
- Colonies had sustained a quantifiable population loss of dozens to a couple hundred, but less than 250 deadbees in and around each hive entrances. Population loss was difficult to quantify due to the concentration ofhives in a small area and may have been affected by the delayed sampling timeline.
- Colonies had a brood pattern rating of 2-4 indicating an average to above average laying pattern.
- Large amounts of dysentery were observed from bees in the affected hives. The unaffected hives had signs of hive beetle.
- Results from the *Varroa* samples showed 0.89 *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 0.65-1.45 million *Nosema* spores/bee. Thethreshold for 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. Results indicated viralpathogens Lake Sinai Virus 2 (medium-high levels), Israeli Acute Paralysis Virus (medium-high levels), and Varroa Destructor Virus (low-high levels) were present.

MDA Pesticide Findings

- Mite Away quick strips were applied to the hives early in the spring to control for varroa mites
- Pesticide analysis was carried out at the MDA and USDA Labs.
- MDA laboratory pesticide results found detectable levels of clothianidin (insecticide) in three out of the six deadbee samples at levels of at 0.68, 0.99, and 1.39ppb, and at levels of 0.63-1.63 ppb in sampled vegetation. USDA laboratory pesticide results found thymol (insecticide) at 170ppb and 329 ppb in live bees and 225 ppb and 370 ppb in dead bees. USDA laboratory found pyrimethanil (fungicide) at 9 ppb in live bees and 10 ppb in deadbees.
- Investigation follow-up determined that a corn field near the staging yard was planted on 5/13/19 with seedtreated with clothianidin at a rate of 0.25mg ai/seed.
- The beekeeper stated that dandelion, wild plum, and willow were all in bloom at the time the planting occurred.

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)**	Vegetation Sample concentration in µg/kg (% acuted benchmark)**	Honeybee Acute LD_{50} (µg/kg=parts per billion [ppb])
MDA	Clothianidin (0.28 ppb)	0.68- 1.39 (4.6-9.4)	No Detection	0.625-1.63 (11.0)	(Oral: 37.0 ppb; Contact: 439 ppb)[1]
USDA[t]	Clothianidin (15 ppb)	<LOD*	No Detection		(Oral: 37.0 ppb; Contact: 439 ppb)[1]
MDA	Chlorpyrifos (25 ppb)	No Detection	No Detection	No Detection	(Oral: 2,500 ppb; Contact: 590 ppb)[2]
USDA	Chlorpyrifos (5 ppb)	Trace <LOD*	No Detection		(Oral: 2,500 ppb; Contact: 590 ppb)[2]
MDA	Iprodione (Not Screened)***	No Detection	No Detection	No Detection	(Not established by EPA)
USDA	Iprodione *50 ppb)	Trace <LOD*	Trace <LOD*		(Not established by EPA)
MDA	Metolachlor (1 ppb)	No Detection	No Detection	No Detection	(Oral:>110,000 ppb; Contact:>110,000 ppb)[3]
USDA	Metolachlor (25 ppb)	Trace <LOD*	No Detection		(Oral:>110,000 ppb; Contact:>110,000 ppb)[3]
MDA	Pyrimethanil (Not Screened)***	No Detection	No Detection	No Detection	(Oral:>110,000 ppb; Contact:>110,000 ppb)4
MDA	Clothianidin (0.28 ppb)	0.68- 1.39 (4.6-9.4)	No Detection	0.625- 1.63 (11.0)	(Oral: 37.0 ppb; Contact: 439 ppb)[1]
USDA[t]	Clothianidin (15 ppb)	<LOD*	No Detection		(Oral: 37.0 ppb; Contact: 439 ppb)[1]
USDA	Pyrimethanil (5 ppb)	9 (0.02)	10 (0.02)		(Oral:>100,000 ppb; Contact:>110,000 ppb)[4]
USDA	Thymol (25 ppb)	170-329	225-370		(Not established by EPA)[5]
USDA	Acetochlor	No Detection	No Detection	No Detection	(Contact:>1,715,000 ppb)[6]
MDA	Thymol (Not Screened)***	No Detection	No Detection	No Detection	(Not established by EPA)[5]

*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] Registration Review: Problem Formulation for the Environmental Fate and Ecological Risk, Endangered Species, and Drinking Water

[2] Exposure Assessment of Clothianidin. DP Barcode: 391491. USEPA. December 13, 2011. Problem Formulation for the Environmental Fate and Ecological Risk, Endangered Species and Drinking Water Assessments in Support of the Registration Review of Chlorpyrifos. November 2008.

[3] Registration Review Problem Formulation for Metolachlor and S-Metolachlor. December 2014.

[4] Pvrimethanil (CAS Reg. No. 53 112-28-0) New Uses on Small Berries (Caneberries and Bushberries) In the co-formulated End-Use Product Fluopyram/Pyrimethanil500 SC. May 2010

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

[6] EFED Registration Review Problem Formulation for Acetochlor. June 2016.

Investigation Conclusions

- Dead bees analyzed by MDA were determined to contain clothianidin residue at a relatively low level of
- 0.68-1.39 ppb. Residues below 10 ppb are normally associated with a larger margin of error due to the current analytical techniques available to the scientific community which should be considered.
- Corn and soybean seed treatment is a common practice and often includes the application of the insecticide clothianidin, which was detected in the affected bees.
- Despite the relatively low residues of the insecticide, clothianidin, found on/in dead bees it is likely that this insecticide acted as a stressor and therefore contributed either directly or indirectly to the observed bee mortality.
- The fungicide (pyrimethanil) is not commonly used in Minnesota early in the growing season. However, the fungicide is commonly used in California crop production.
- Due to the presence of the insecticide in the dead bees, it is likely that the pesticide exposure contributed to colony mortality.
- A conclusion as to whether this was an acute pesticide poisoning was not able to be determined due to an insufficient number of dead bees per hive quantified by investigators as well as pesticide concentrations in dead bees, which may have been affected by the delayed sampling time line.
- When the case was closed, results were reported to the EPA.

Compensation - The beekeeper was not registered with BeeCheck before the observed mortality. Due to this and the reasons listed above, the beekeeper is not eligible for compensation.

Appendix B
Investigation Summary – Pesticide Bee Kill Complaint

Dakota County, Hastings **Case File Number:** AJI147001239
Received date: May 31, 2019

Date	May 31, 2019	May 31, 2019	June 1, 2019	June 26, 2019	July 19, 2019	July 29, 2019	Aug 5, 2019	Feb 19,2020
Action	Call received	MDA responds	Samples sent to labs for analysis	USDA bee residue results received	USDA bee residue results sent to beekeeper	MDA bee residue results received	MDA bee residue results sent to beekeeper	Case closing letter issued

Background of Complaint and MDA Response

- In early May 2019 a hobby beekeeper split a large colony that had been overwintered at the site.
- Due to high mite counts (8 mites/100), the beekeeper applied Mite Away strips on May 16th, 2019.
- On May 29th, 2019, the beekeeper received word that pesticide applications would take place nearby and decided to plug the exit hole in the hive in order to prevent the bees from intercepting the pesticide while foraging.
- On May 30th, 2019, the beekeeper observed a high degree of mortality from one hive. Dead bees had tongues sticking out and live bees were unable to fly from the affected hive.
- The beekeeper had two hives located adjacent to the beekeeper's house, in a partially protected area with a retaining wall along one side of the hives.
- The apiary was located adjacent to a house with a natural area approximately 40 feet away. Raspberry bushes were present on the east end of the house. Samples were collected from the bushes, but were not analyzed upon receiving the results from the bee samples.
- MDA Agricultural Chemical Investigators (ACI) along with an MDA Pesticide Management Unit (PMU) staff entomologist responded on May 31st, 2019.
- Weather at the time of the observed mortality and investigation was very hot and humid, but no rainfall occurred between the time of the observed mortality and the investigation.
- Investigators examined one colony considered affected by the beekeeper as well as one colony considered not affected and were able to corroborate the beekeepers reported symptoms.
- Using the affected colony, hive health samples were collected and used to evaluate colony stress from common viruses. There were not enough live bees present in the affected hive to collect samples for varroa/nosema analyses in addition to virus samples.
- Using the same affected 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 colony selected to evaluate hive health. Individual colony samples included live bees taken from frames containing nectar and pollen and dead bees located in front of sampled colonies.

MDA Colony Heath Findings

- Colonies contained a mean of <1 frame of bees at the time of the investigation, indicating that at least 300 dead bee threshold would be used as guidance to indicate an acute pesticide poisoning.
- Colonies had sustained a minimum quantifiable population loss of thousands dead bees in and around hive entrances.
- Colonies had a brood pattern rating of 3.5 indicating an average laying pattern.
- Signs of shiny bee and deformed wing virus suspected, but not corroborated.
- Samples for Varroa mites were not gathered due to a limited number of live bees, however the beekeeper completed a mite check two weeks prior to the complaint and reported 8 mites/100 bees as the most recent count.
- Viral RNA was quantified in colonies sampled and compared to national baselines. Result indicated the colony had Varroa Destructor Virus (high levels).
- The affected colony contained a large amount of moisture and crumbling honeycomb.

MDA Pesticide Findings

- Pesticide analyses were carried out at the MDA and USDA Labs.
- MDA laboratory pesticide results found no pesticides present in live or dead bees. USDA laboratory pesticide results found detectable levels of carbendazim, diuron, and fluometuron screened in dead bees as well as trace levels of metolachlor. MDA's analytical methods are more sensitive for detecting metolachlor (Level of Detection [LOD] = 1 ppb) than USDA analytical methods (LOD = 25 ppb), and no metolachlor was detected in MDA's lab samples
- Residential pest control companies were applying in the neighborhood at the time of the investigation and just prior to the complaint, however, the products they were applying were not found in the bees.

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])
USDA	Carbendazim (25 ppb)	60 (0.03)	<LOD**	(Contact: >500,000 ppb)[1]
MDA	Carbendazim Not screened*	--	--	(Contact: >500,000 ppb)[1]
USDA	Diuron (5 ppb)	23 (0.004)	<LOD**	(Contact: >1,450,000 ppb)[2]
MDA	Diuron Not screened*	--	--	(Contact: >1,450,000 ppb)[2]

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])
USDA	Fluometuron (2 ppb)	10 (0.02)	<LOD**	(Contact: >110,000 ppb)[3]
MDA	Fluometuron Not screened*	--	--	(Contact: >110,000 ppb)[3]
USDA	Metolachlor (25 ppb)	Trace (LOD=25)	<LOD**	(Oral: > 850,000 ppb; Contact: >2,000,000 ppb)[4]
MDA	Metolachlor (5 ppb)	<LOD**	<LOD**	(Oral: > 850,000 ppb; Contact: >2,000,000 ppb)[4]

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

** 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.

[1] 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 Thiophanate Methyl and Carbendazim. https://www.regulations.gov/document?D=EPA-HQ-OPP-2014-0004-0012.

[2]Diuron: Registration Review Problem Formulation for the Environmental Fate, Ecological Risk, Endangered Species, and Drinking water Assessments. https://www.regulations.gov/document?D=EPA-HQ-OPP-2015-0077-0003

[3]Registration Review- Preliminary Problem Formulation for Ecological Risk and Environmental Fate, Endangered Species, and Drinking Water Assessments for Fluometuron

[4]Ecological Risk Assessment for Use of S-Metolachlor on Pumpkins and Winter Squash. https://www.regulations.gov/document?D=EPA- HQ-OPP-2009-0081-0191

Investigation Conclusions

- The pesticide detections in the dead bees did not reach a level of concern and were not considered to contribute to bee mortality.
- The pesticides found in the dead bees were not a result of a pesticide application and instead were from standard product use.
- Based on the concentration of the pesticides found in the dead bees and the additional observations made at the time of the investigation, pesticides are not believed to contribute to the mortality found in the bees. Mortality is instead attributed to overheating of the hive.
- When the case was closed, results were reported to the EPA.

Compensation – The beekeeper was registered with BeeCheck, however, the investigation concluded bee mortality is not considered an acute pesticide poisoning (based on pesticide residues present in dead bees).

Appendix C

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

#	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.