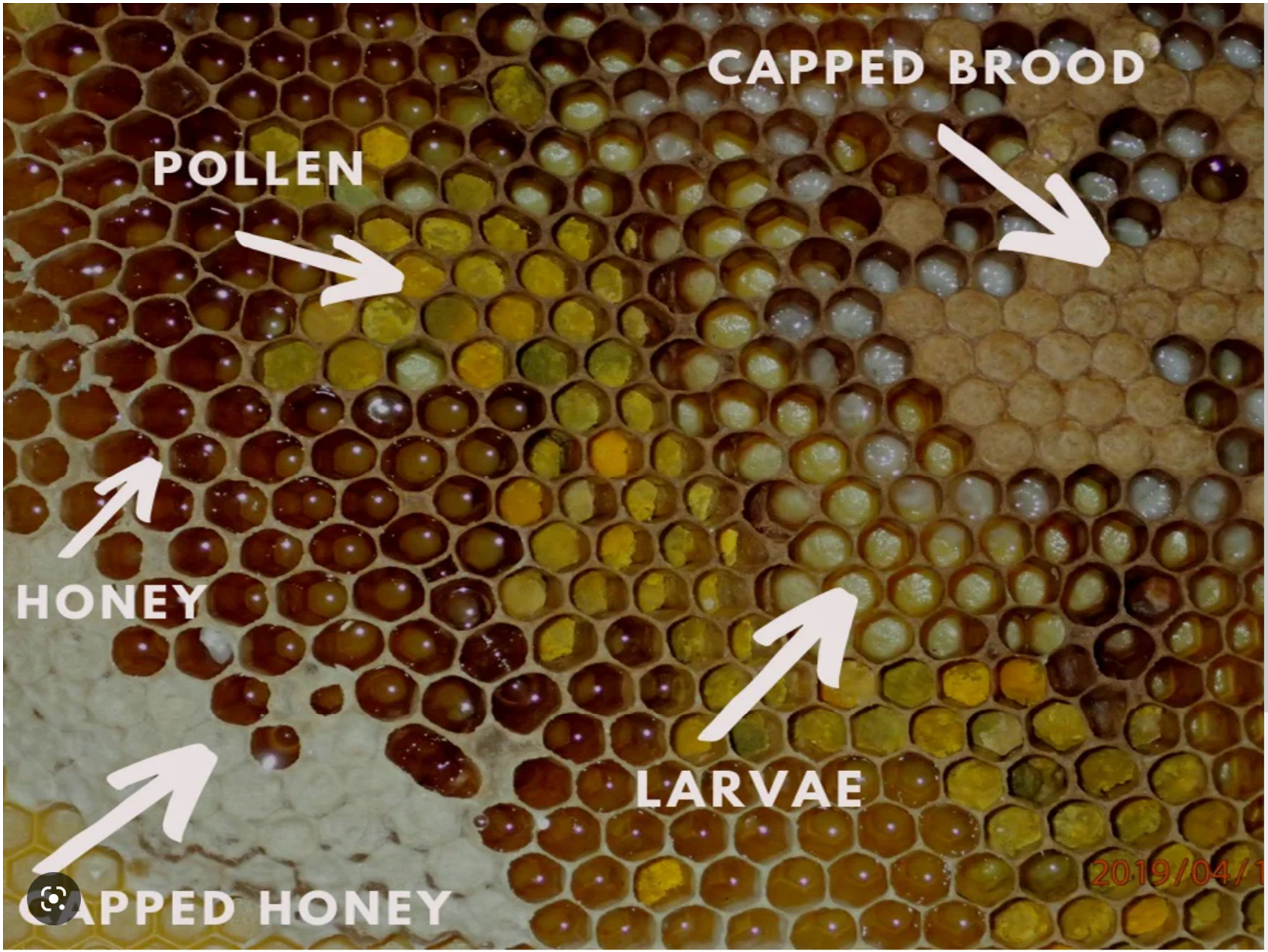
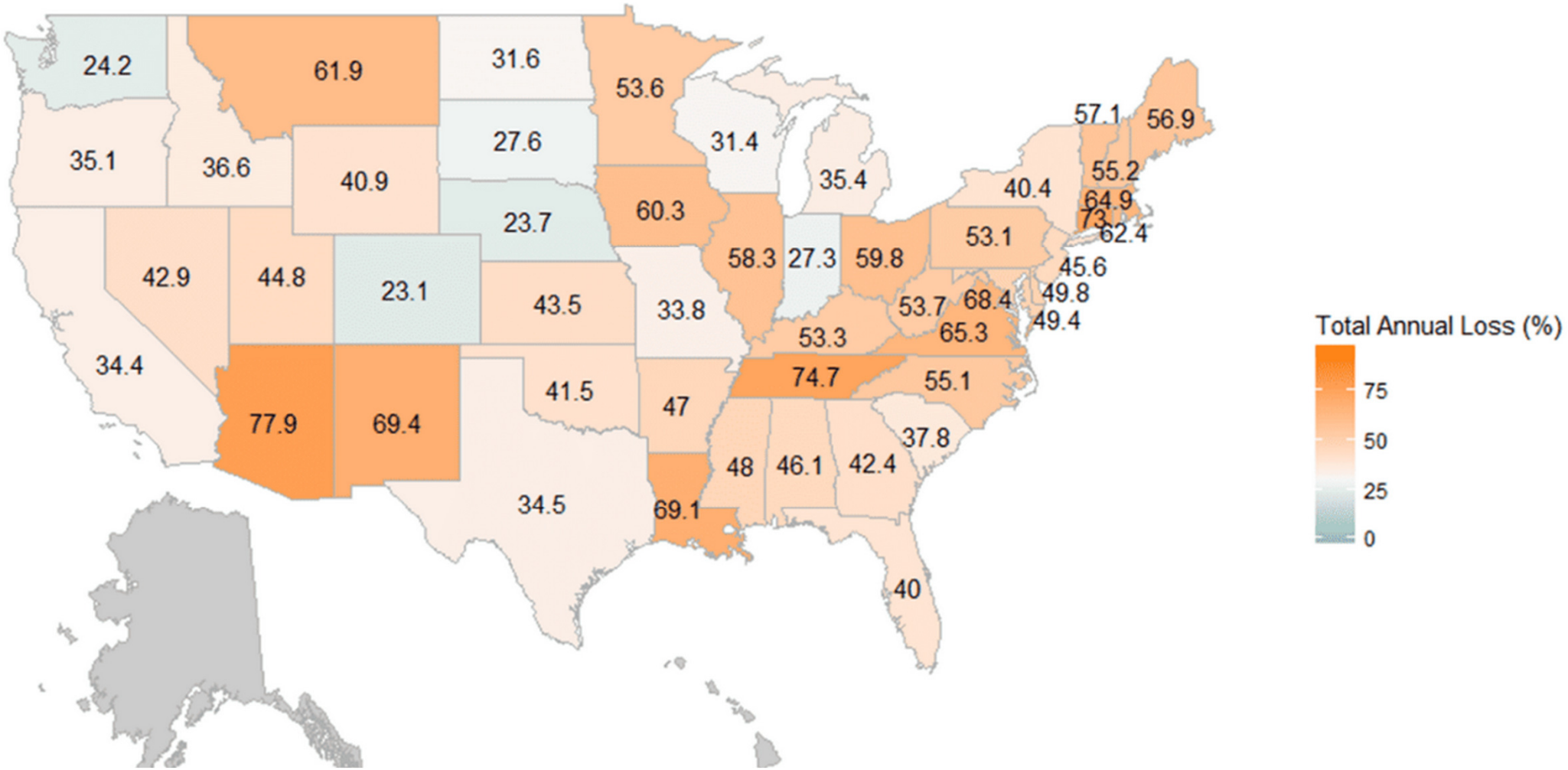
Vermont Beekeepers Association

Representing over 600 beekeepers in the state of Vermont.

Pollinators contribute $24 billion to the US economy every year.


CAPPED BROOD
POLLEN
HONEY
LARVAE
APPED HONEY
2019/04/1

Bee Informed Partnership



Replacing colony losses

1000 colony loss at 50%:

With nucleus colonies:$100,000

With Packages:$75,000

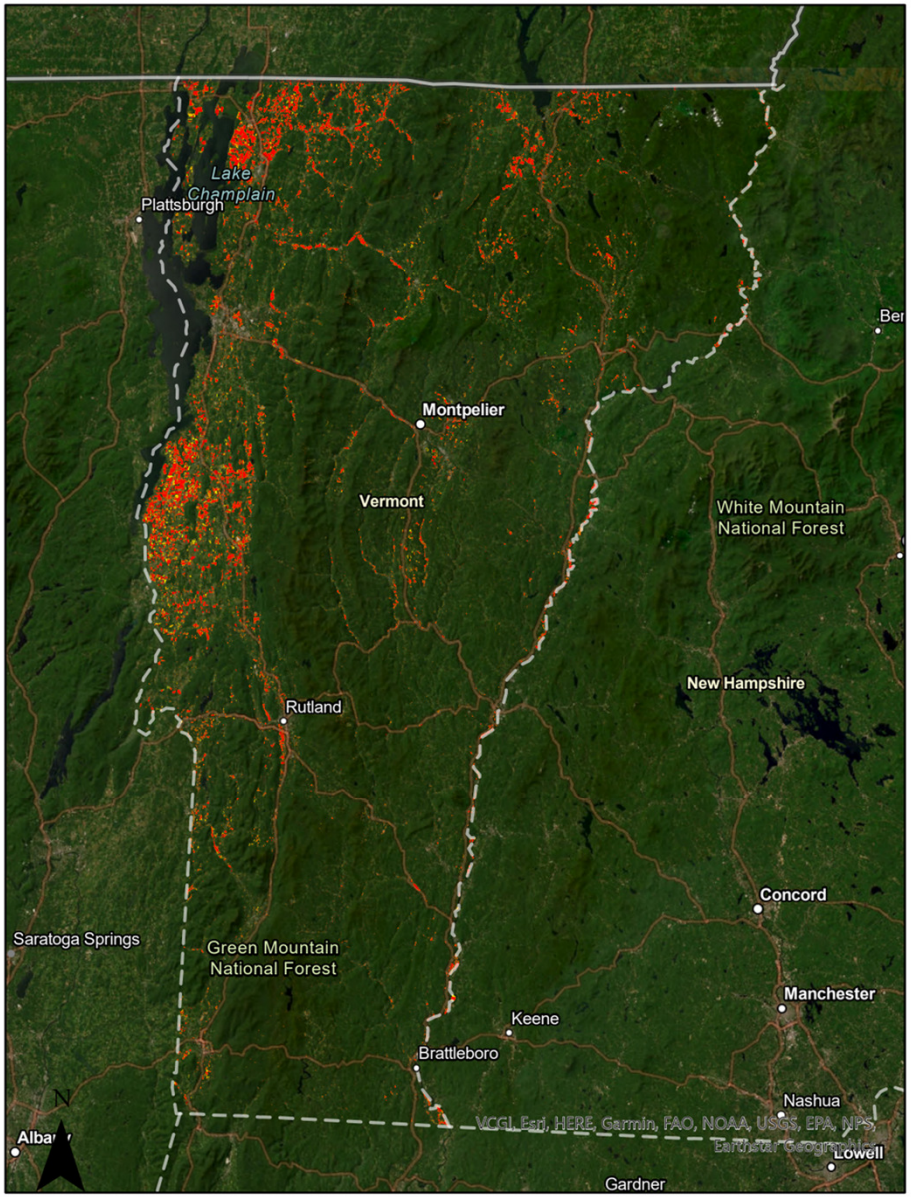
Or equivalent lost income

from honey production and bee sales

Migratory vs. stationary

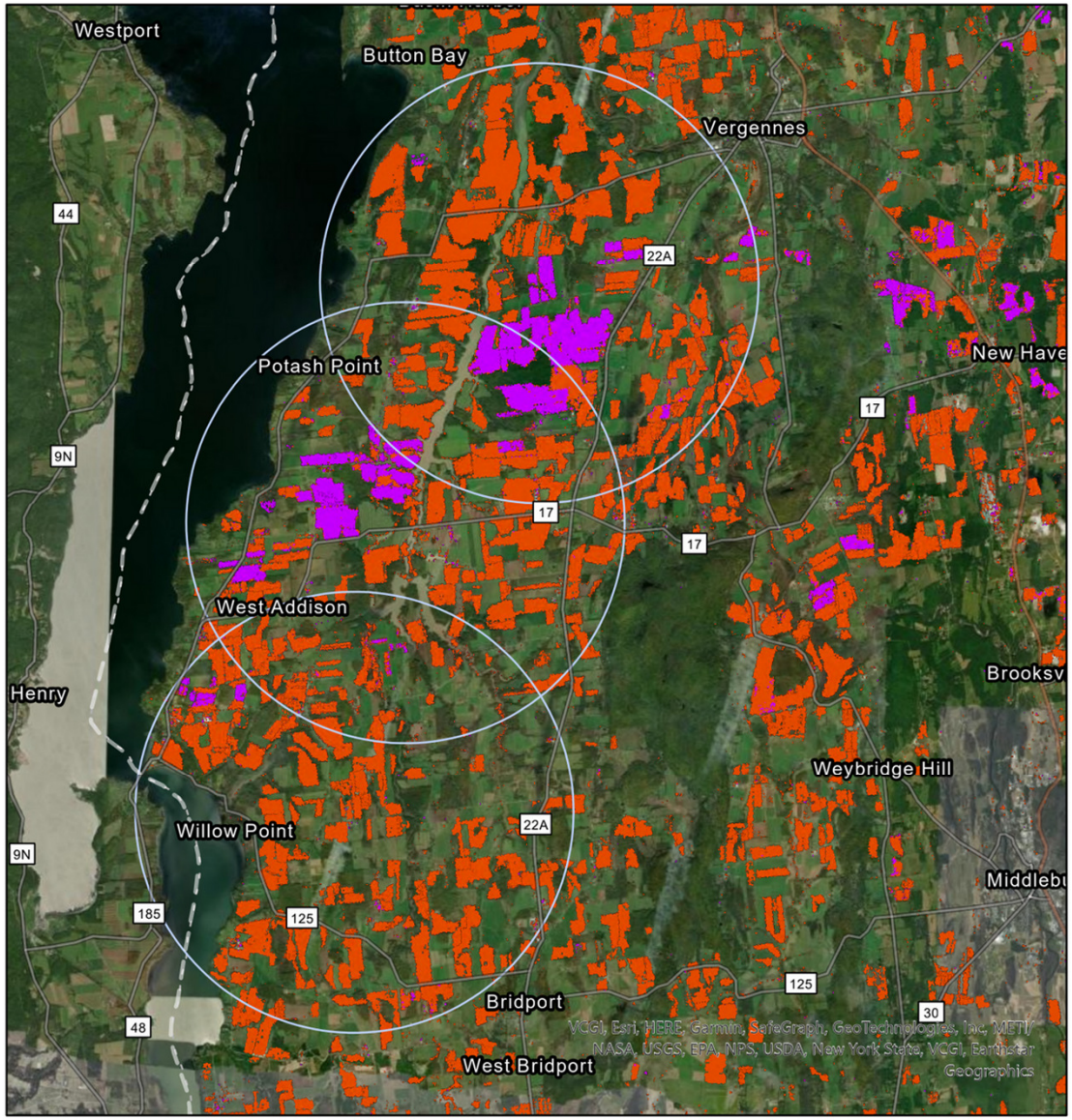
Neonicitinoid seed treatments

Vermont Corn & Soybean Crop Land Cover (2020-2022) ; Potential Neonicitinoid Pesticide Exposure Zones for Honey Bees



Data source: USDA Cropland CROS Online
Map created by: Sydney Miller

Addison Co. Vermont Corn & Soybean Crop Land Cover (2020-2022) ; Potential Neonicotinoid Pesticide Exposure Zones for Honey Bees



0 0.5 1 2 Miles

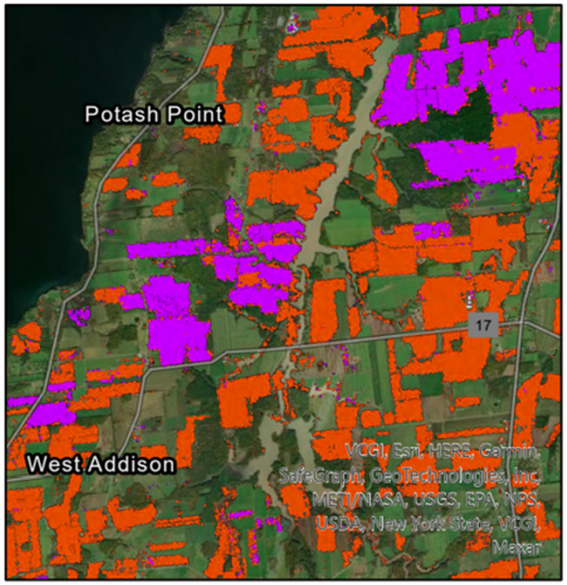
Data source: USDA Cropland CROS Online
Map created by: Sydney Miller
Date: 03-21-2023

Crop Region (2020-2022)

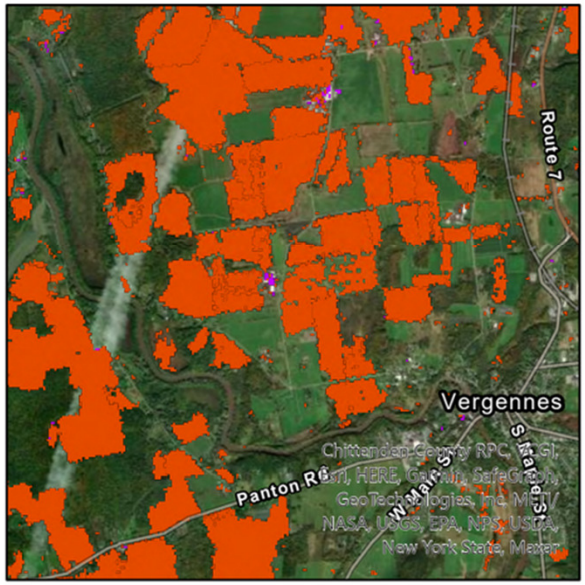
- VT County Boundary
- Apiary Location & Bee Foraging Zone
- Corn
- Soybeans

Vermont Corn & Soybean Crop Land Cover (2020-2022) ; Potential Neonicotinoid Pesticide Exposure Zones for Honey Bees

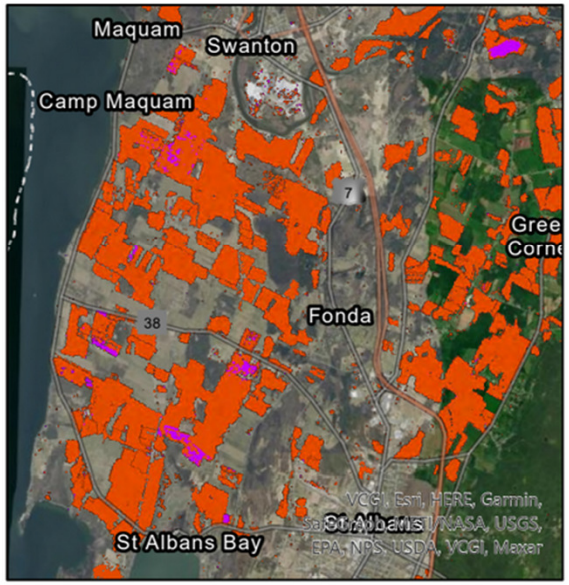
Addison, VT



Vergennes, VT



Swanton, VT



0 0.5 1 2 Miles

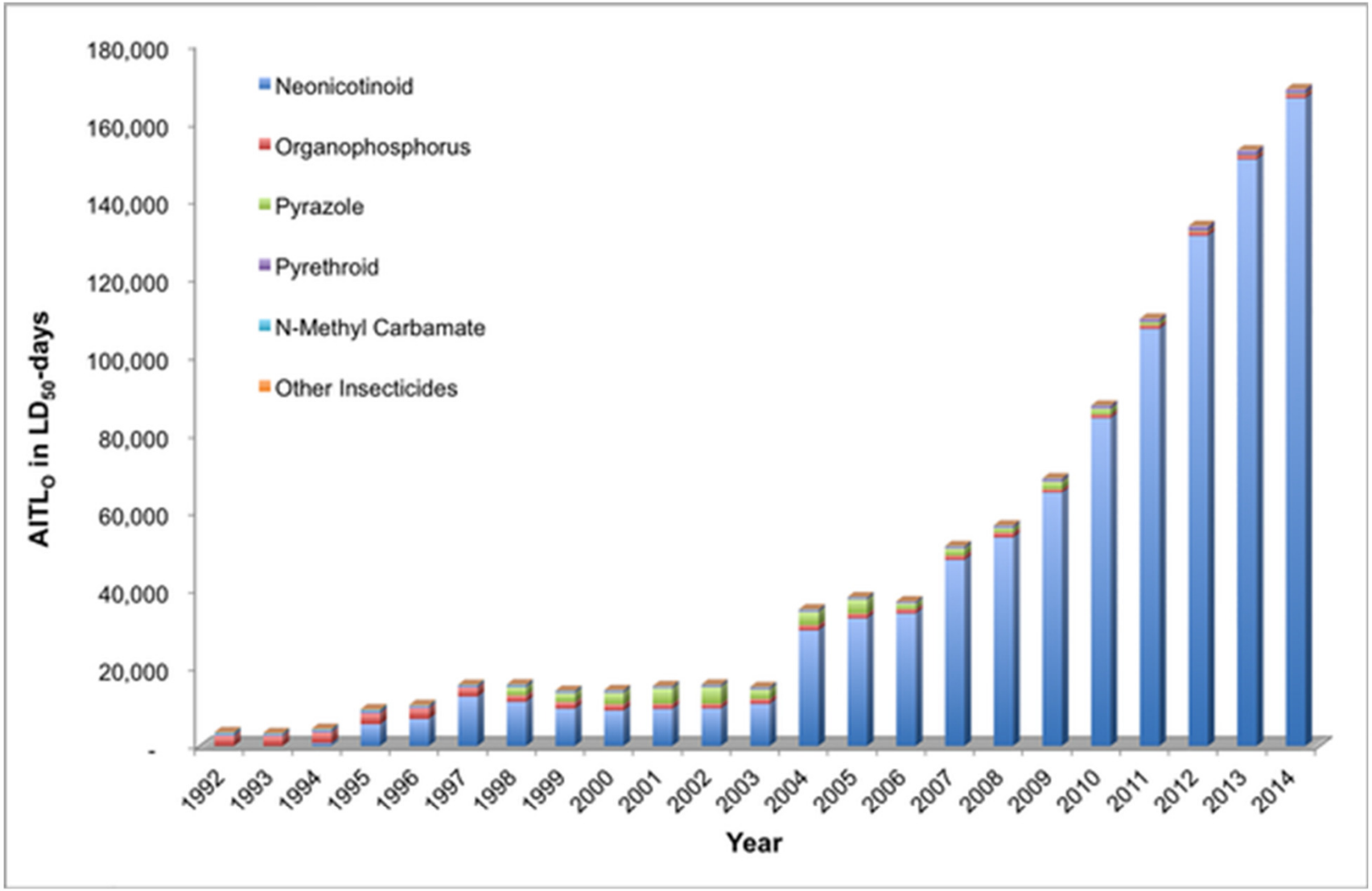
Crop Region (2020-2022)

- Corn
- Soybeans

N

Data source: USDA Cropland CROS Online
Map created by: Sydney Miller
Date: 03-23-2023

Fig 5. Oral acute insecticide toxicity loading (AITLO) by chemical class, 1992–2014.



DiBartolomeis M, Kegley S, Mineau P, Radford R, Klein K (2019) An assessment of acute insecticide toxicity loading (AITL) of chemical pesticides used on agricultural land in the United States. PLOS ONE 14(8): e0220029. https://doi.org/10.1371/journal.pone.0220029
https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0220029

Exposure routes:

Dust (acute)

Guttation fluid (acute)

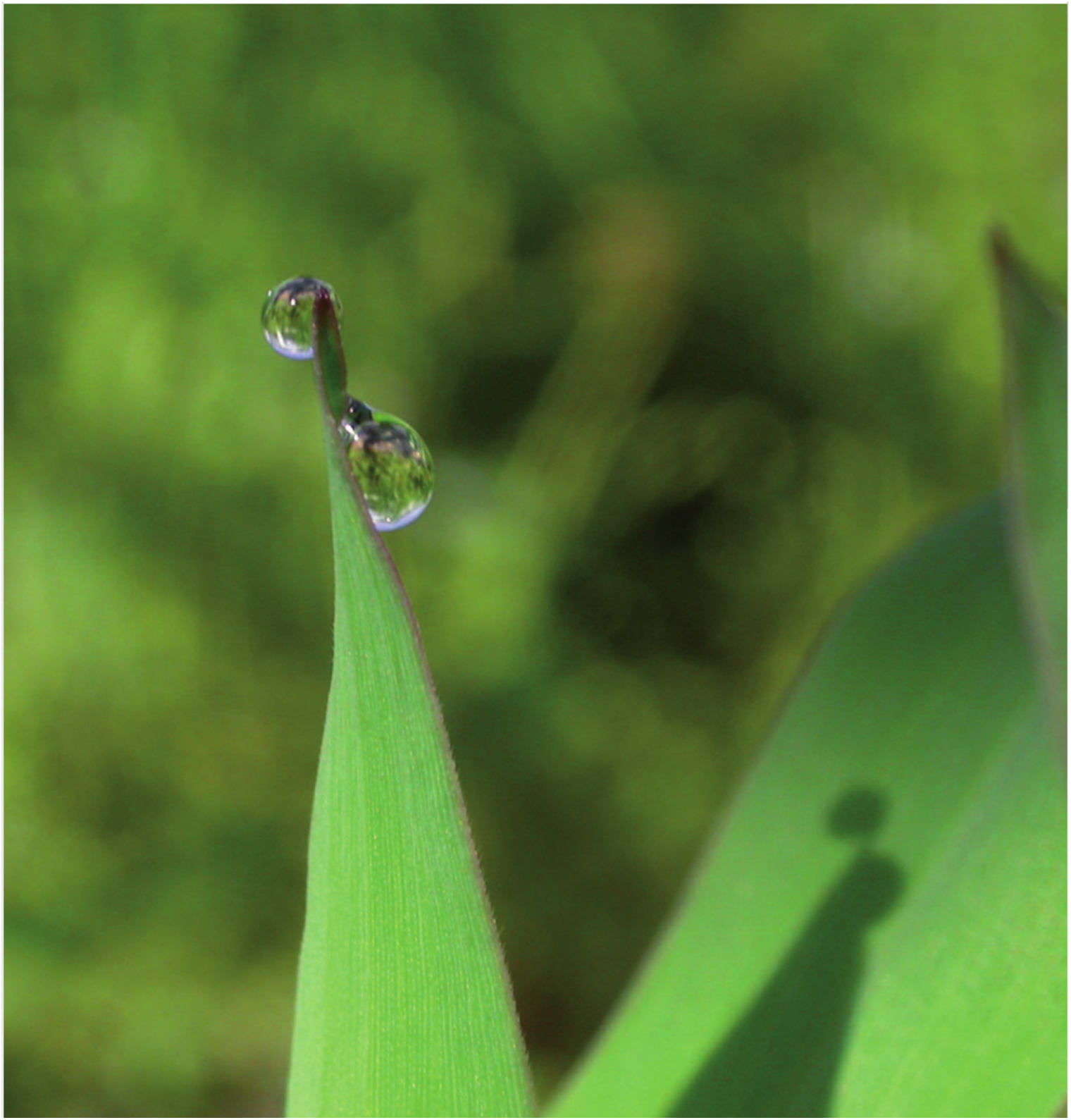
Pollen (chronic)


KUHN
PLANTER 3
INSECTICIDE

Acute exposure to dust

Exposure to dust on field adjacent plants up to 9 ppb

Guttation fluid



Always higher than 10,000ppb up to 200,000ppb

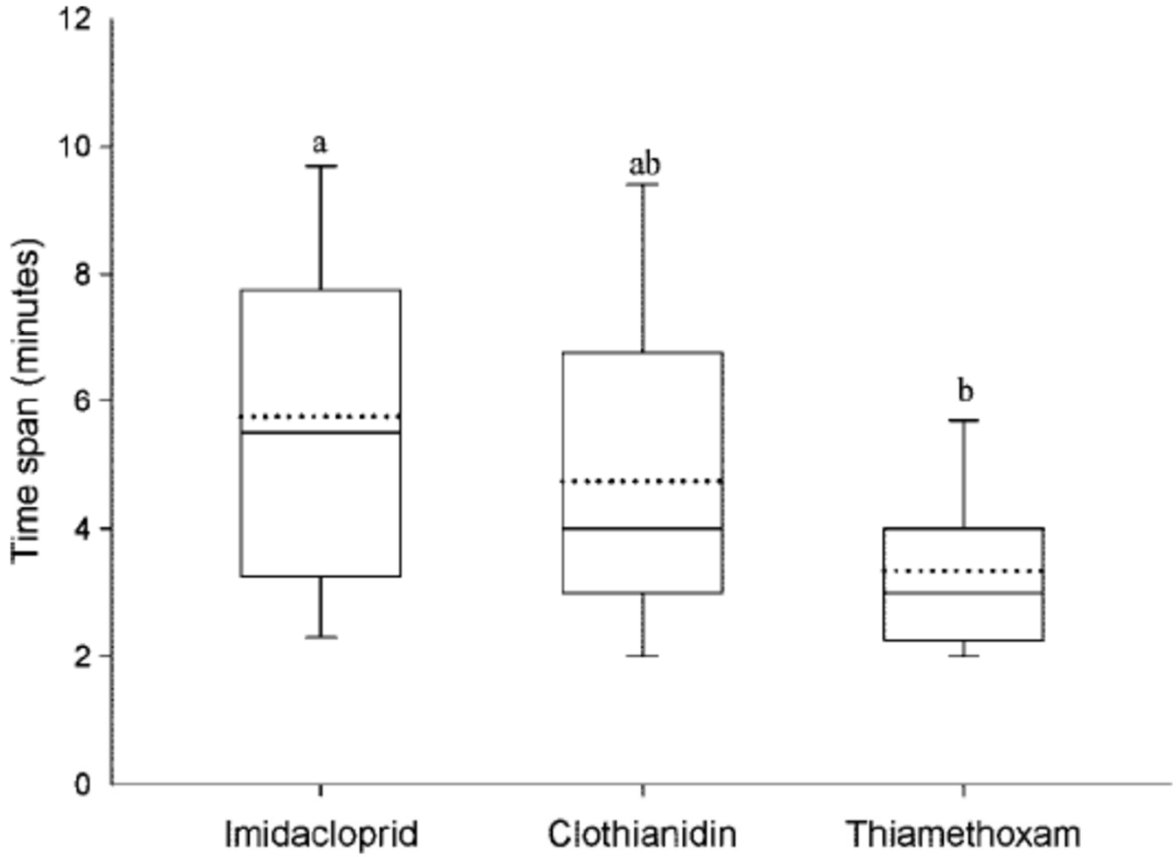


Fig. 2. Time between appearance irreversible wing-block and drinking of guttation drops collected on leaves of field corn crops, from three marketed neonicotinoid-coated. Guttation sampled on plants germinated from untreated seeds did not show any toxicity. The whisker represents the maximum and the minimum of the recorded time; the dotted line indicates the average; the upper, middle, and lower lines of the box indicate the 75, 50, and 25% of the time, respectively. Bars marked with different letters indicate significant differences ($P < 0.05$; Tukey–Kramer test).

Chronic exposure

Neonics are very toxic
at extremely low levels.

Sublethal/chronic exposure
drastically lowers colony survival.

Table 3. Comparison of honey bee LD50's with sublethal lowest observed effect concentrations (LOEC) for neonicotinoids and related compounds.

Active Ingredient	Field/Soil Half-life (days)	LD50 Contact (µg/bee)	LD50 Oral (µg/bee)	LOEC Contact (µg/bee)	LOEC Oral (µg/bee)
Acetamiprid	3	8.1	15	0.1*	0.1*
Clothianidin	121	0.044	0.0079	0.0022*	0.0005–0.0009
Dinotefuran	75	0.03	0.04	0.0075*	NA
Imidacloprid	174	0.032	0.0037	0.0001*	0.0001–0.0015
Sulfoxaflor	2.2	0.38	0.15	NA	NA
Thiacloprid	18	26	18	NA	0.0013*
Thiamethoxam	39	0.02	0.005	0.0001–0.004	0.0004–0.002

Half-life and LD_{50} data transferred from S1 Appendix, and LOEC data from S2 Appendix.

* No range available.

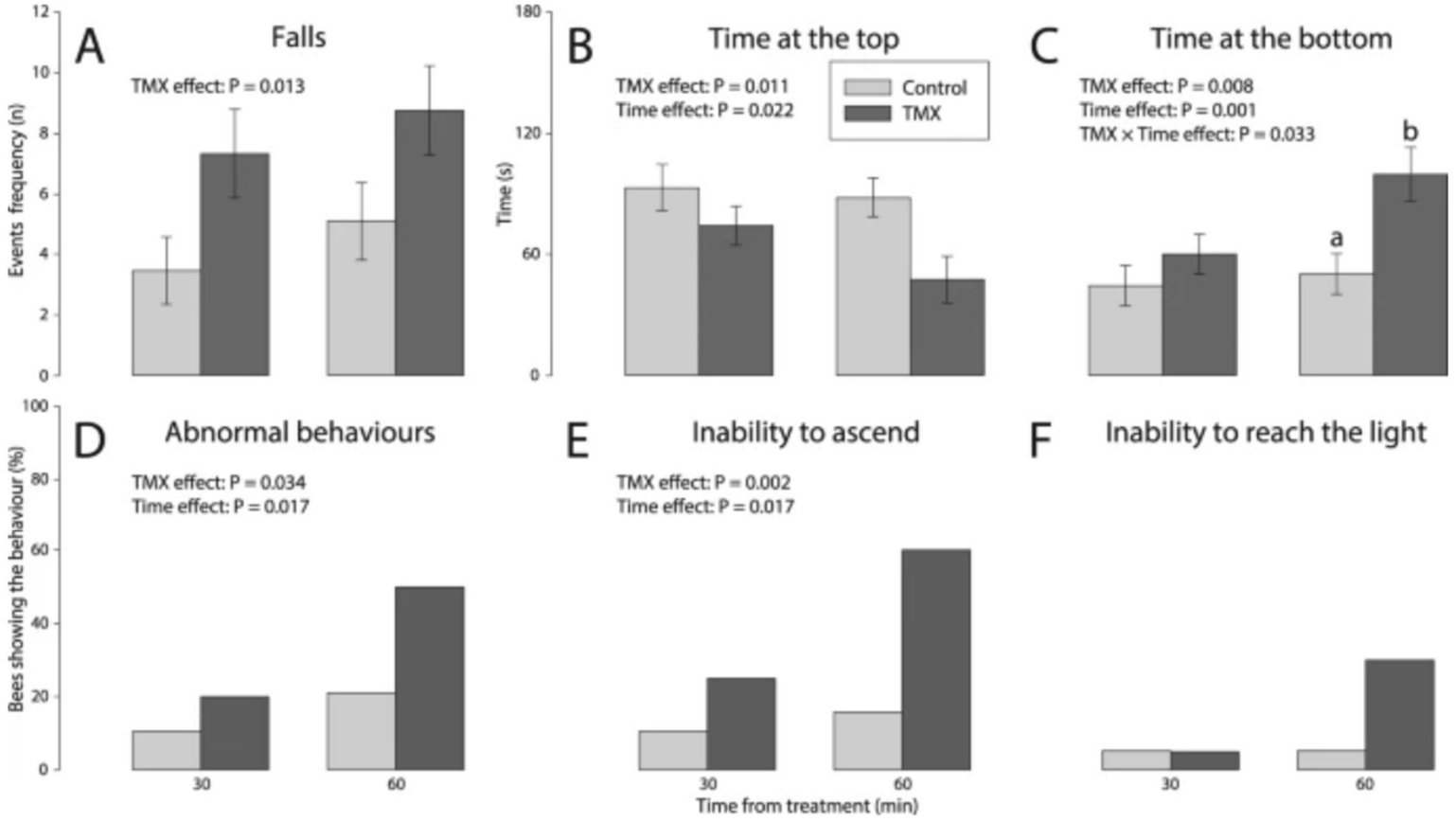
NA Not available

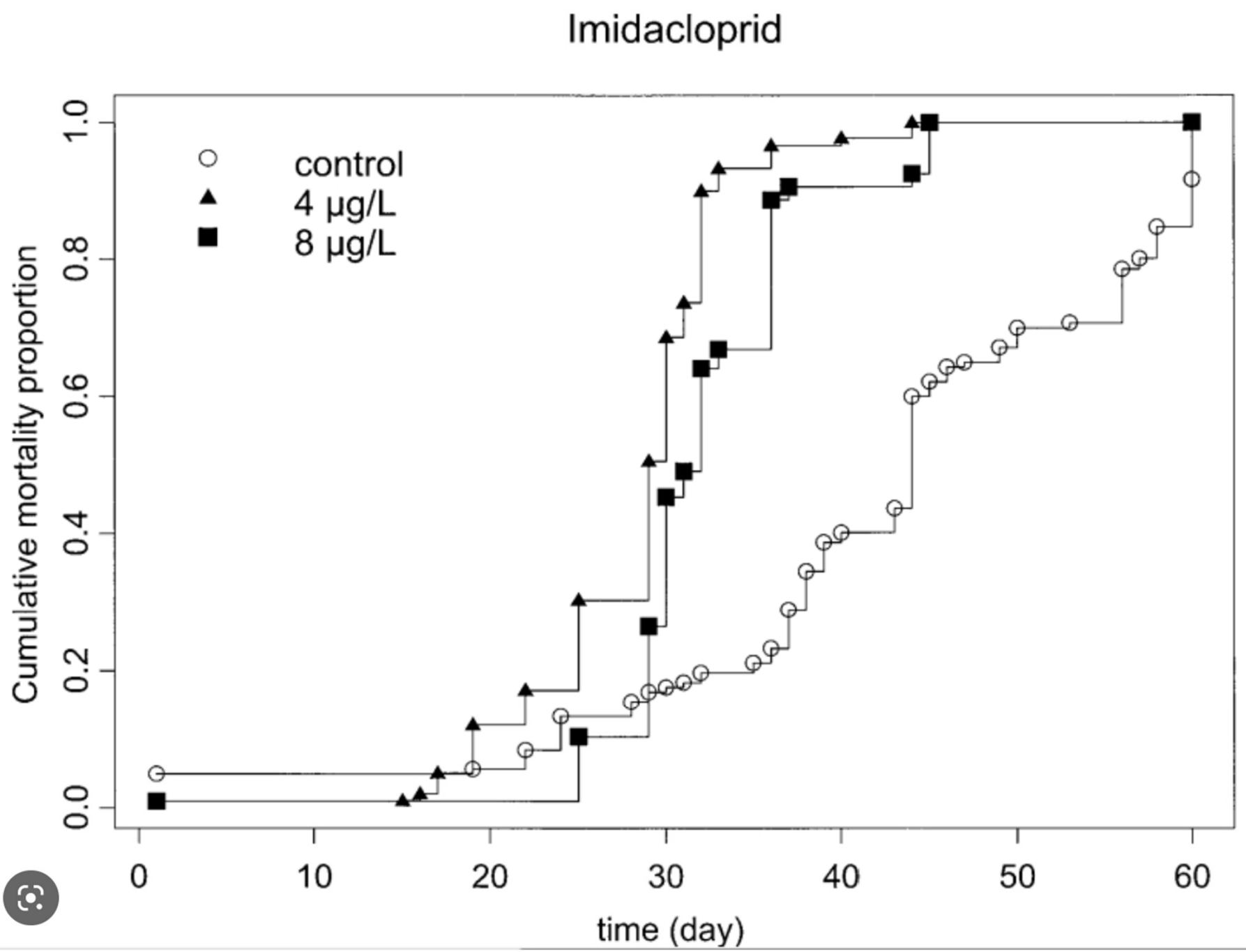
https://doi.org/10.1371/journal.pone.0220029.t003

DiBartolomeis M, Kegley S, Mineau P, Radford R, Klein K (2019) An assessment of acute insecticide toxicity loading (AITL) of chemical pesticides used on agricultural land in the United States. PLOS ONE 14(8): e0220029. https://doi.org/10.1371/journal.pone.0220029
https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0220029

sample_type	File.Name	Client.ID2	Mass..g.	Thiamethoxam	Clothianidin	Imidacloprid	Acetamiprid	Thiacloprid
Pollen (trap)	2022-04-13_040	S041706	5.05	NA	NA	NA	NA	NA
Pollen (trap)	2022-04-13_041	S041707	4.93	NA	NA	NA	NA	NA
Pollen (trap)	2022-04-13_042	S041708	5.04	NA	NA	NA	NA	NA
Pollen (trap)	2022-04-13_043	S041709	5	NA	NA	NA	NA	NA
Pollen (trap)	2022-04-13_044	S041710	4.95	0.202020202	0.606060606	NA	NA	NA
Pollen (trap)	2022-04-13_045	S041711	4.62	NA	NA	NA	NA	NA
Pollen (trap)	2022-04-13_046	S041712	5.07	NA	NA	NA	NA	NA
Pollen (trap)	2022-04-13_047	S041713	5.06	NA	NA	NA	NA	NA
Pollen (trap)	2022-04-13_048	S041714	5.03	NA	NA	NA	NA	NA
Pollen (trap)	2022-04-13_049	S041715	5.02	0.199203187	NA	NA	NA	0.133466135
Pollen (trap)	2022-04-13_050	S041716	5	NA	NA	NA	NA	NA
Pollen (trap)	2022-04-13_051	S041717	4.97	NA	NA	NA	NA	NA
Pollen (trap)	2022-04-13_052	S041718	4.96	NA	NA	NA	NA	NA
Pollen (trap)	2022-04-13_053	S041719	0.2591	0.270165959	NA	NA	NA	NA
Pollen (trap)	2022-04-13_054	S041720	4.98	NA	NA	0.602409639	NA	NA
Pollen (trap)	2022-04-13_055	S041721	5.04	NA	NA	0.595238095	NA	NA
Pollen (trap)	2023-04-10_SM_I	SM_001	4.8132	NA	5.31	NA	NA	NA
Pollen (trap)	2023-04-10_SM_I	SM_010	4.7057	NA	NA	NA	NA	NA
Pollen (trap)	2023-04-10_SM_I	SM_011	4.821	NA	NA	NA	1.18	NA
Pollen (trap)	2023-04-10_SM_I	SM_012	5.0375	NA	NA	NA	NA	NA
Pollen (trap)	2023-04-10_SM_I	SM_013	5.0648	NA	NA	NA	NA	NA
Pollen (trap)	2023-04-10_SM_I	SM_014	4.5683	NA	NA	NA	NA	NA
Pollen (trap)	2023-04-10_SM_I	SM_015	4.7021	NA	NA	NA	NA	NA
Pollen (trap)	2023-04-10_SM_I	SM_016	4.6379	NA	NA	NA	NA	NA
Pollen (trap)	2023-04-10_SM_I	SM_017	4.5091	NA	NA	NA	NA	NA
Plant Tissue	2023-04-10_SM_I	SM_018	7.4533	NA	NA	NA	NA	NA
Plant Tissue	2023-04-10_SM_I	SM_019	6.9484	NA	NA	NA	NA	NA
Pollen (trap)	2023-04-10_SM_I	SM_002	4.9198	NA	1.361843977	NA	NA	NA
Plant Tissue	2023-04-10_SM_I	SM_020	6.5574	NA	NA	NA	NA	NA
Plant Tissue	2023-04-10_SM_I	SM_021	5.2068	NA	NA	NA	NA	NA
Plant Tissue	2023-04-10_SM_I	SM_022	7.6986	NA	NA	NA	NA	NA
Plant Tissue	2023-04-10_SM_I	SM_023	6.2717	NA	1.068290894	NA	NA	NA
Plant Tissue	2023-04-10_SM_I	SM_024	8.8519	NA	NA	NA	NA	NA

Figure 3


A
Falls
TMX effect: P = 0.013
Events frequency (n)
B
Time at the top
TMX effect: P = 0.011
Time effect: P = 0.022
Control
TMX
Time (s)
C
Time at the bottom
TMX effect: P = 0.008
Time effect: P = 0.001
TMX × Time effect: P = 0.033
a
b
D
Abnormal behaviours
TMX effect: P = 0.034
Time effect: P = 0.017
Bees showing the behaviour (%)
E
Inability to ascend
TMX effect: P = 0.002
Time effect: P = 0.017
F
Inability to reach the light
30
60
Time from treatment (min)


Imidacloprid
control
4 µg/L
8 µg/L
Cumulative mortality proportion
0.0
0.2
0.4
0.6
0.8
1.0
0
10
20
30
40
50
60
time (day)

Is it all the mites?

No. Mites have been around since the late 1980s. Beekeepers learned how to manage mite levels a long time ago.

Synergistic effects

Deformed wing virus

Figure 1

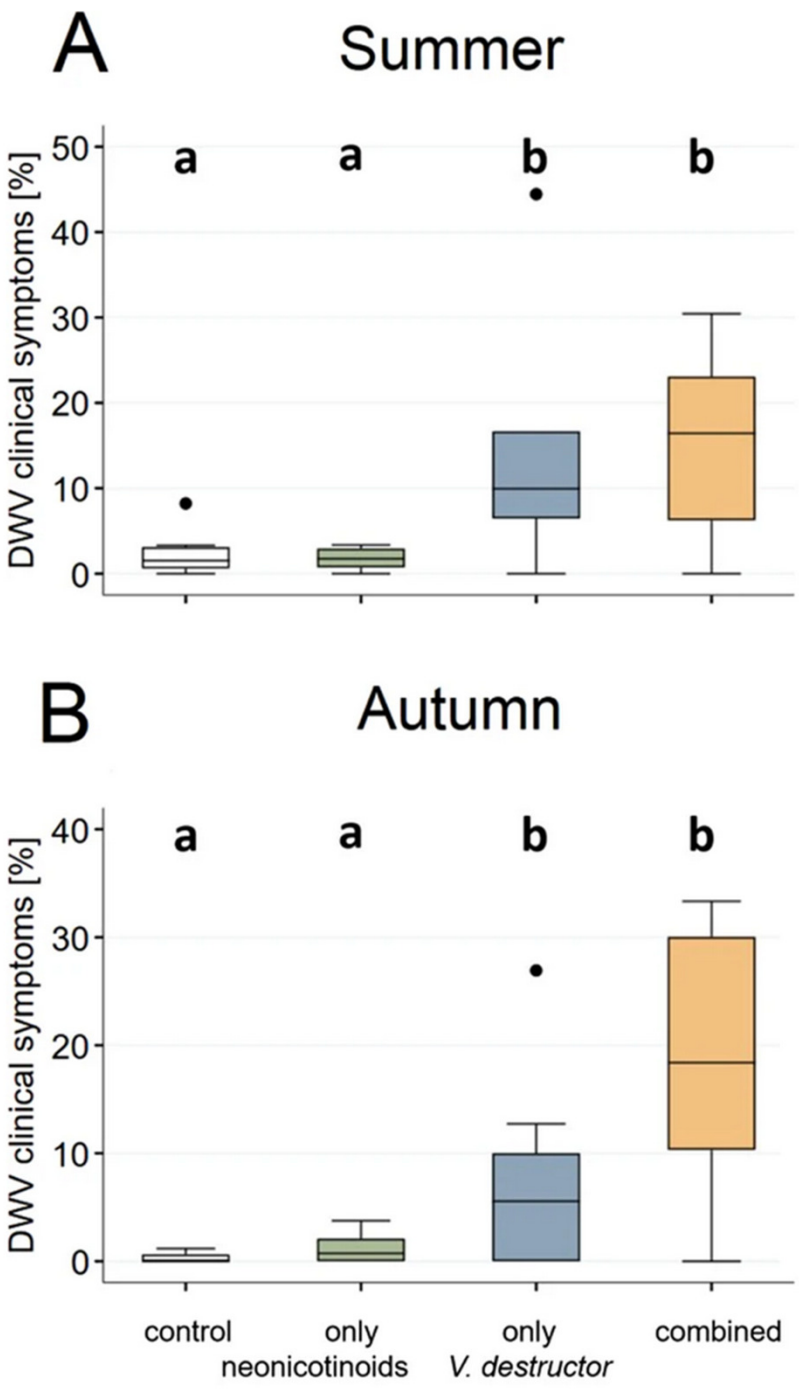
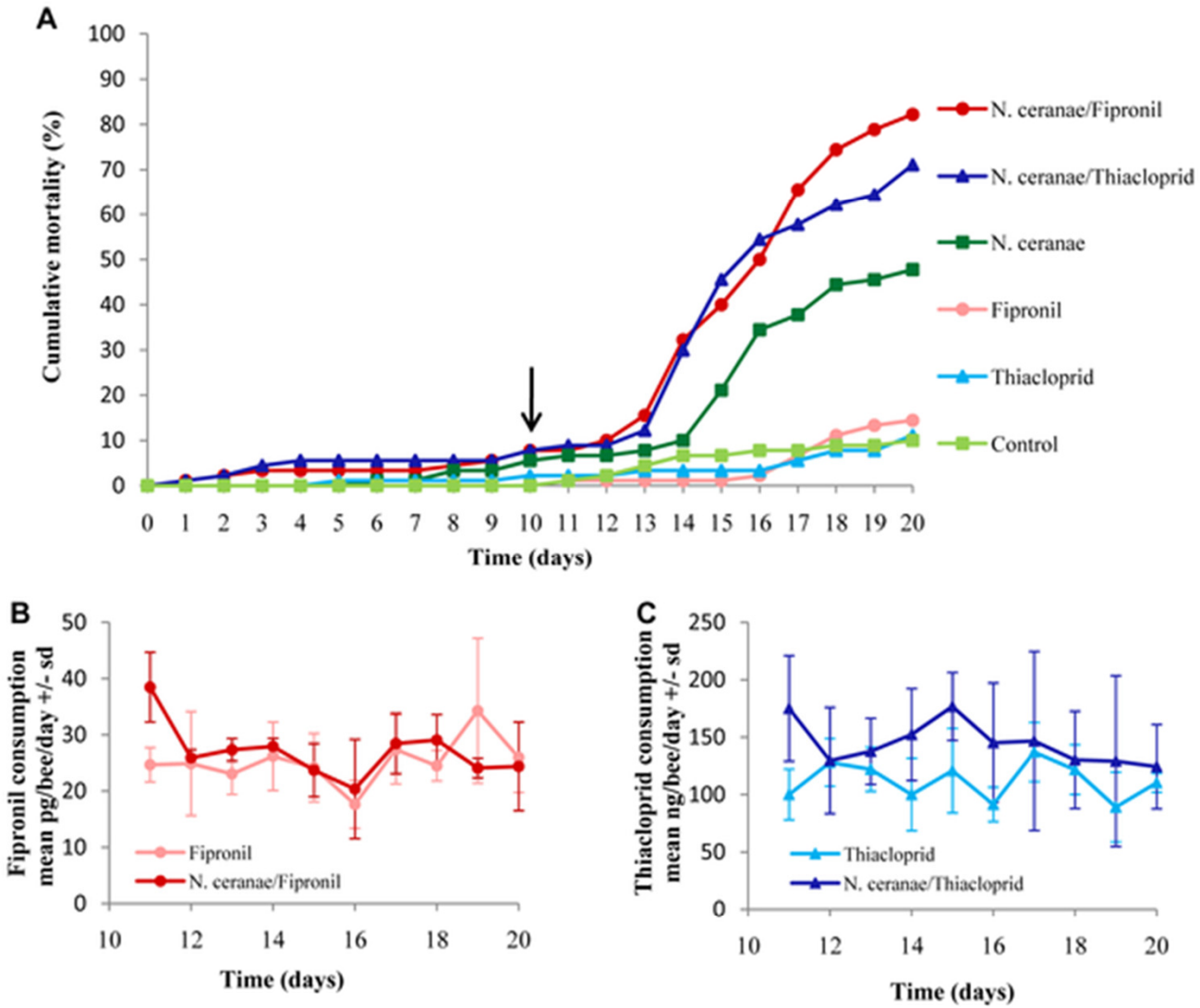

A
Summer
DWV clinical symptoms [%]
0
10
20
30
40
50
a
a
b
b
B
Autumn
DWV clinical symptoms [%]
0
10
20
30
40
a
a
b
b
control
only neonicotinoids
only V. destructor
combined

Figure 3. Effect of N. ceranae infection on honeybee sensitivity to insecticides.



Vidau C, Diogon M, Aufauvre J, Fontbonne R, Viguès B, et al. (2011) Exposure to Sublethal Doses of Fipronil and Thiacloprid Highly Increases Mortality of Honeybees Previously Infected by Nosema ceranae. PLOS ONE 6(6): e21550. https://doi.org/10.1371/journal.pone.0021550
https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0021550

Queens and colony strength

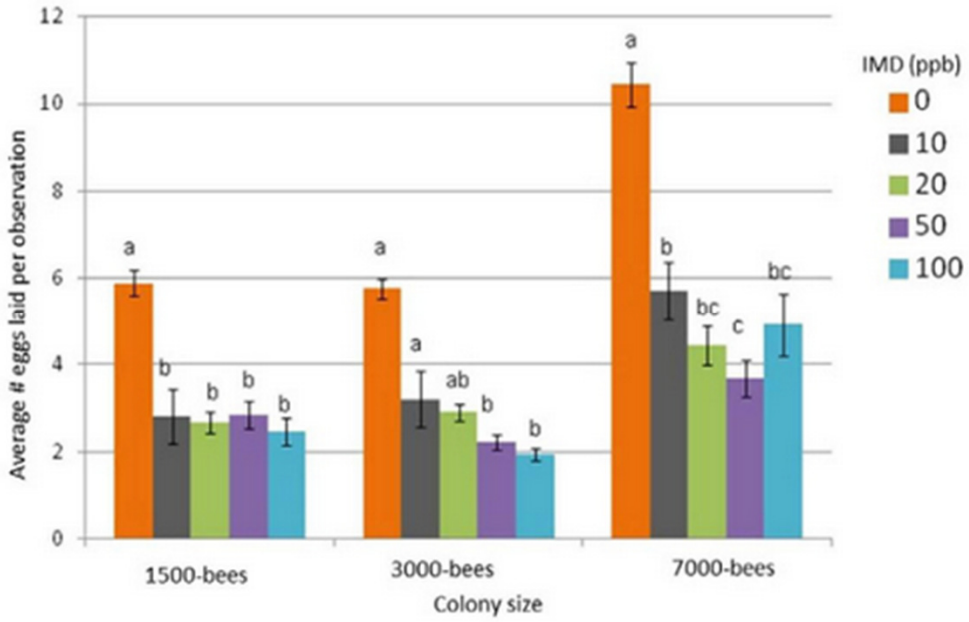


Figure 1. Average (SE) number of eggs laid by queens per 15 minute observation period pooled over three week chronic exposure of imidacloprid (IMD) (0, 10, 20 50, and 100 ppb) in 1500-, 3000-, and 7000-bee colonies ((dose*size*week) interaction: $F_{16,1053} = 0.93$; $p = 0.54$; (dose*size) interaction: $F_{8,1053} = 6.17$; $p < 0.0001$). Different letters denotes significant statistical differences among treatment levels within each colony size at $\alpha < 0.05$. Results indicate that queens in untreated colonies laid significantly more eggs than queens in treated colonies at all colony sizes.

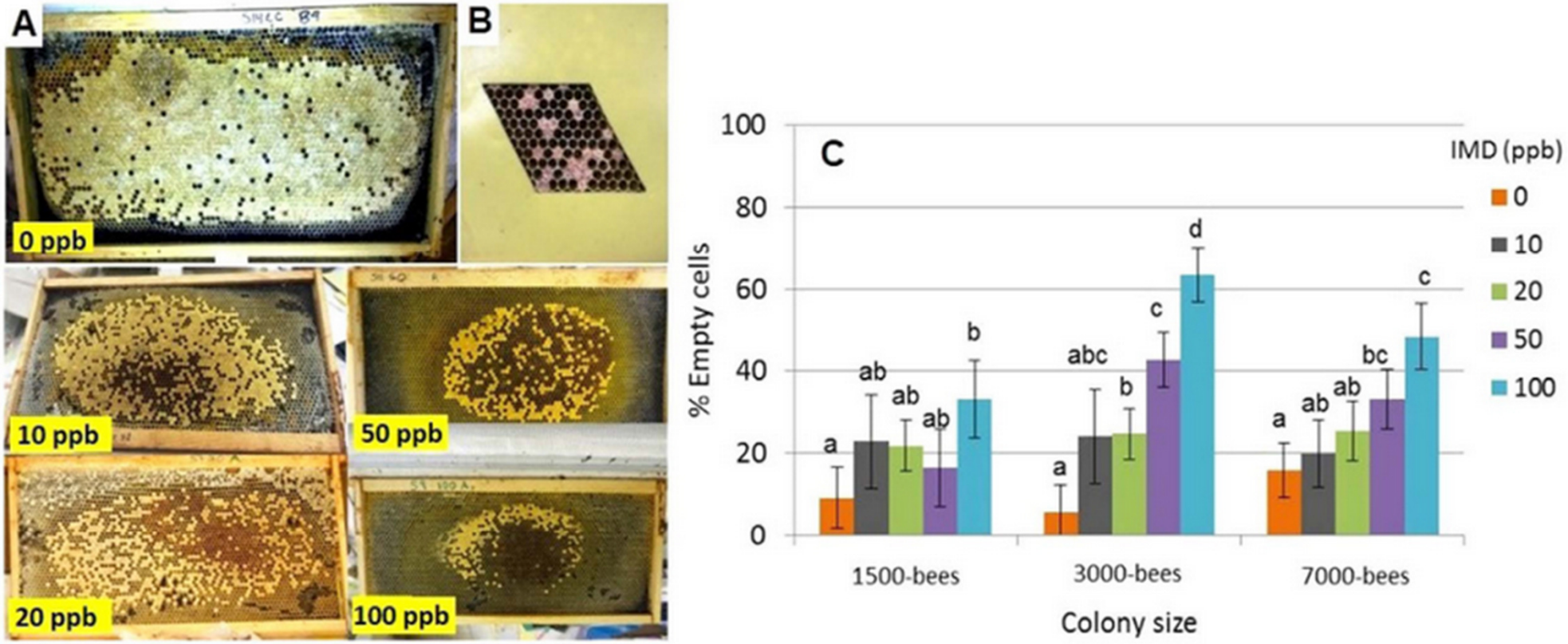


Figure 3. Examples of brood patterns from colonies chronically exposed to imidacloprid (0, 10, 20, 50 and 100 ppb) during brood rearing illustrating a dose-dependent effect where the amount of empty cells in a given brood area increases with treatment concentration (**A**); parallelogram containing 100 cells used to standardize brood pattern measures (**B**); and the average percentage (SE) of cells not containing pupae (empty) in a brood area of 100 cells separated by colony size (1500, 3000, and 7000 bees) and imidacloprid (IMD) dose (0, 10, 20, 50 and 100 ppb) (dose: $F_{4, 39} = 10.9$; $p < 0.0001$; colony size: $F_{2, 39} = 2.1$; $p = 0.14$; interaction effect: $F_{8, 39} = 1.3$; $p = 0.3$). Greater % of empty cells indicates worse brood patterns and overall brood health (**C**). Letters denote statistically significant differences among treatment levels within each colony size at $\alpha < 0.05$. Results indicate significantly worse brood pattern (more empty cells), particularly at higher treatments (50 and 100 ppb), compared to untreated colonies.

Outcomes

From a ban on Neonic seed treatments.

Quebec

Early signs show significant reduction of honeybee losses.

No reduction of crop yields.

Sweden

- Similar climate to Vermont
- Similar land use patterns
- National beekeeping organization reports less than 10% annual losses after EU ban on Neonics. (2013)
- 25-30% losses are now unheard of.

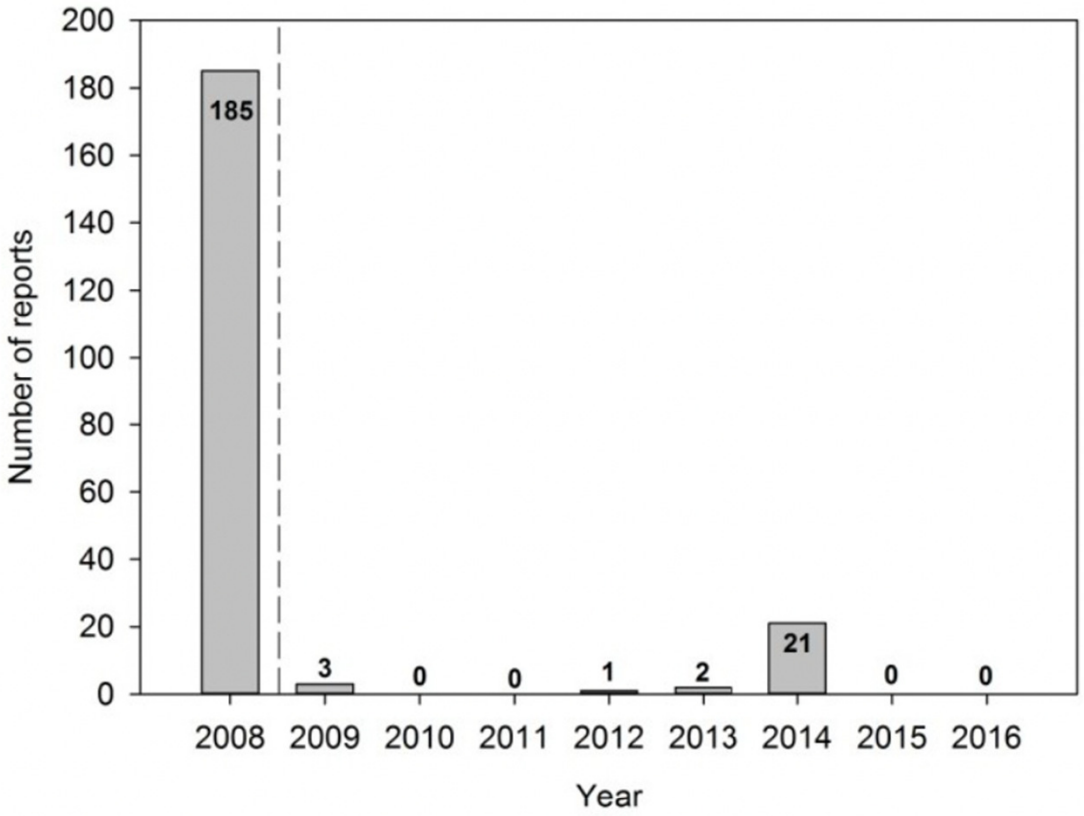
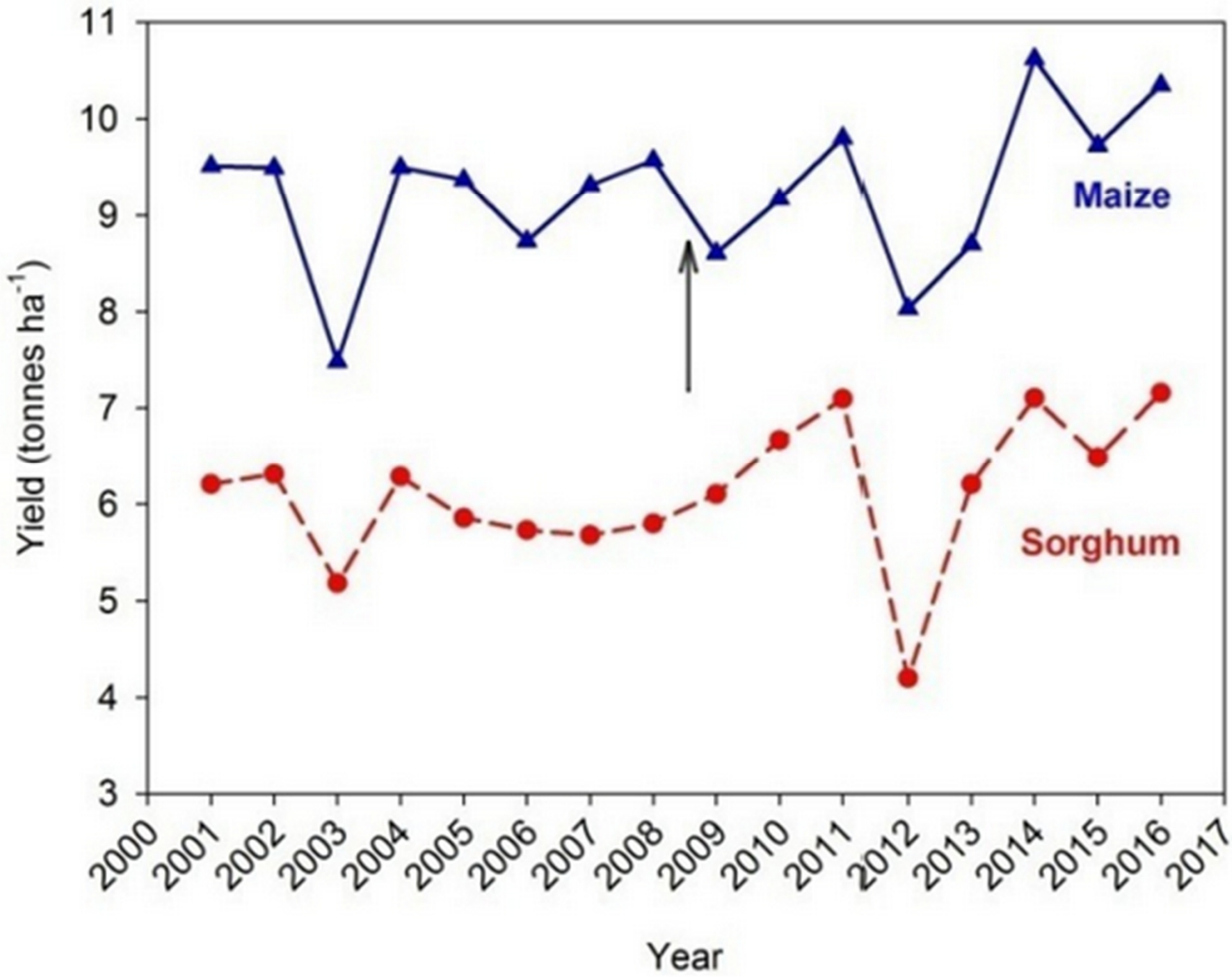


Figure 1. Number of adverse events (e.g. abnormal behaviours, high bee mortality, colony weakening) officially reported in maize-cultivation area of Northern Italy linked to maize sowing. The dashed line indicates the beginning of the precautionary suspension.


Yield (tonnes ha-1)
11
10
9
8
7
6
5
4
3
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Maize
Sorghum

References

Berens et al 2021

Williams et al 2015

Wu Smart and Spivak 2016

Tison et al 2020

Girolami et al 2012 and 2009

Charreton et al 2015

Milone et al 2021

Grassl et al 2018

Alaux et al 2010

Tosi et al 2017

Vidau et al 2011

Sandrock et al 2014

Piironinen and Goulson 2016

Yang et al 2012