Neonicotinoid Education & Research

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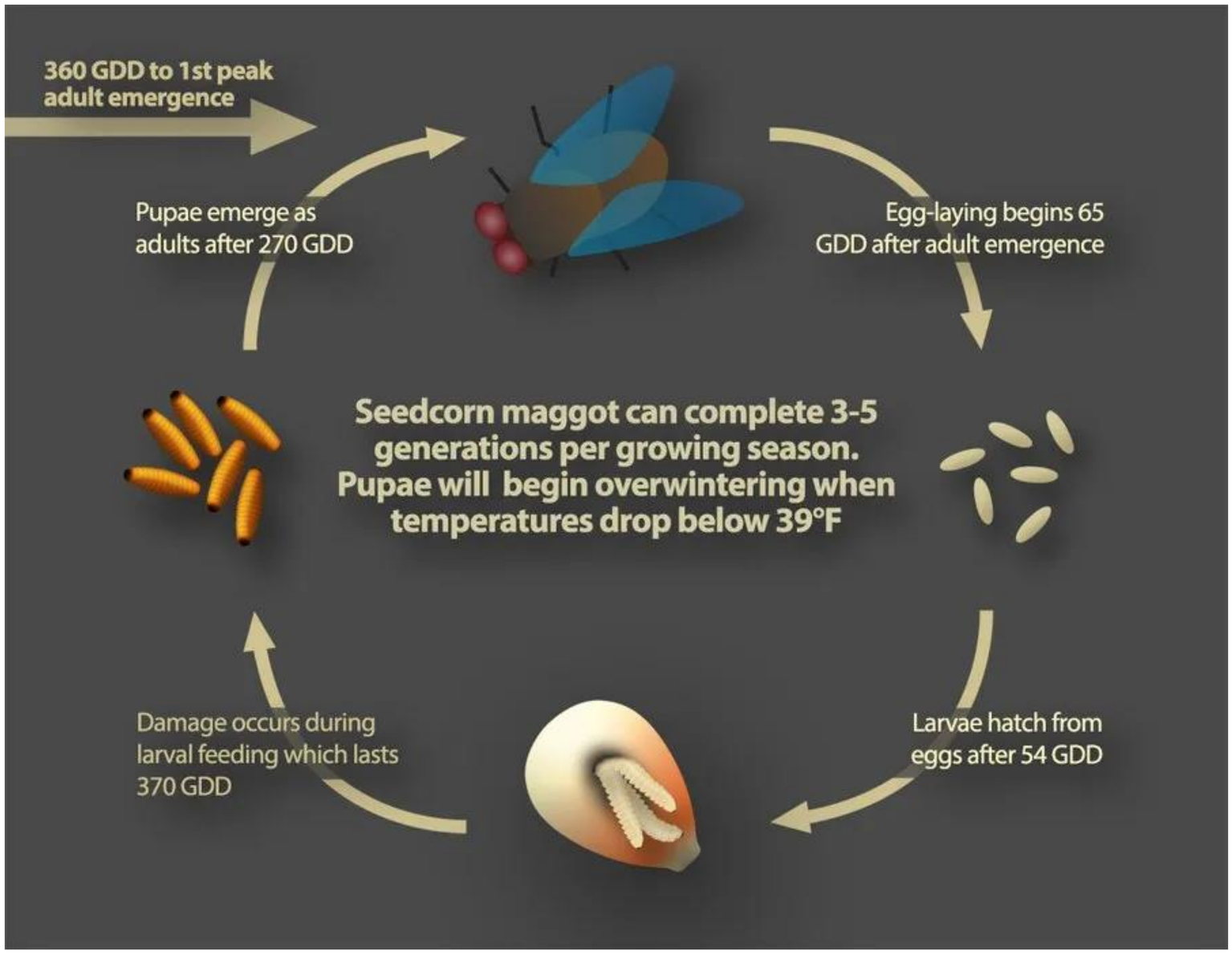
University of Vermont Extension


360 GDD to 1st peak adult emergence
Egg-laying begins 65 GDD after adult emergence
Larvae hatch from eggs after 54 GDD
Damage occurs during larval feeding which lasts 370 GDD
Pupae emerge as adults after 270 GDD
Seedcorn maggot can complete 3-5 generations per growing season. Pupae will begin overwintering when temperatures drop below 39°F

Seed corn maggot

Delia platura

- Occurrence of this pest is not completely predic
but its
- More common under some soil management and cultural practices.
- Seedcorn maggot is mainly an early season pest
- Greater losses in fields with abundant decaying organic matter, such as manure and green plant residues
- Fields at highest risk of severe infestations include
  - heavily manured fields
  - old pastures and hay fields that have recently been plowed under,
  - fields with heavy-textured or wet soils, or fields with naturally high organic matter levels.
  - The incorporation of cover crops into soil may also increase the risk of seedcorn maggot infestation.

Seed corn maggot

- Larvae feed on germinating seeds or seedlings of corn and soybean
- Feeding can delay development or kill the plant.
- Plant injury is especially prevalent during cool and wet springs when plants are growing slowly.
- Infestations tend to be field-wide instead of in patches like for many other pests.

Delia platura

Cultural Controls

- There are no rescue treatments other than re-planting
- Cultural practices that speed germination and plant emergence will help reduce crop losses
- Delaying planting until soil is warm allows for rapid germination and early seedling growth
- Maggot flies are attracted to decaying vegetation
  - plowing in sod, green manures or animal manures at least two to three weeks in advance of planting is recommended
- Maggot populations are generally higher after a legume (e.g., beans) is incorporated into the soil than where a grass is incorporated.
- Conservation tillage can result in lower seedcorn maggot populations
  - plant residues occur mainly on the surface of the soil rather than being incorporated into the soil where decomposition occurs.

Tillage, Cover Crops and Seedcorn Maggot

- 2-year study cover crops and tillage (Hammond 1990)
  - Cover crops and residues dramatic effect on populations.
    - Highest in alfalfa followed by rye, soybean residue, and corn residue lowest
    - More maggot with living versus dead residue
  - No-tillage no enhancement of populations

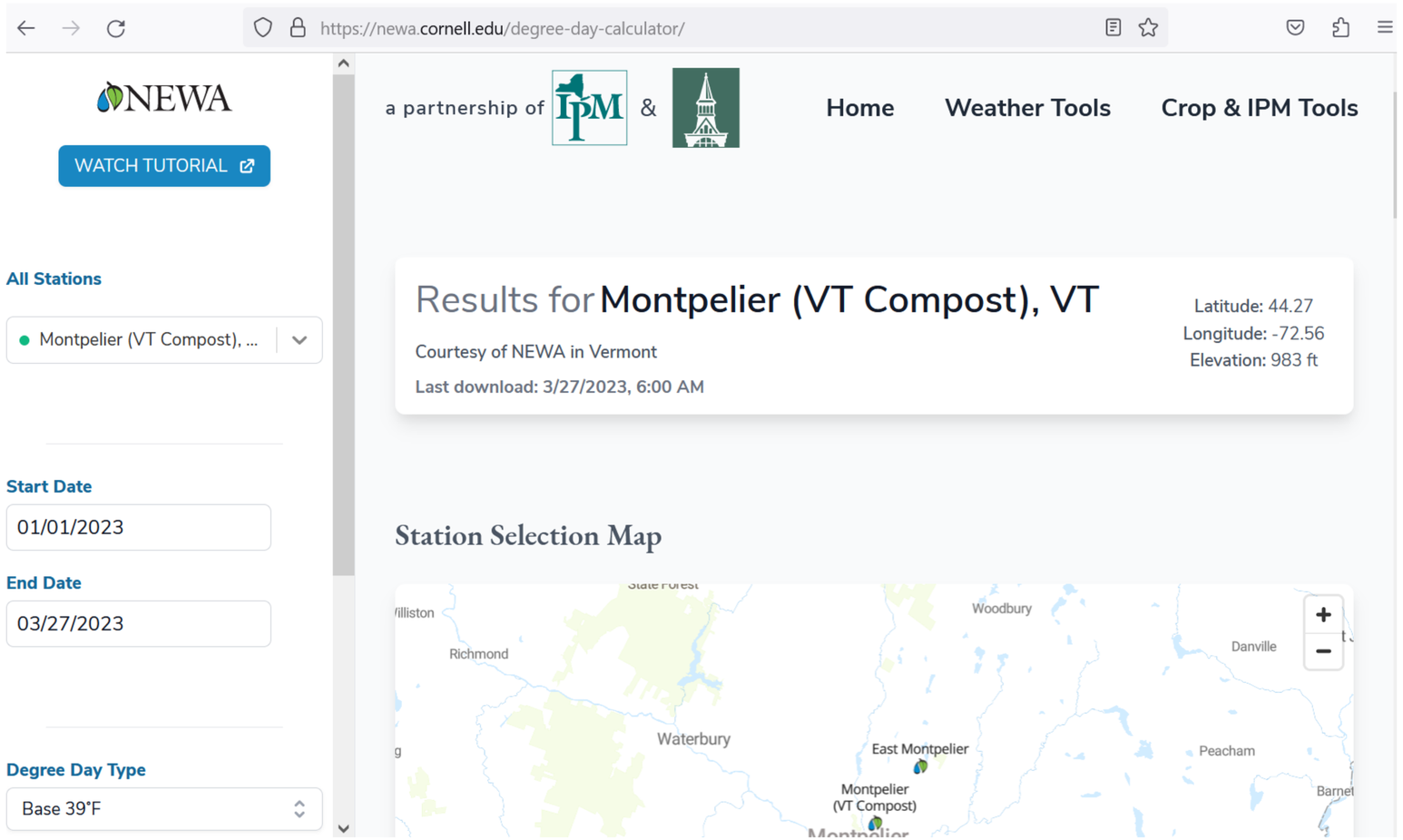
- 2-year study evaluating cover crops (Hammond, 1993)
  - Spring tillage of cover crops or green living organic matter increased maggot damage.
  - Wait 2.5 to 3.0 weeks following incorporation.

- 12-year study evaluating tillage practices (Hammond, 1997)
  - No-till with little disturbance had few adults
  - Chisel plow slight increase
  - Plowing and disking highest levels

“Fly-Free” Period

- Plant the field during a “fly-free" period between fly generations.
- Peak fly emergence estimated by accumulating GDDs above 39F after January 1.
- Peak emergence of the overwintering generation in the spring occurs at 360 GDD after January 1.
- Peak emergence can be monitored using yellow sticky cards.
- A “fly-free" period occurs 450 GDD after this peak adult emergence.

Growing Degree Day Calculators



Wireworms

- Wireworms are the soil-dwelling larvae of click beetles
- Resemble mealworms and are slender, elongate, yellowish to brown with smooth, tough skin.
- Wireworms may remain in the soil as larvae from 1 to 3 or more years, depending upon the species and the food supply.

Wireworm Damage

- Wireworm damage to crops often is confined to certain areas of a field
- Stand losses can vary from zero to 75 or 80 percent.
- The two major species prefer grasses as host plants
- Greatest damage occurs in crops planted in fields that were in grass sod the previous year or two.
- Major crop losses are to corn small grains, and potatoes.

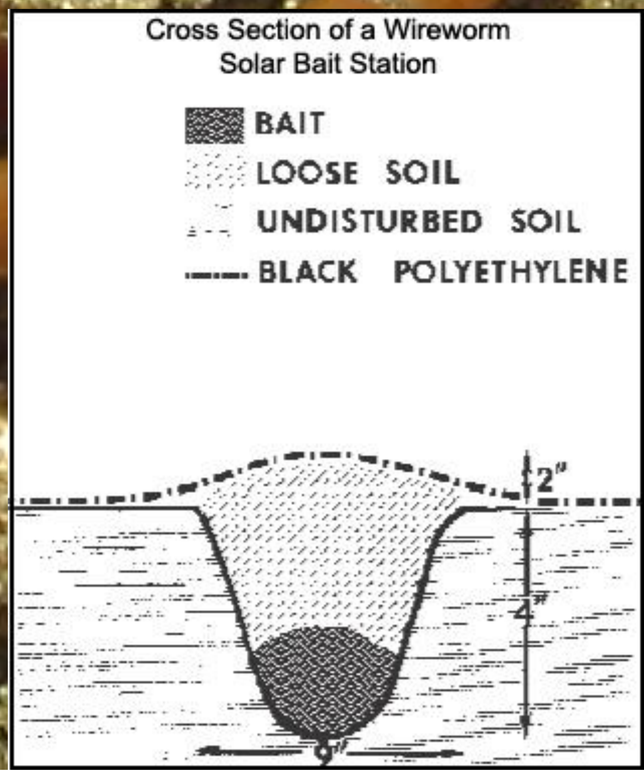
Wireworm Damage on Older Plants

- Slow development of wireworm larvae extends the time that crops planted into an infested field will be subjected to damage.

- Unless wireworms are controlled, moderate to heavy damage can be expected for 2 to 3 years.

Scouting/Monitoring for Wireworm

- Bait stations are a popular method for scouting
- 2 to 3 inch (5-8 cm) deep hole with one cup of untreated wheat or shelled corn in it.
- Cover the grain with soil and then a piece of black plastic to increase soil temperature and seed germination.
- Baits should be placed in grassy areas in the field or parts of the field with a wireworm history.
- Use 5-10 bait stations per 30 acre.
- The baits can be checked for wireworms after two weeks.
- The economic threshold is an average of 1 wireworm per bait station for the whole field.
- Ideally bait and scouting should be done in fall when temperature still above 45F.



Other Scouting

Using a shovel - dig down about 10 inches and lift the shovel of soil for examination.

Round the soil sample off to approximately 6 inches in diameter.

Sift through at least 20 shovels of soil from different locations in the field to check for wireworms.

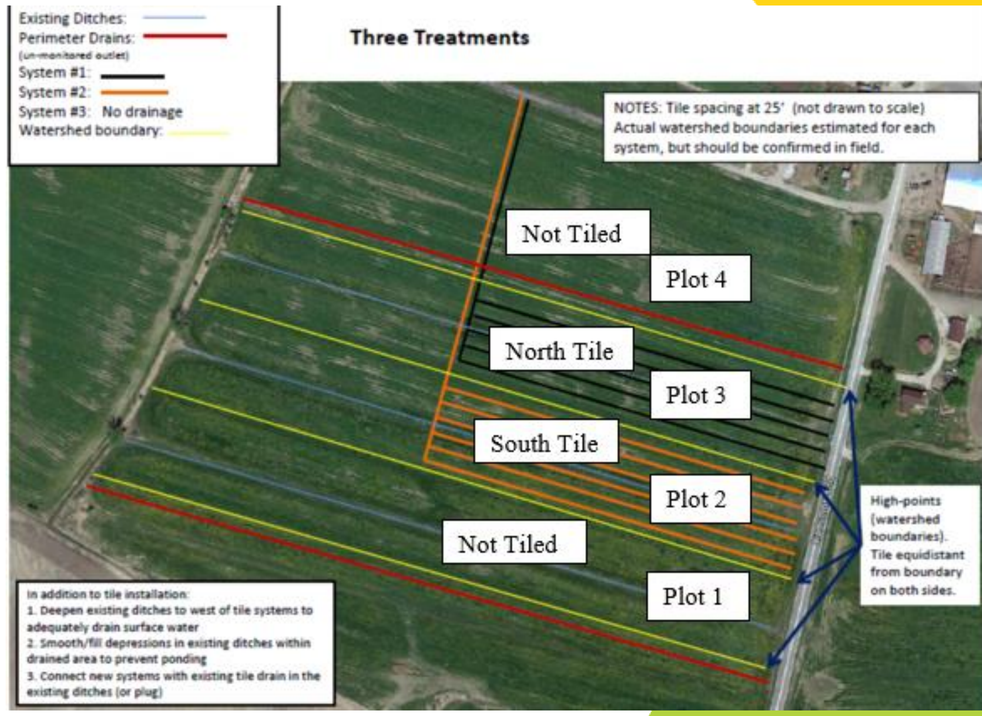
An average of one wireworm per shovel of soil = 20,000 wireworms per acre.

Economic injury level for corn is an average of 2 or more wireworms per 10 shovels of soil.

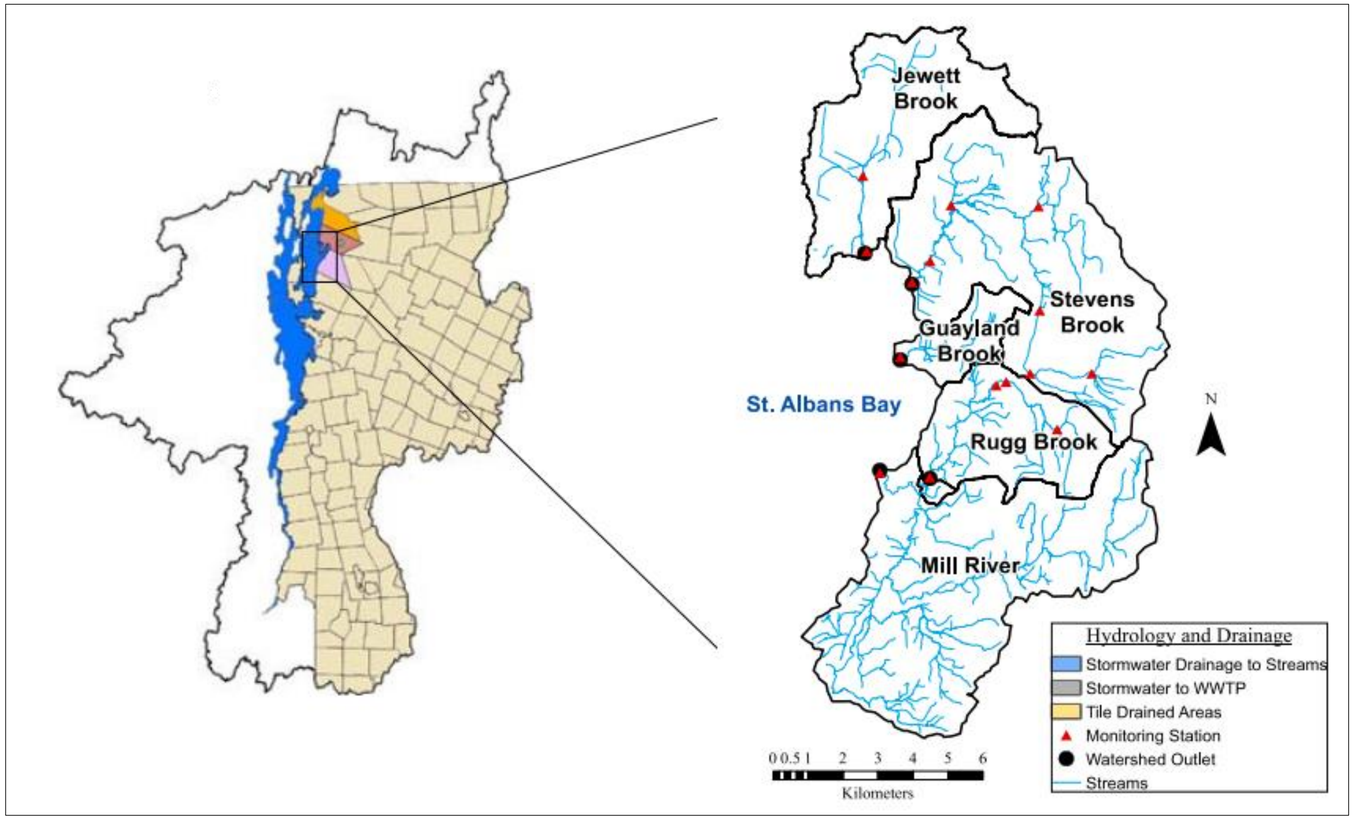
2023 - VT

- Grubs & Wireworms Build Up in Sod Years of Rotation
- Conducive Systems in Vermont

- **Discovery Farm**
  - Assess the impact of management methods on water quality (N&P).
  - Neonicotinoid movement in surface and subsurface water.
  - Neonicotinoids in soil persistence and movement.



Source: Lake Champlain Basin Program.



Source: Gaddis & Voinov, 2010.

Site location: Jewett Brook watershed of the St. Albans Bay, Franklin County

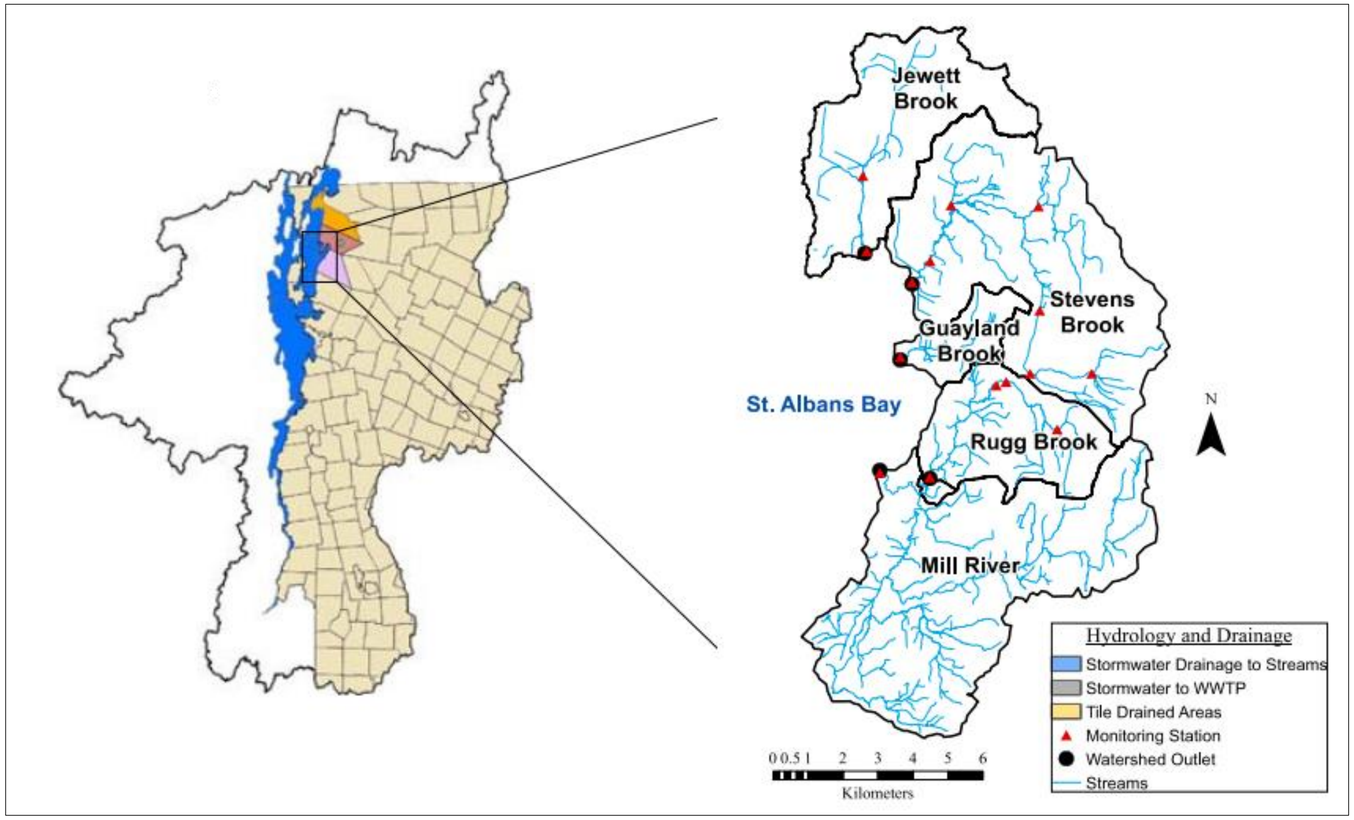
Franklin Co. has the most acres of farmland (15.9%) in the state (USDA NASS, 2017 Census of Agriculture).

Heavy clay, poorly drained soils (Covington Clay)

Water quality issues:

- Impaired watershed & high priority for P reductions
- Shallow bay with substantial accumulated P in sediment and releasing into water column over time
- Frequent eutrophic conditions
  - Reported 0.024-0.058 mg P/L
  - Total P Criterion = **0.017 mg P/L** (annual mean)
  - Overall reduction of **24.5%** needed to meet TMDL

  (US EPA, 2016)



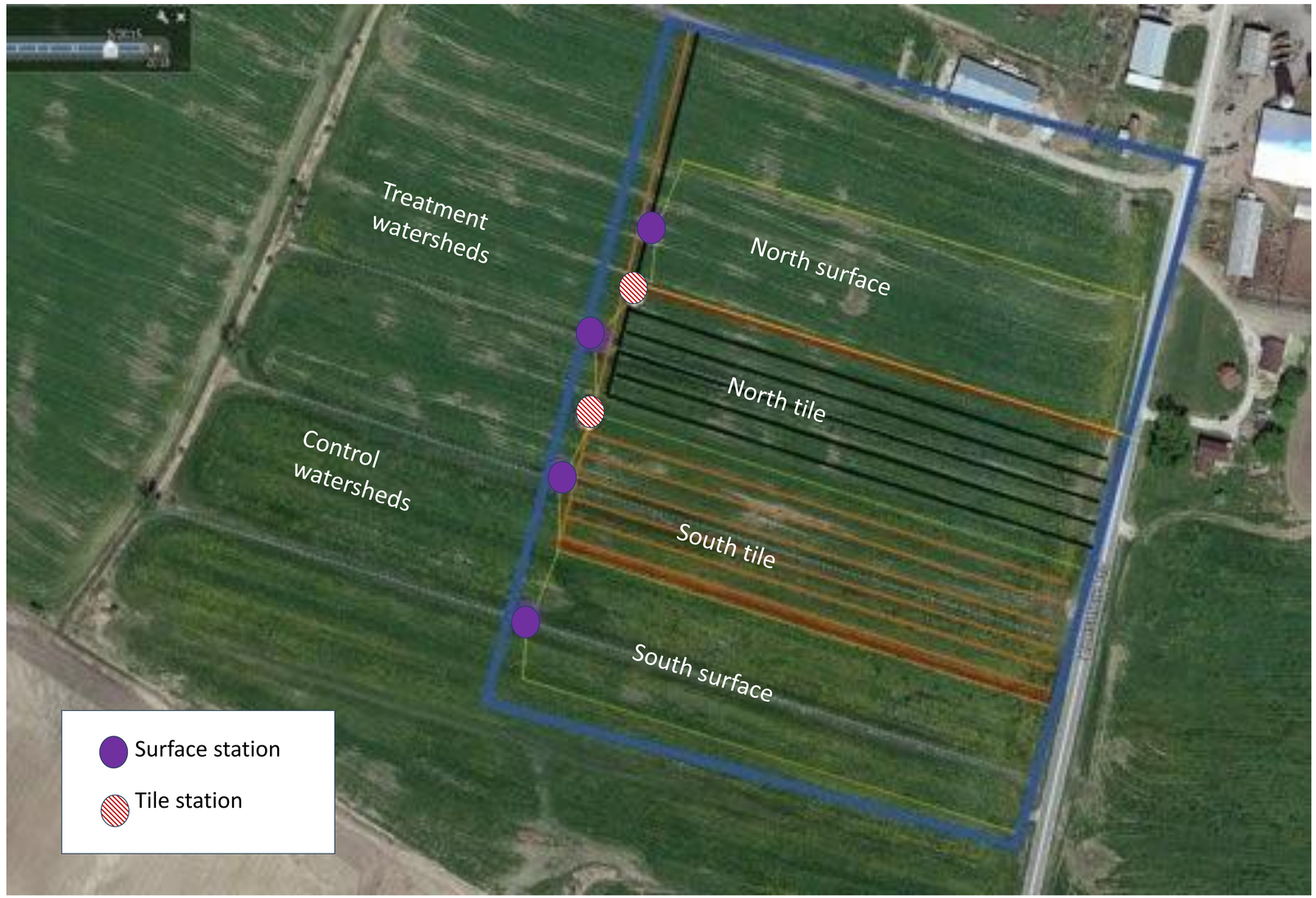
Source: Gaddis & Voinov, 2010.

Paired watershed design with edge-of-field monitoring

2 surface EoF on non-tile drained land
North Surface & South Surface
2 surface & 2 sub-surface (tile) EoF on tile drained land
North Tile & South Tile

6 total water monitoring stations

Watershed		Stations	Station IDs
North Surface	NS	surface	NS-Surface
North Tile	NT	surface and tile	NT-Surface
			NT-Tile
South Tile	ST	surface and tile	ST-Surface
			ST-Tile
South Surface	SS	surface	SS-Surface



Site Design with Four Plots

South surface

No Till

Conventional Management

CONTROL

South tile

Tile Drained

Conventional Management

CONTROL

North tile

Tile Drained

BMP Management

TREATMENT

North surface

No Till

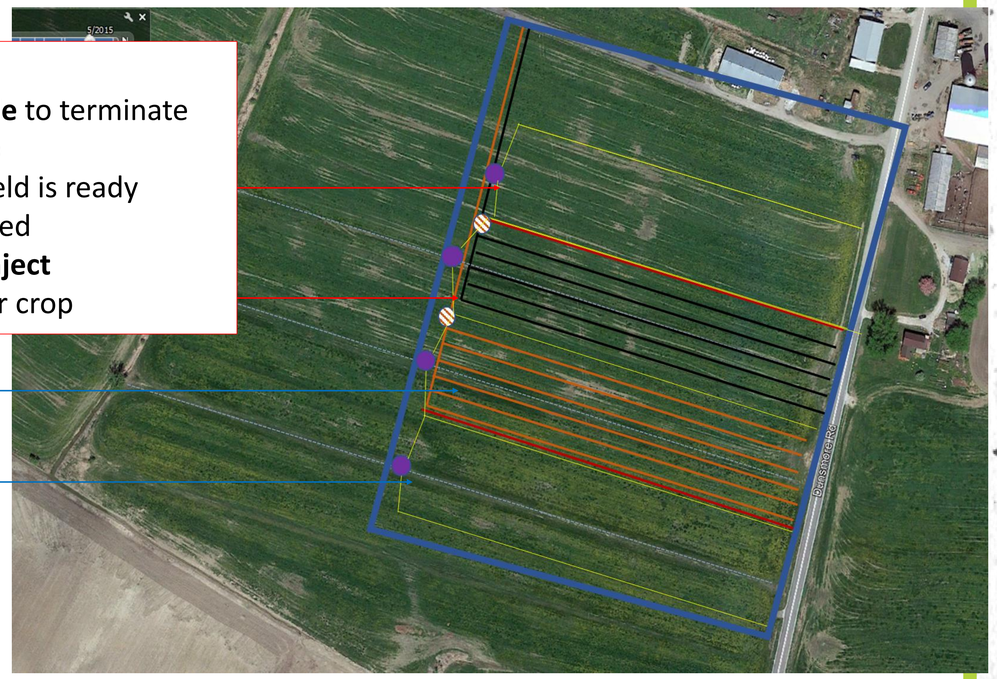
BMP Management

TREATMENT

2020- Site installation
2021 & 2022- Calibration period
2023-Treatment implementation

<u>Control</u>
Herbicide and till to terminate cover crop
Plant when field is ready
Corn harvested
Fall manure broadcast and till
Winter rye cover crop

<u>Trial</u>
Plant green and herbicide to terminate cover crop
No-till plant when field is ready
Corn harvested
Fall manure inject
Winter rye cover crop



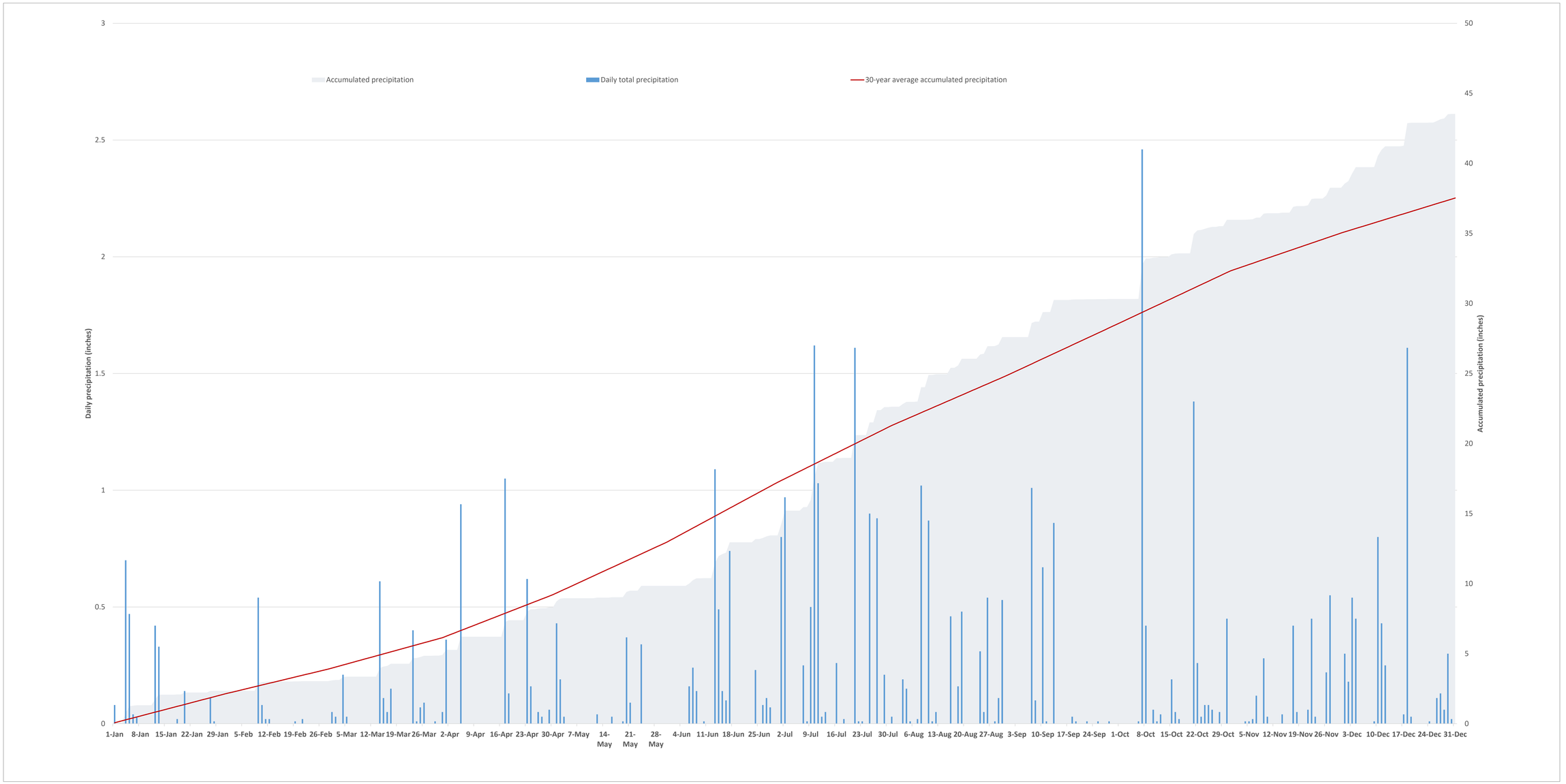


Figure 1. Daily total precipitation and yearly accumulated precipitation at Discovery Acres in 2023.

Sample date	Station ID	Field notes
4/13/2023		Soil sampled at split depths (0-2.5” and 2.5-6”)-*Baseline*
4/29/2023		Cover crop terminated in ST and SS (Control) watersheds
5/15/2023	NT-Tile	Cover crop terminated in NT and NS (Treatment) watersheds
	ST-Tile	Corn planted
5/19/2023	NT-Tile	Soil sampled-*Post planting*
6/14/2023	ST-Tile	
6/16/2023	NT-Tile	
	ST-Tile	
6/18/2023	SS-Surface	
6/20/2023		Soil sampled -*PSNT*
6/22/2023		Side-dress fertilizer application
7/3/2023	NT-Surface	
	NT-Tile	
	NS-Surface	
	ST-Surface	
	ST-Tile	
	SS-Surface	
7/11/2023	SS-Surface	
	ST-Surface	
	NS-Surface	
7/23/2023	NS-Surface	
	NT-Tile	
	ST-Tile	
	SS-Surface	
7/26/2023	NT-Surface	
	ST-Surface	
9/8/2023	NT-Tile	
	ST-Tile	
	SS-Surface	
9/20/2023		Soil sampled-*Pre harvest*
10/2/2023	ST-Tile	Corn harvested
	NT-Tile	Manure injected in NT and NS (Treatment) watersheds
10/6/2023		Manure broadcast and incorporated in ST and SS (Control) watersheds
		Cover crop planted

Sample date	Station ID	Field notes
10/9/2023	ST-Surface	
	ST-Tile	
	SS-Surface	
	NT-Surface	
	NT-Tile	
	NS-Surface	
10/18/2023	NT-Tile	
	ST-Tile	
10/23/2023	SS-Surface	
	ST-Surface	
	ST-Tile	
	NS-Surface	
	NT-Surface	
	NT-Tile	
10/31/2023	NS-Surface	
	ST-Tile	
	SS-Surface	
11/3/2023		Soil sampled at split depths (0-2.5” and 2.5-6”)-*End of season*
11/25/2023	SS-Surface	
	ST-Surface	
11/27/2023	ST-Surface	
	NS-Surface	
	ST-Tile	
11/28/2023	NT-Tile	
12/6/2023	NT-Tile	
	ST-Surface	
	NS-Surface	
12/11/2023	ST-Tile	
	ST-Surface	
	NT-Surface	
12/12/2023	NT-Tile	
	SS-Surface	
	NS-Surface	
12/18/2023	SS-Surface	
	NS-Surface	
	ST-Tile	
	ST-Surface	
12/19/2023	NT-Tile	
	NT-Surface	

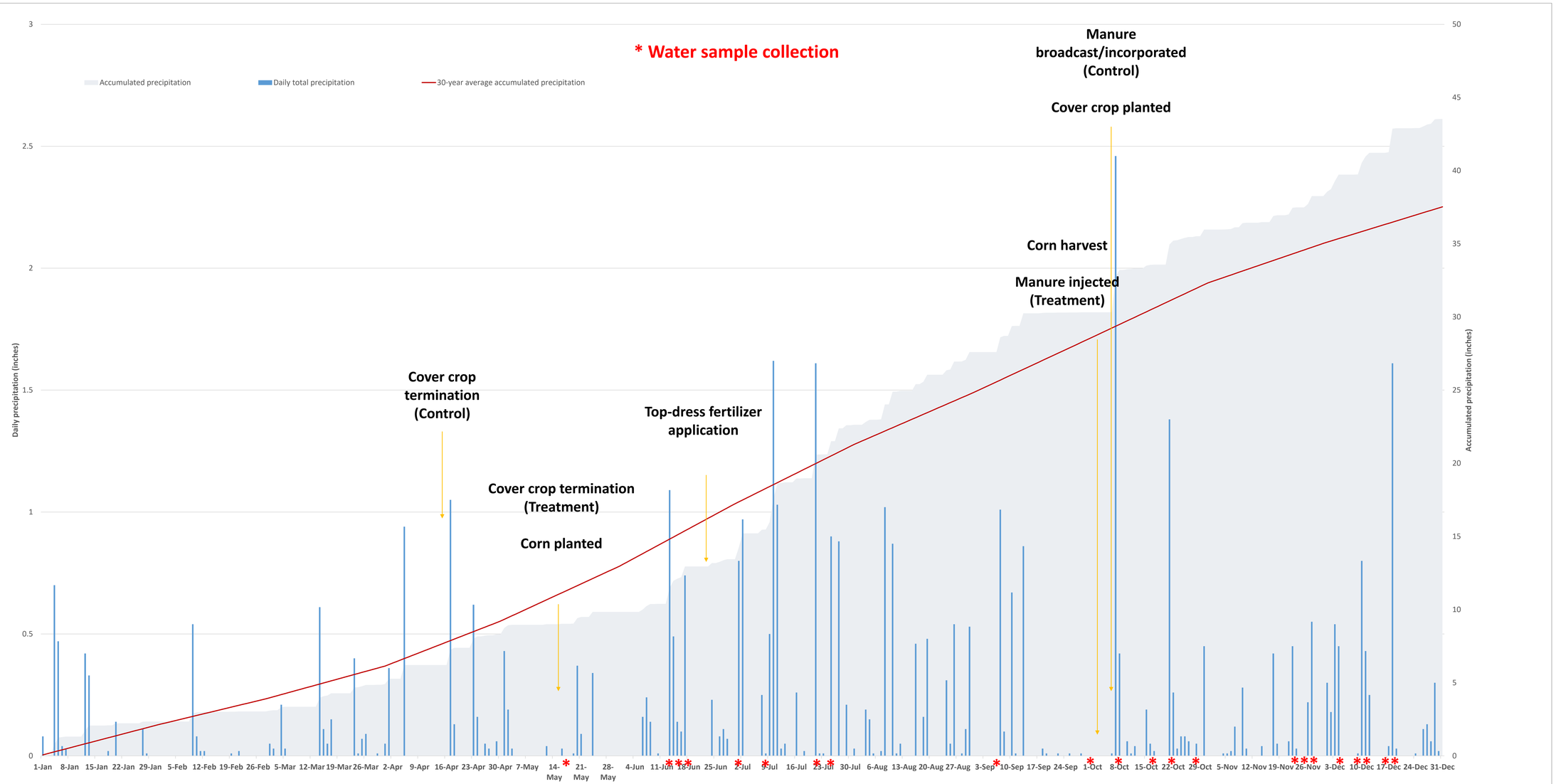


Figure 2. Daily total precipitation and yearly accumulated precipitation at Discovery Acres in 2023.

Frequency and concentration of clothianidin at different soil depths prior to corn planting & , St. Albans, VT, 2023.

	0 - 2.5 in.		*2.5 - 6 in.*	
	Detects†	Average concentration‡	Detects	Average concentration
	%	ug/kg	%	ug/kg
Pre-plant	87.5	3.95	43.4	4.65
187 DAP (3-Nov)	86.0	5.06	75.0	4.45

† The number of samples with concentration greater than reporting limit (2.0 ug/kg or ppb) divided by total number of samples (n=16), reported as a percentage of samples where analyte was detected.

‡ Average concentration of samples where concentration was greater than reporting limit.

Soil type: Covington clay, poorly drained.

Crop history:
3rd year of corn silage with cover crop

Historic use of neonicotinoid treated seed

Previous crop- alfalfa

DISCOVERY ACRES VERMONT

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Frequency and concentration of clothianidin in soil after planting, St. Albans, VT, 2023.

	0 - 6 in.	
	Detects†	Average concentration‡
	%	ug/kg
4 DAP (19-May)	94.0	4.45
35 DAP (20-Jun)	94.0	3.72
125 DAP (20-Sep)	94.0	5.24

† The number of samples with concentration greater than reporting limit (2.0 ug/kg or ppb) divided by total number of samples (n=16), reported as a percentage of samples where analyte was detected.

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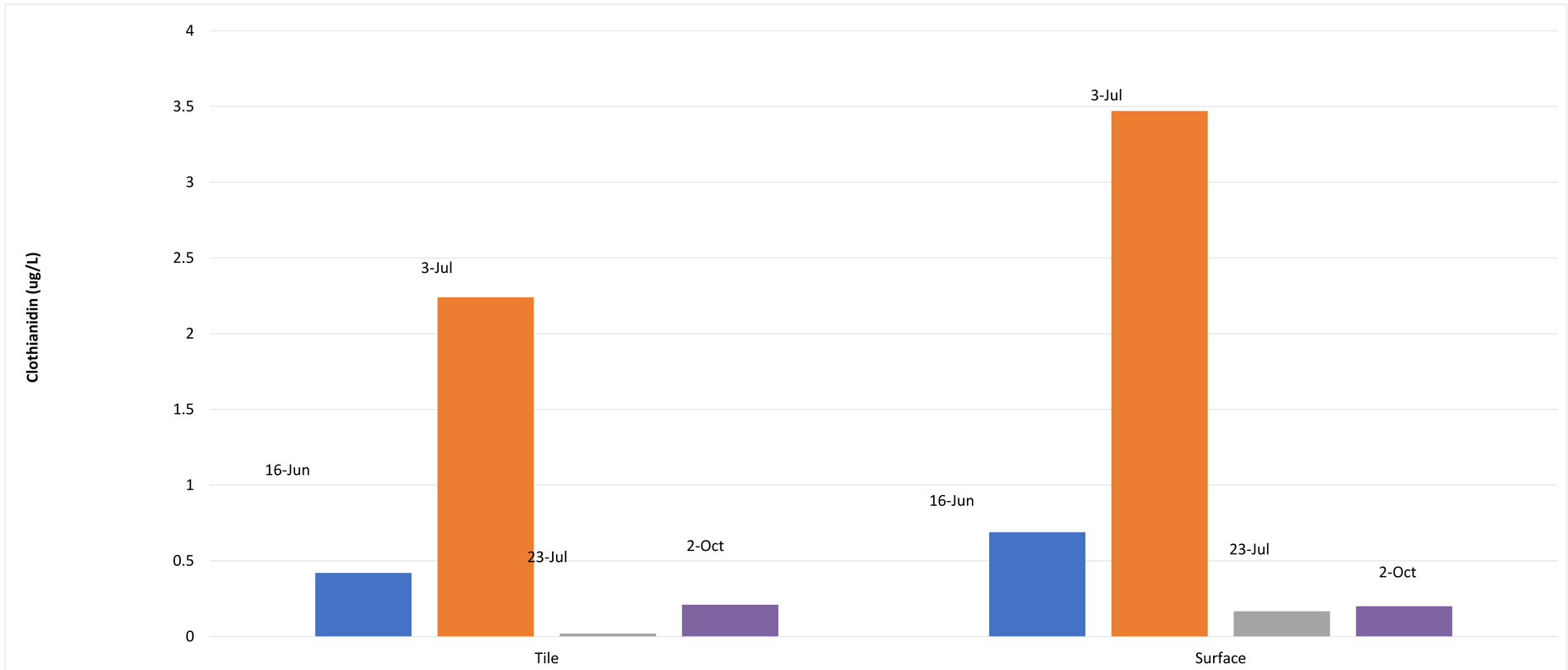

Samples with concentration greater than reporting limit (0.0500 ug/L).

*This is not the loading rate just concentrations from single samples taken from surface or tile when there was water moving off from surface or out of the tiles.

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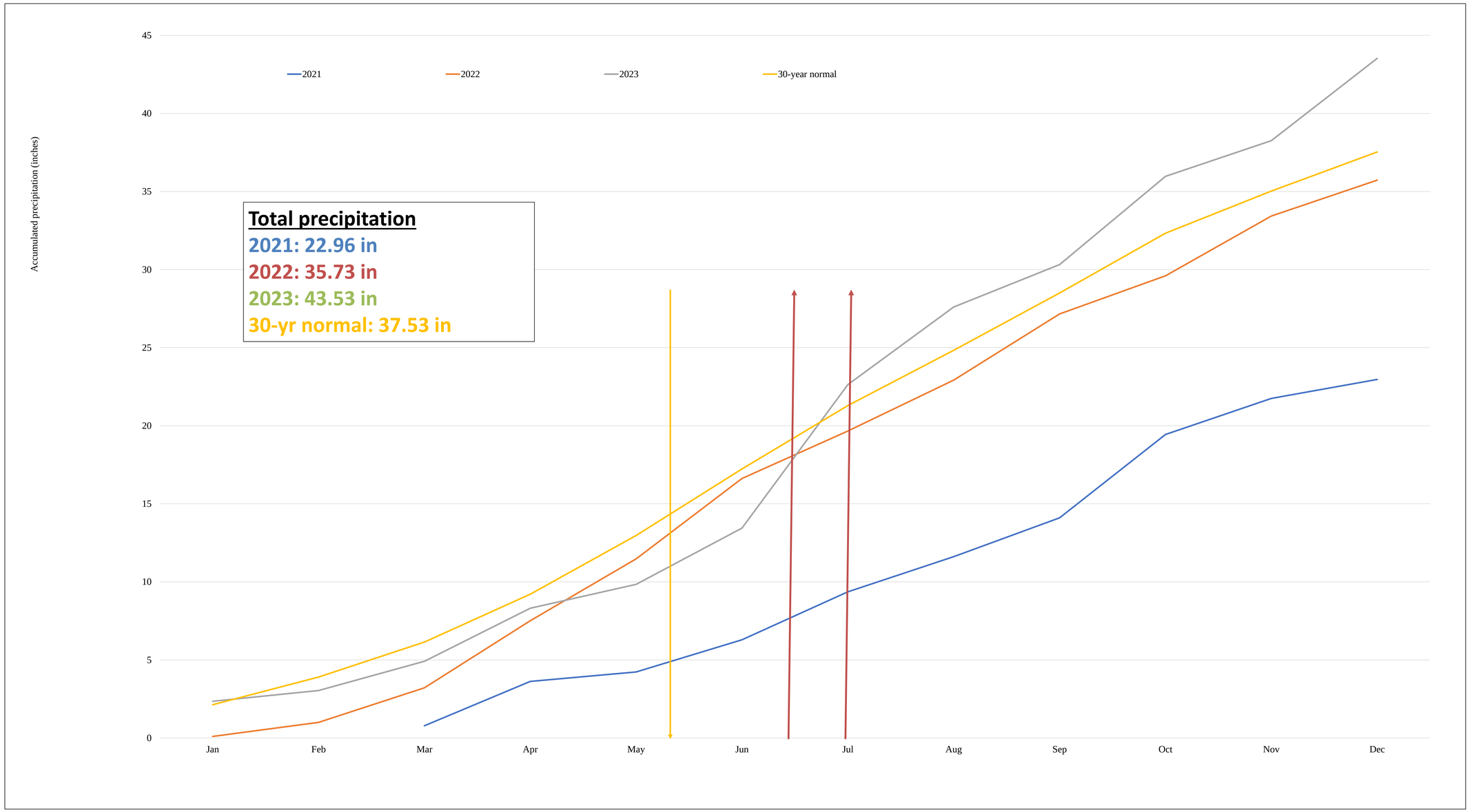


Figure 1. Annual accumulated rainfall at Discovery Acres in 2021-2023 compared to the 30-year average.

Neonicotinoid Data from Discovery Acres

- 13 sampling events, 40 total samples (surface and subsurface flows)
- May 15th through October 23rd
- 49% of samples were below detection limit (1.0 ppb)
- Average Load in Tile: 0.49 mg/ha*
- Average Load in Surface Runoff: 1.82 mg/ha*

Watershed	Seasonal Load (mg/ha)*
NSS	7.11
NTS+NTT	3.20
STS+STT	5.06
SSS	3.60

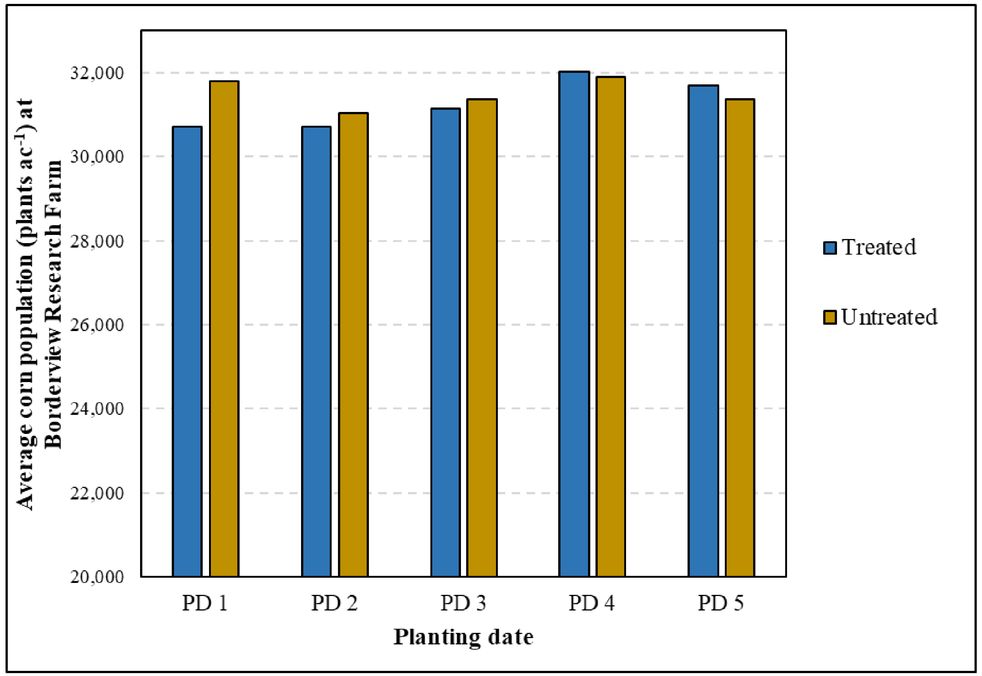
*All loads are a minimum due to low surrogate recovery. Actual loads may be higher.

Impact of Treated Seed on Plant Stands

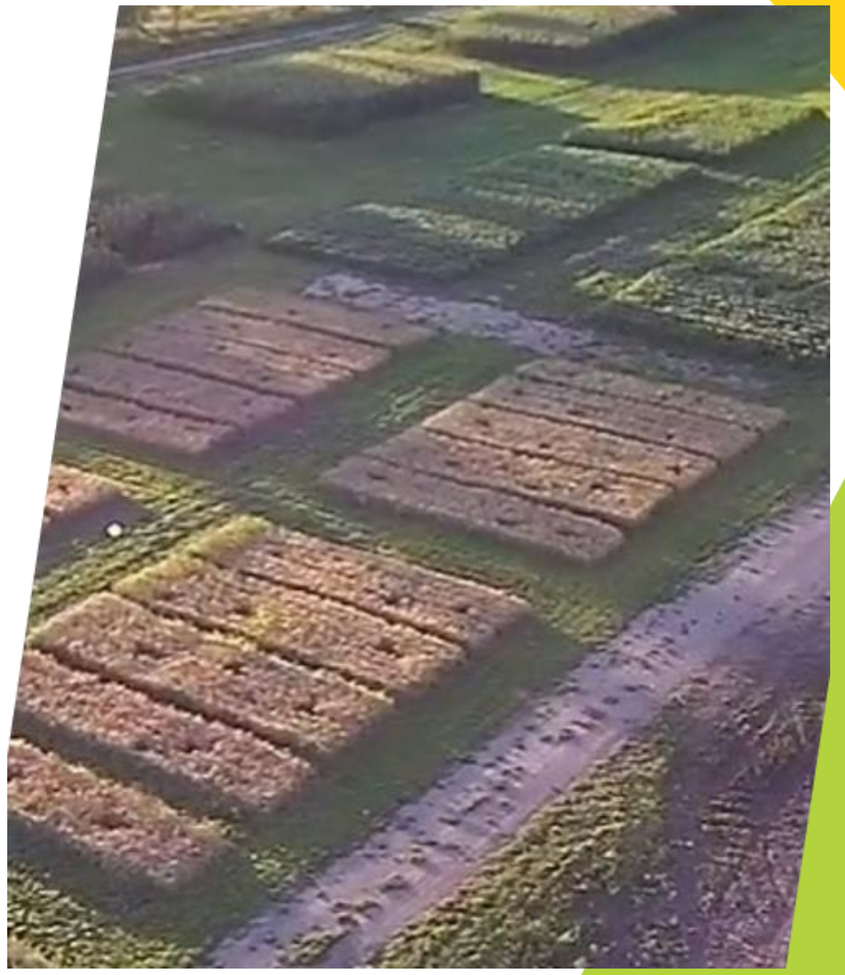
- **Borderview Research Farm & On-Farm Research**
  - Replicated trial
  - Two treatments: treated and untreated
  - Five planting dates (6th eliminated due to planting error)
  - Soil & crop measurements

Planting date number	Planting date
PD 1	10-May
PD 2	16-May
PD 3	26-May
PD 4	1-June
PD 5	9-June
PD 6	16-June

Impact of Treated Seed on Plant Stands



No statistical difference in corn populations between treated and untreated corn seed.



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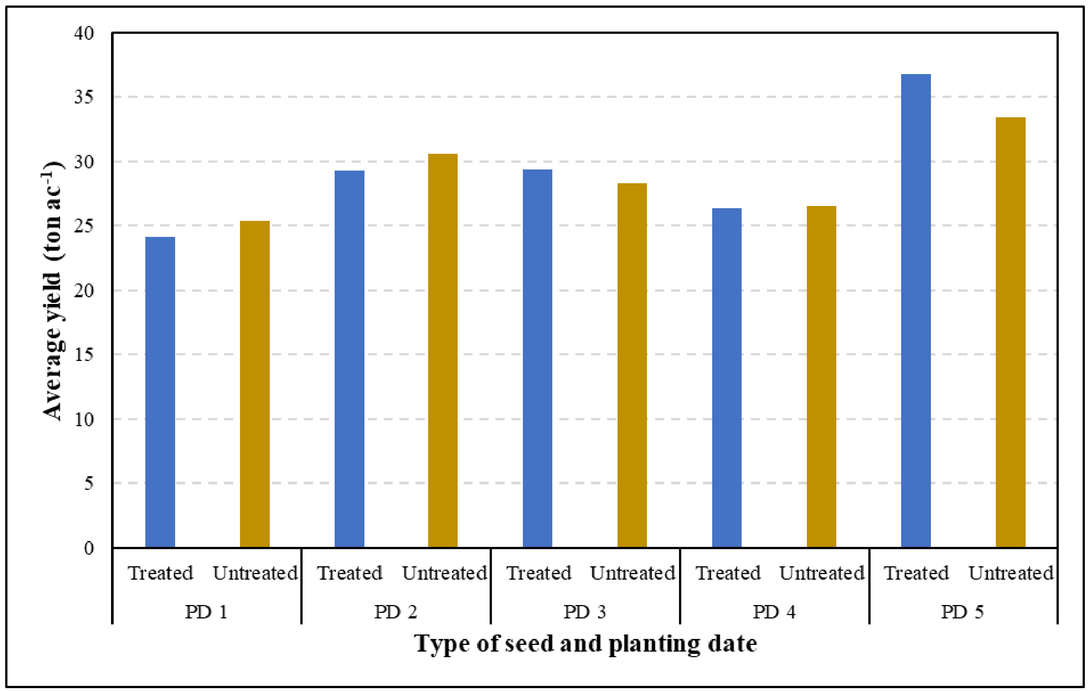
Impact of Treated Seed on Yields



No statistical difference in corn yields between treated and untreated corn seed.

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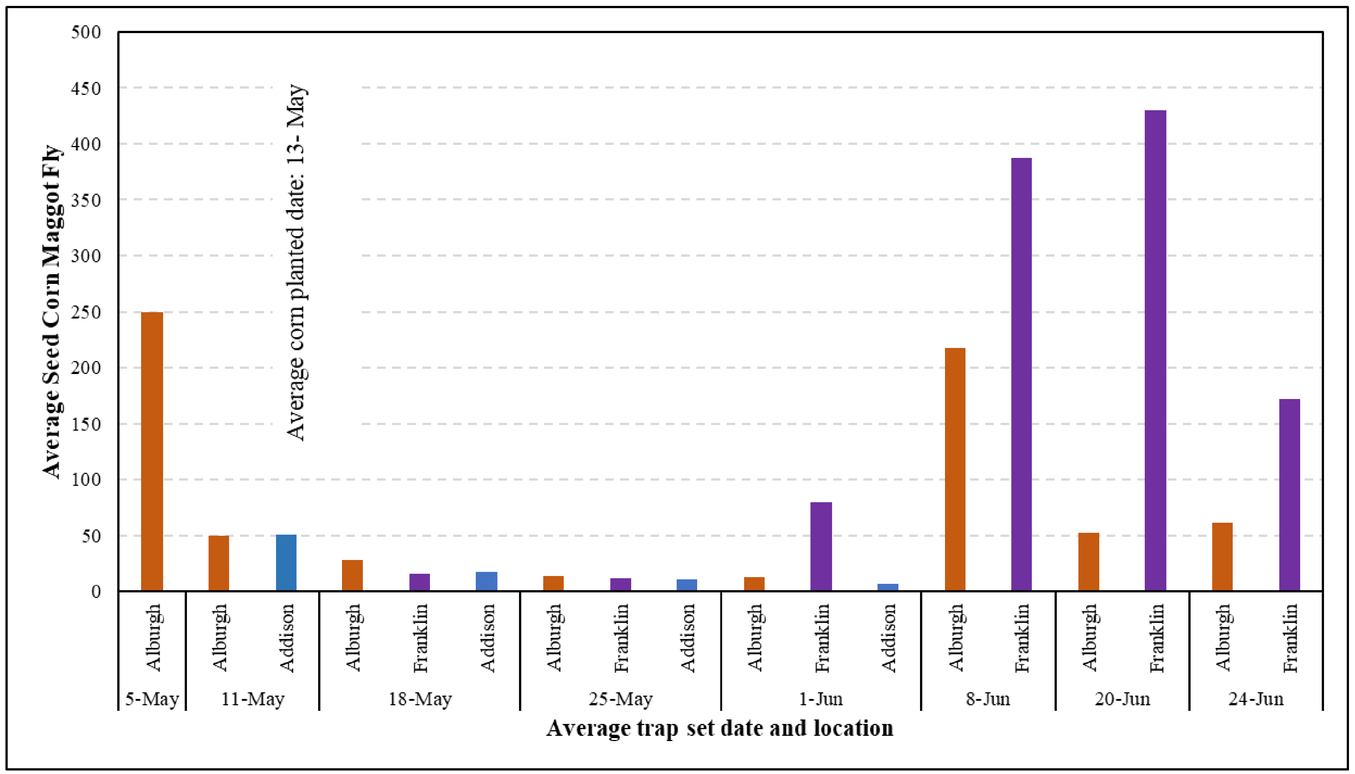
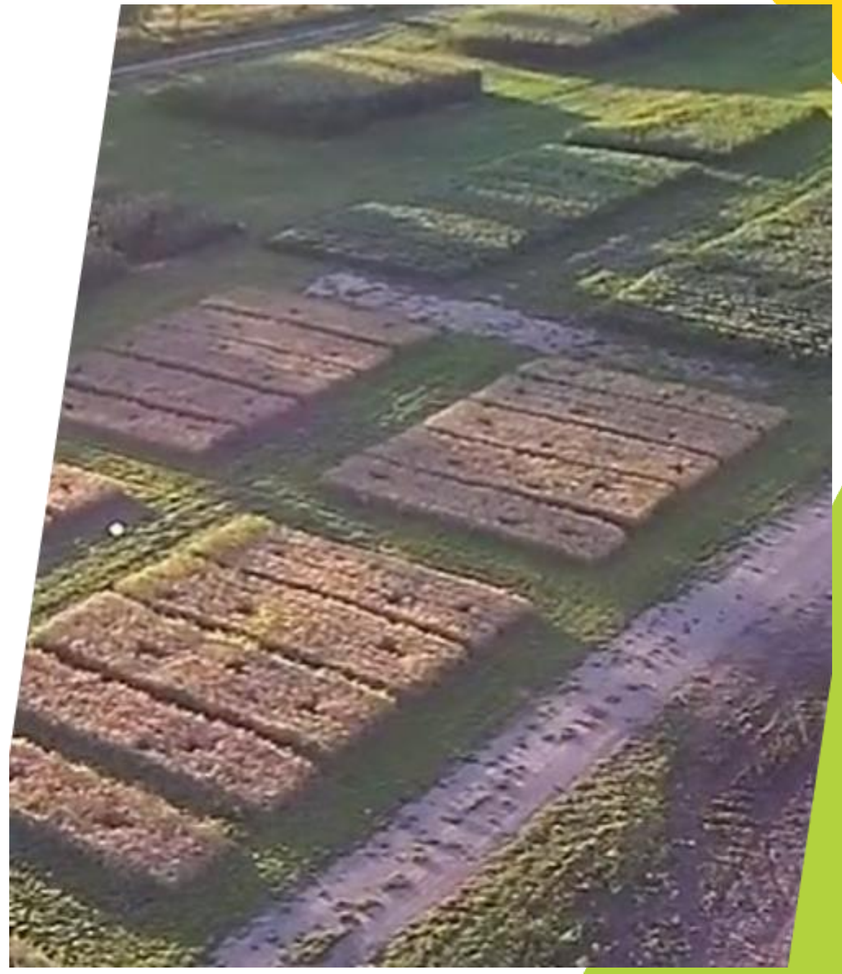
Corn Seed Maggot Flies





Seed corn maggot flight recorded on 8-Jun. Did this impact the corn yield at this planting date?

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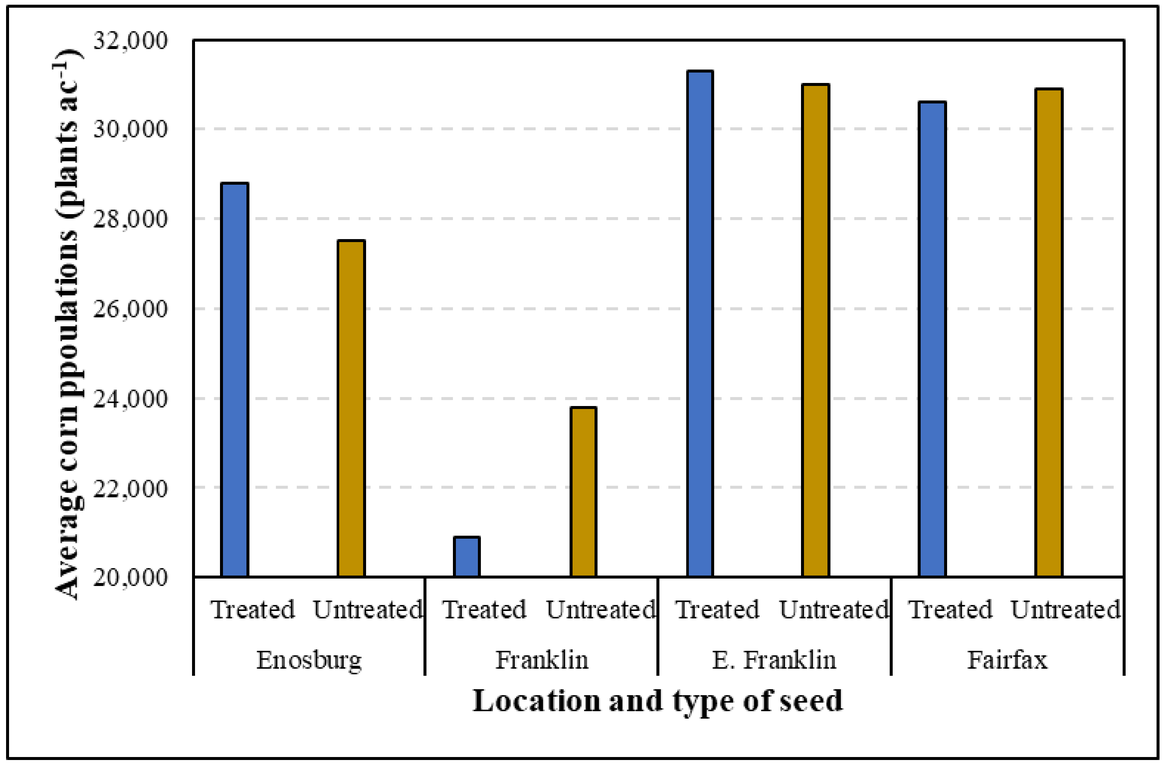
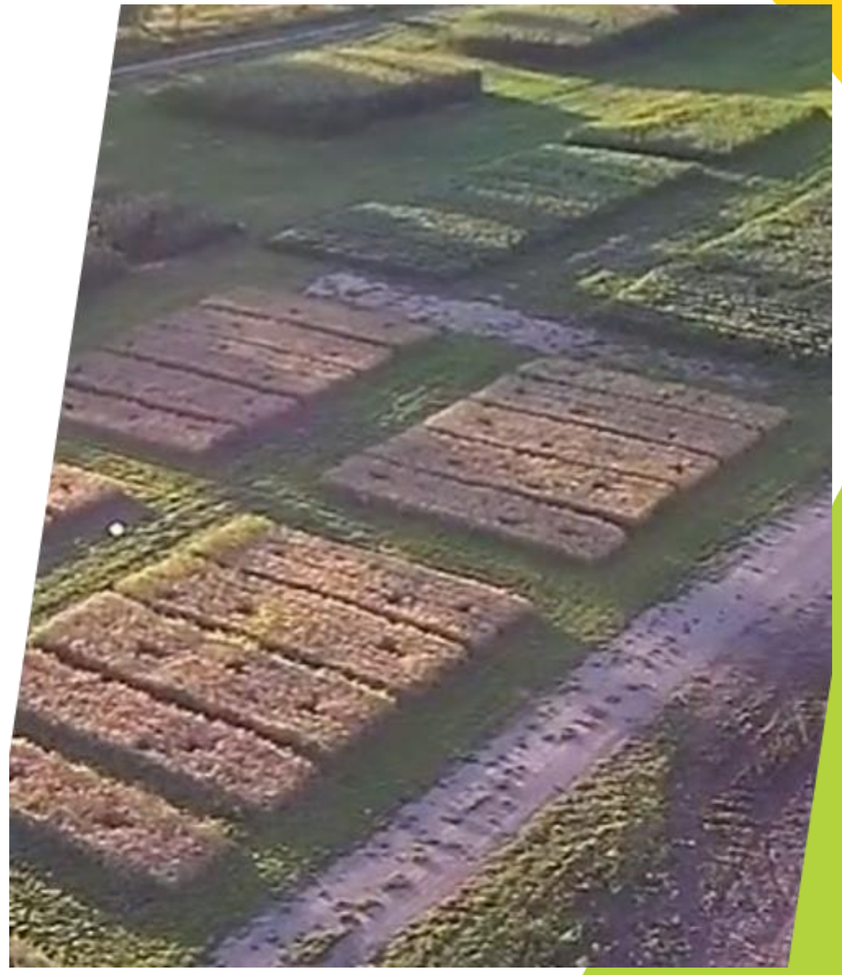
Impact of Treated Seed on Plant Stands





On-farm sites (one planting date) observes some differences in populations; however, related to bird damage and dry conditions at planting.

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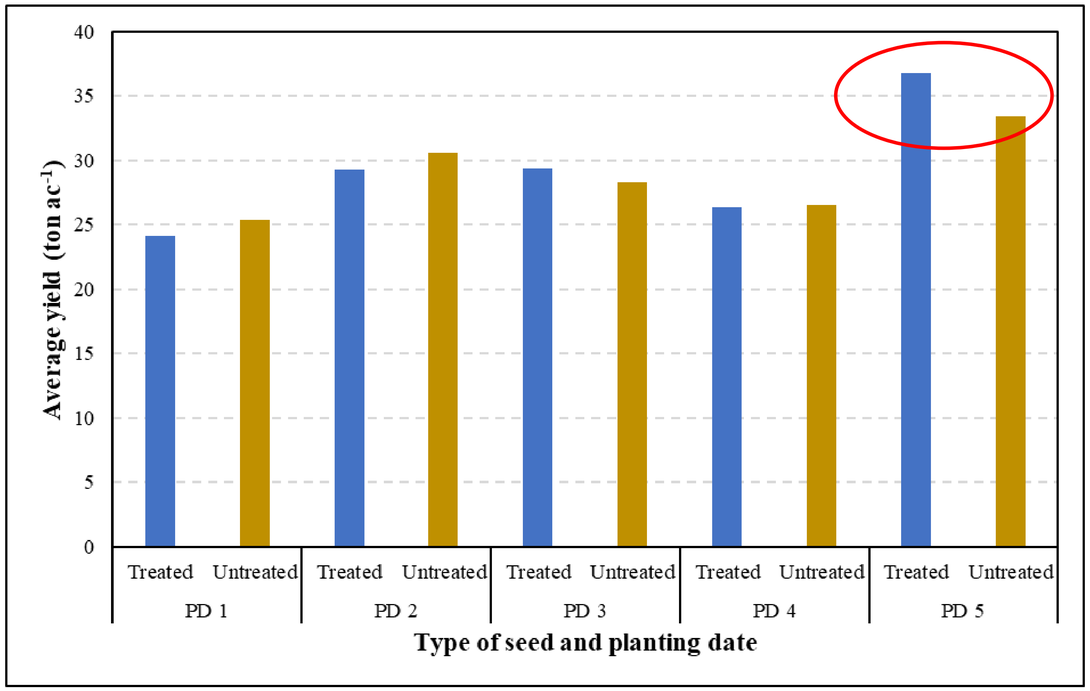
Impact of Treated Seed on Yields



What about planting date 5? This is a 4-ton yield difference!

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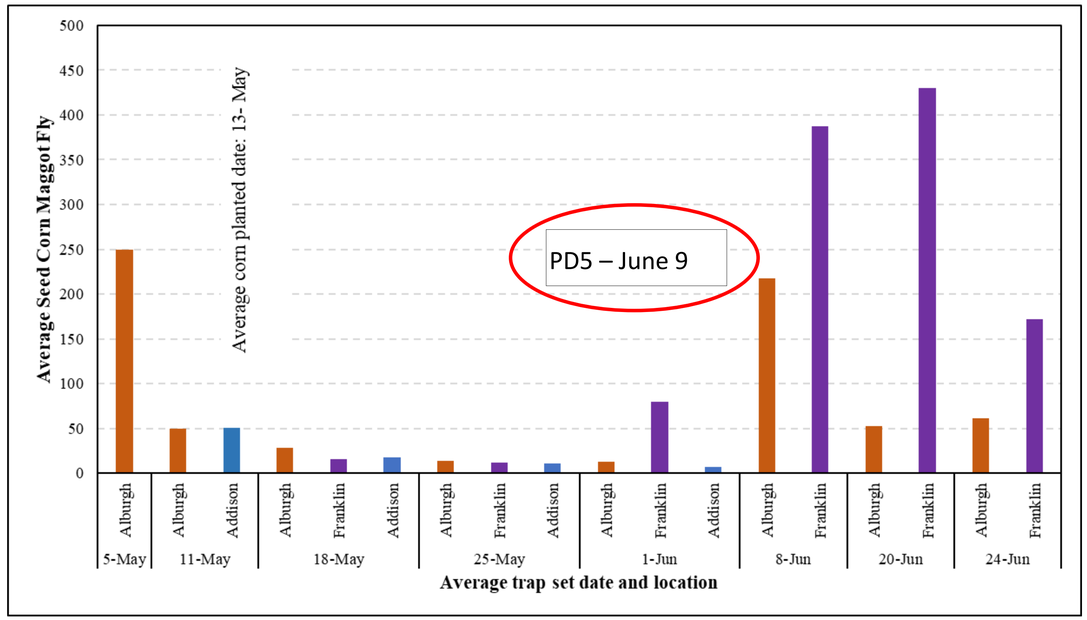
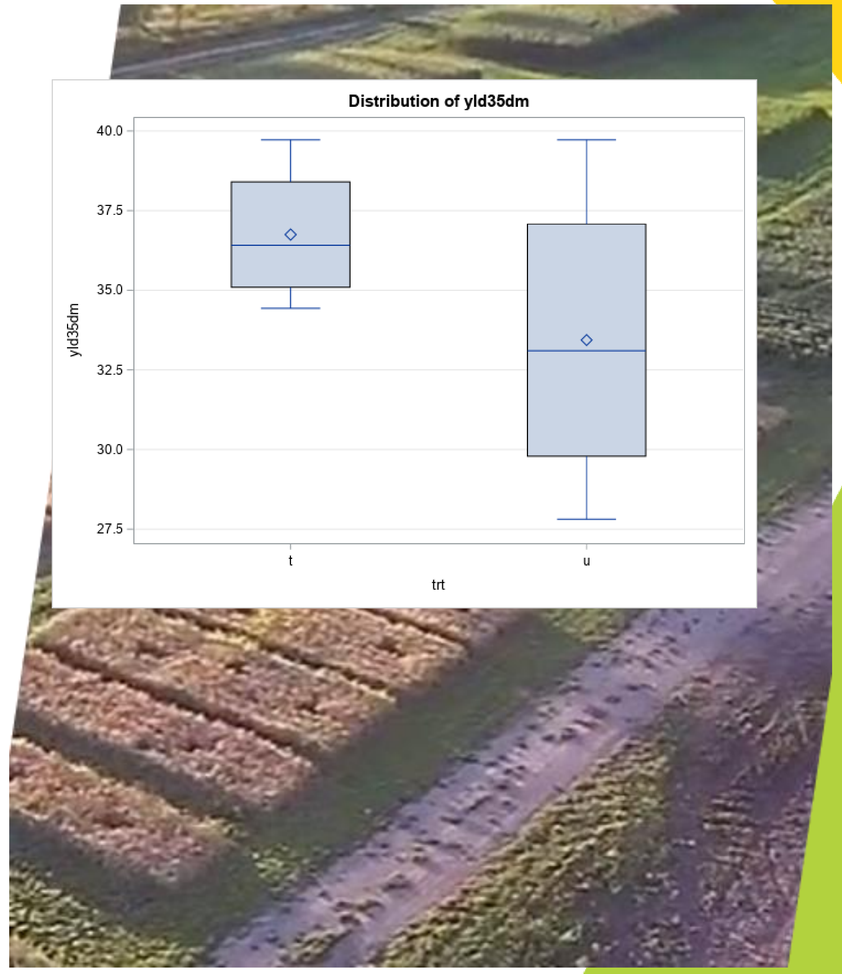
Corn Seed Maggot Flies





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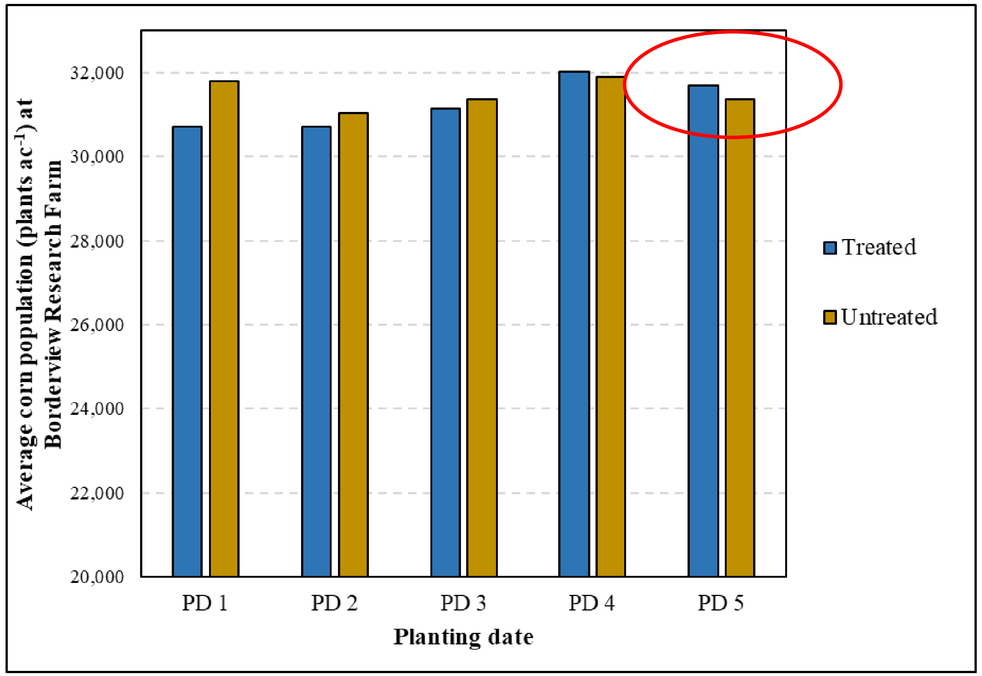

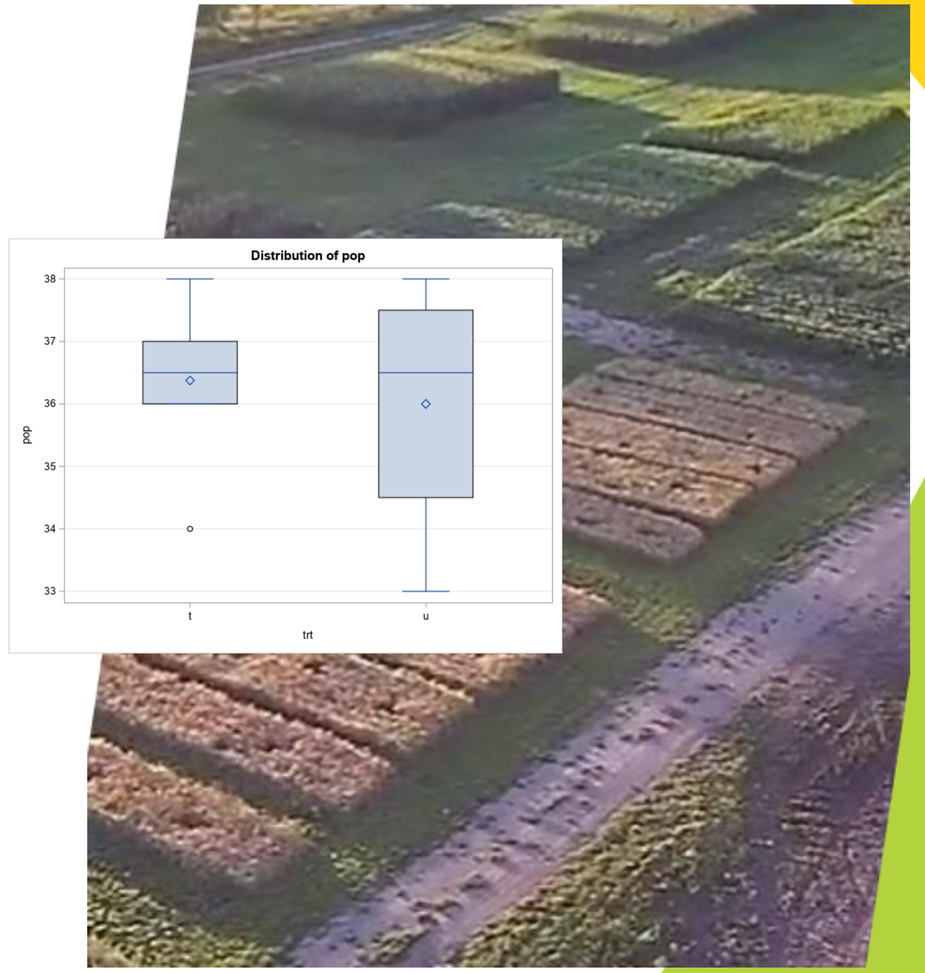

No statistical difference in corn populations between treated and untreated corn seed.

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Frequency and concentration of clothianidin at different soil depths prior to corn planting, Alburgh, VT, 2023.

Soil type: Benson rocky silt loam, over shaly limestone

Crop history: No direct use of neonicotinoid seed treatments in 15 years. Previous crops include hemp grain & fiber, summer annuals, milkweed. Equipment for planting same as corn in some cases.

	0 - 2.5 in.		*2.5 - 6 in.*	
	Detects†	Average concentration‡	Detects	Average concentration
	%	ug/kg	%	ug/kg
Pre-plant (9-May)	0	n/a	75	5.97
178 DAP (3-Nov)	25	2.20	75	3.15

† The number of samples with concentration greater than reporting limit (2.0 ug/kg or ppb) divided by total number of samples (n=4), reported as a percentage of samples where analyte was detected.

‡ Average concentration of samples where concentration was greater than reporting limit.

THE UNIVERSITY OF VERMONT EXTENSION

Frequency and concentration of clothianidin in soil 41 days after planting , Alburgh, VT, 2023.

Soil type: Benson rocky silt loam, over shaly limestone

Crop history: No use of neonicotinoid seed treatments in 15 years
Previous crops include hemp grain & fiber, summer annuals, milkweed

	0 - 6 in.	
	Detects†	Average concentration‡
	%	ug/kg
7 DAP (18-May)	50	2.50
42 DAP (21-Jun)	100	8.80
147 DAP (02-Oct)	25	2.30

† The number of samples with concentration greater than reporting limit (2.0 ug/kg or ppb) divided by total number of samples (n=4), reported as a percentage of samples where analyte was detected.
‡ Average concentration of samples where concentration was greater than reporting limit.

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- **Next Steps**
  - Neonicotinoid movement in surface and subsurface water.
  - Neonicotinoids in soil persistence and movement.
  - Impact of conservation practices on pests.
  - Impact of conservation on dust.
  - Alternative treatments
  - Continue on-farm work on monitoring.