Evaluation of Neonicotinoid Seed Treatments in the Environment II

VERMONT
AGENCY OF AGRICULTURE, FOOD & MARKETS

Overview:

- What are neonicotinoids?
- Why are they used?
- Risks and challenges
- Miner Institute project (Laura Klaiber)
- Updated research results
- Vermont Beehive wax analysis results
- Moving forward

Purdue University Extension

Neonicotinoids

- **Modeled after Nicotine**
- **Low mammalian toxicity**
- **Systemic insecticides**
  - Neonicotinoid taken up by plant or crop
  - Insect feeds on plant
  - Causes insect paralysis which leads to death
- **Much concern over the impact of these pesticides on pollinators**

Neonicotinoids in Vermont

- One way neonicotinoids enter the state is as seed treatments on corn and soybeans
- Neonicotinoids used as seed treatments:
  - Corn = thiamethoxam and clothianidin
  - Soybean = imidacloprid

Estimated annual acreage of treated seed planted in Vermont (2018)

- 100,000 – 120,000 acres of corn
- 2,500 – 3,000 acres of soybeans

Neonicotinoids in Vermont

Purpose:

To protect seeds and seedlings from insect pests;

White grubs, Seed Corn Maggots, and Wireworms

Larvae (grubs)
Photo by J. Obermeyer, Purdue University

Larvae (maggot)
Photo by J. Obermeyer, Purdue University

Feeding Wireworm
Photo by J. Obermeyer, Purdue University

What Increases Pest Pressure?

Risks for **seed corn maggot** are higher with fields that are recently incorporated animal manure, green cover crops, old alfalfa stands or weeds.

- Problems can be especially severe when planting occurs within two weeks of incorporation.

Risks for **wireworms** or **white grubs** are higher for fields transitioning from pasture or grass hayfields and tend to have higher populations of long-lived soil pests, which cannot be controlled with foliar insecticides.

Wireworm is a pest for only 2-3years after a field has been in a grass sod. Preventing wireworm damage requires treatment before or at planting. There are no practical or effective ways to control the pest after the crop has been planted.

Impact of Farm Practices to Improve Water Quality

Photos: K. Workman, UVM Extension (Ferrisburgh, VT 2014)

Pest Damage:

Challenges:

- **No reliable scouting tools:**
  - Pest pressures are hard to predict
  - Pre-plant scouting protocols are time consuming and their efficacy is still being determined
  - Difficult to detect pests until after the damage is done –Corn plant that is gone, is gone

- **Alternative control:**
  - Various at-planting applied insecticides; carbamates, organophosphates, pyrethroids, and neonicotinoids
  - Exposure to non-target insects
  - Human exposure from direct handling

Alternative Control Measures?

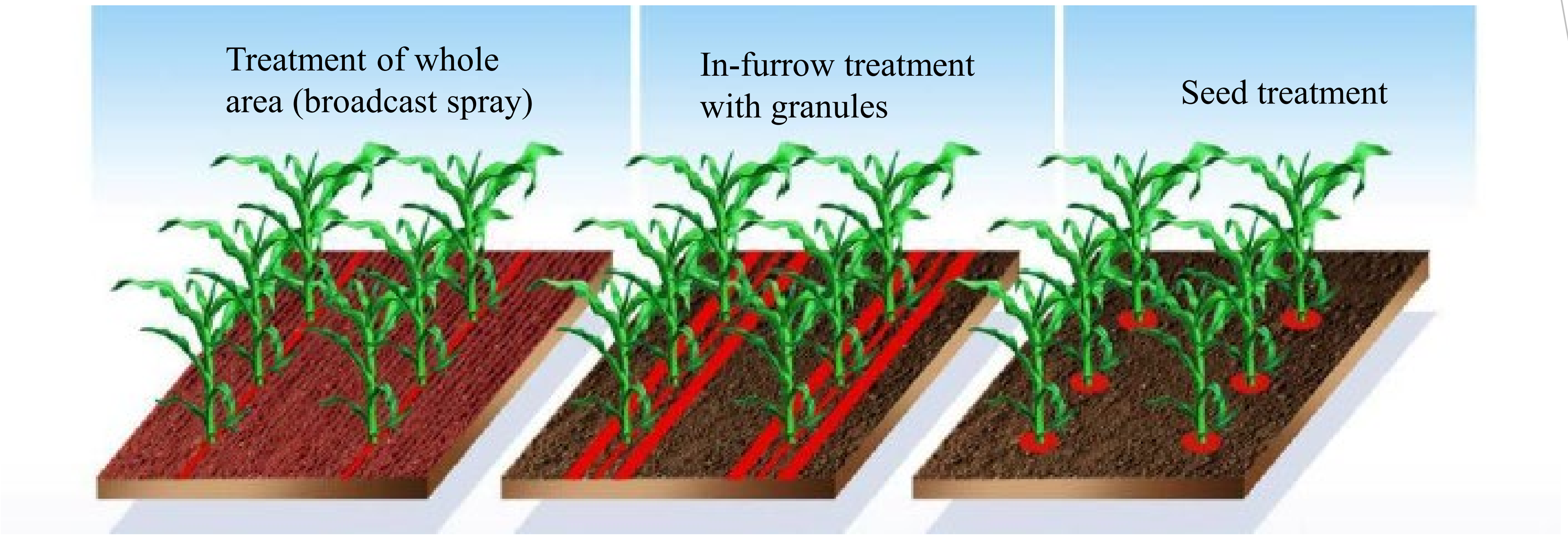
Examples of At-Planting Treatments for Seed and Seedling Insect Pests

Insecticide (Trade Names)	**Rates**	**Common Pests Controlled or Suppressed**
chlorpyrifos (Lorsban 15G)*	Not registered for use in Vermont	Seedcorn maggot, Southern corn rootworm, Wireworms, White grubs, Cutworms
terbufos (Counter 20G)*	5 - 6 oz/1000 row ft	Seedcorn maggot, Southern corn rootworm, Wireworms, White grubs
cyfluthrin, tebupirimphos (Aztec 2.1G)*	6.7 oz/1000 row ft	Seedcorn maggots, Southern corn rootworm, Wireworms, White grubs, Cutworms
tefluthrin (Force 3G)	4 - 5 oz/1000 row ft	Seedcorn maggots, Southern corn rootworm, Wireworms, White grubs, Cutworms
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)**	0.15 - 0.3 oz/1000 row ft	Seedcorn maggots, Southern corn rootworm, Wireworms, White grubs
bifenthrin (Capture LFR 1.5)	0.2 - 0.78 oz/1000 row ft	Seedcorn maggots, Southern corn rootworm, Wireworms, White grubs, Cutworms, Sugarcane beetle
λ-cyhalothrin (Ballista LFC 1)	0.66 oz/1000 row ft	Seedcorn maggots, Southern corn rootworm, Wireworms, White grubs, Cutworms

See the insecticide label for specific use instructions.
* Caution: When using organophosphate insecticides such as Aztec, Counter or Lorsban with herbicides such as Accent, Callisto, Capreno, Halex GT, Steadfast, Option or Resolve, the possibility for plant injury exists. See herbicide label for restrictions.
** Many other pyrethroid insecticides are labeled for at-planting control of cutworms and some other pests. These include Asana XL, Baythroid XL, Declare, Mustang Max and Pounce. Please see their labels for specific use instructions.

University of Tennessee Extension, 2020

Application Rate Comparisons:



Product	Active Ingredient	Rate	Rate*	Rate
		mg/seed	oz. per 1000 foot row	oz. per acre
Poncho 250	clothianidin	0.25	0.0167	0.29
Poncho 1250	clothianidin	1.25	0.0835	1.46
Capture (LFR 1.5)	bifenthrin		0.2 -0.78	8.71 – 33.98

Based on 33,000 seeds per acre with 30-inch rows

Broadcast spray

Environmental Benchmarks

- Part Per Billion (PPB) = 1 cent in $10,000,000 or 1 second in 32 years
- Aquatic invertebrate values = Most conservative (restrictive)
  - Used as comparison in water results
- Aquatic invertebrate values = Most closely related to terrestrial insects
- **Note**: Thiamethoxam degrades into Clothianidin

Environmental benchmarks in parts per billion (ppb)

Pesticide	Year Updated	Fish		Aquatic Invertebrates		Nonvascular Plants	Vascular Plants
		Acute	*Chronic*	*Acute*	*Chronic*	*Acute*	*Acute*
Imidacloprid	2017	114500	9000	0.385	0.01		
Thiamethoxam	2017	> 57000	20000	17.50	0.74	> 99000	> 90200
Clothianidin	2016	> 50750	9700	11.00	0.05	64000	> 280000
Chlorantraniliprole		> 6900	110	5.80	4.47	1780	> 2000

*All units ug/L or parts per billion (ppb); data updated 1/2020

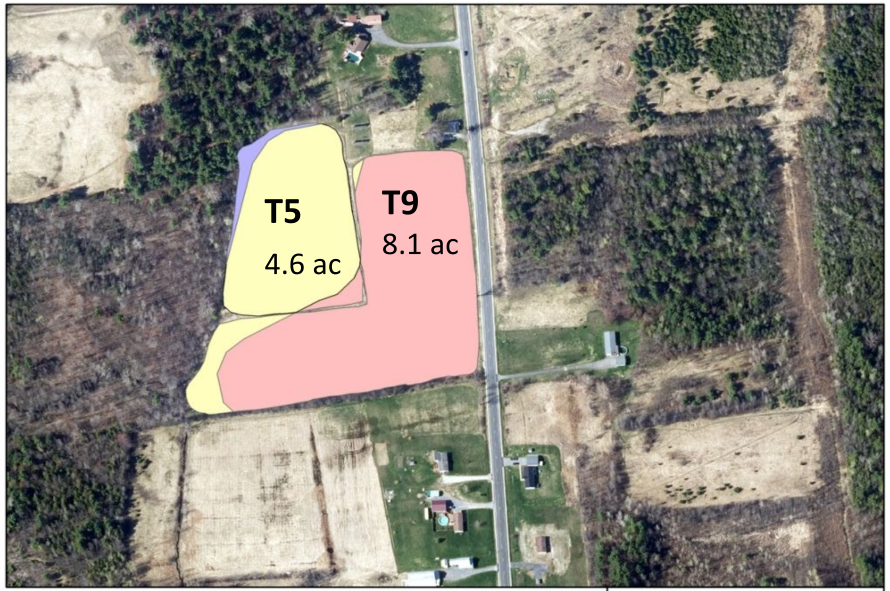
NRCS Edge-of-field Study at Miner Institute

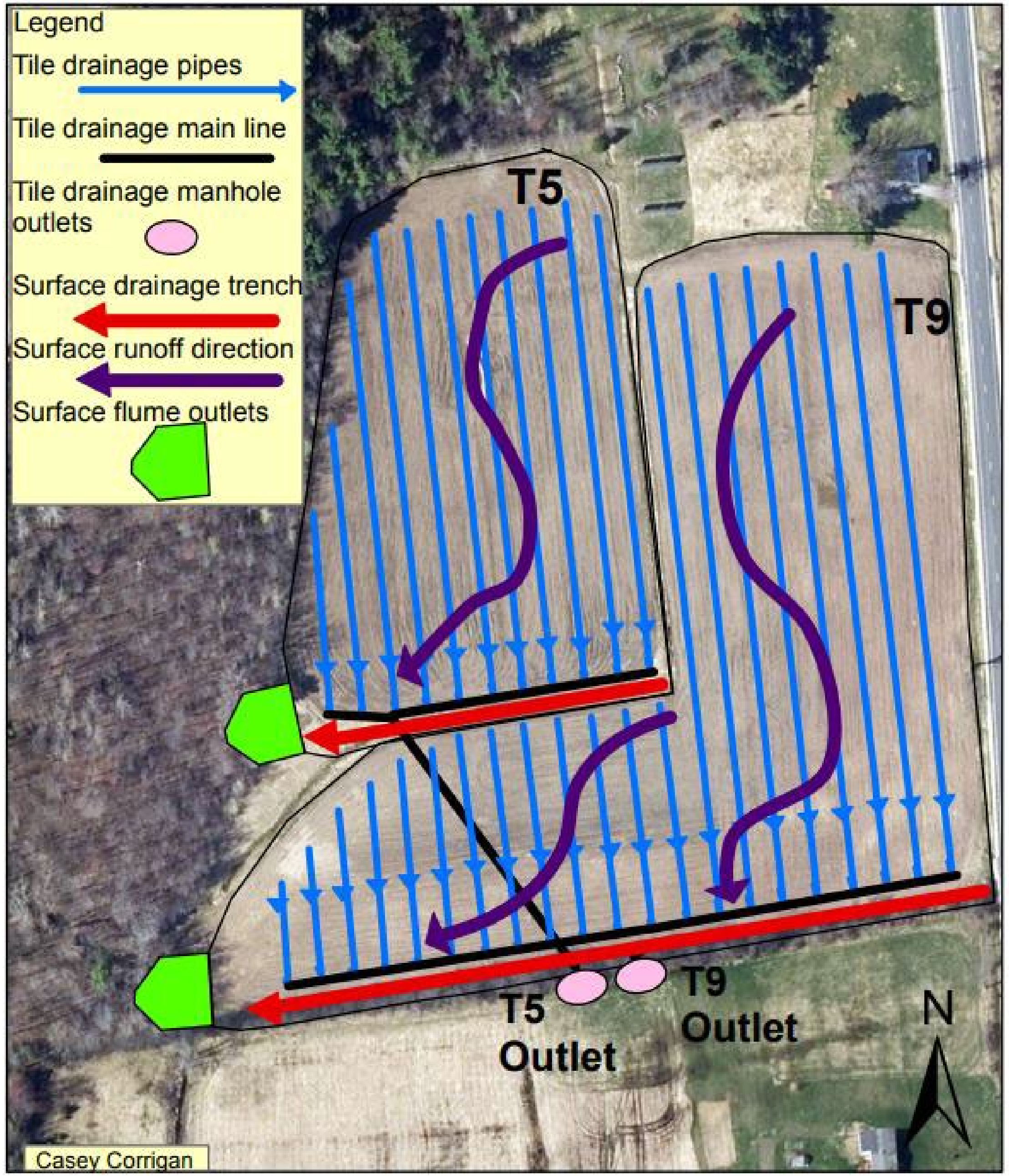
Objective:

- Measure P, N, and TSS exports from tile drainage and surface runoff
- 2-year baseline, 4-year treatment period
- Drainage water management (DWM) initiated Dec. 2017

Site:

- Chazy, NY
- Small paired watersheds (4.6 & 8.1 ac fields)
- 4 ft tile depth; 35 ft lateral spacing
- 1-2% field slope
- Corn for silage, winter fallow period
- Planting dates: 5/25/17, 5/16/18, 5/30/19
- Following fall corn harvest, manure applied and incorporated w/ disk harrow (~30% surface residue)




Legend
Tile drainage pipes
Tile drainage main line
Tile drainage manhole outlets
Surface drainage trench
Surface runoff direction
Surface flume outlets
T5
T9
T5 Outlet
T9 Outlet
N
Casey Corrigan

Drainage water management

How it Works

After Harvest
1 ft drainage

Before Planting or Harvest
4 ft drainage

After Planting
2.5 ft drainage

Illustrations Credit: Dr. Jane Frankenberger, Purdue University

Drainage water management


www.croplife.com

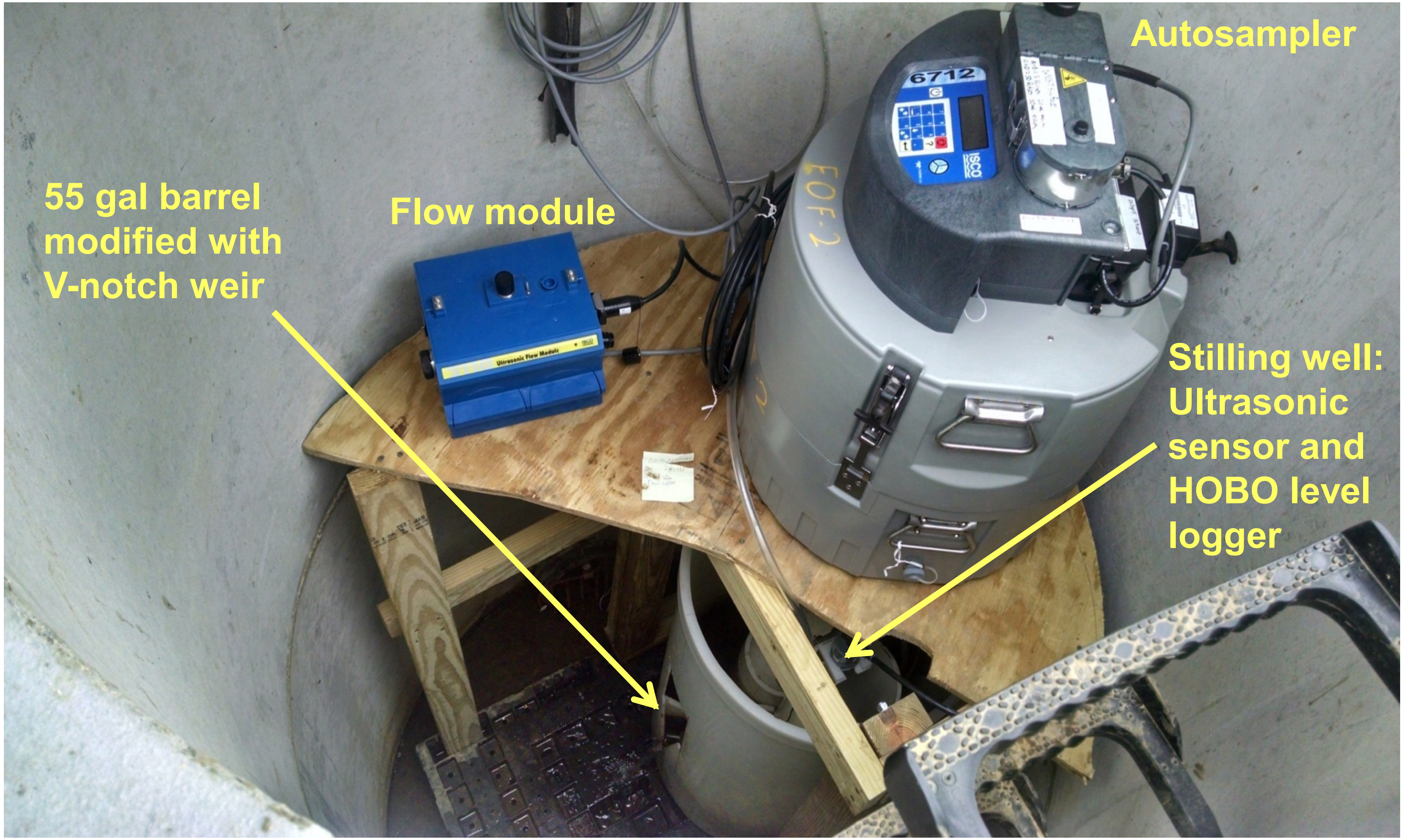

www.nrcs.usda.gov

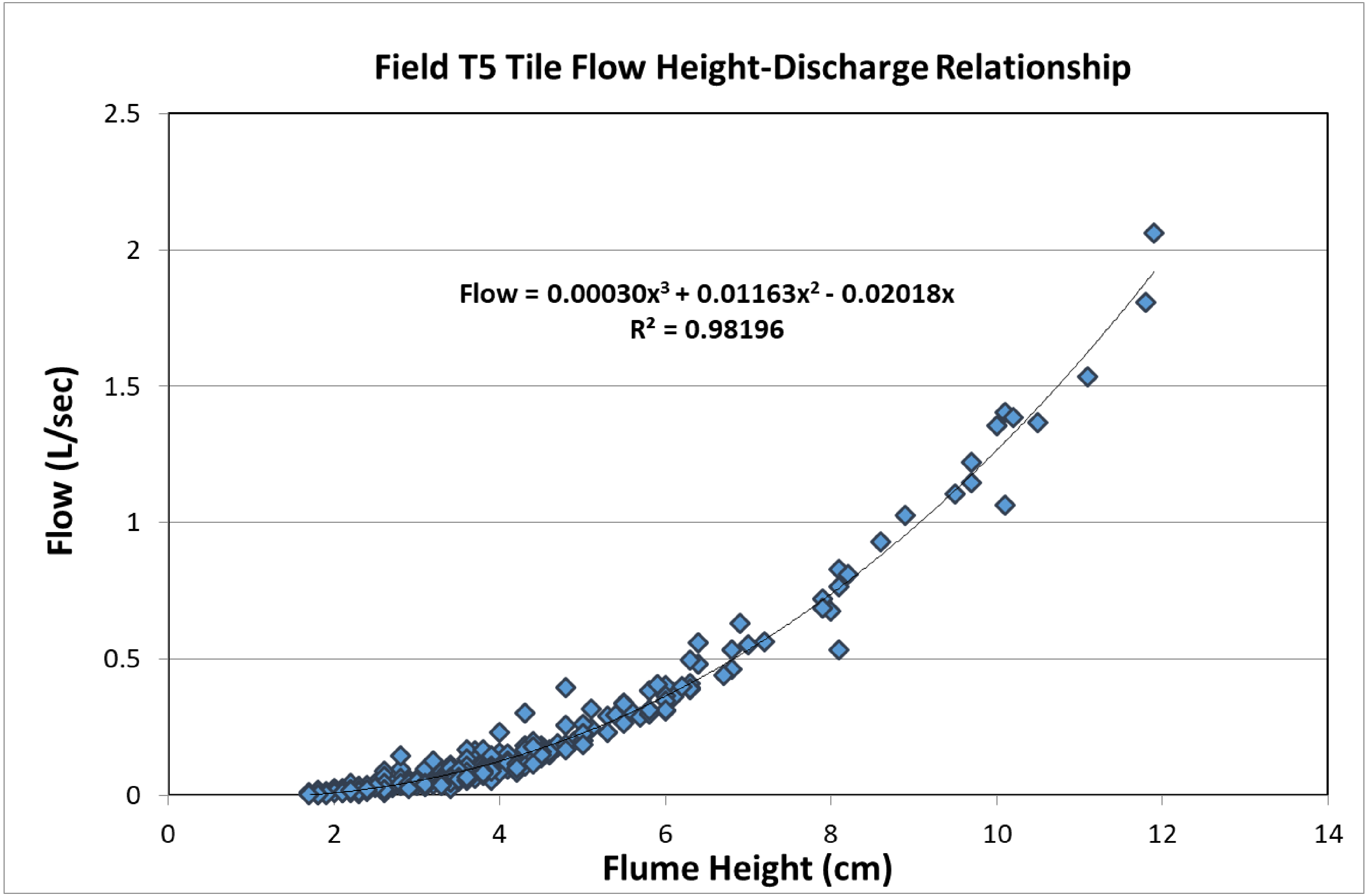
www.agbmps.osu.edu

Runoff Monitoring and Sampling

- Flow-based sampling: 200 mL/0.36 mm of runoff
- Total suspended solids (sediment), total N, nitrate-N, ammonium-N, total P, and dissolved reactive P

Tile Drainage Monitoring

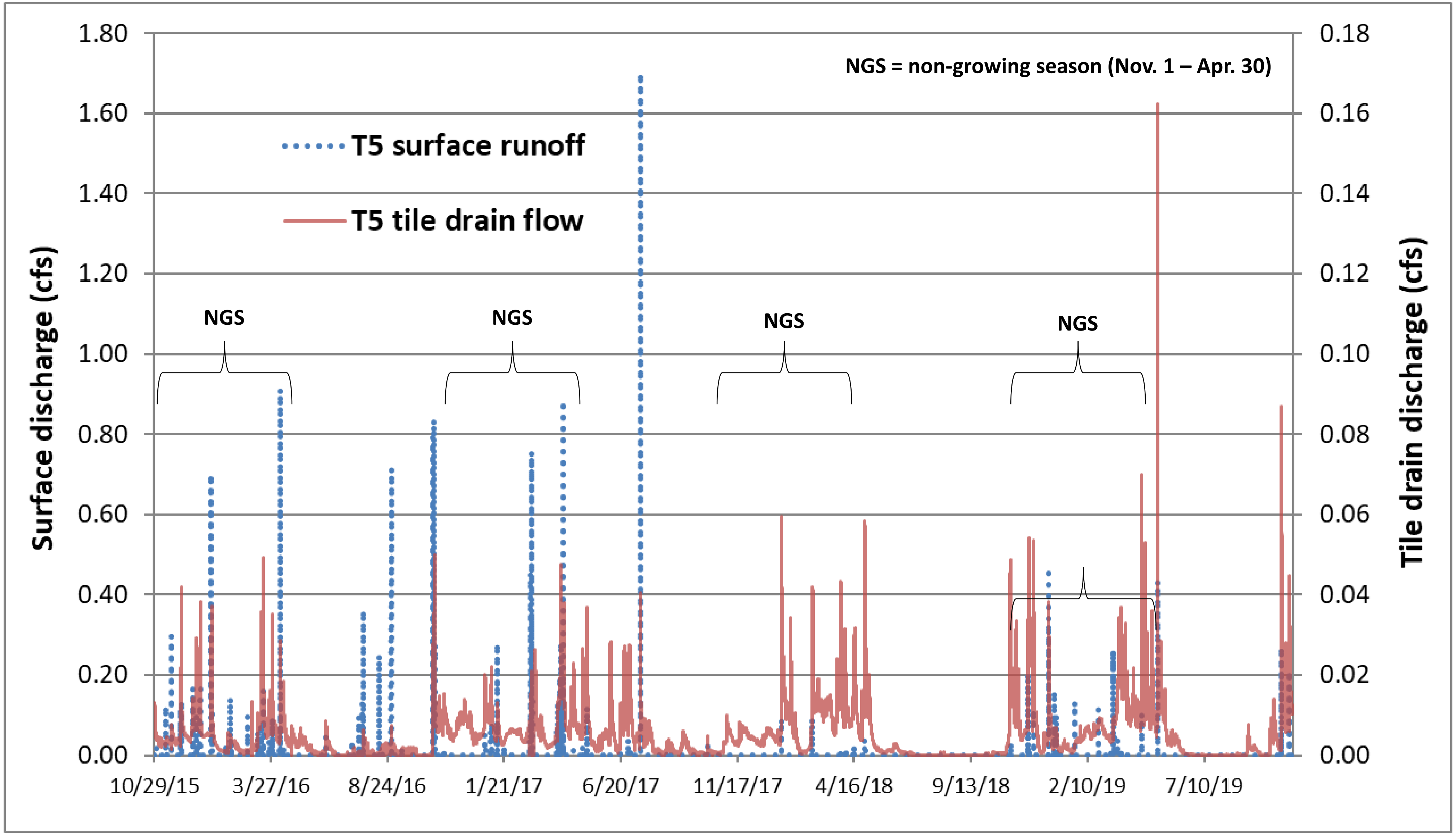




Field T5 Tile Flow Height-Discharge Relationship
Flow = 0.00030x³ + 0.01163x² - 0.02018x
R² = 0.98196
Flow (L/sec)
2.5
2
1.5
1
0.5
0
0
2
4
6
8
10
12
14
Flume Height (cm)

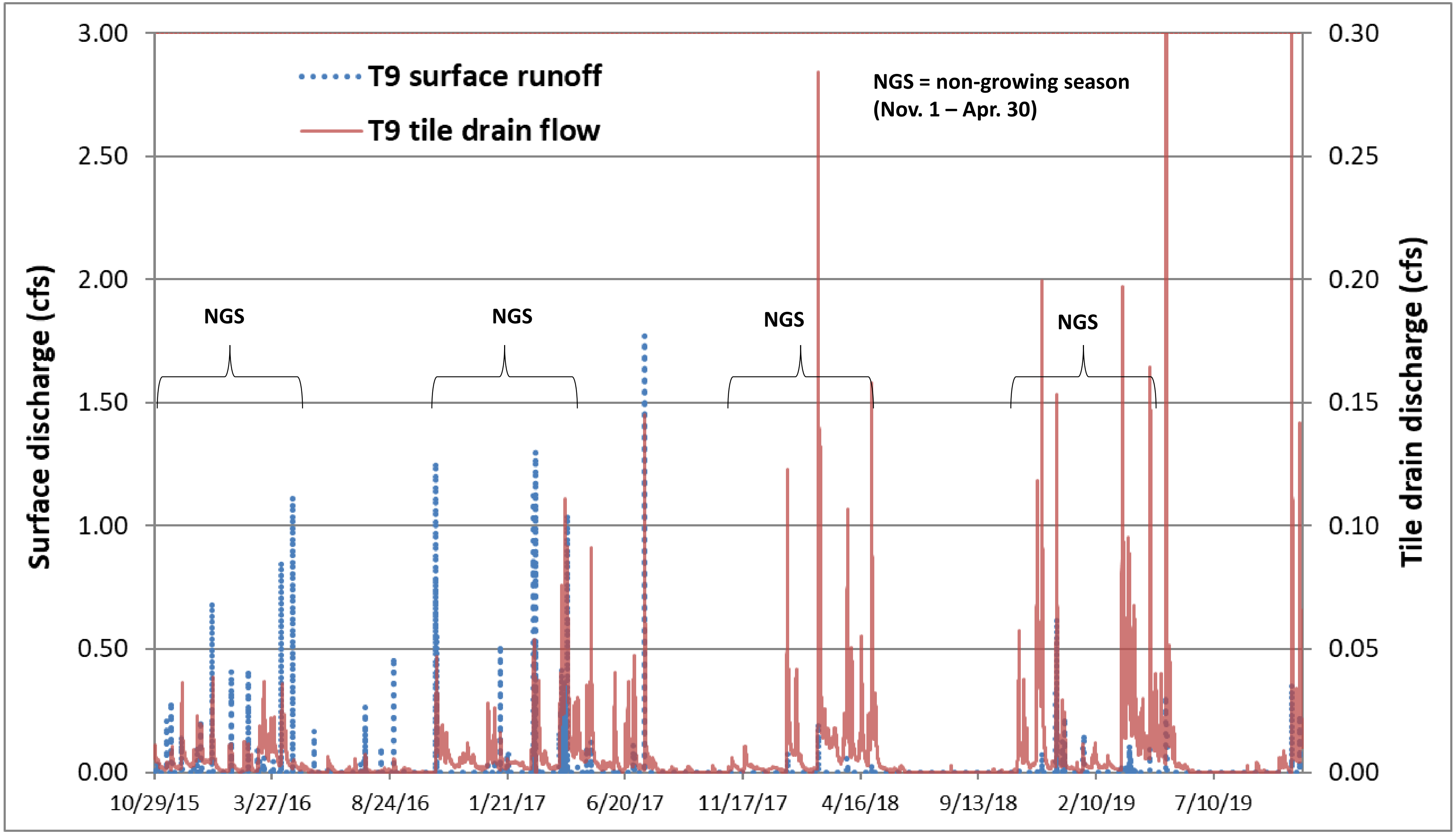
Field T5 Discharge

Tile flow contribution:
2016 = 58%   2017 = 75%
2018 = 96%   2019 = 84%



Field T9 Discharge

Tile flow contribution:
2016 = 47%   2017 = 59%
2018 = 94%   2019 = 90%



New York Subsurface and Surface Water, (2017-2019)

- Collaboration with Miner Institute, Chazy, NY
- Samples from edge-of-field research project
  - Comparing subsurface tile and surface water
  - Dependent on precipitation
  - Fields - continuous corn
  - Seed treated with neonicotinoids 2017-2018
  - Seed treated with insecticide Lumivia 2019

New York Subsurface and Surface Water, (2017-2019)

- 169 Subsurface water samples analyzed
- 29 Surface water samples analyzed
- No detections of imidacloprid
- All detections of clothianidin and thiamethoxam were below acute toxicity levels for aquatic invertebrates.
- Detections occurred during planting or in the fall when plant debris was incorporated
- No implications for chronic exposure exceedances

Vermont Surface Water

- 2014 – 2019: 382 surface waters tested
  - Areas of high agricultural use
  - 1 positive for imidacloprid
    - Below acute benchmark
  - More detections thiamethoxam and clothianidin
    - Usually at time of planting
  - No implications for chronic exposure exceedances

A surface water sampling site.

Summary of neonicotinoid results from the surface water samples.

Neonicotinoid	Positive detection	Detection range	Acute benchmark*	Results ≥ Acute benchmark*
	#	ppb	ppb	#
Thiamethoxam	15	0.052 - 0.575	17.50	0
Clothianidin	18	0.059 - 0.50	11.00	0
Imidacloprid	1	0.203	0.385	0

*aquatic invertebrates

No Acute Toxicity

Vermont Soil

2016 Sampling

- High agricultural use; corn, soy/corn, soy/soy, & alfalfa/grass
- Three dates; June, September, & December
- Three depths; 0-12, 12-24, & 24-36 inches
- Next to tile drains.

Results

- Corn fields = several positive detections of thiamethoxam & clothianidin (2.08 -14.13 ppb)
  - Most during planting (June)
  - 0 – 12 inches
- Soy field = positive detection of imidacloprid (6.43 ppb)
  - 0 - 12 inches

Vermont Vegetation

Question: Are neonicotinoids being taken up by non-crop plants?

A vegetation sample taken from water sampling areas

- **Sampling:**
  - September 2015 & 2016
  - Vegetation collected from surface and tile drain water sampling areas in Franklin county
  - Goldenrod = forage source for pollinators-later season
  - Positive control = corn leaves from treated seed
  - Corn leaves **<u>only</u>** positive detection
    - Clothianidin (2.91 ppb)

Vermont Beehive Wax Analysis, 2018

- Sponsored by USDA and the Bee Informed Partnership
- Wax from 5 hives sampled twice
  - Spring (June)
  - Fall (Sept. – Oct.)
- Commercial beekeepers:
  - Addison county
  - Franklin county
  - Rutland county
- Wax analyzed for **193** pesticides:
  - Pesticides found at reportable levels = **10**
  - Pesticides used in beekeeping = **5**
  - No neonicotinoids detected

Vermont Beehive Wax Results, 2018

Pesticides Used in Beekeeping:

Spring:

Pesticide	Type	Positive Detections (number)	Positive Detection Range (ppb)	Detection Limit (ppb)
Amitraz (2,4 DMPF)	Varroacide	2	309 - 2,100	25.0
Coumaphos	Varroacide	5	13.00- 2,480	15.0
Coumaphos oxon	Varroacide	5	3.00 - 281	1.0
Fluvalinate	Varroacide	3	51.0 - 1,850	50.0
Thymol	Varroacide	3	74.0 - 4,290	25.0

Environmental benchmarks for aquatic invertebrates

Pesticide	Acute benchmark (ppb)
Amitraz (2,4 DMPF)	17.5
Coumaphos	0.037

Fall:

Pesticide	Type	Positive Detections (number)	Positive Detection Range (ppb)	Detection Limit (ppb)
Amitraz (2,4 DMPF)	Varroacide	2	623 - 1,800	25.0
Coumaphos	Varroacide	5	15.0 - 218	15.0
Coumaphos oxon	Varroacide	5	2.00 - 27.0	1.0
Fluvalinate	Varroacide	2	218 - 612	50.0
Thymol	Varroacide	3	29.0 - 15,200	25.0

Vermont Beehive Wax Results, 2018

Additional Pesticides Detected:

Spring:

Pesticide	Type	Positive Detections (number)	Positive Detection Range (ppb)	Detection Limit (ppb)
Atrazine	Corn herbicide	3	3.00 - 4.00	3.00
Carbendazim (MBC)	Fungicide	1	95.0	25.0
Diuron	Herbicide	1	14.0	5.0
Fluometuron	Cotton herbicide	1	5.00	2.0
Propargite	Insecticide/Miticide	2	7.00 - 17.00	5.0

No registered used in Vermont, 2010-2018

Fall:

Pesticide	Type	Positive Detections (number)	Positive Detection Range (ppb)	Detection Limit (ppb)
Carbendazim (MBC)	Fungicide	1	84.0	25.0
Diuron	Herbicide	1	15.0	5.0
Fluometuron	Cotton herbicide	1	6.00	2.0
Propargite	Insecticide/Miticide	3	5.00 - 17.00	5.0

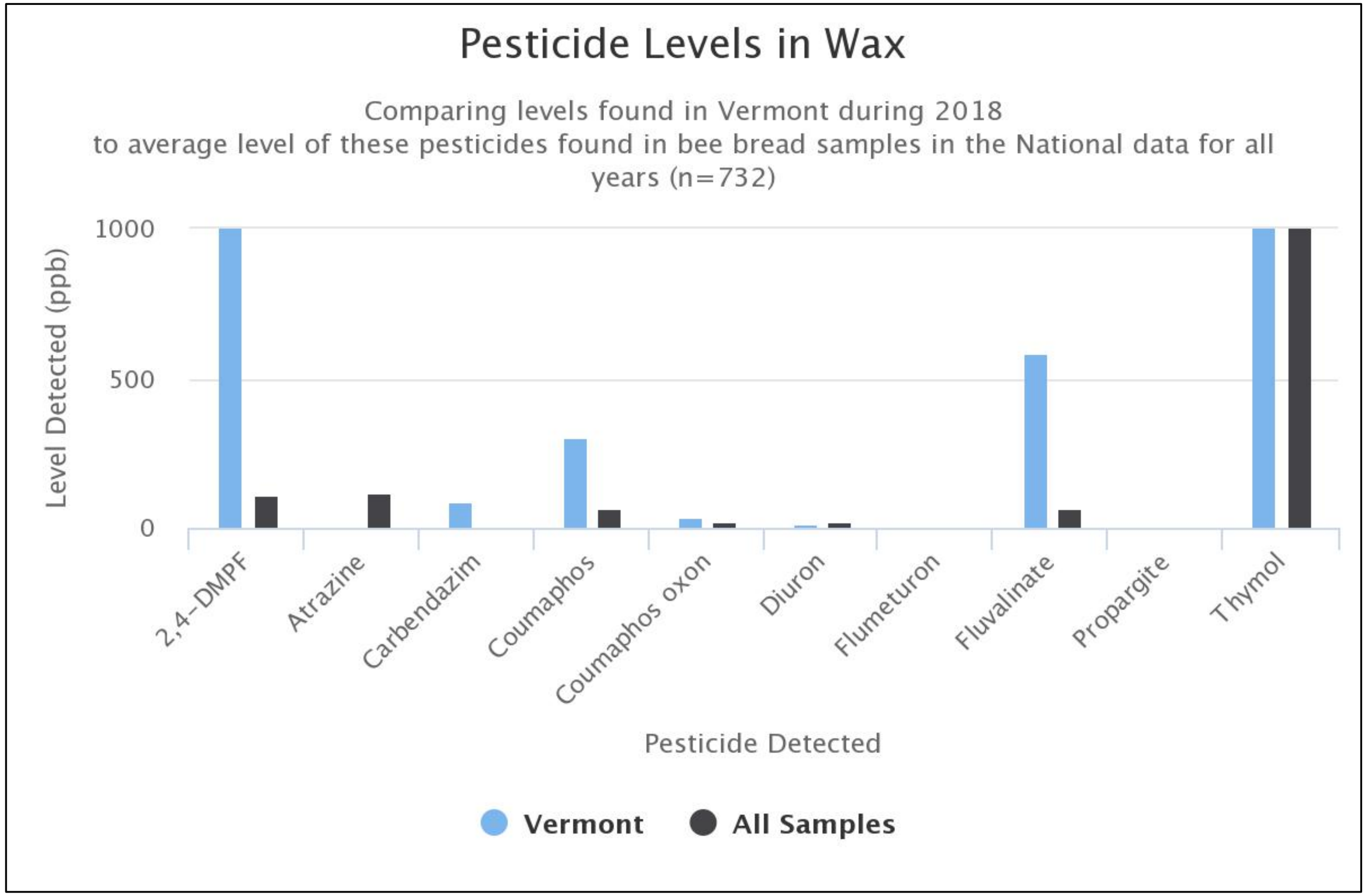
Vermont Beehive Wax Results, 2018

Unquantifiable Pesticide Detections:

Pesticide	Type
Acetochlor	Herbicide
Boscalid	Fungicide
Chlorothalonil	Fungicide
Chlorthal-dimethyl (DCPA)	Herbicide
DDE p,p’	Insecticide
DEET	Insecticide
Diphenylamine	Herbicide
Fenamidone	Fungicide
Fenpyroximate	Varroacide
Fluopyram	Fungicide
Hexythiazox	Insecticide
Metolachlor	Herbicide
Piperonyl butoxide	Insecticide
Trifluralin	Herbicide

- Total = 14
- Fungicides = 4
- Herbicides = 5
- Insecticides = 4
- Varroacide = 1

Vermont vs. National Average, 2018



United States Department of Agriculture

The Bee Informed Partnership
at beeinformed.org
funded by USDA National Institute of Food and Agriculture

Moving Forward:

- The Agency will continue to monitor waters throughout the state to determine if there's a need for regulatory action.
- Miner Institute continues donating their time and resources to increase our dataset.
- 2020 the EPA proposed new interim registration decisions for neonicotinoids, that’s currently open for public comment.