1st International Conference - BeSafeBeeHoney CA22105

# BEekeeping products valorization and biomonitoring for the SAFEty of BEEs and HONEY

16:20, May 28th, Larissa, Greece.

**Interactions between poor nutrition, pesticides, pests and pathogens of honeybees in an intense agricultural landscape**

WAGENINGEN UNIVERSITY & RESEARCH

**Dr. Harmen P. Hendriksma**

Biointeractions & Plant Health, Wageningen University & Research

Food and Agriculture Organization of the United Nations

**Food security** is likely to remain one of the critical challenges for the world to face in 2024.

Looking to 2028: **global severely food insecure population** is projected to hit **956 million**

WAGENINGEN UNIVERSITY & RESEARCH

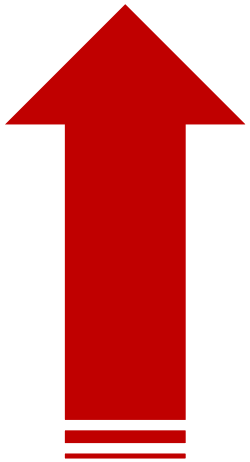
https://blogs.worldbank.org/en/agfood/food-security-trends-2024-and-beyond

Food and Agriculture Organization of the United Nations



Worldwide:

Primary production
9.4 billion tonnes
(+53%)



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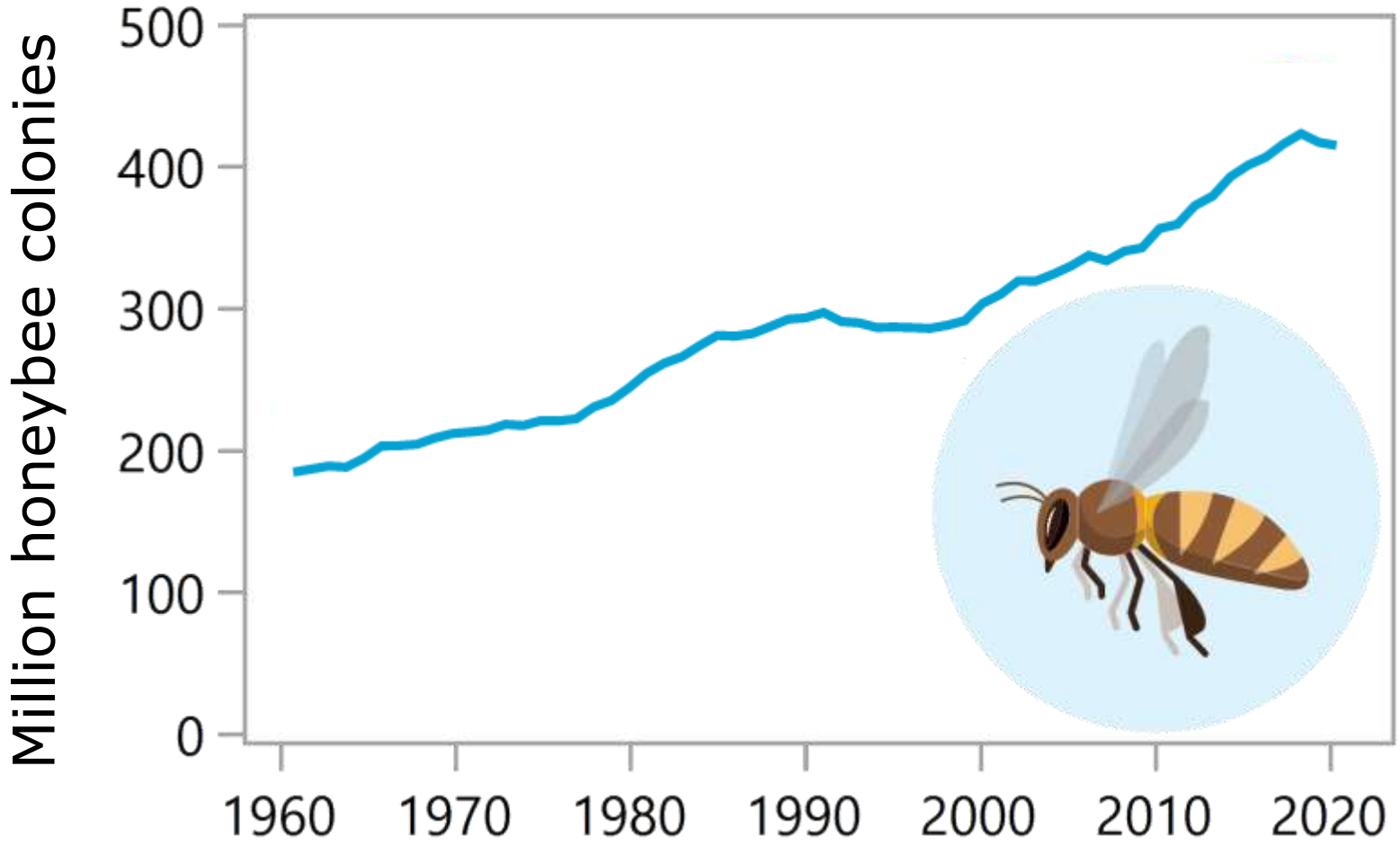
Food and Agriculture Organization of the United Nations

# Worldwide estimate: ~ 400 million colonies

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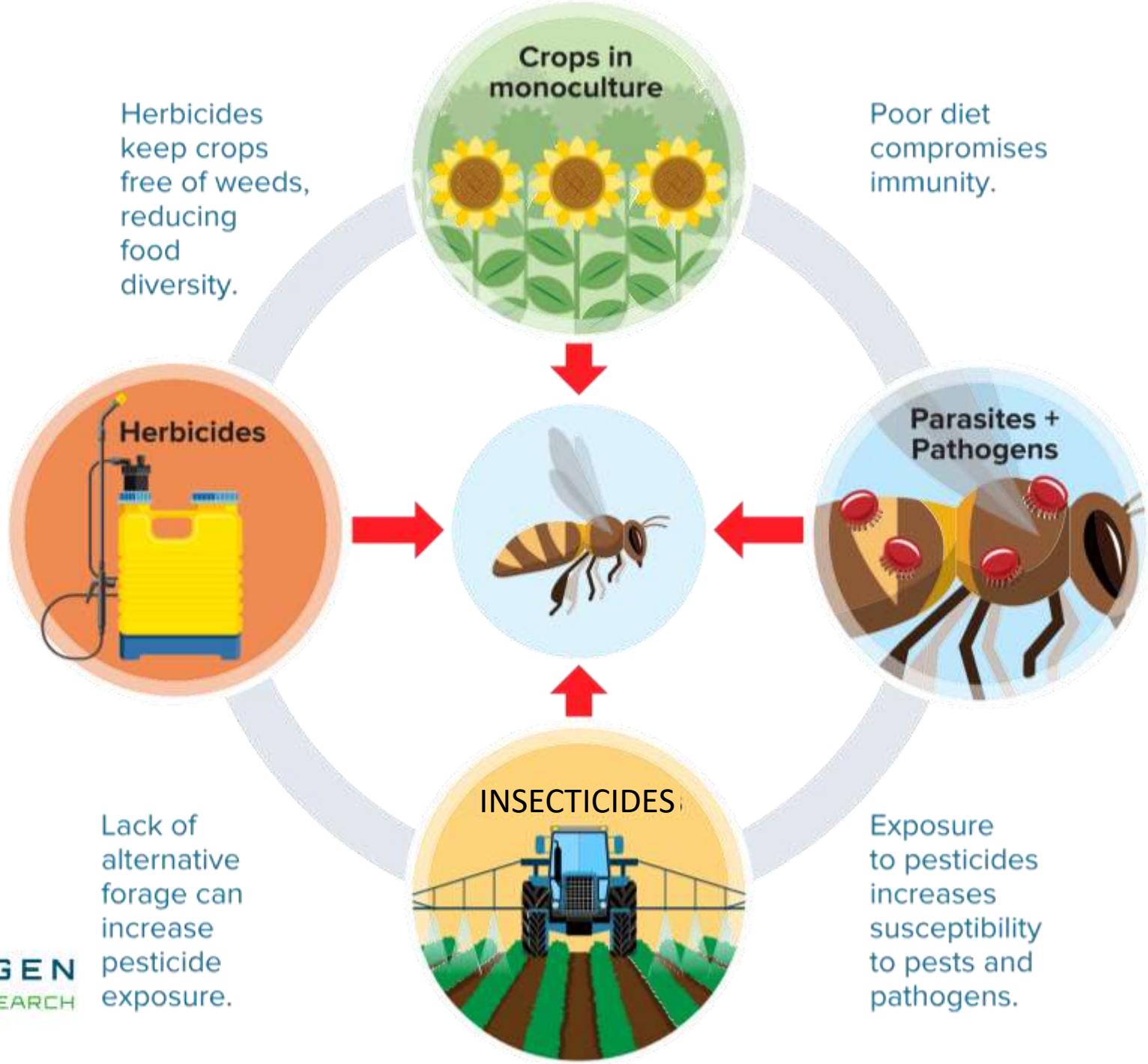
280 million wild https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10568204/
102 million managed https://www.fao.org/faostat/en/#search/bees

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IOWA STATE UNIVERSITY

Department of Ecology, Evolution, and Organismal Biology (EEOB)

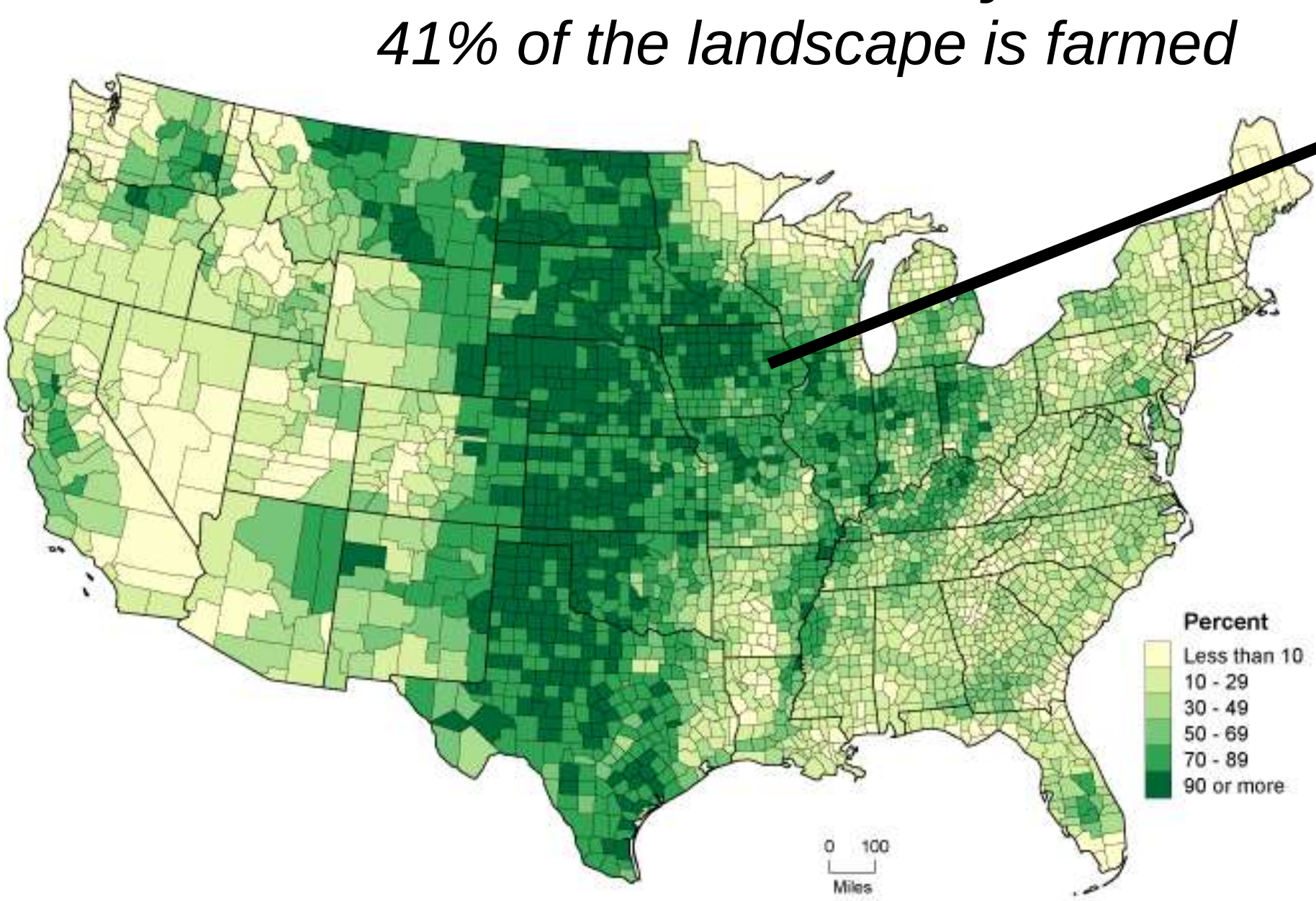
USDA NIFA

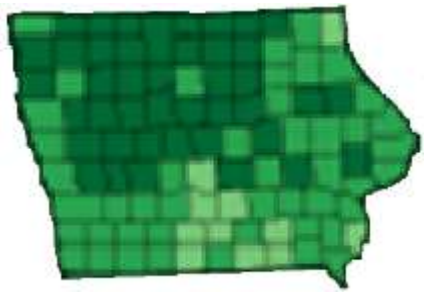
United States Department of Agriculture
National Institute of Food and Agriculture

# INTEGRATIVE INSECT SOCIOBIOLOGY
# **THE TOTH LABORATORY**

# **USA is dominated by farms**:

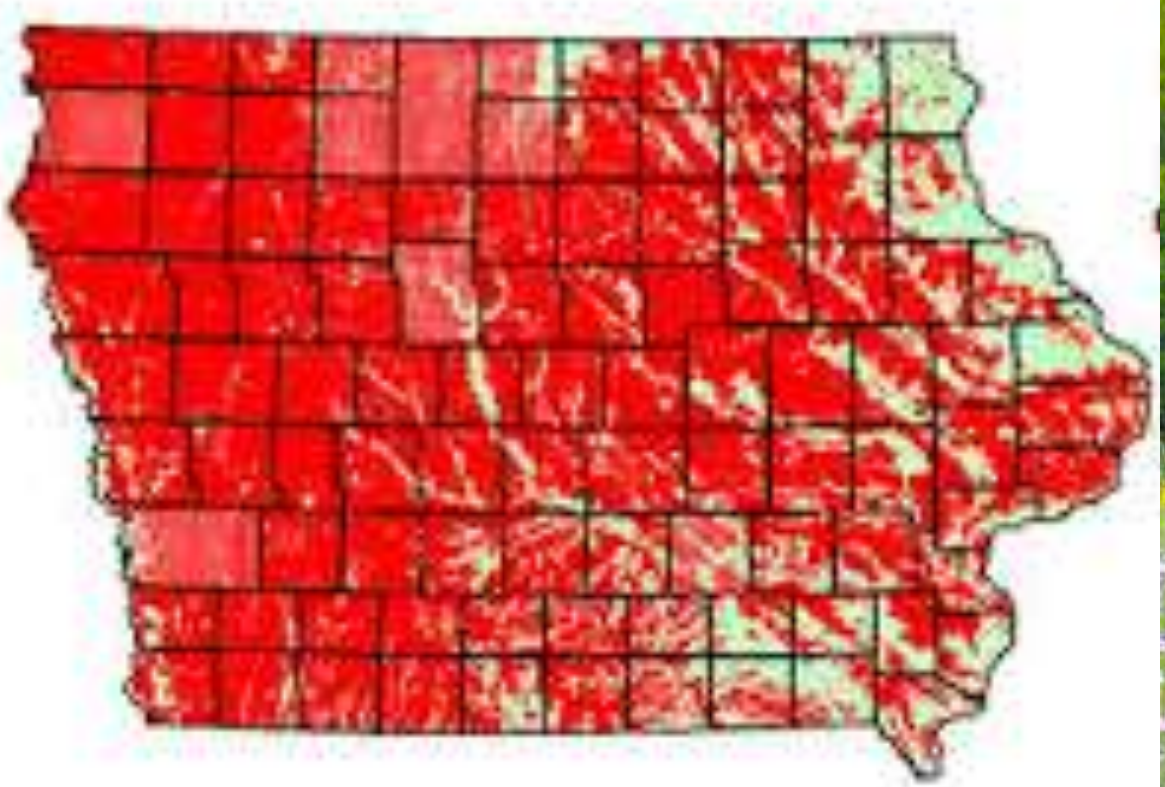
*41% of the landscape is farmed*

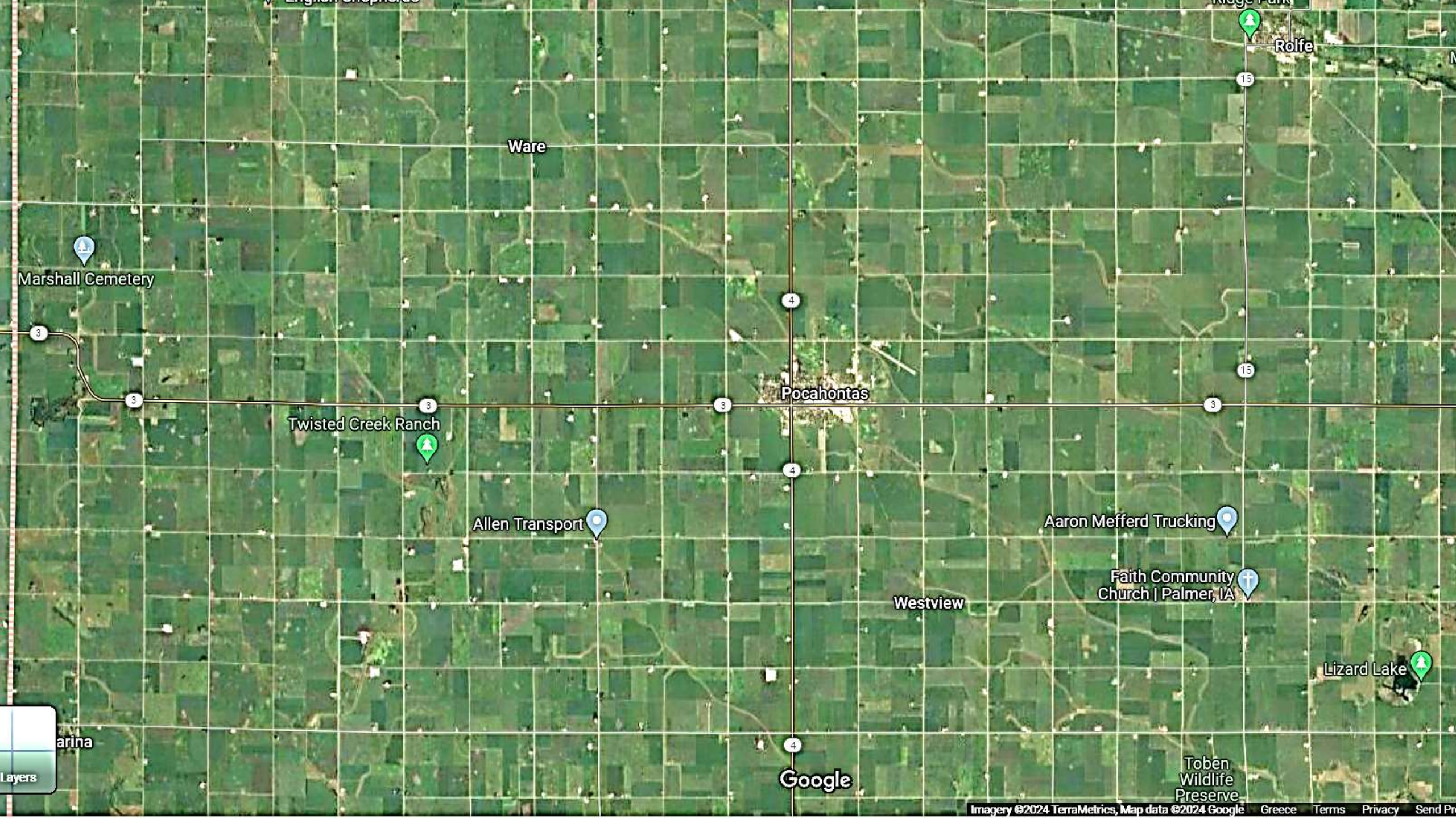


*Iowa 86%*

# 85% of Iowa was prairie




Rolfe
Ware
Marshall Cemetery
Pocahontas
Twisted Creek Ranch
Allen Transport
Aaron Mefferd Trucking
Faith Community Church | Palmer, IA
Westview
Lizard Lake
Toben Wildlife Preserve
Google
Layers
Imagery ©2024 TerraMetrics, Map data ©2024 Google
Greece
Terms
Privacy

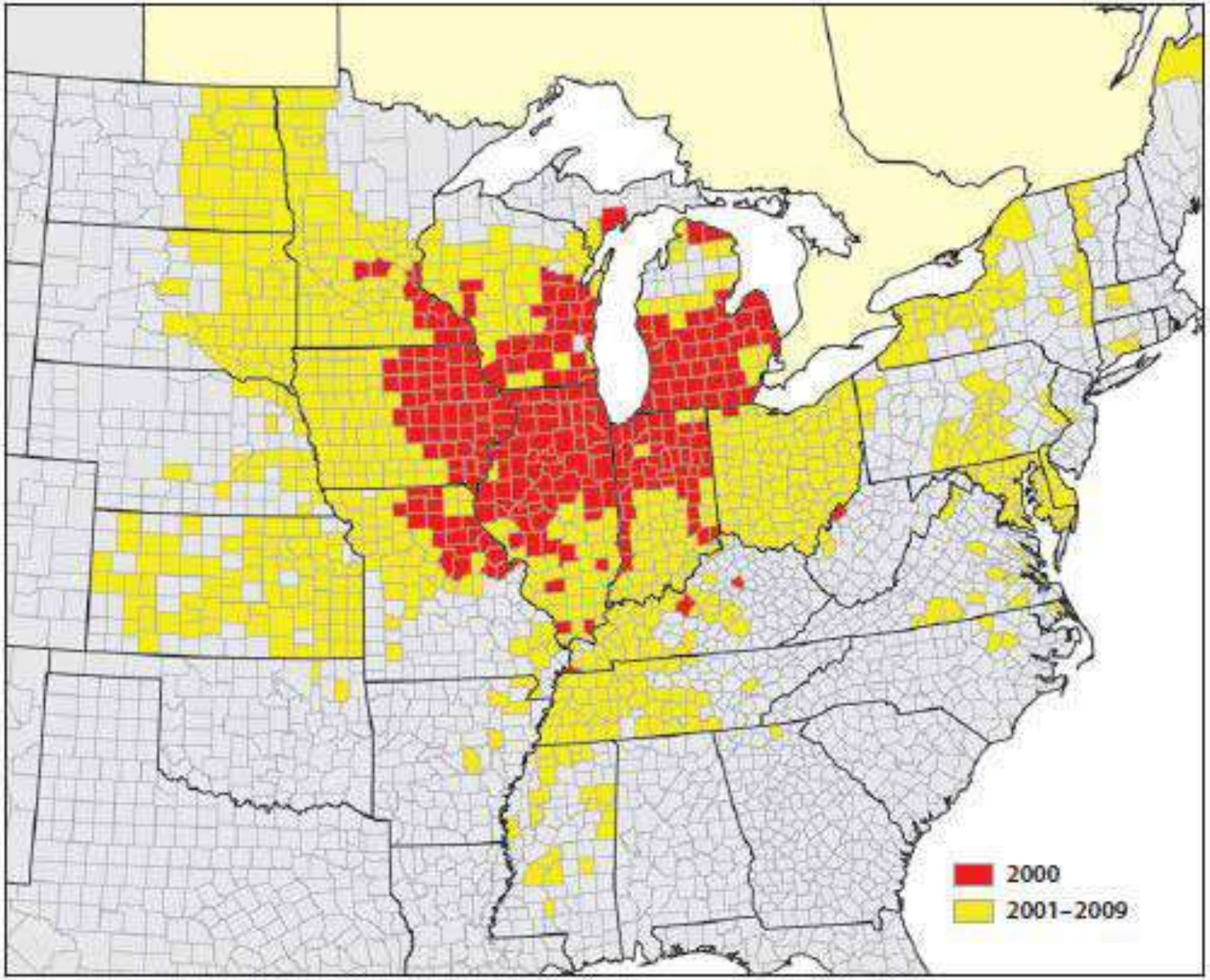

220th Ave
190th Ave
Westview
570th St
570th St
570th St
570th St
Layers
Google

Iowa farmland is

| | |
|---|---|
| Soybean | 40.000 km2 |
| Corn / maize | 53.000 km2 |

*Source: extension.iastate.edu*

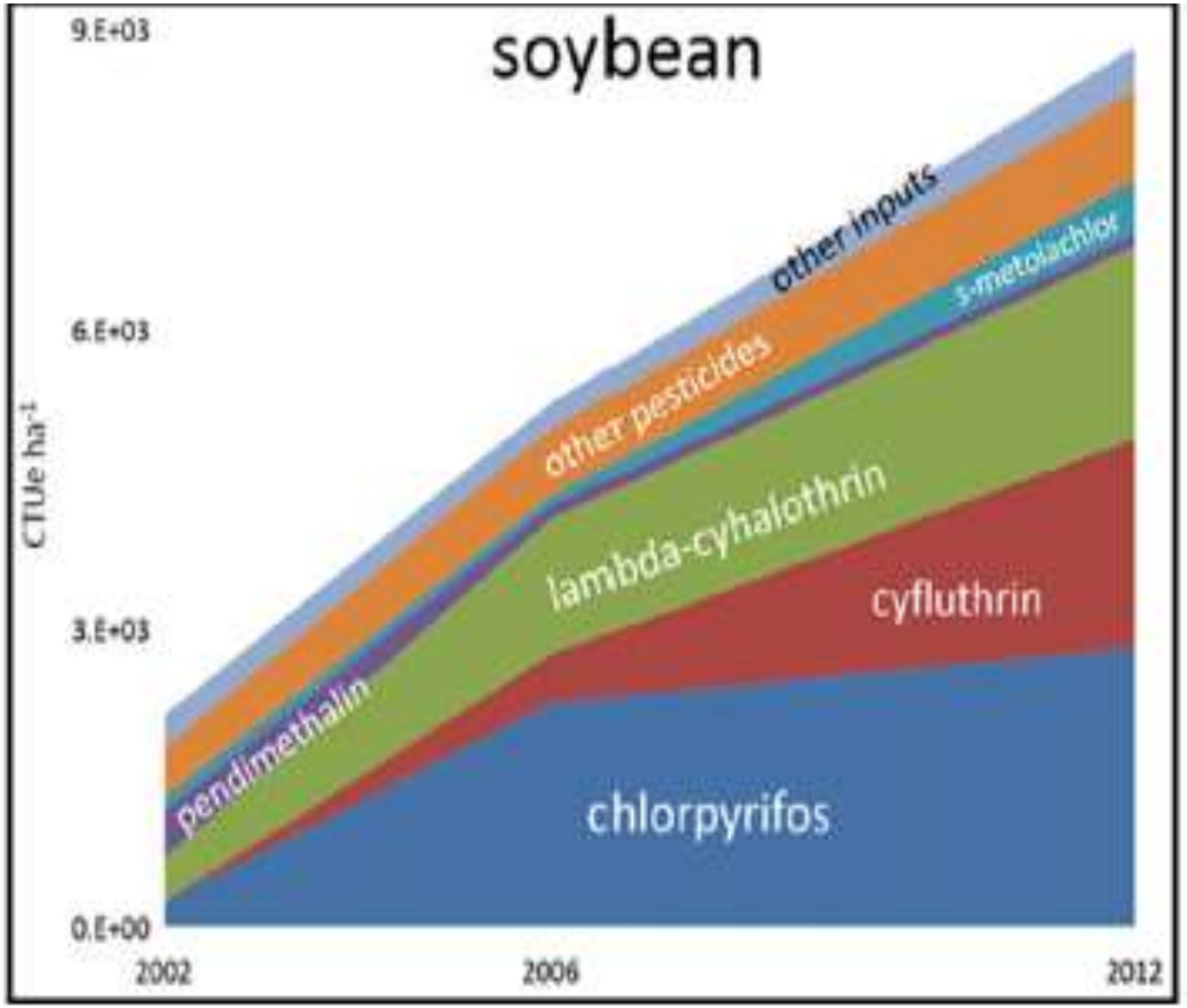

Nectar &
no pollen
unitedsoybean.org




"if left untreated, yield reductions >40% can occur in heavily infested fields"

https://www.insectforecast.com/2014/03/soybean-aphid/

# Foliar Insecticides

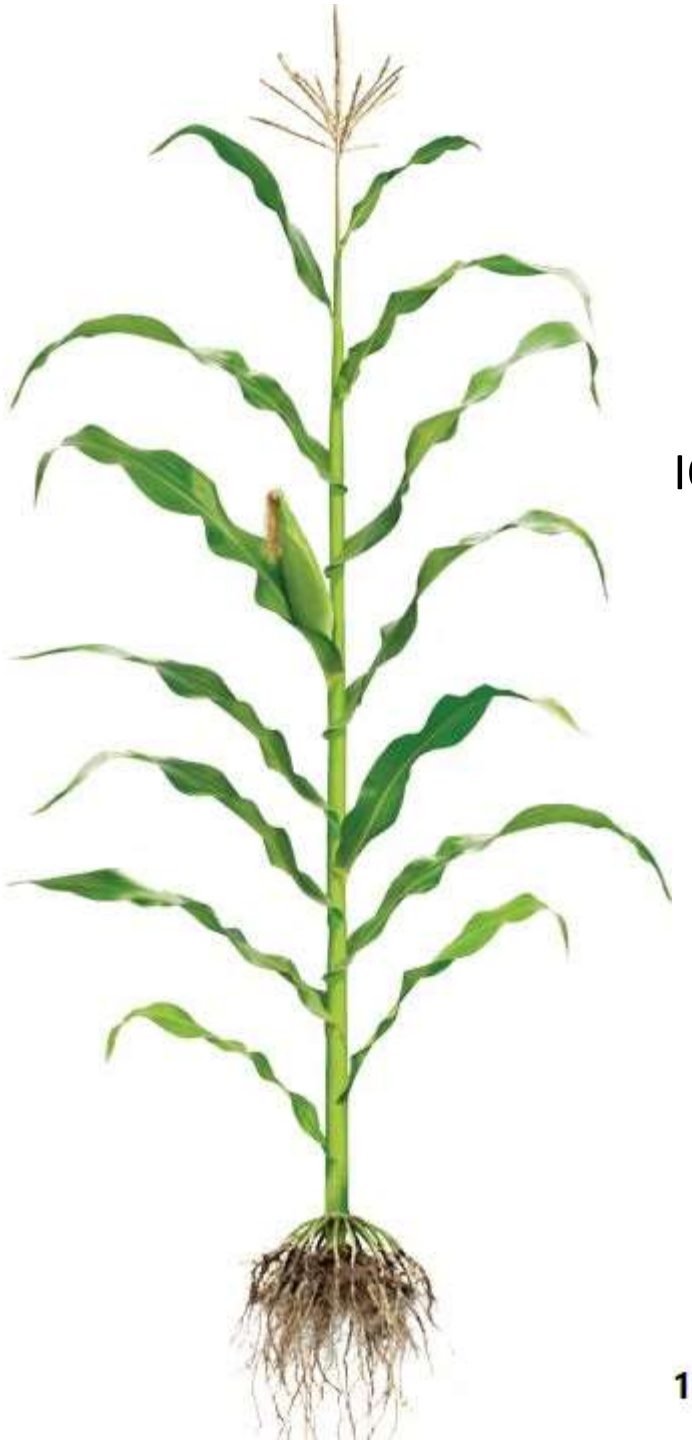



Yang and Suh 2015

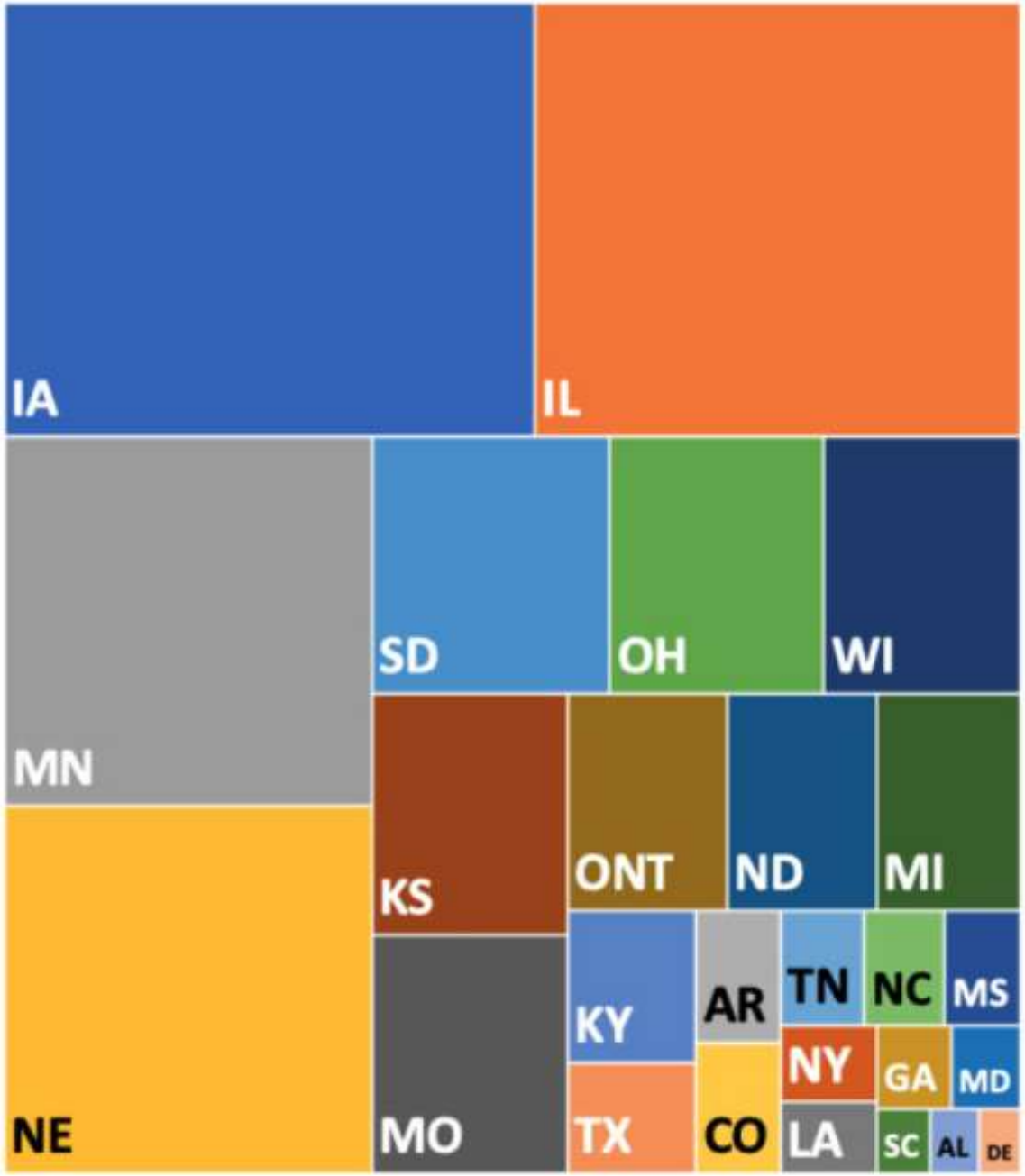
https://heimpellab.cfans.umn.edu/projects/soybean-aphid-biological-control-north-america


Foto source: unknown

https://cropprotectionnetwork.org/publications/corn-invertebrate-loss-estimates-from-the-united-states-and-ontario-canada-2022



IOWA ->

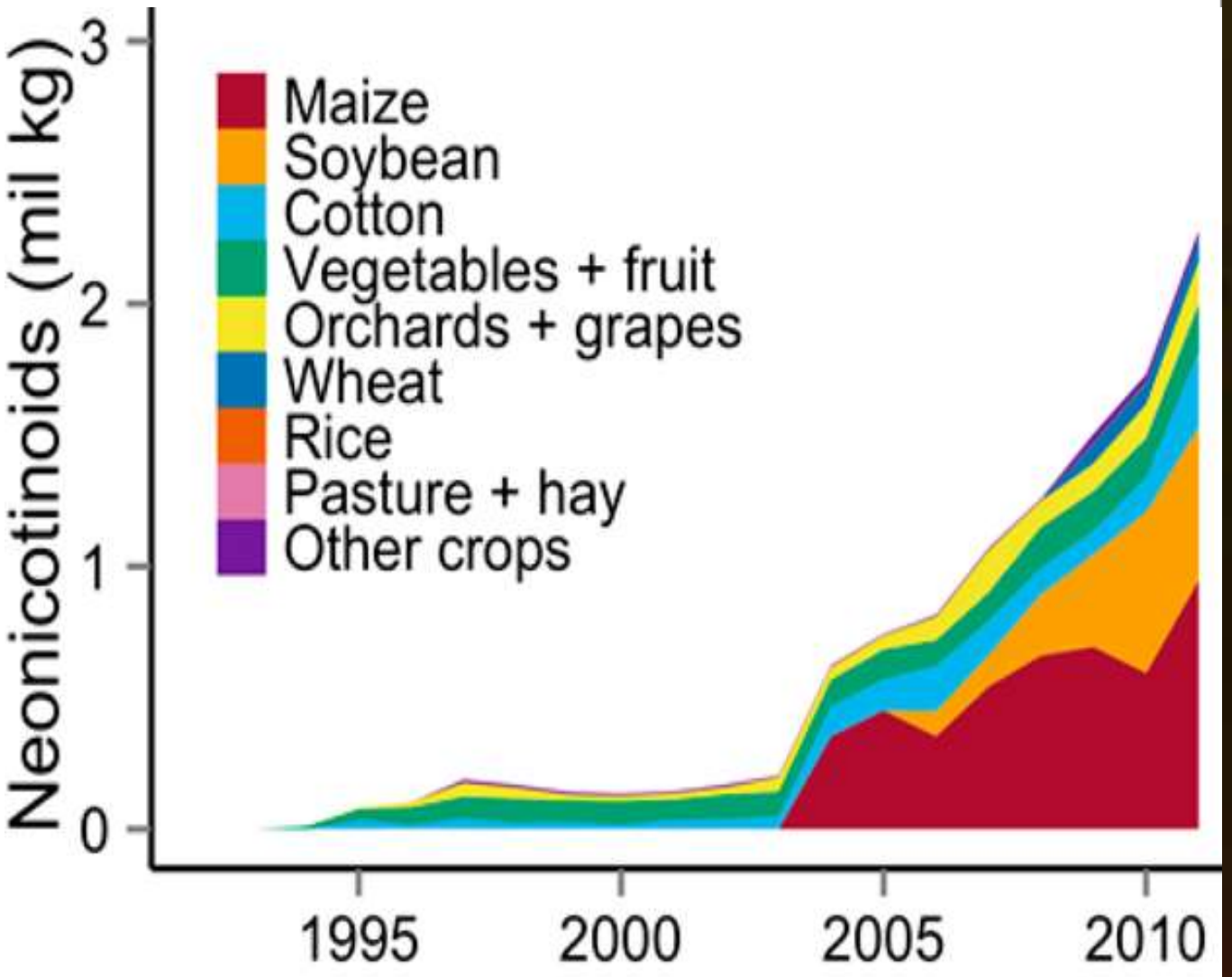



**1.** Proportion of 2022 corn production by state or province for the 25 U.S. states and Ontario, Canada

https://cropprotectionnetwork.org/publications/corn-invertebrate-loss-estimates-from-the-united-states-and-ontario-canada-2022

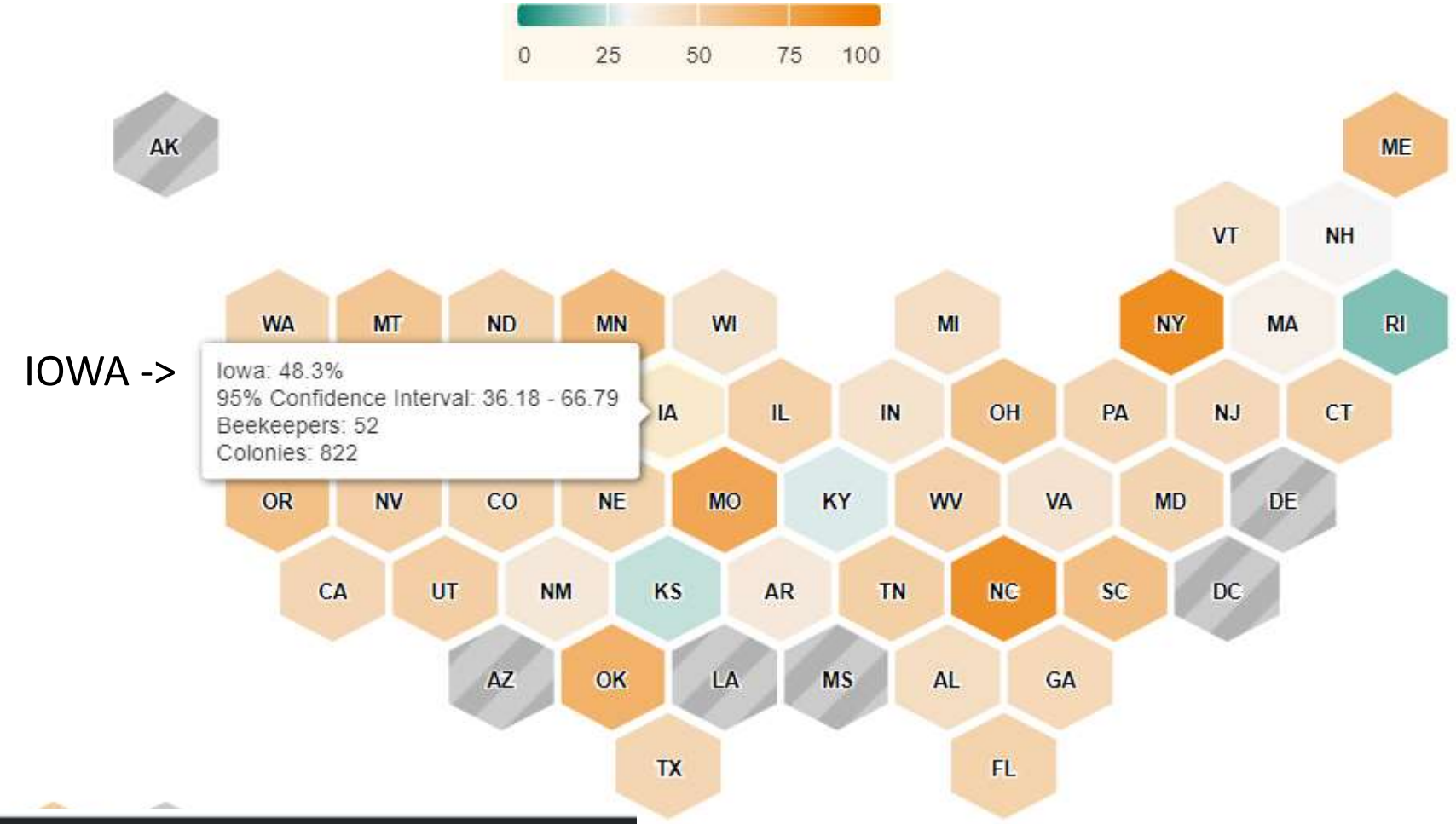
**Figure 2.** Corn rootworm larvae on corn roots. Rootworms were estimated to reduce overall yield 447 million bushels in 2022.
(11 million metric tonnes)
*Iowa State University Integrated Pest Management Program*

# Seed Treatments




Douglas and Tooker 2015

# Honey bee colony mortality: 2022/2023




https://research.beeinformed.org/loss-map/

Bee Informed Partnership

Highcharts.com

Season

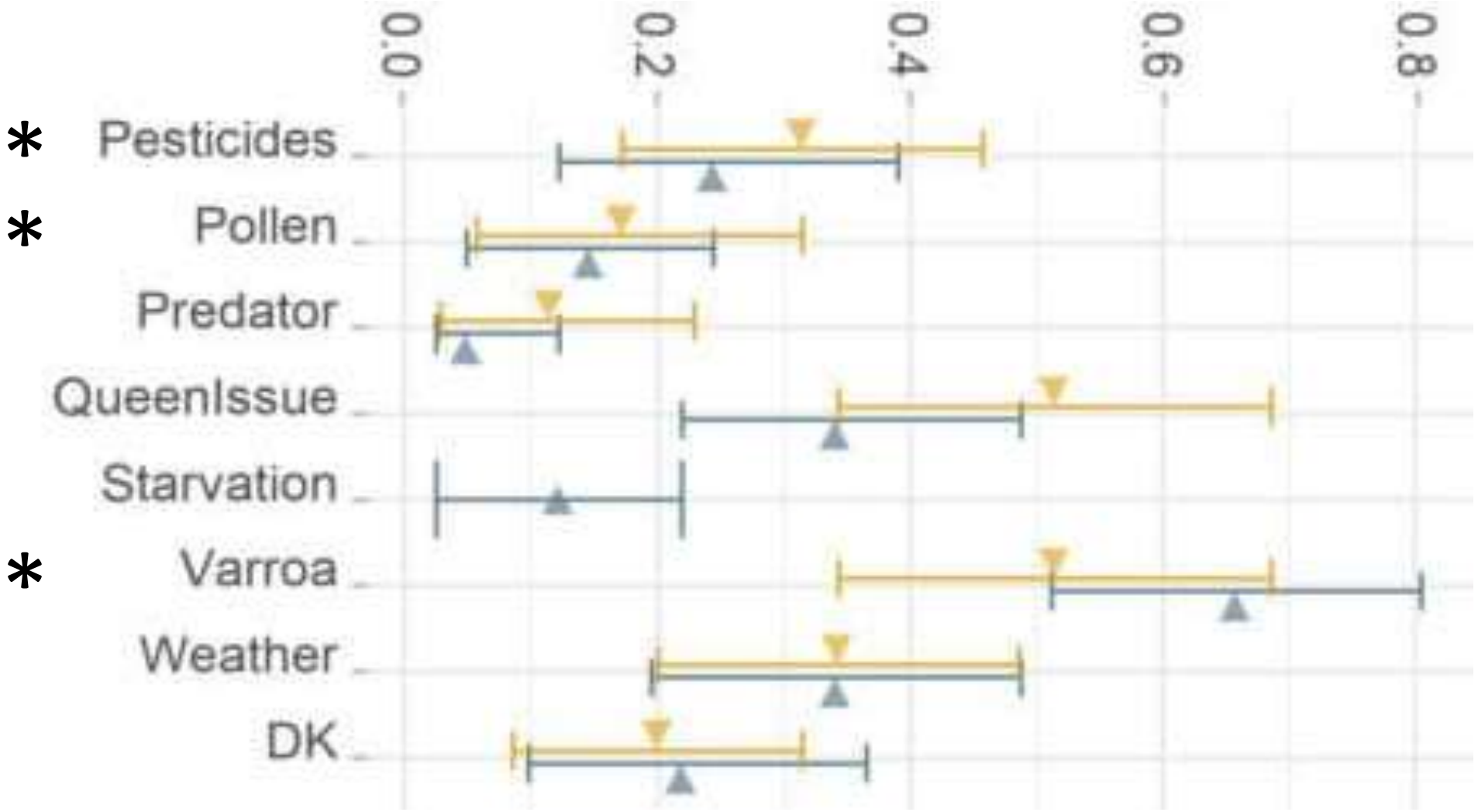
Annual

Operation Type

All

# USA: Self reported causes of colony losses

Respondent % (commercial beekeepers)

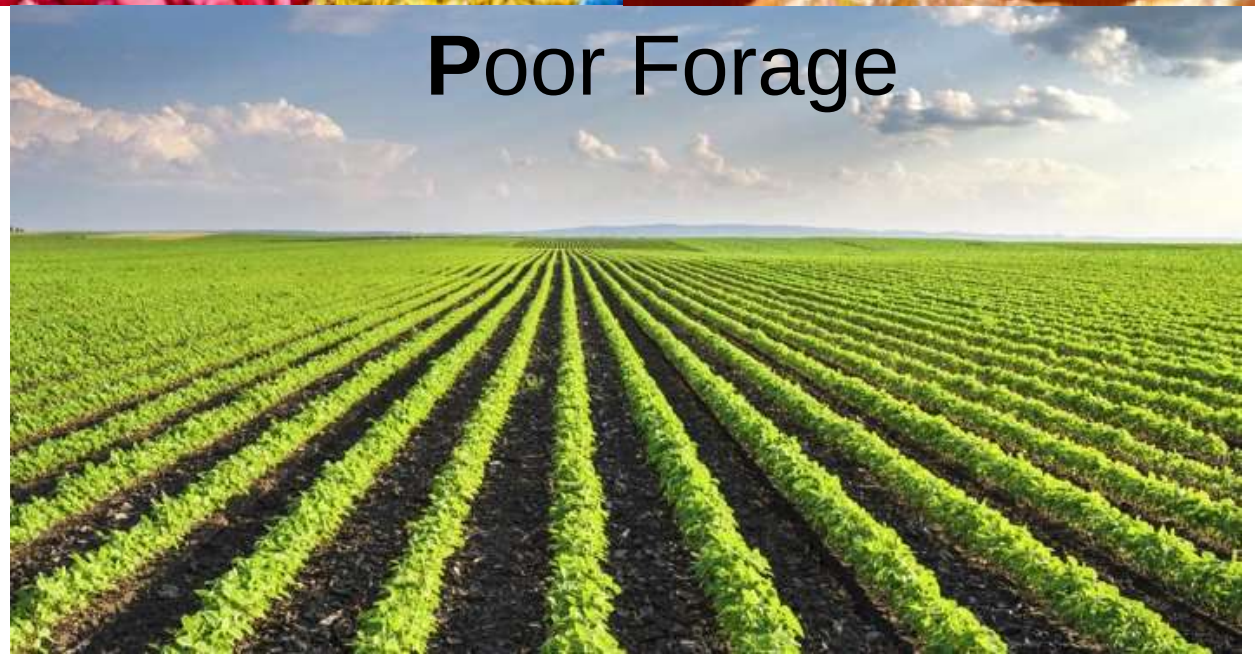



Source: Bee Informed Partnership

# *Environmental stress - bee health*

**P**esticides

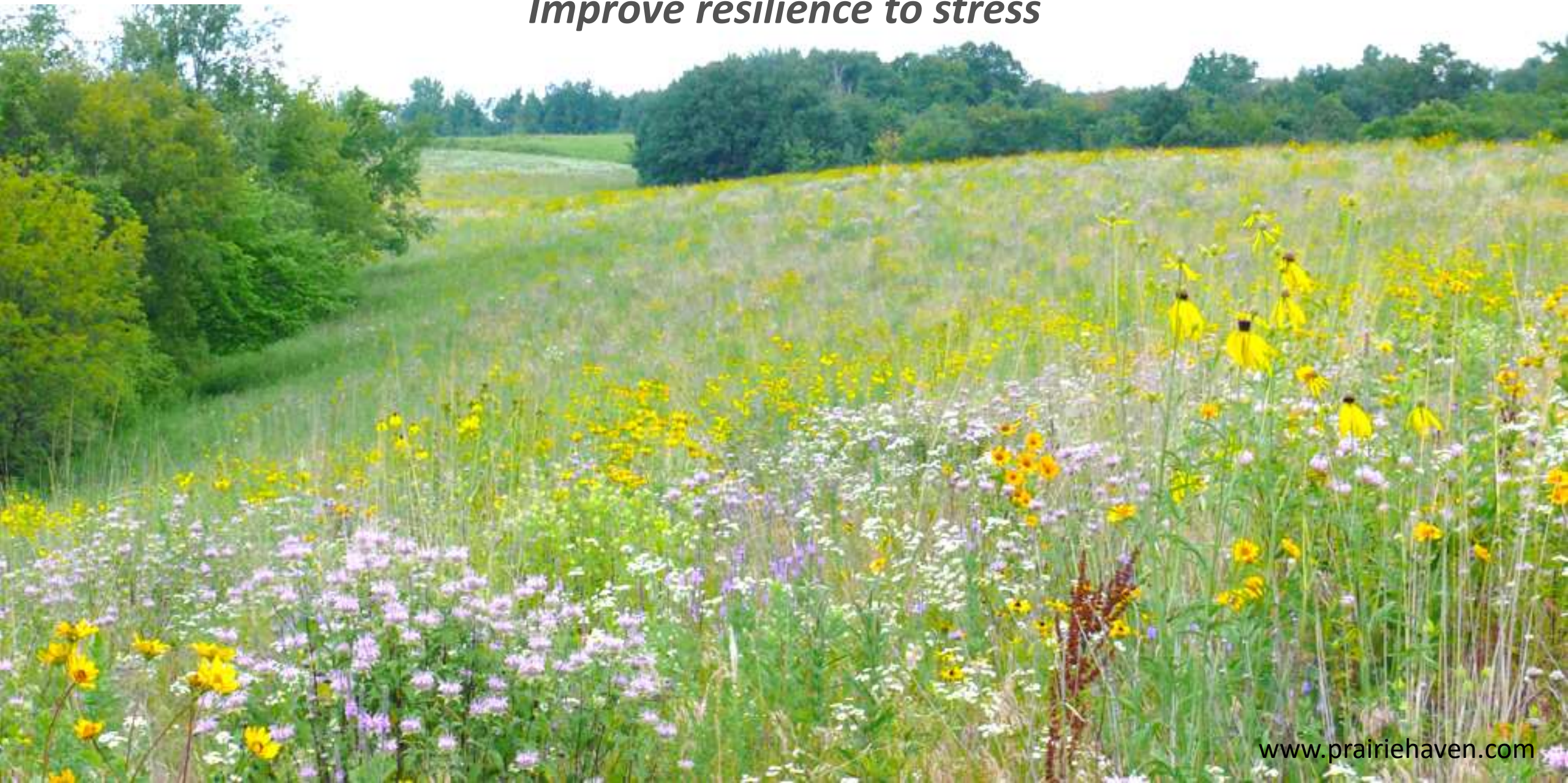
**P**oor Forage



**P**athogens

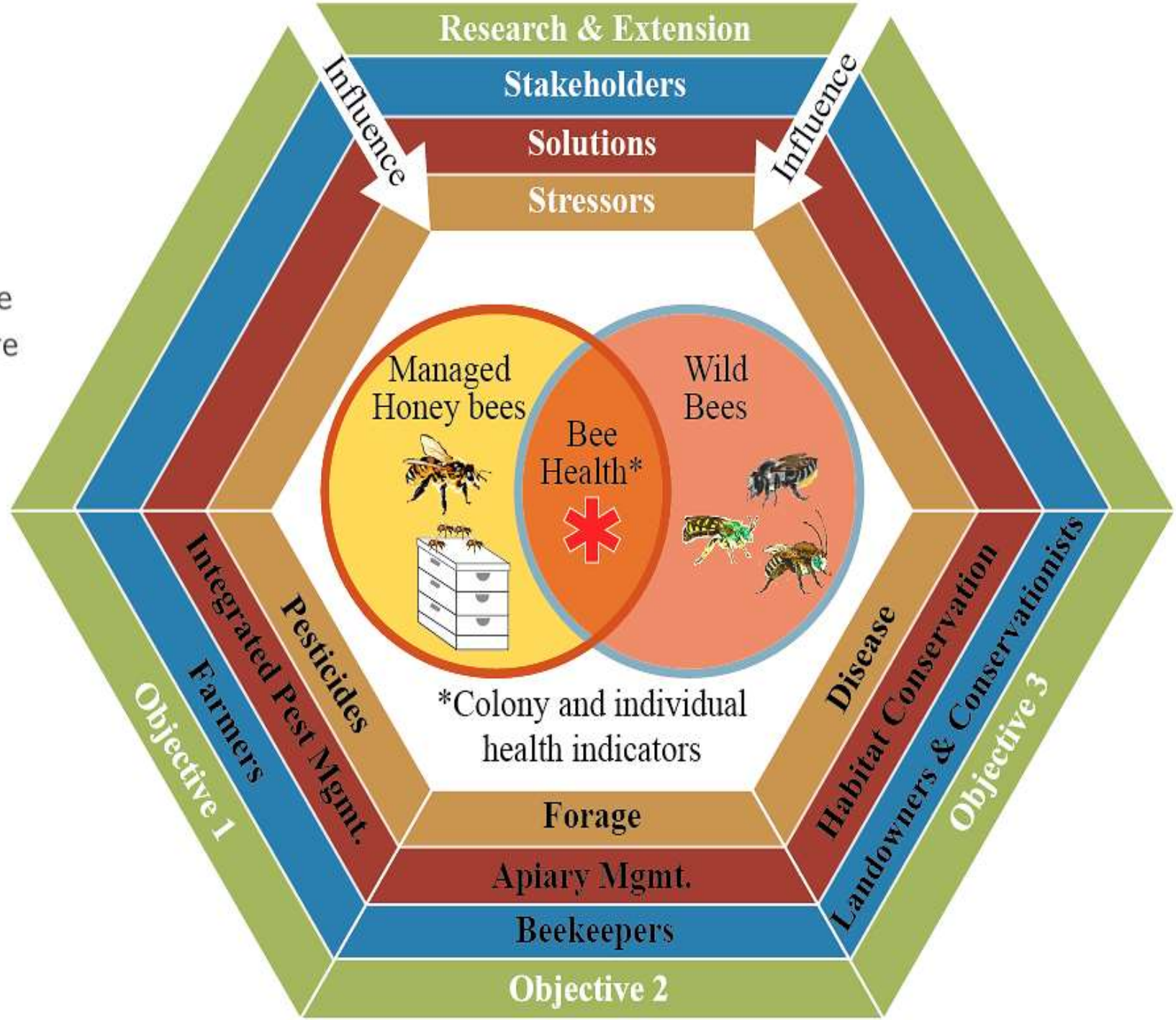
# Can NATIVE PRAIRIE help honey bees?

## *Improve resilience to stress*



www.prairiehaven.com

United States Department of Agriculture
National Institute of Food and Agriculture

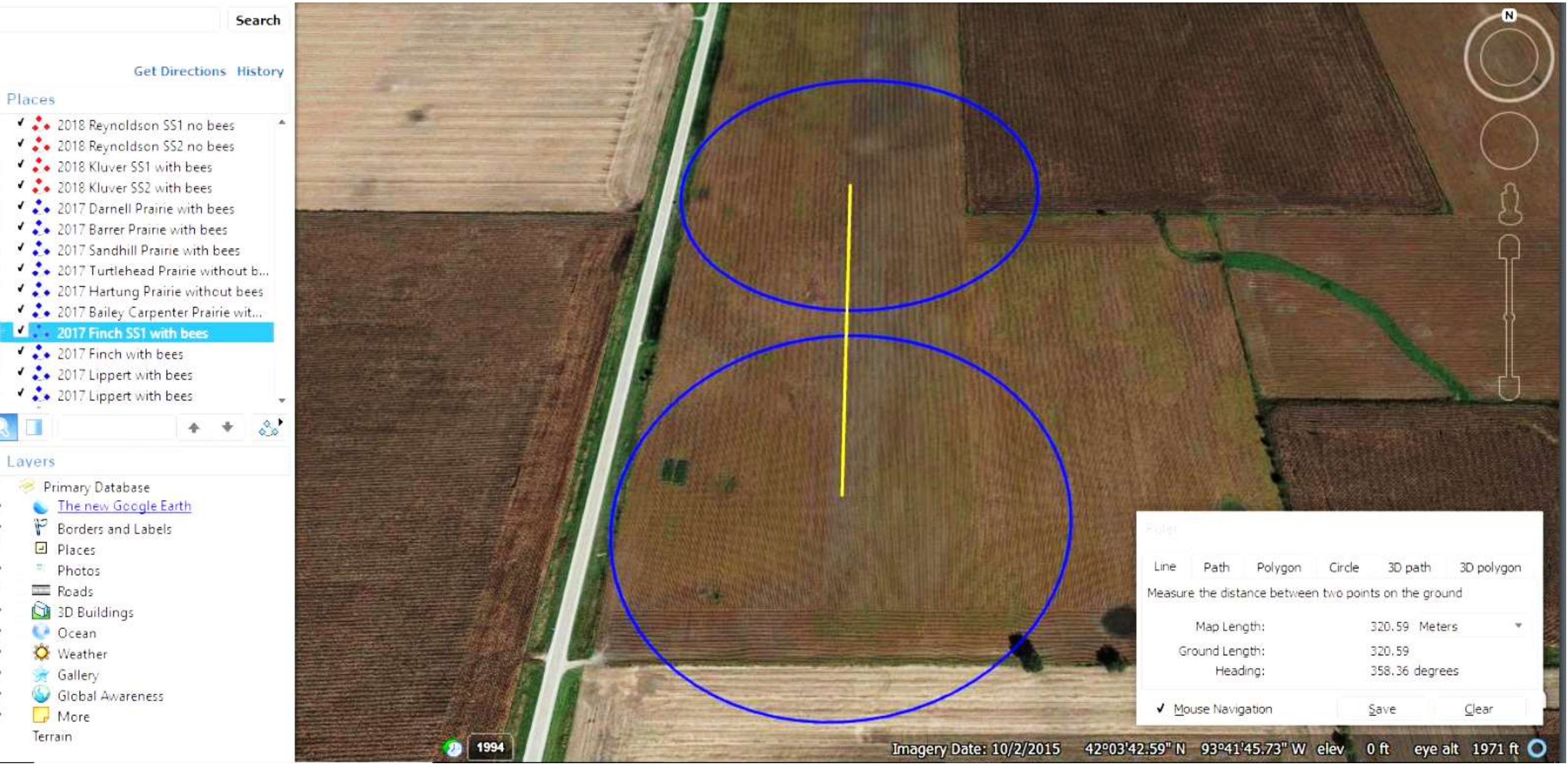


6 Soybean fields

6 Prairie sites

> 0.2 km2

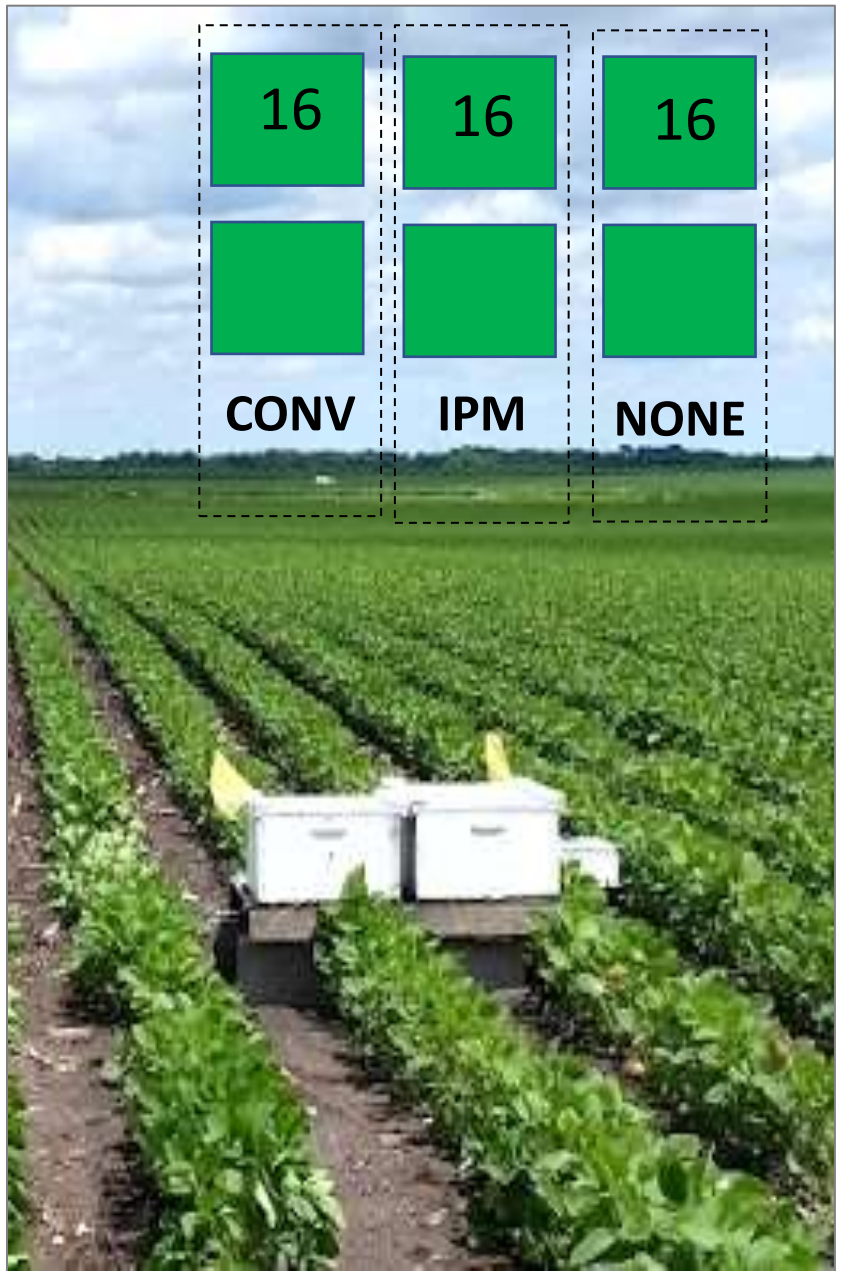
> 1.6 km


Search
Get Directions
History
Places
2018 Reynoldson SS1 no bees
2018 Reynoldson SS2 no bees
2018 Kluver SS1 with bees
2018 Kluver SS2 with bees
2017 Darnell Prairie with bees
2017 Barrer Prairie with bees
2017 Sandhill Prairie with bees
2017 Turtlehead Prairie without b...
2017 Hartung Prairie without bees
2017 Bailey Carpenter Prairie wit...
2017 Finch SS1 with bees
2017 Finch with bees
2017 Lippert with bees
2017 Lippert with bees
Layers
Primary Database
The new Google Earth
Borders and Labels
Places
Photos
Roads
3D Buildings
Ocean
Weather
Gallery
Global Awareness
More
Terrain
N
Line
Path
Polygon
Circle
3D path
3D polygon
Measure the distance between two points on the ground
Map Length: 320.59 Meters
Ground Length: 320.59
Heading: 358.36 degrees
Mouse Navigation
Save
Clear
1994
Imagery Date: 10/2/2015 42°03'42.59" N 93°41'45.73" W elev 0 ft eye alt 1971 ft

# 6 Soybean fields


# 6 Prairie sites

# 6 Soybean fields




# 6 Prairie sites

| Site | Seed treatment | 1st Herbicide used | 2nd Herbicide used | Insecticide |
|---|---|---|---|---|
| Dairy CONV | Pioneer Premium minus Ilevo | 2pints Prowl H20, 5oz Sonic | 36oz Roundup Powermax, 8oz Clethodim, 10oz Cobra | Warrior II |
| Lippert IPM | fungicide | Zidua Pro | Clethodim, Flexstar, & Zidua | NA |
| Finch NONE | fungicide | 2pints Prowl H20, 5oz Sonic | 36oz Roundup Powermax, 8oz Clethodim, 10oz Cobra | NA |

# Warrior II with Zeon Technology®

## Insecticide

| | |
|---|---|
| *Active Ingredient:* | |
| Lambda-cyhalothrin[1,2] . . . . . | 22.8% |
| *Other Ingredients:* | 77.2% |
| *Total:* | 100.0% |

Warrior II with Zeon Technology contains 2.08 lb of active ingredient per gal and is a capsule suspension.

[1]CAS No. 91465-08-6
[2]Synthetic pyrethroid

Contains petroleum distillate.

**EPA Reg. No. 100-1295**
**EPA Est. 39578-TX-1**

a.i.; a synthetic pyrethroid,
Lambda-cyhalothrin

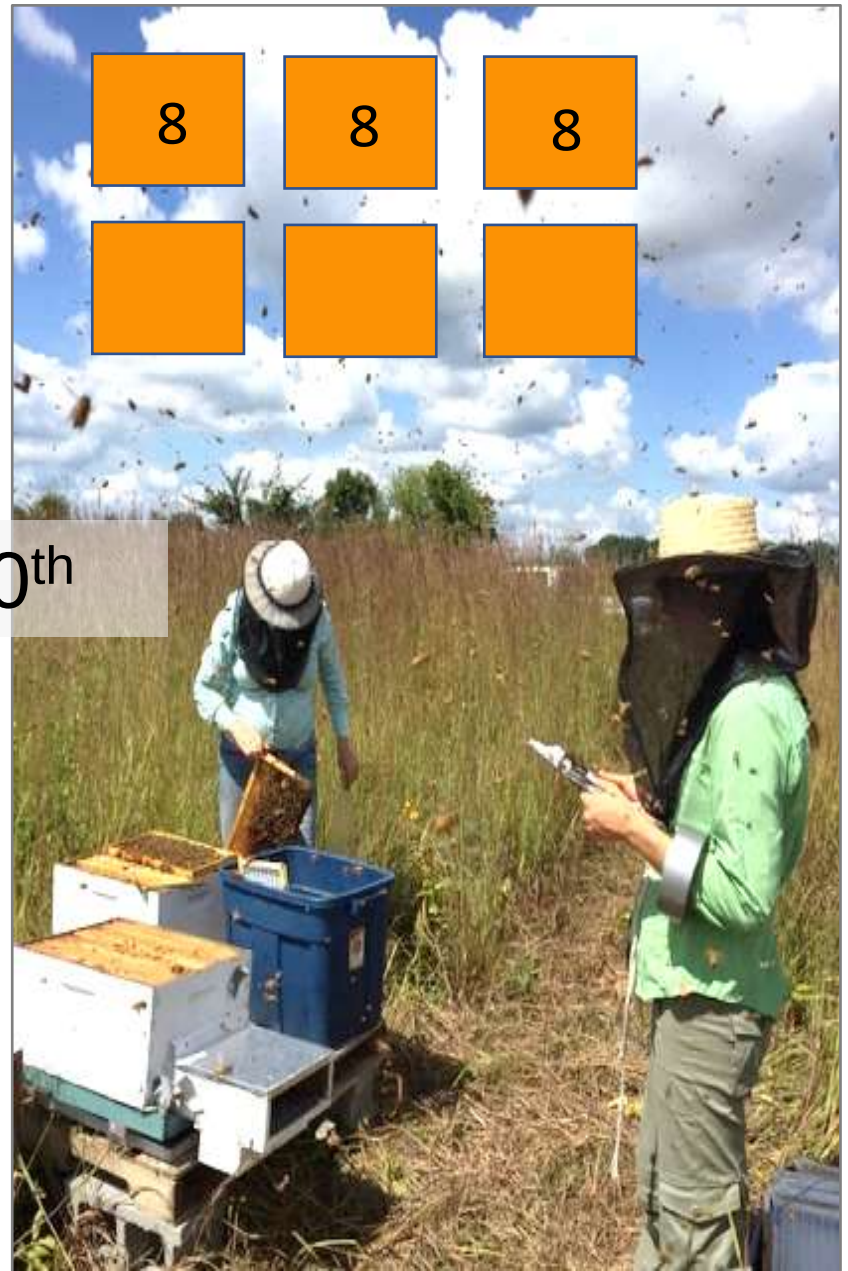
*"pyrethroid bifenthrin enhances CYP9Q1 transcripts"*

***Mao W, Schuler MA, Berenbaum MR.*** *(2011) CYP9Q-mediated detoxification of acaricides in the honey bee (Apis mellifera). Proc Natl Acad Sci U S A :12657-62. doi: 10.1073/pnas.1109535108.*

6 Soybean fields


August 10th

6 Prairie sites



## *Hive assessments*

Hive weight
Brood Cover
Sides of bees
Queen present Y/N
**10 times**

## *Pollen collection*

Trap activated every two weeks

**15 times**

## *Labwork*

*VIRUS TITERS HB*
*FAT HB*

***4 dates***

## *Wild bees*

Bee bowls
Transects
Every two weeks

## *Winter survival*

Listening if colonies are alive
About every two weeks

## *Additional*

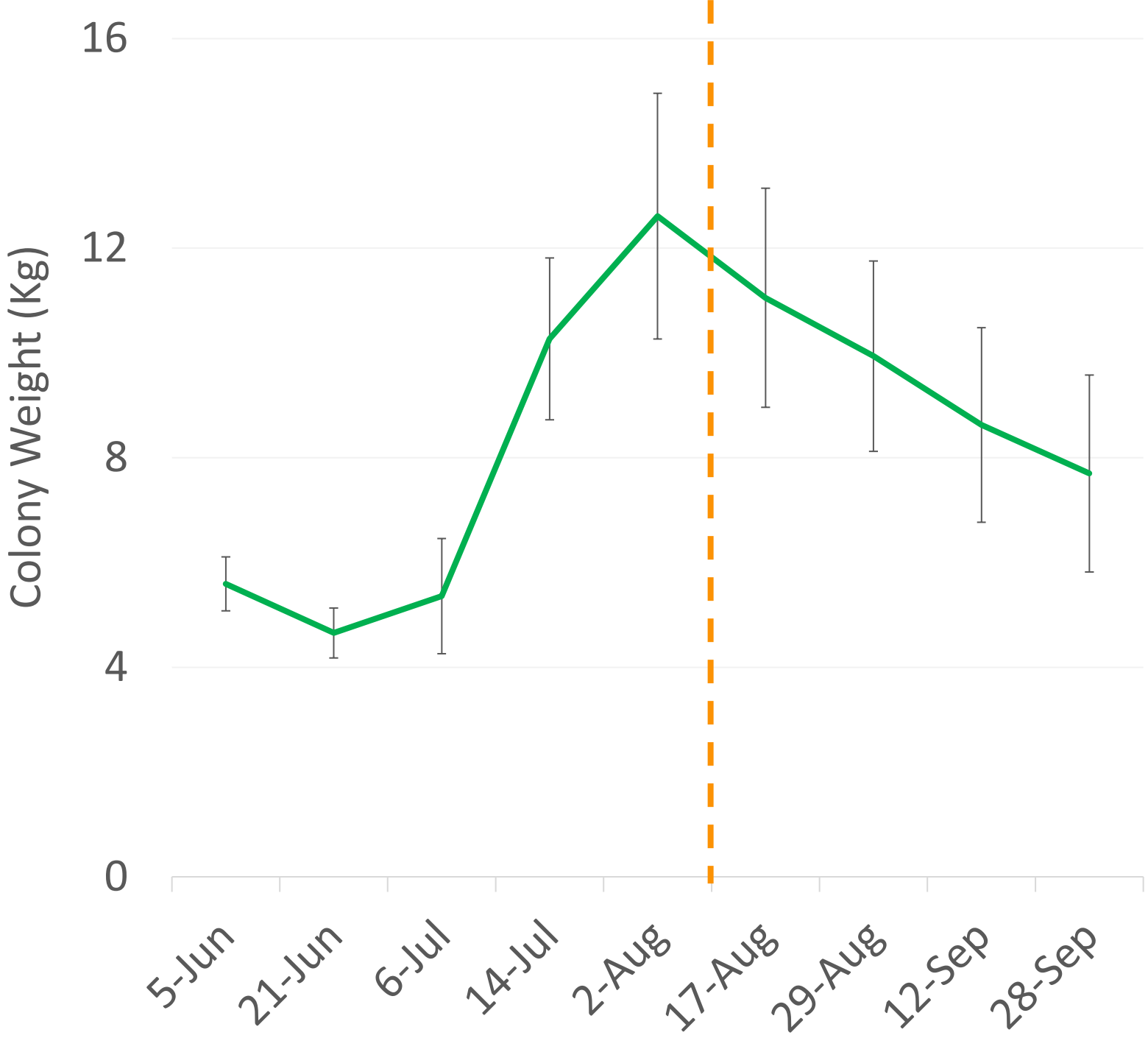
*BROODMINDERS*
*iBUTTONS*
*FLIR HEAT CAMERA*


simply southern

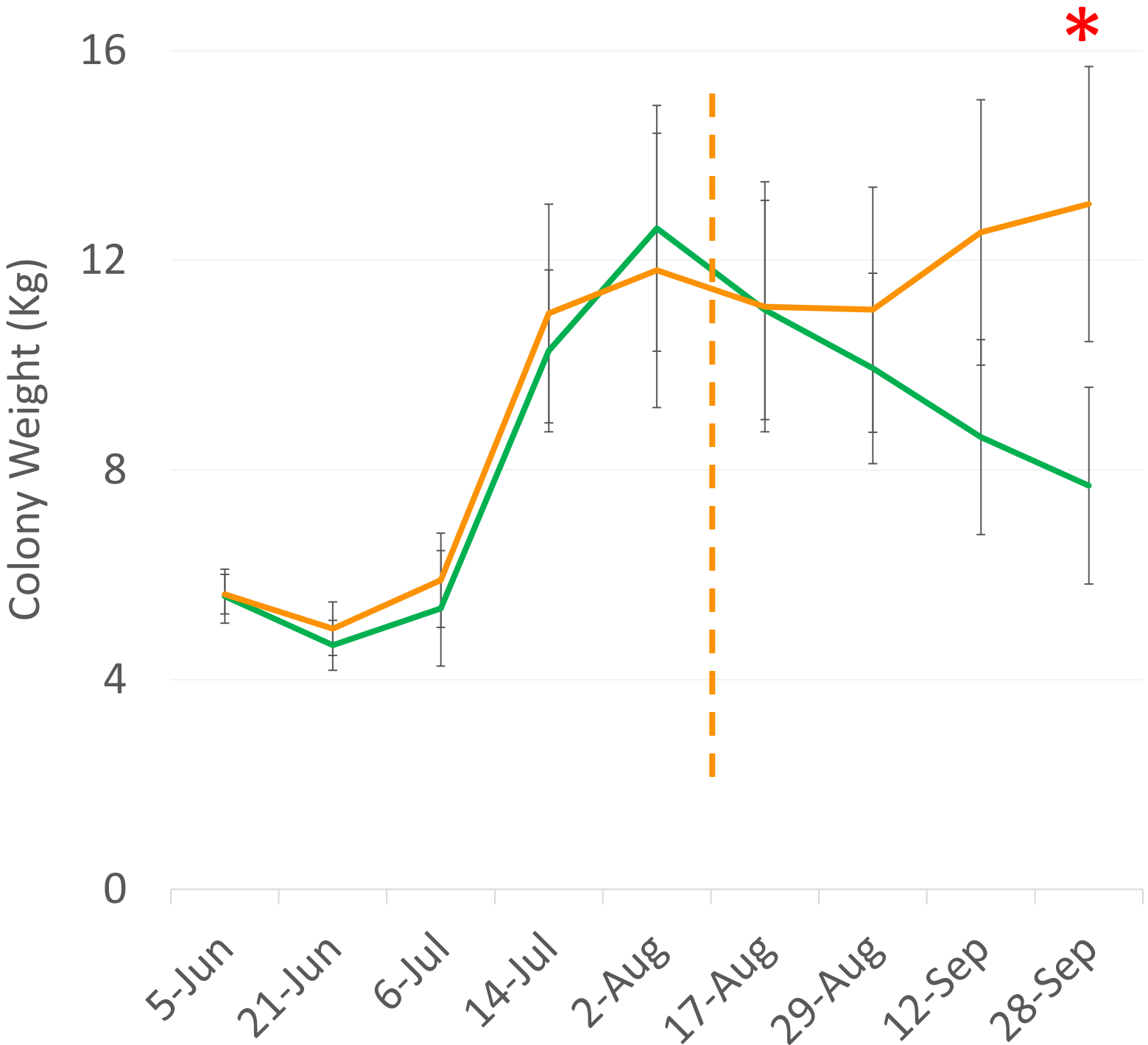
*2017 + 2018 + 2019*

*2017 data suggests:*

(*unpublished data*)



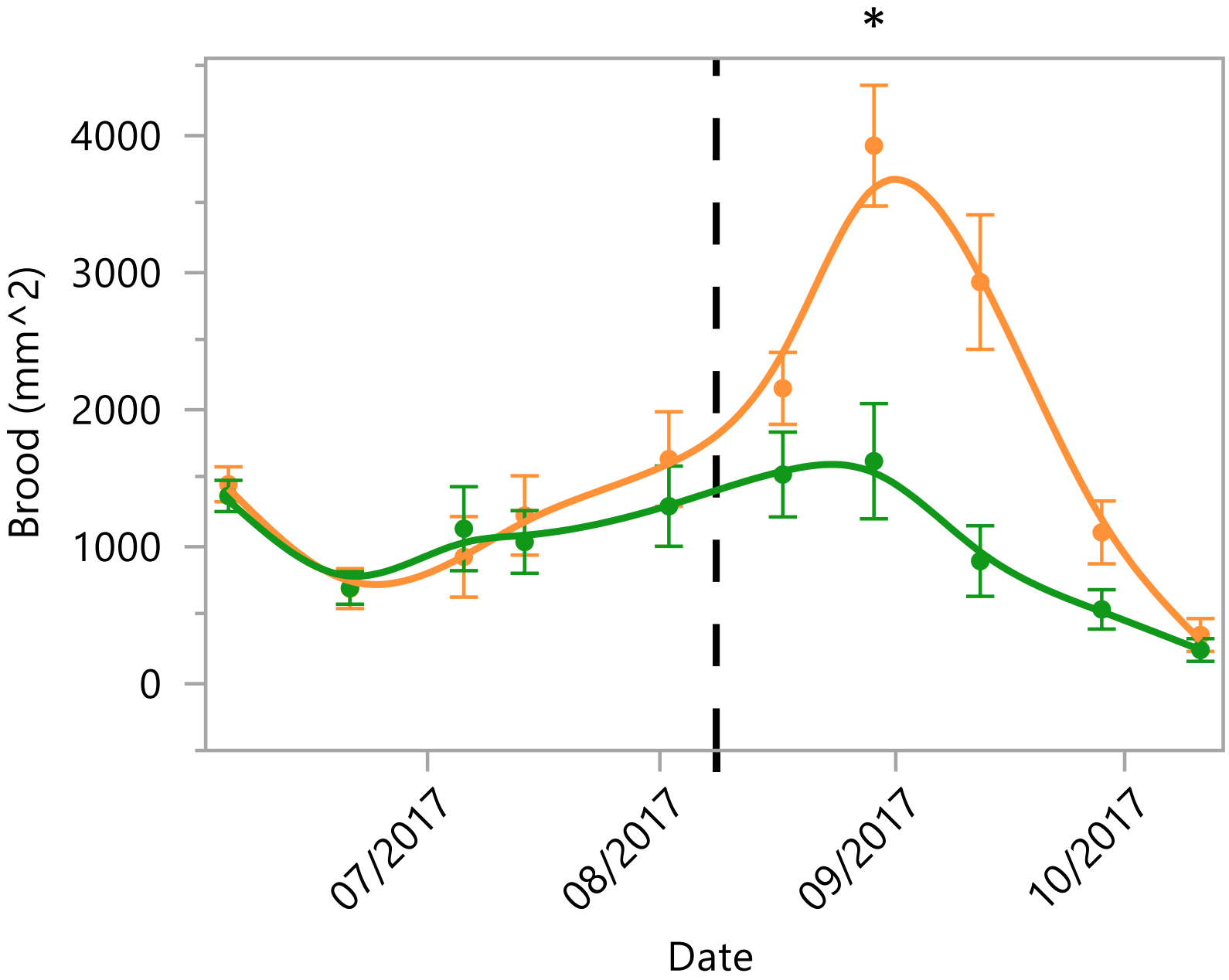

(*unpublished data*)




Prairie/Soy

$F(1,131)=5.0$ , $p=0.027$ *

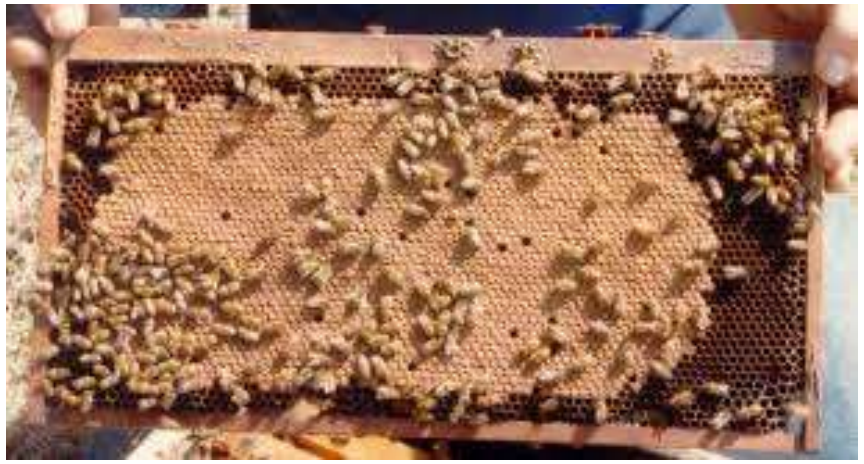
(*unpublished data*)




Prairie/Soy

Prairie

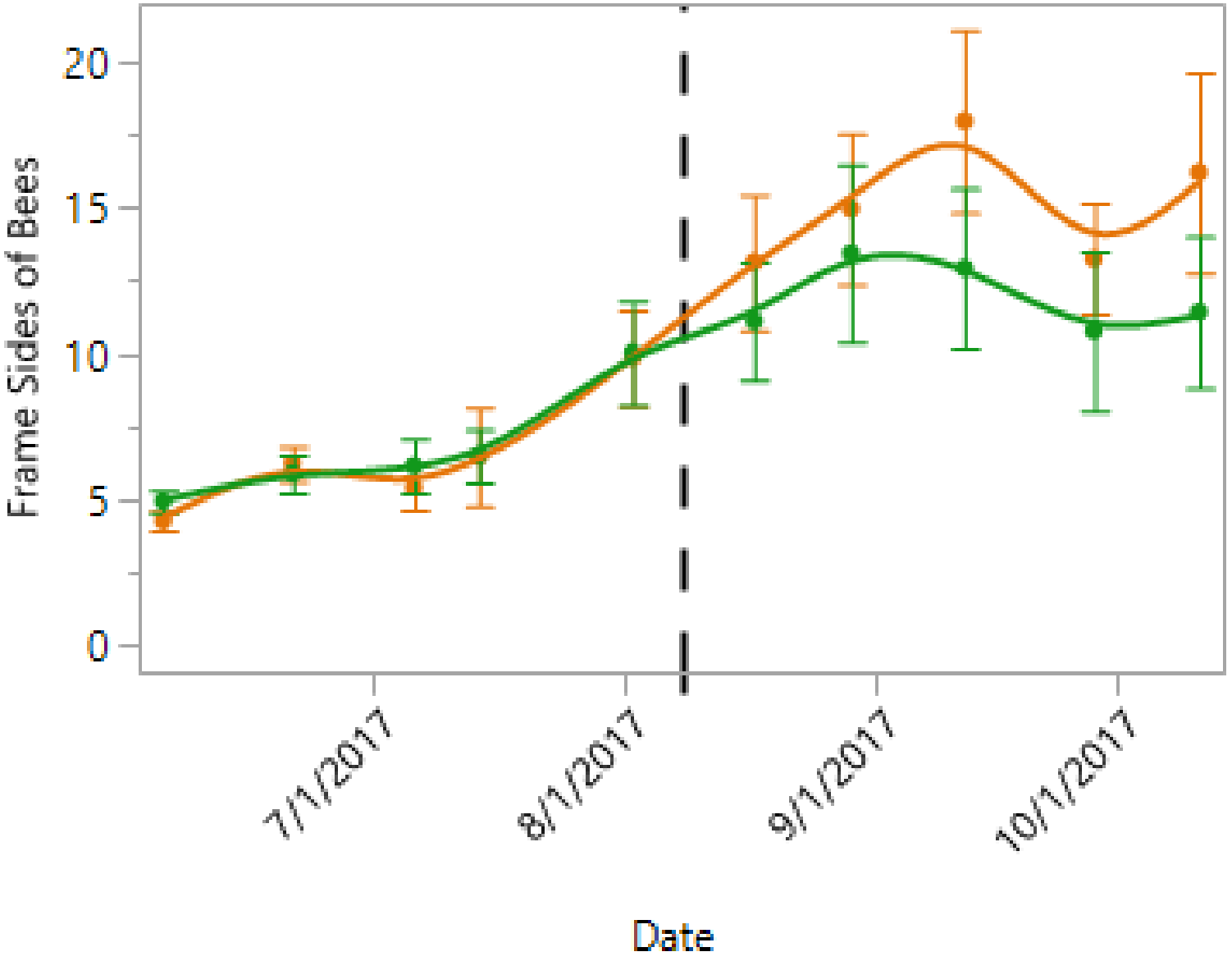
Soy



Prairie/Soy

$F(1,131)=29$ , $p<0.001$*

(*unpublished data*)




Prairie/Soy

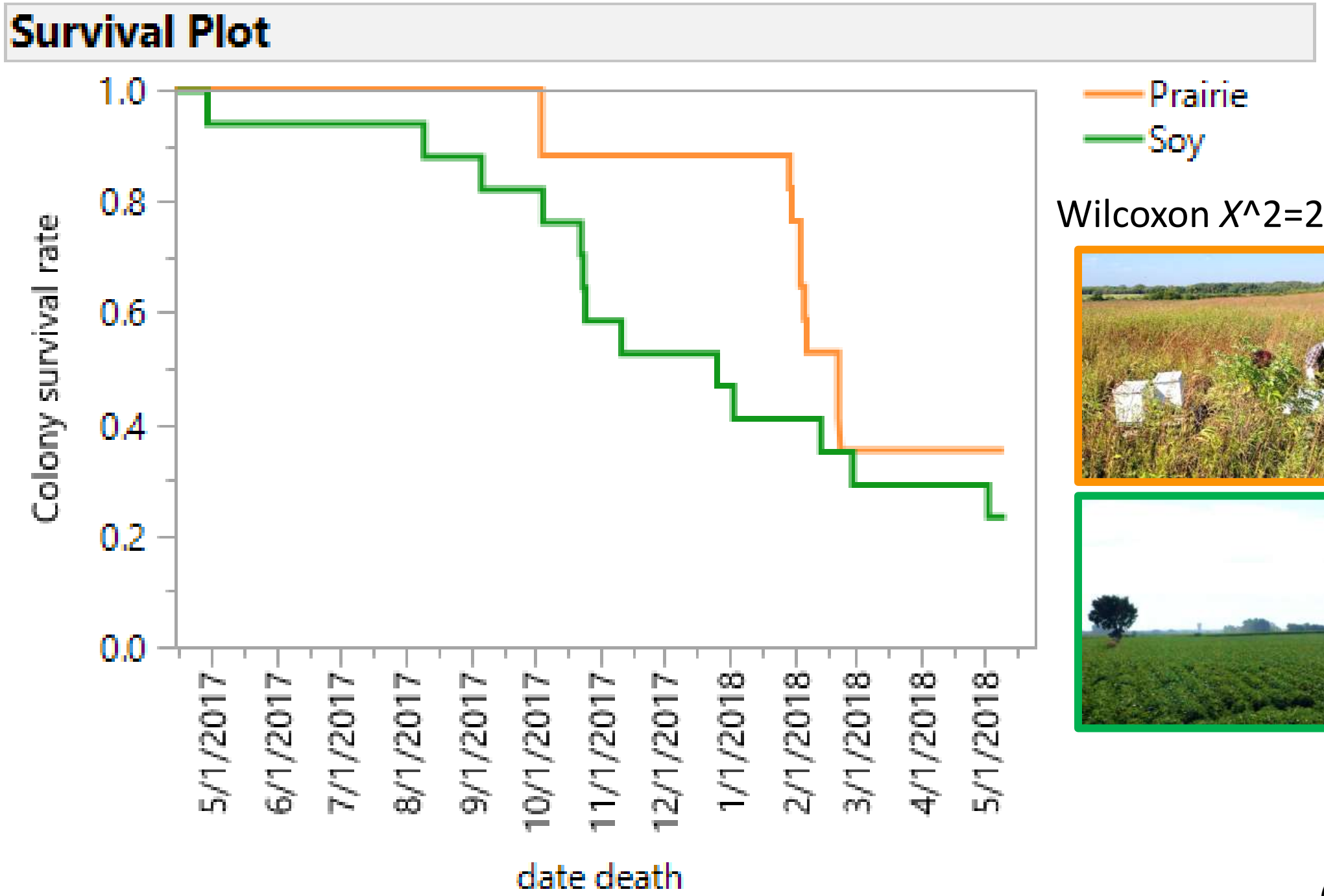
$F(1,131)=3.1$ , $p=0.08$

(*unpublished data*)

OCT 13th 2017

# WINTER SURVIVAL

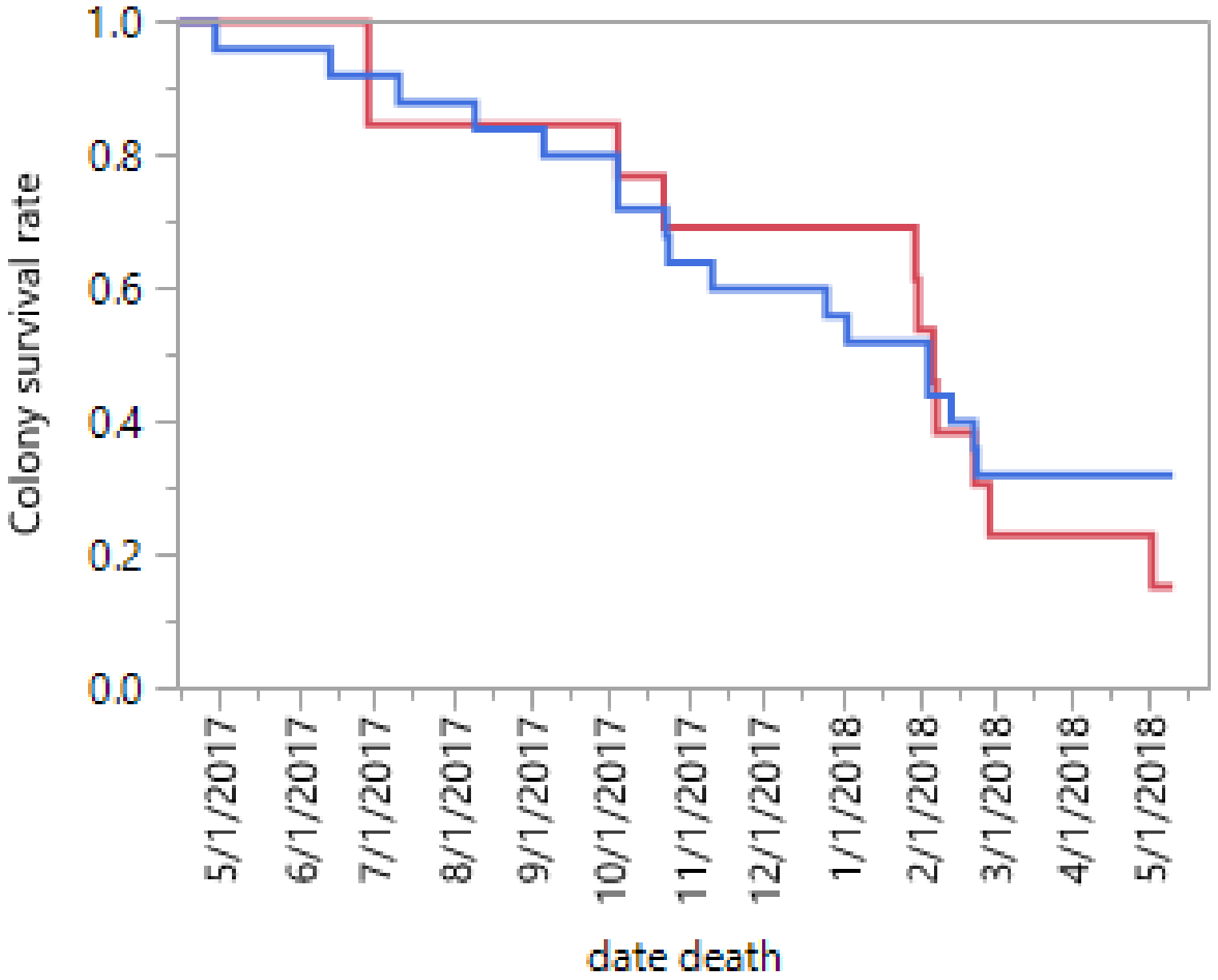
MAY 2nd 2018




Wilcoxon $X^2=2.57$ , $p=0.11$

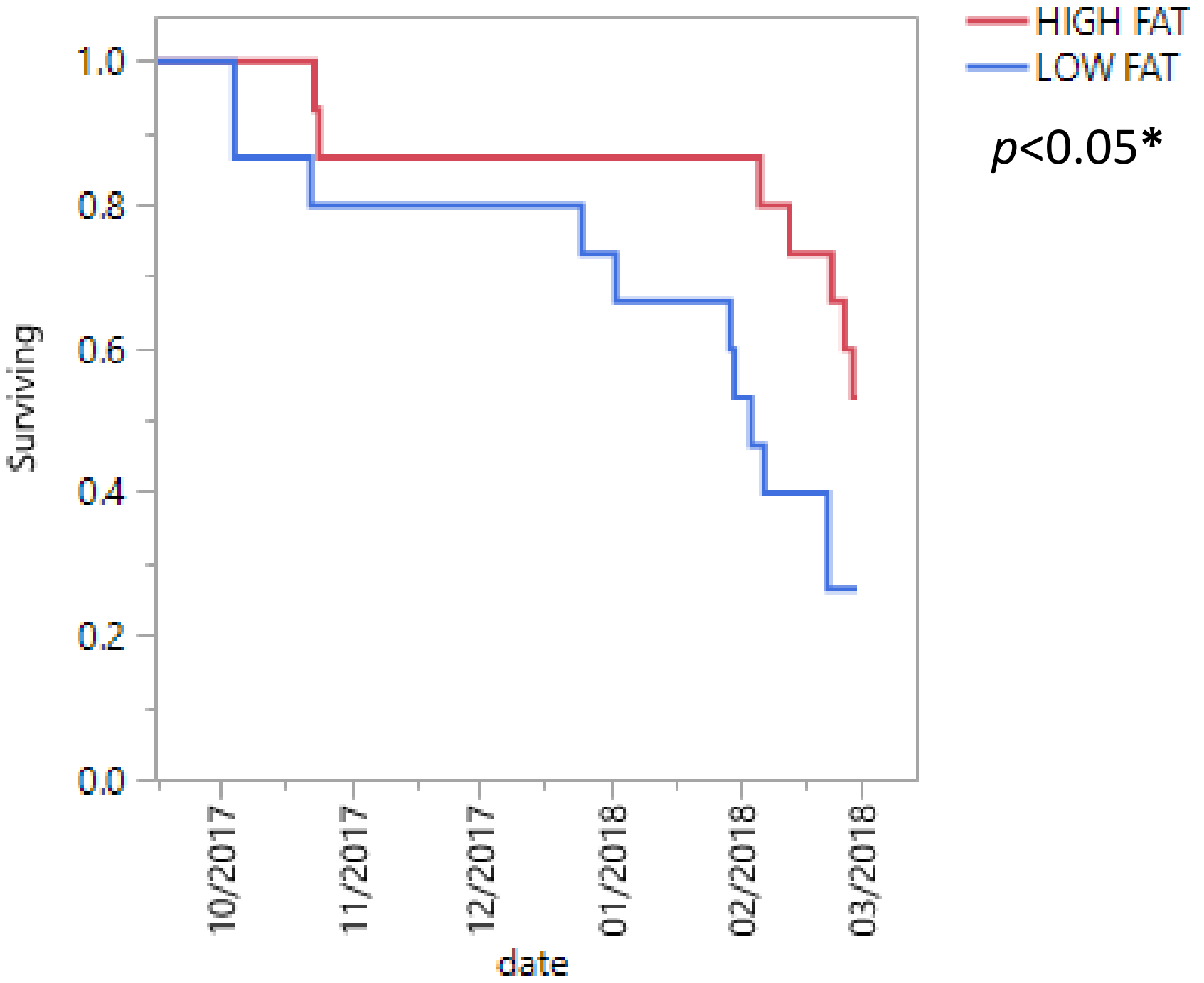
(*unpublished data*)

## Survival Plot




Wilcoxon $X^2=0.004$ , $p=0.95$

(*unpublished data*)

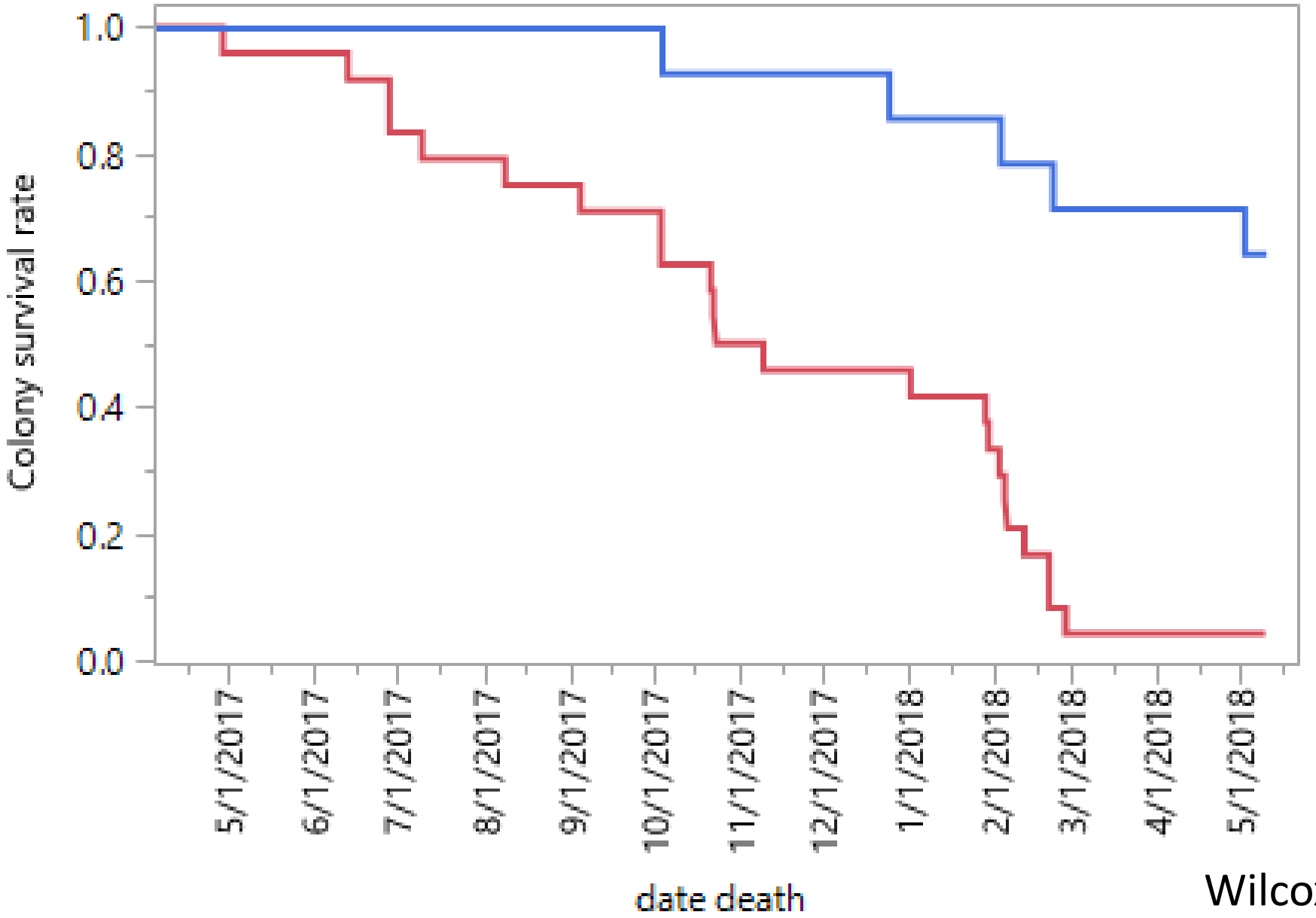



$p<0.05$*

(*unpublished data*)

**Survival Plot**

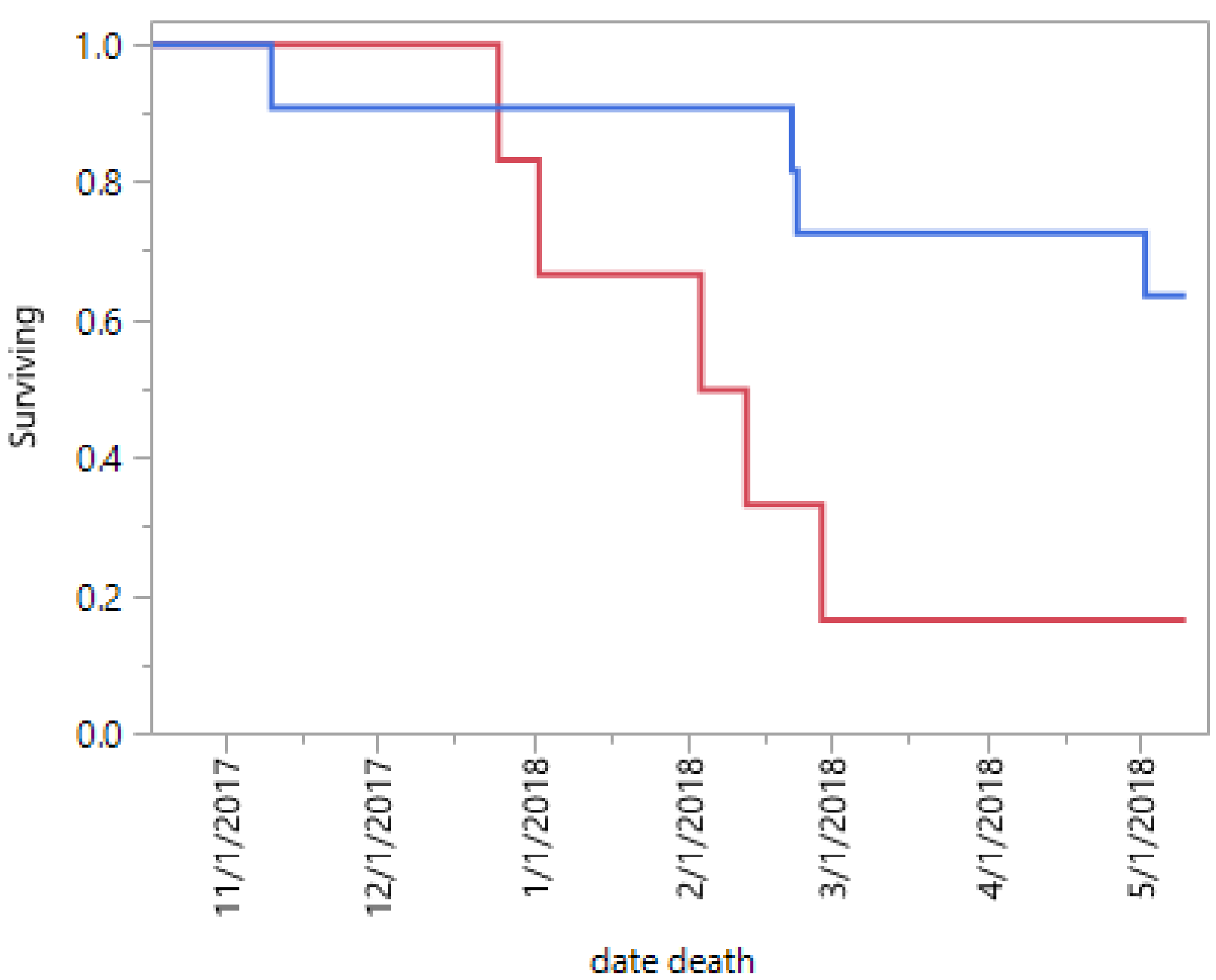
*COLONY WEIGHT*




Wilcoxon $X^2=14.3$ , $p<0.001$***

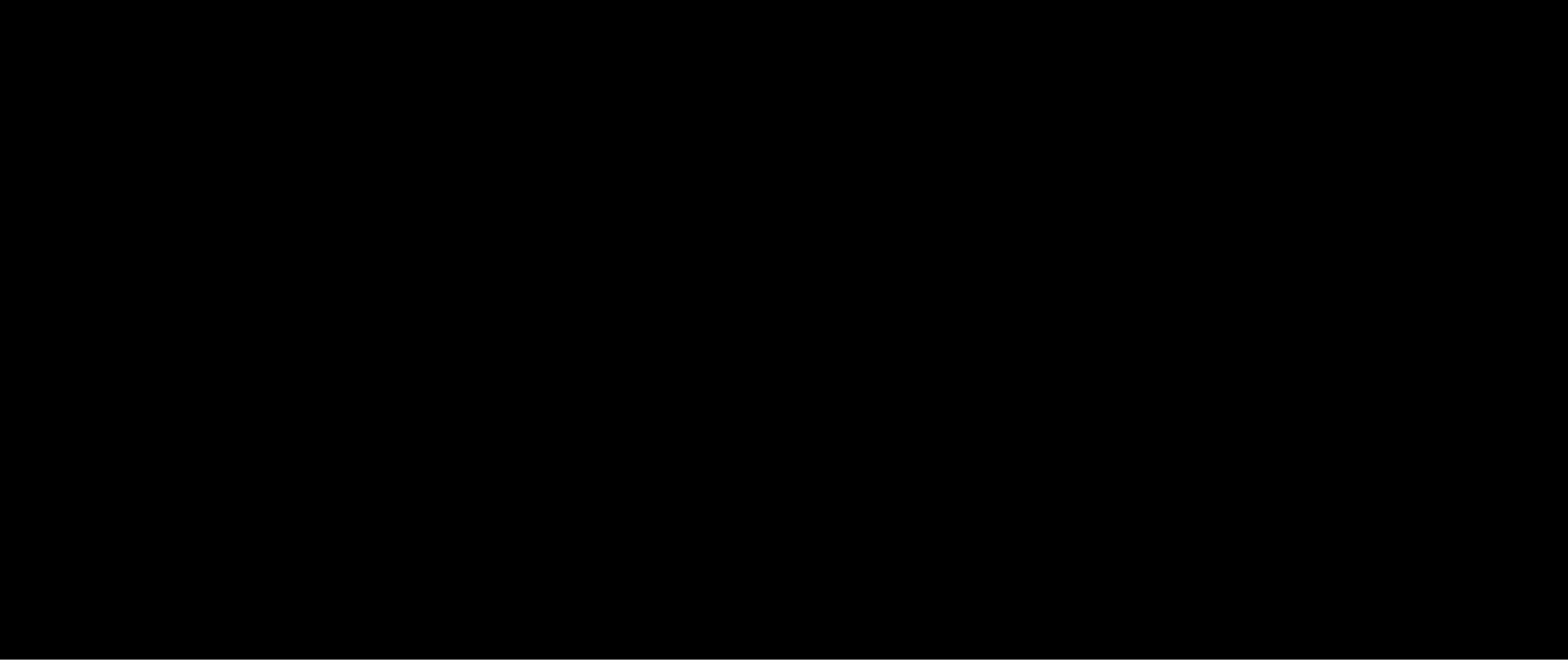
(*unpublished data*)

## Survival Plot




(*unpublished data*)

| | Oral* | Fecal | Body Contact | Venereal | Vector-mediated | Queen to eggs |
|---|---|---|---|---|---|---|
| IAPV | + | + | + | Ve.S. | + (Vd) | + |
| ABPV | + | + | BC.S | Ve.S. | Vd.S., Tm.S. | + |
| KBV | + | + | BC.S | – | + (Vd) | + |
| BQCV | + | + | ? | Ve.S. | – | + |
| DWV | + | + | – | + | + (Vd, Tm, At.S.) | + |
| SBV | + | – | – | Ve.S. | – | + |
| SBPV | + | ? | ? | ? | + (Vd) | ? |
| CWV | O.S. | ? | ? | ? | – | ? |
| CBPV | + | + | + | – | Vd.S | + |
| LSV | + | ? | ? | – | Vd.S. | + |
| BeeMLV | ? | ? | ? | ? | Vd.S. | ? |



# Sacbrood example: Workers that feed larva

Siefert et al 2021

# DWV example: Varroa

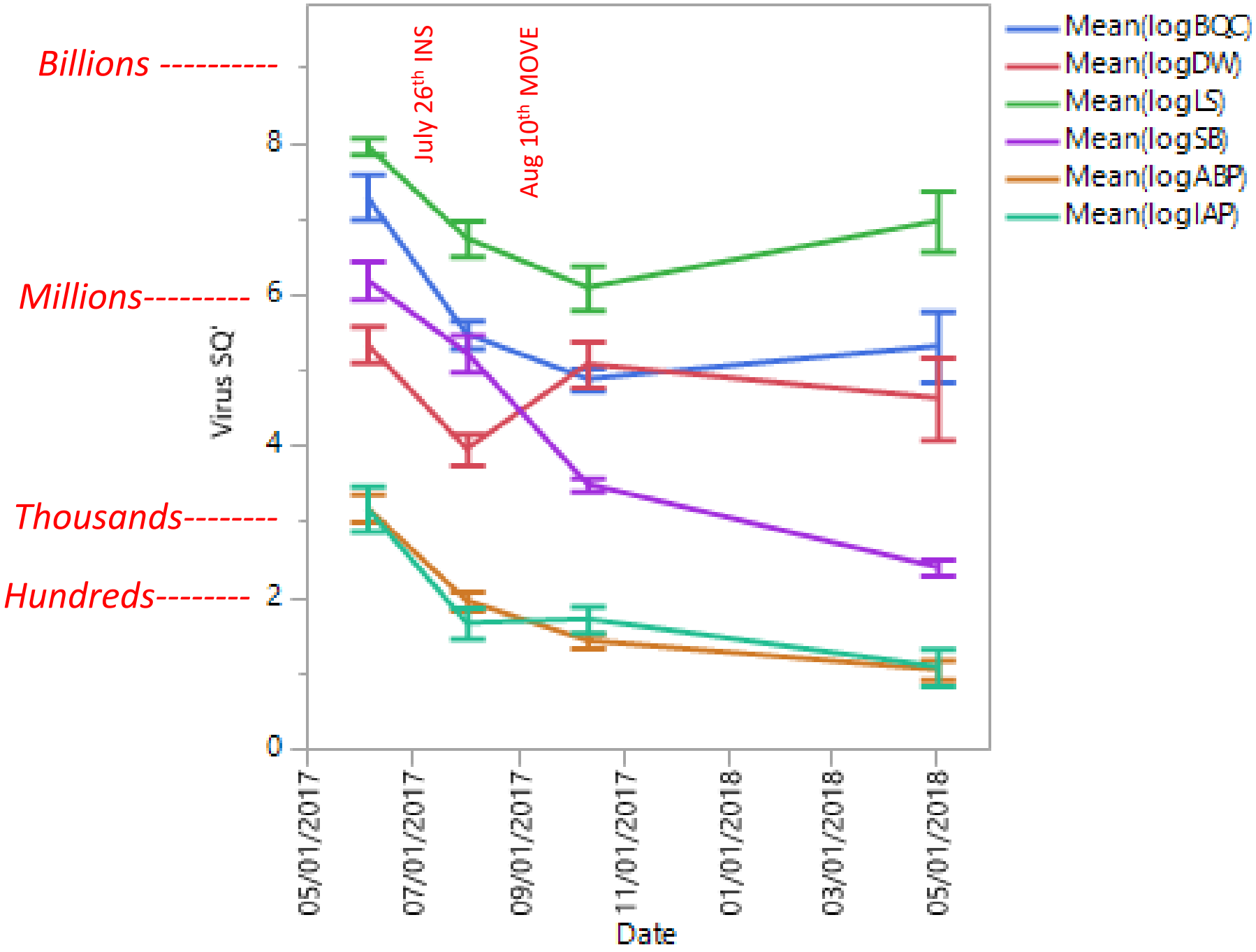
Siefert et al 2021

HONEY BEE BEHAVIOURS WITHIN THE HIVE:
INSIGHTS FROM LONG-TERM VIDEO ANALYSIS

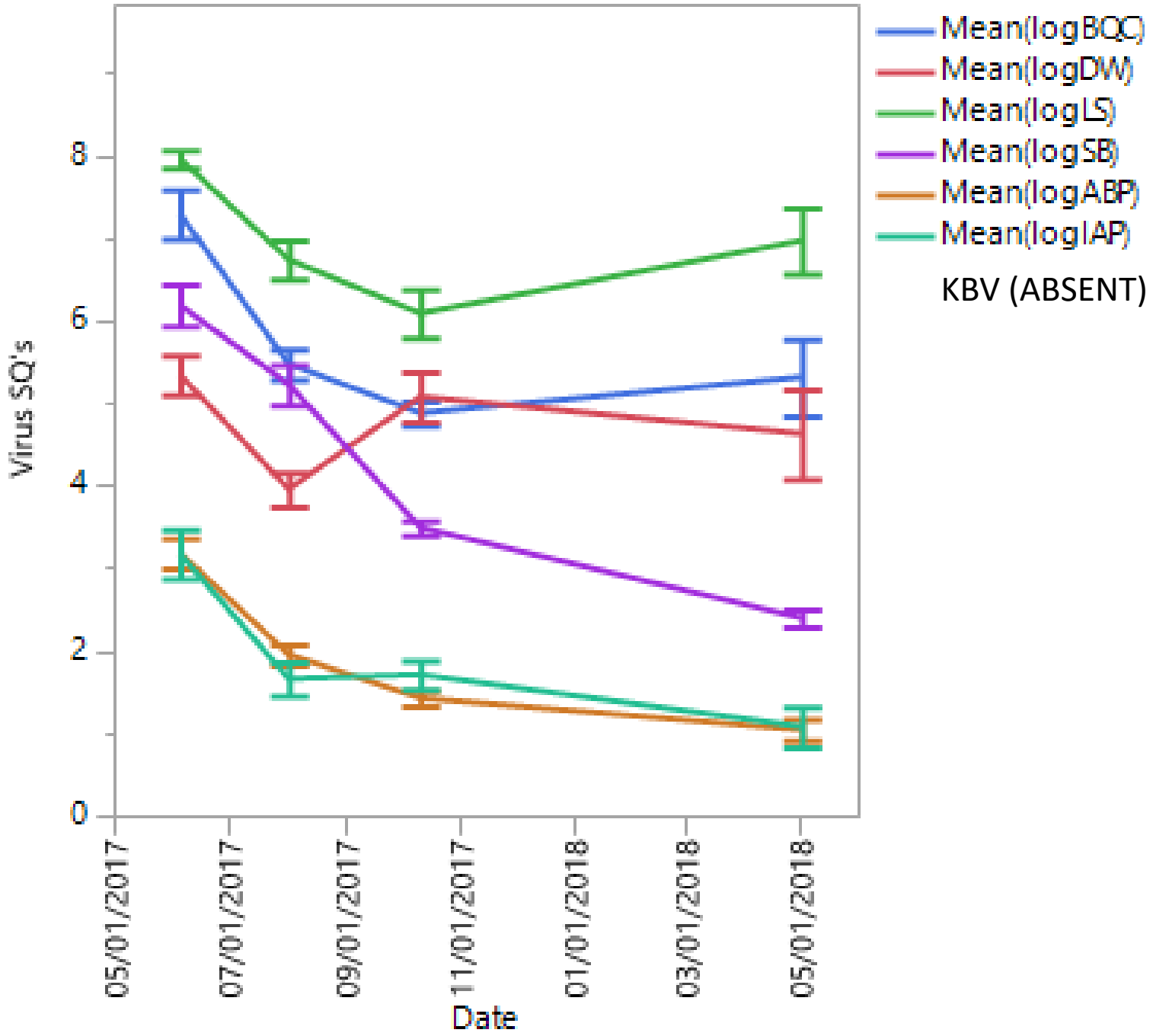
# Honey Bee Worker Development: Oviposition

DOI: 10.1371/JOURNAL.PONE.0247323

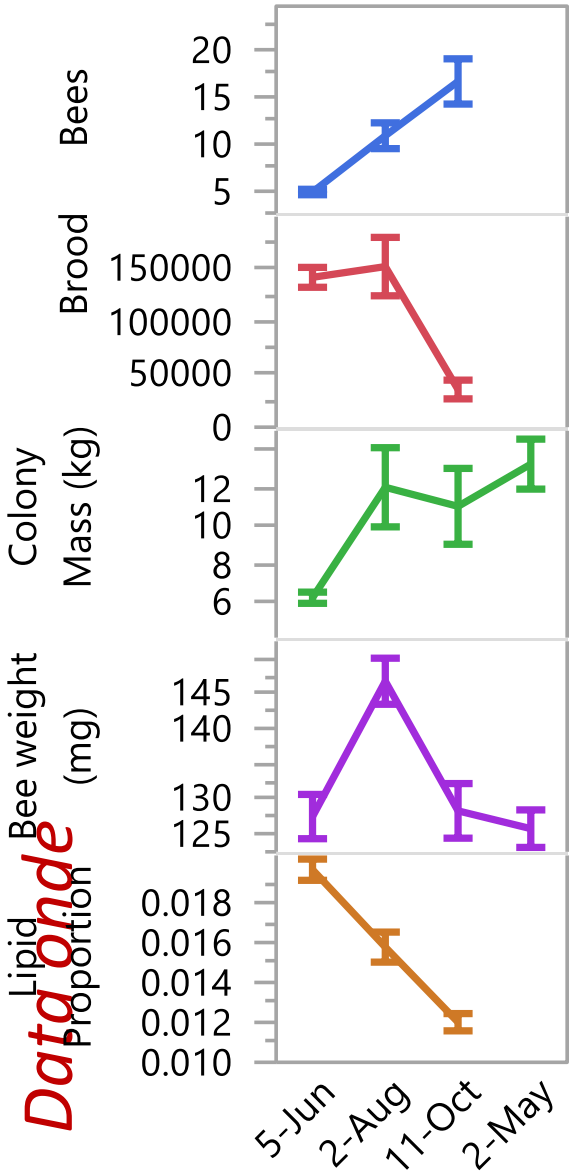
Siefert P, Buling N, Grünewald B (2021)
Honey bee behaviours within the hive: Insights from long-term video analysis.
PLoS ONE 16(3): e0247323. doi:10.1371/journal.pone.0247323




(*unpublished data*)




(*unpublished data*)




*Data onde*

(*unpublished data*)

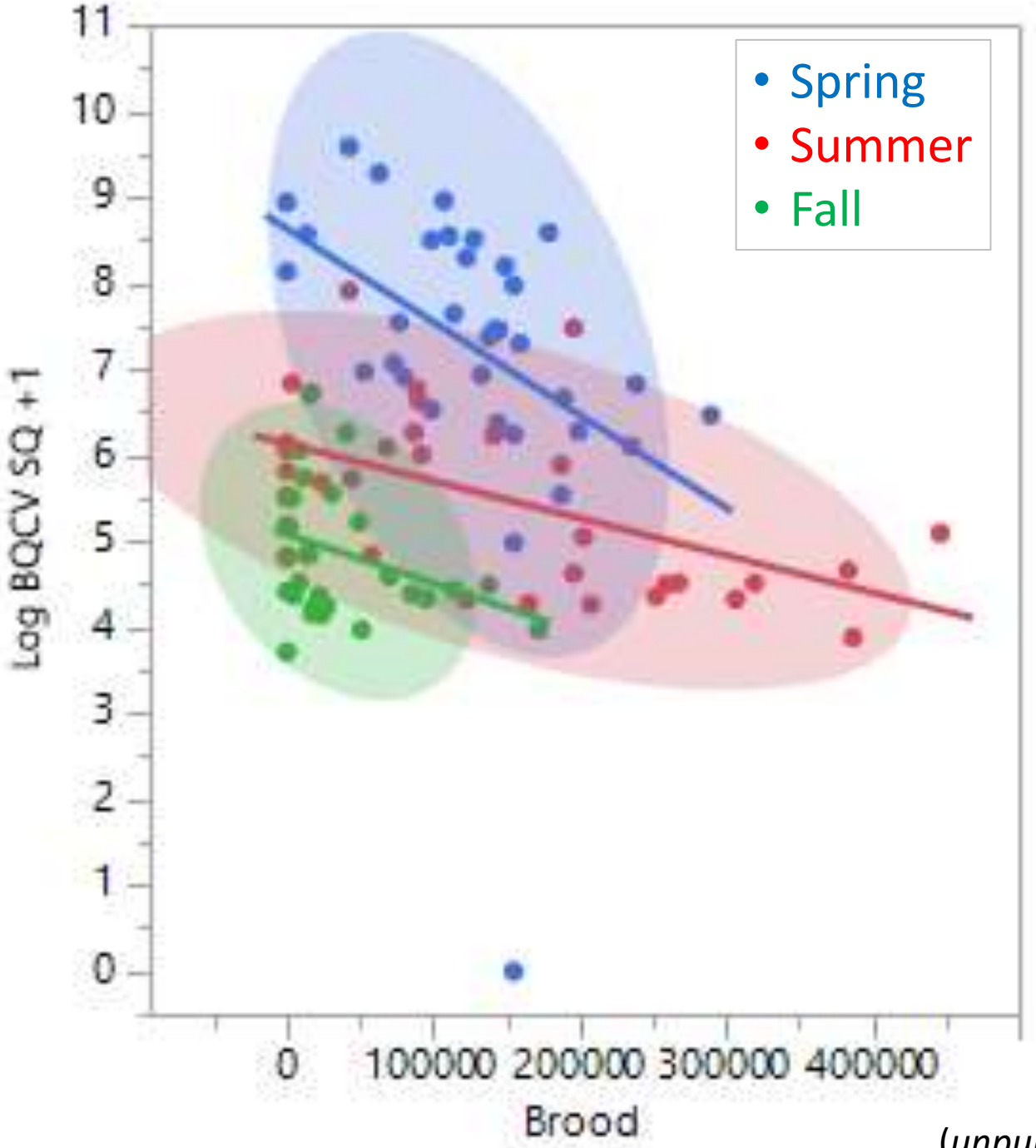
| Factor / Variable | Unit | BQCV | DWV | SBV | LSV |
|---|---|---|---|---|---|
| Date | 4 levels | | | | |
| Colony | 33 levels | | | | |
| Site (forage) | 8 levels | | | | |
| Insecticide | 2 levels | | | | |
| Queen status | 2 levels | | | | |
| Colony weight | kg | | | | |
| Brood ammount | $mm^2$ | | | | |
| Bee Population | n frames | | | | |
| Bee weight | mg | | | | |
| Varroa | % | | | | |
| Fatbody | % | | | | |
| RNA quantity | ng/µl | | | | |
| ABPV | n copies | | | | |
| BQCV | n copies | | | | |
| DWV | n copies | | | | |
| SBV | n copies | | | | |
| LSV | n copies | | | | |
| IAPV | n copies | | | | |
| Averaged Models | | 5 | 10 | 23 | 72 |

Model selection and averaging

in *R*

*(package MuMIn)*

| | BQCV |
|---|---|
| Date | *** |
| Brood amount | *** |

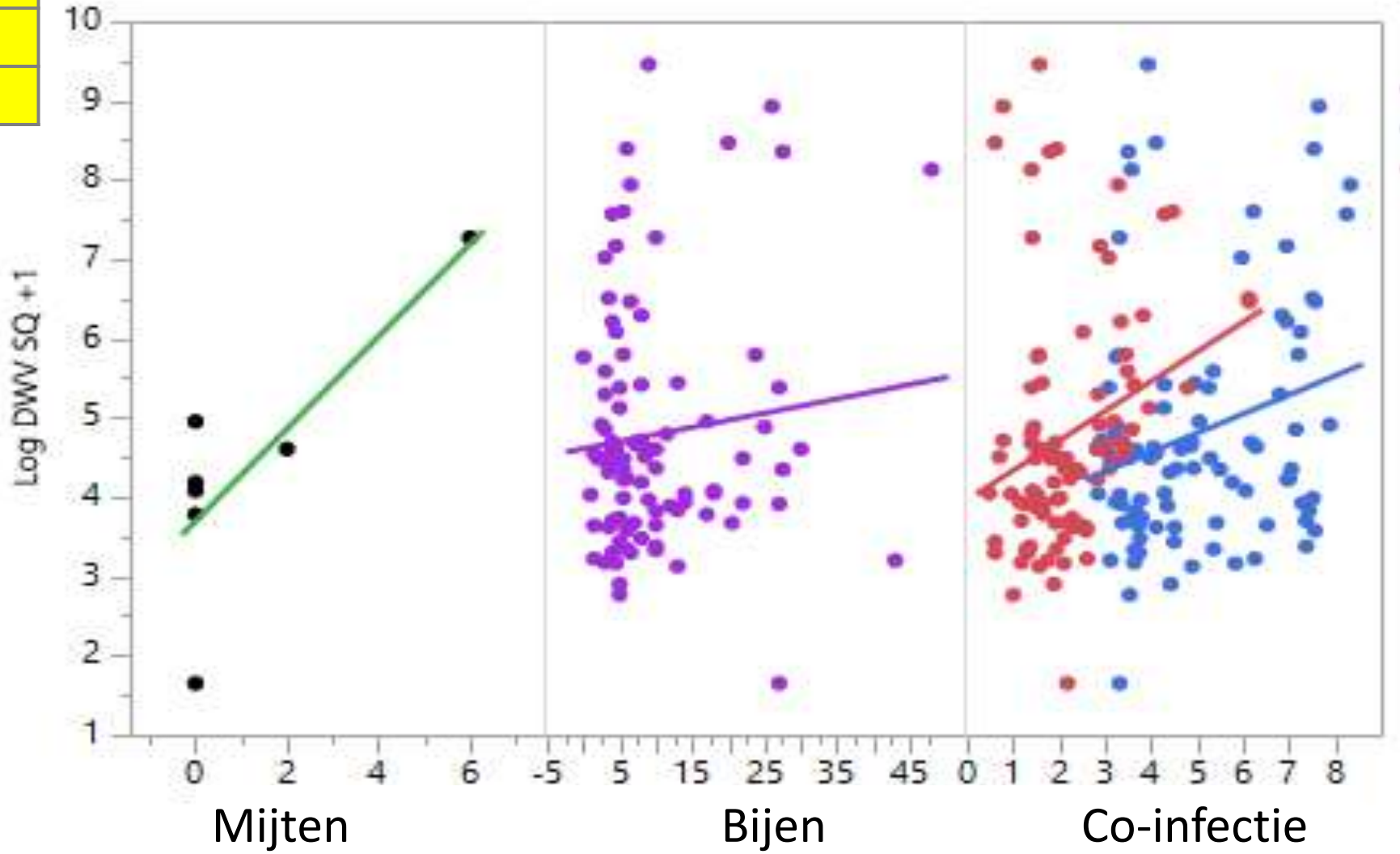



(*unpublished data*)


DWV

| | DWV |
|---|---|
| Date | *** |
| Bee population | (.) |
| Varroa | (.) |
| ABPV | * |
| SBV | *** |

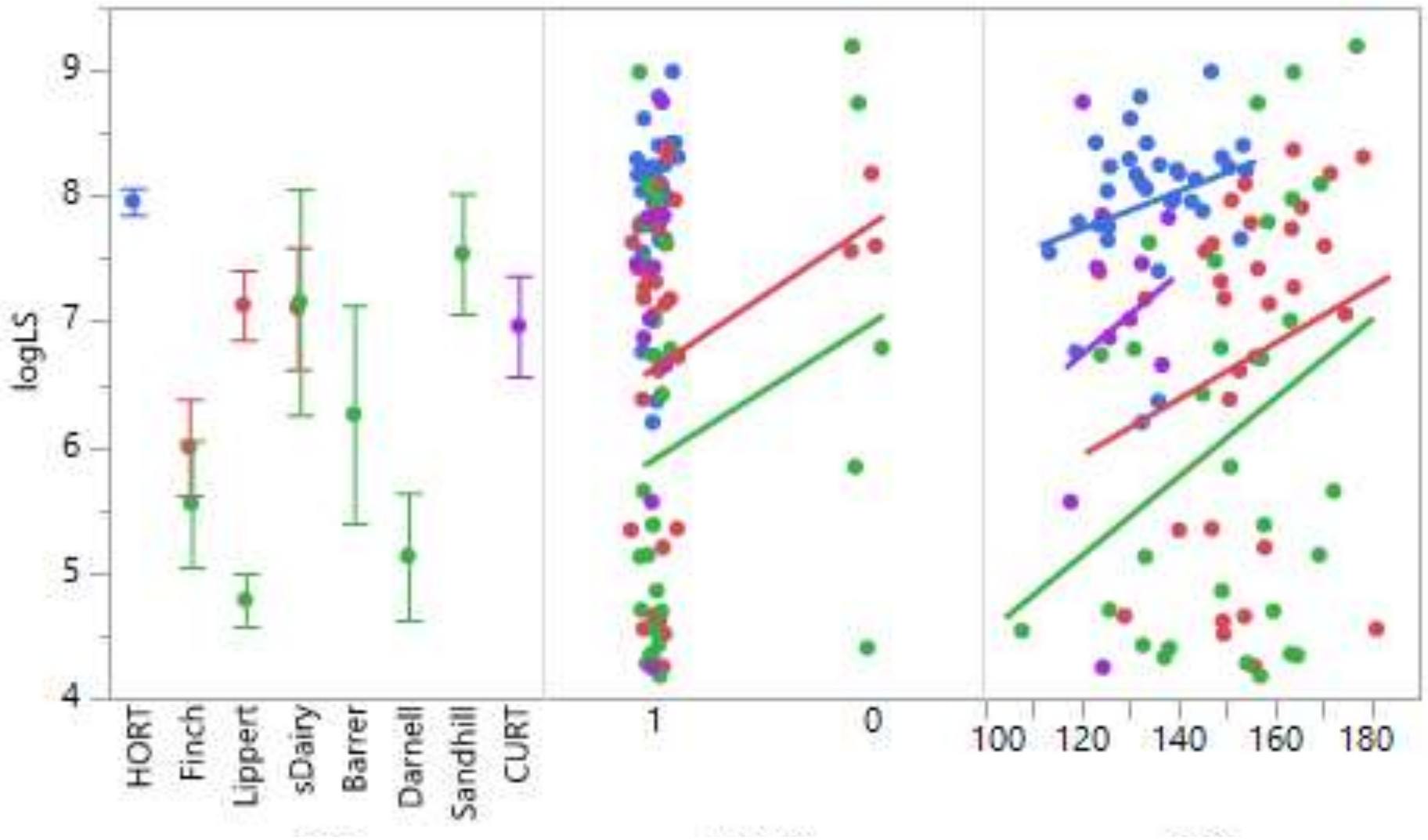
- Spring
- Summer
- Fall
- Winter




(*unpublished data*)

| | LSV |
|---|---|
| Date | *** |
| Colony | (.) |
| Site | *** |
| Insecticide | (.) |
| Queen status | * |
| Bee weight | (.) |

- Spring
- Summer
- Fall
- Winter




Site Queen status Bee weight

(*unpublished data*)

| | SBV |
|---|---|
| Date | *** |
| Colony | ** |
| Fatbody | (.) |
| DWV | ** |
| LSV | (.) |

- Spring
- Summer
- Fall
- Winter

Foto: Harmen Hendriksma

(*unpublished data*)

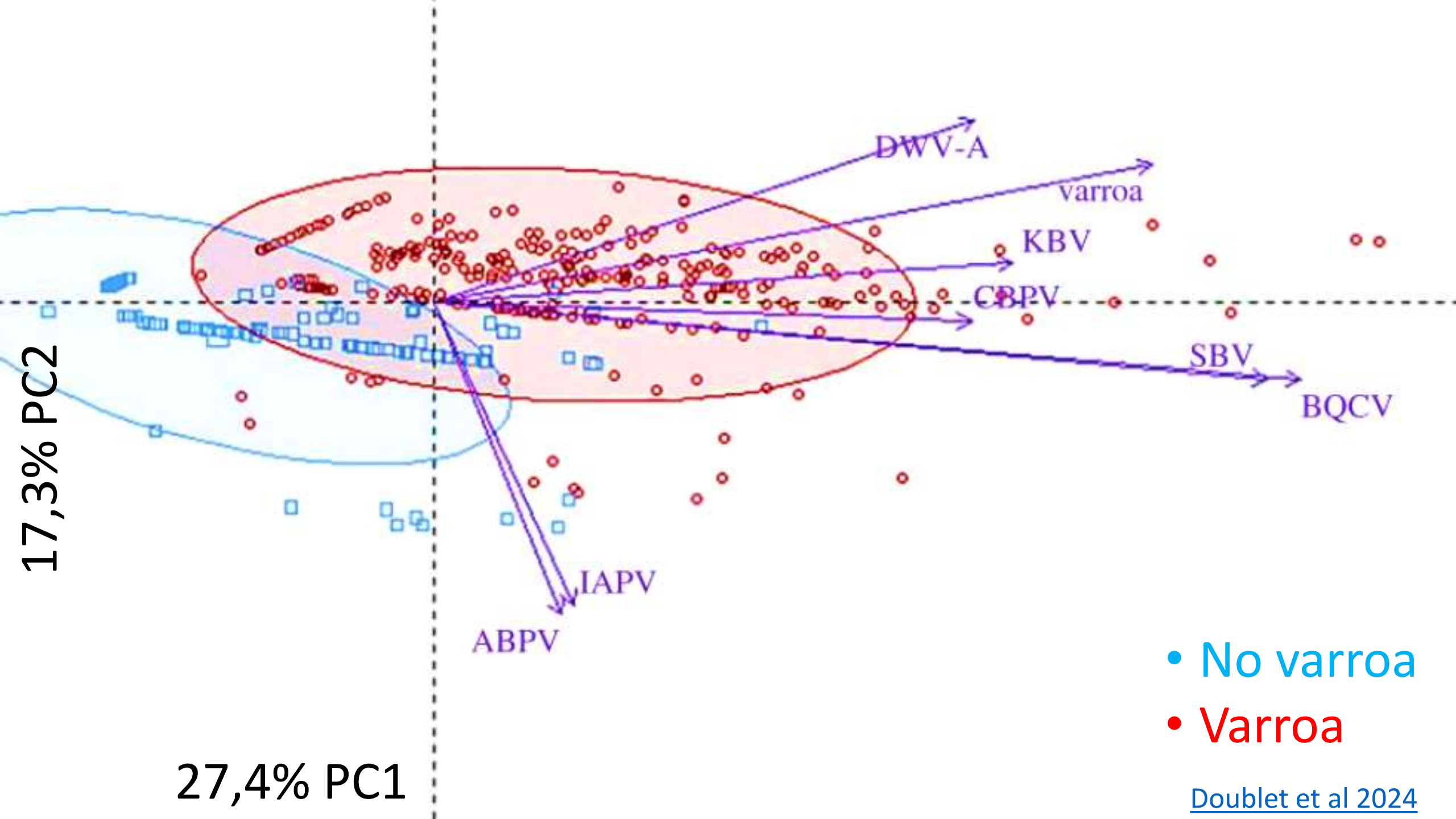
# *A PRELIMINAIRY INSIGHT*

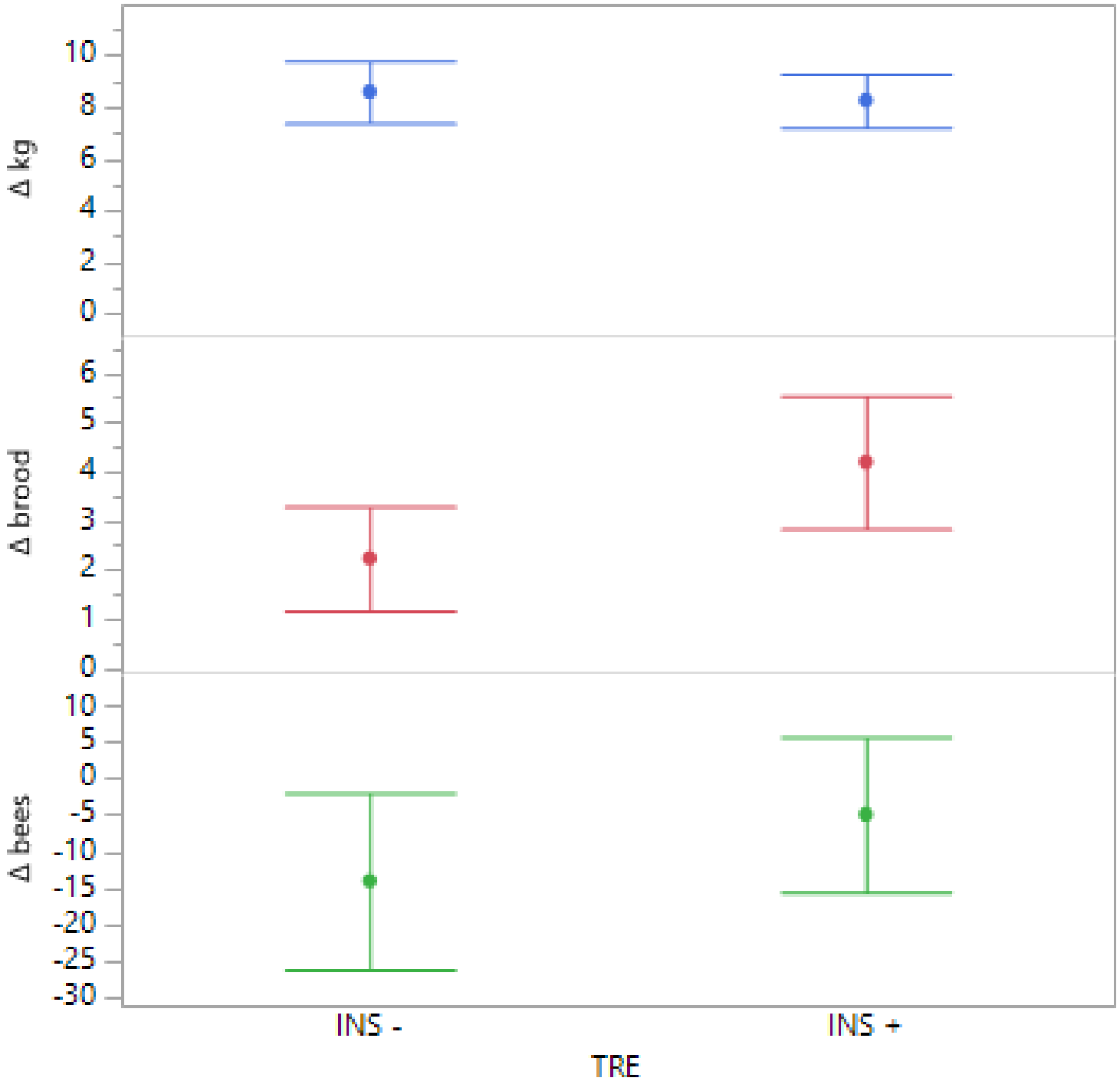
**Viral pathogens:**

- variable over time
- can interact / co-infect
- aren't less abundant at prairies
- correlate to colony traits

- BQCV BROOD
- DWV BEES/MITES/VIRUS
- SBV COLONY / LIPIDS?
- LSV SITE

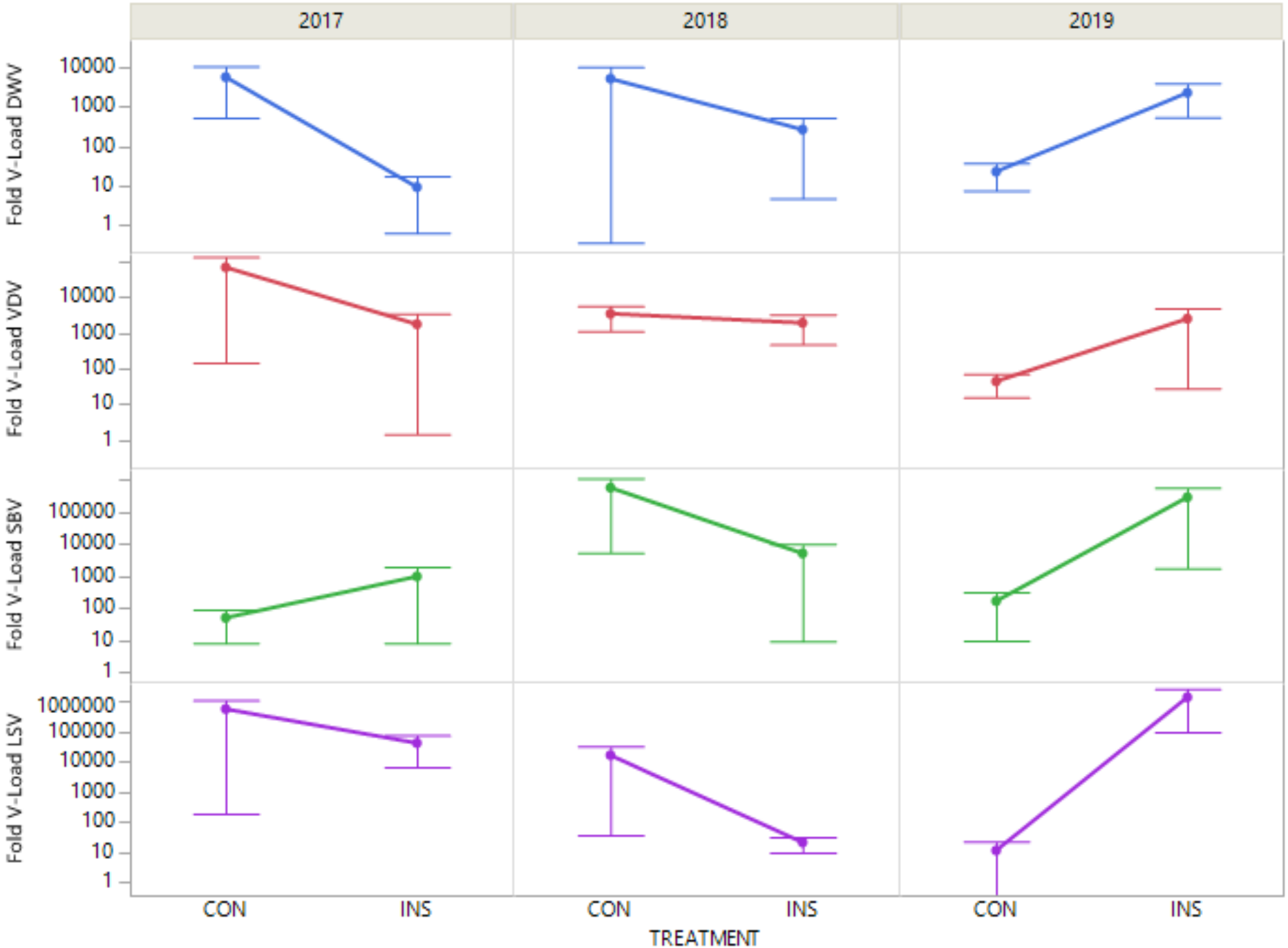
(*unpublished data*)


DWV-A
varroa
KBV
CBPV
SBV
BQCV
IAPV
ABPV
17,3% PC2
27,4% PC1
• No varroa
• Varroa
Doublet et al 2024

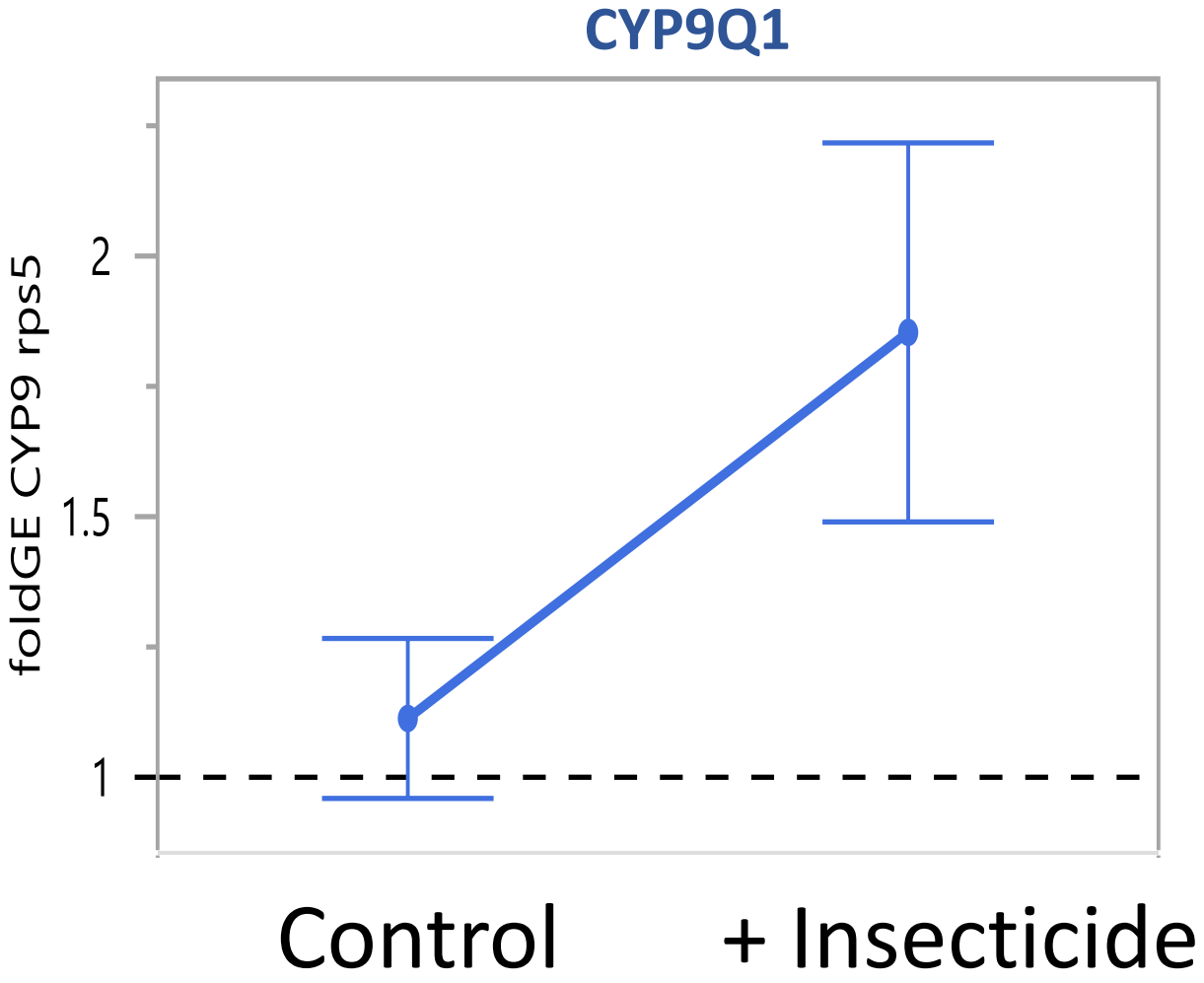


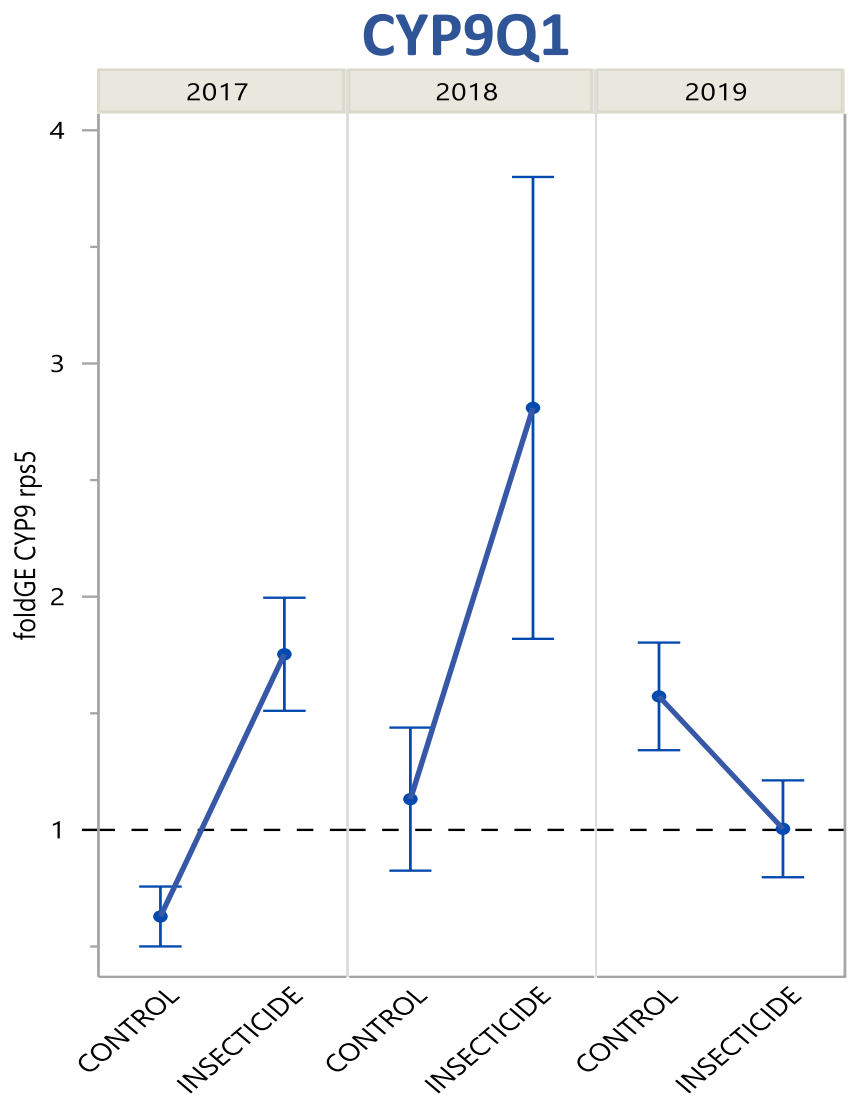


(*unpublished data*)




(*unpublished data*)




**Effect Tests**

| Source | Nparm | DF | Sum of Squares | F Ratio | Prob > F |
|---|---|---|---|---|---|
| TREATMENT | 1 | 1 | 6.239148 | 3.5890 | 0.0656 |
| YEAR | 2 | 2 | 5.414519 | 1.5573 | 0.2235 |
| YEAR*TREATMENT | 2 | 2 | 10.261914 | 2.9515 | 0.0640 |

(*unpublished data*)

(Data unpublished)

**VIRUSES**

seasonal patterns, colony dynamics,
disease co-incidence

**PERFORMANCE and SURVIVAL**

nutrition, varroa mite pressure, frost

(pesticide: not a severe impact & not consistent)

DriftWatch - Home

driftwatch.org

driftwatch
Specialty Crop Site Registry
by FieldWatch

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Username Password Log In

# Welcome to DriftWatch™

*Communication + Cooperation + Collaboration = Successful Co-existence*

This site is a voluntary communication tool that enables crop producers, beekeepers, and pesticide applicators to work together to protect specialty crops and apiaries through use of mapping programs. It is not a substitute for any state regulatory requirements.

For more resources and information, please visit **FieldWatch, Inc.**

Don't have an Account yet?

Zoeken

12:35
27-5-2024

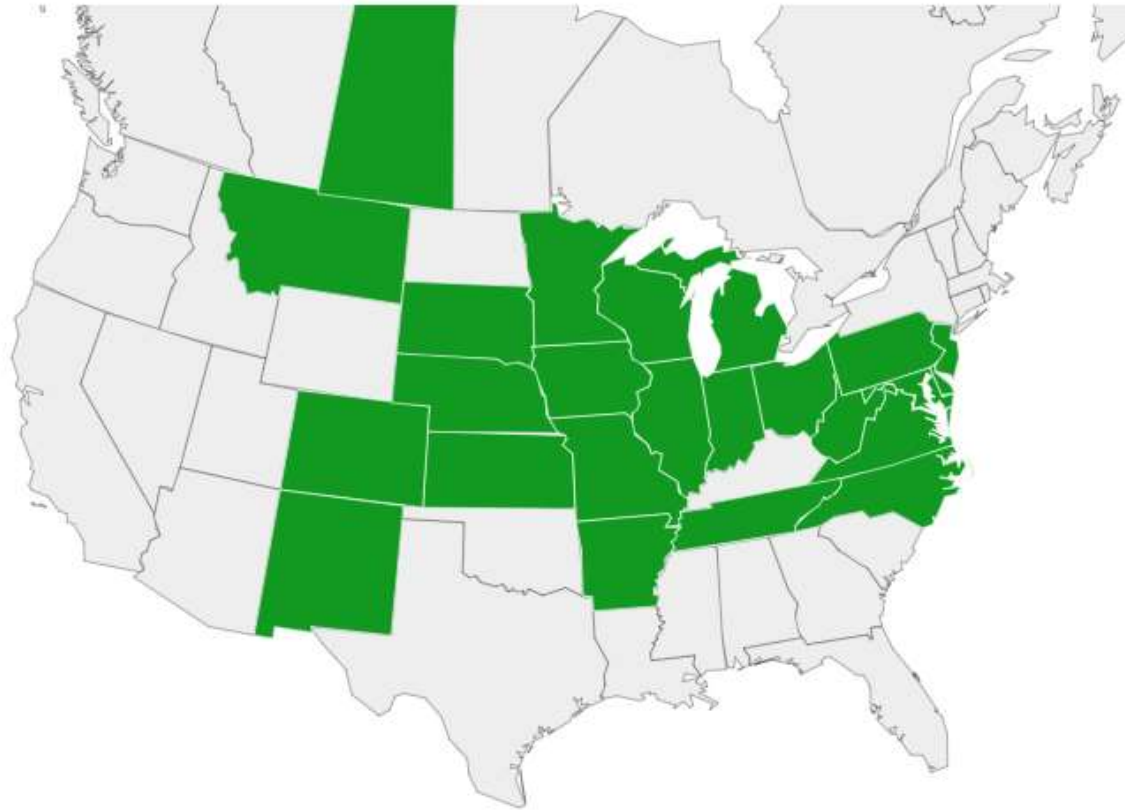
Select a state below to view the interactive map:

**United States**

- Arkansas
- Colorado
- Delaware
- District of Columbia
- Illinois
- Indiana
- Iowa
- Kansas
- Maryland
- Michigan
- Minnesota
- Missouri
- Montana
- Nebraska
- New Jersey
- New Mexico
- North Carolina
- Ohio
- Pennsylvania
- South Dakota
- Tennessee
- Virginia
- West Virginia
- Wisconsin

**Canadian Provinces**

- Saskatchewan



DriftWatch IA - Map

ia.driftwatch.org/map

IOWA DEPARTMENT OF AGRICULTURE & LAND STEWARDSHIP | FieldWatch

IOWA CROP SITE REGISTRY

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Username | Password | Log In

SUBMIT NEW SITE | Go To My Location | Search by Address, Zip Code, etc.

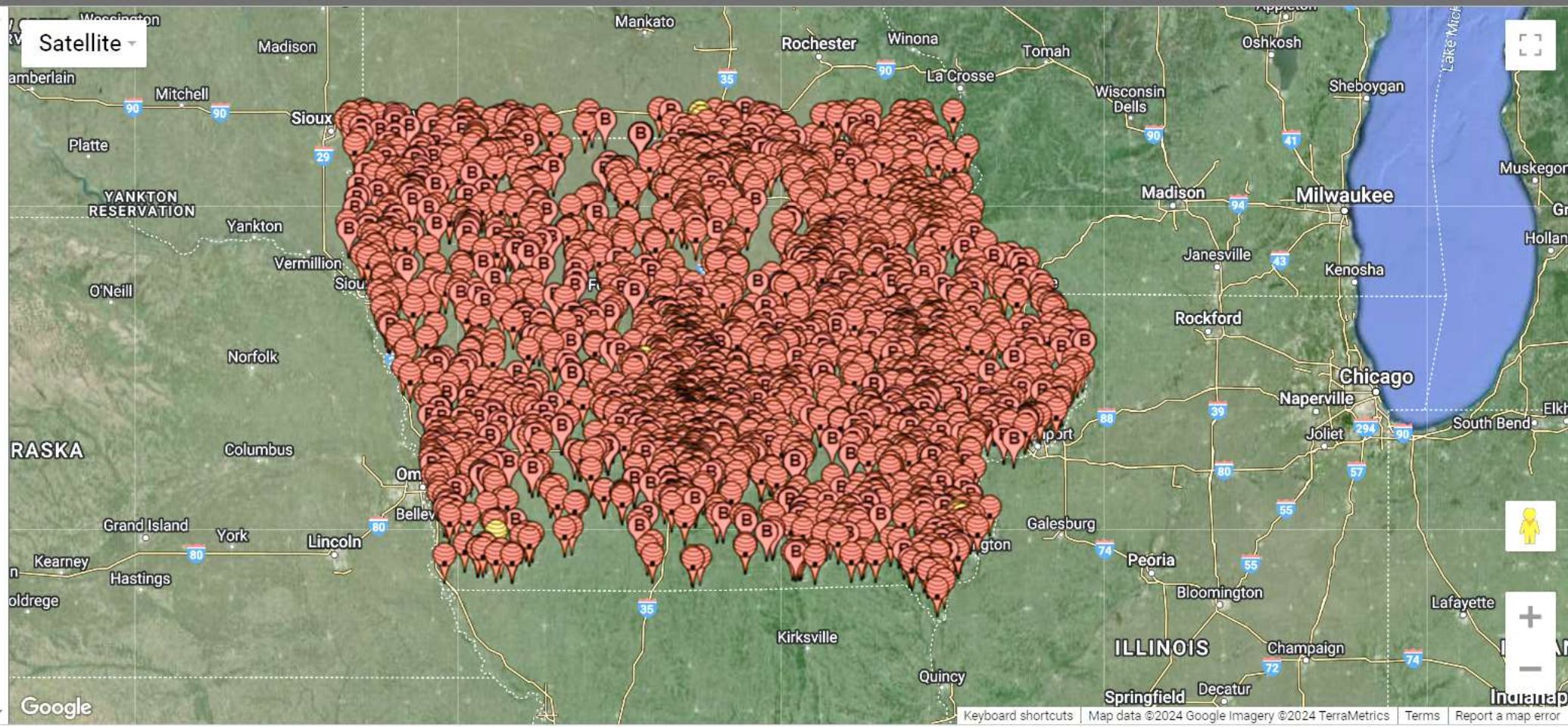
## Filter Growing Conditions

- [x] All
- [x] Organically Grown (in states permitted)
- [x] Certified Organic
- [x] Conventionally Grown

## Filter Crop Types

ALL STATES | IA

- [ ] All
- [x] Beehives
- [ ] Berries
- [ ] Corn
- [ ] Cotton
- [ ] Evergreen/Christmas Trees
- [ ] Fruits
- [ ] Grapes
- [ ] Hops
- [ ] Industrial Hemp
- [ ] Non-specialty Certified Organic
- [ ] Non-specialty Transition to Certified Organic
- [ ] Nursery Crops
- [ ] Orchard (Nuts, Fruit, Trees)
- [ ] Pumpkins or Melons

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Zoeken

12:43
27-5-2024

**Pollinator Extension Specialist Randall Cass**

"Iowa is home to more than 300 different species of bees. Extension will help gain a better understanding of bee populations and the challenges they face, as well as actions individuals can take to mitigate stressors that affect bees."

RP Cass, EW Hodgson, ME O'Neal, AL Toth, AG Dolezal (2022) Attitudes About Honey Bees and Pollinator-Friendly Practices: A Survey of Iowan Beekeepers, Farmers, and Landowners Journal of Integrated Pest Management 13 (1), 30.




*Thank you team* TOTH LAB *et al.*




United States Department of Agriculture
National Institute of Food and Agriculture

***@USDA***
***JAY***

***KYLE***
***DAWN***

***JUDY***
***MIGUEL***

***- EVERYONE I MET -***








Delphine Panziera


Séverine Kotrschal


Harmen Hendriksma



WAGENINGEN
UNIVERSITY & RESEARCH

# Team bijen@wur

1st International Conference - BeSafeBeeHoney CA22105

# BEekeeping products valorization and biomonitoring for the SAFEty of BEEs and HONEY

APIVITA

## SIB2023-002: Grip op bijenvirussen

Dutch Ministry of Agriculture, Fisheries, Food security and Nature