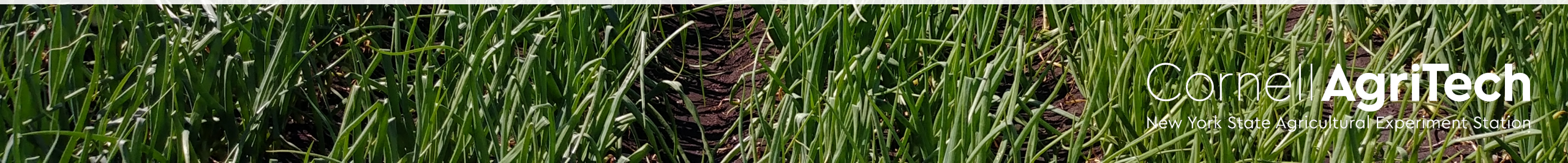




Influence of environmental factors on onion maggot larval damage in commercial onion fields

Erica Moretti and Brian Nault
Cornell University, Entomology
Empire State Producers Expo, 15 January 2020





Onion Maggot (*Delia antiqua* Meigen)

Diptera: Anthomyiidae

- Pest of *Allium* crops
- Adult flies oviposit at or near the base on onions
- Three generations per year in NY
 - First generation flies emerge mid-May



Feeding damage can exceed 50% if left unmanaged

Onion Maggot Management



Feeding damage can exceed 50% if left unmanaged

Onion Maggot Management

- Seed treatments (Wilson et al. 2015; Nault et al. 2006)
 - FarMore FI500 (spinosad + thiamethoxam)
 - Trigard (cyromazine)



Feeding damage can exceed 50% if left unmanaged

Onion Maggot Management

- Seed treatments (Wilson et al. 2015; Nault et al. 2006)
 - FarMore FI500 (spinosad + thiamethoxam)
 - Trigard (cyromazine)

- ✓ **Seed treatments perform equally well**
- ✓ **No evidence of resistance to these products**


Damage is highly variable across NY State

- Some growers experience up to 30% damage
- Others experience little to no damage



Damage is highly variable across NY State

- Some growers experience up to 30% damage
- Others experience little to no damage



What other factors may influence the disparity in damage across the state?

Environmental factors influence pest dynamics

Climate

- Temperature
- Precipitation



Cool, moist conditions favor maggot damage

(Ellington, 1963)



Hot, dry conditions lead to fly mortality, egg desiccation, and larval mortality in *Delia* sp.

(Ellington, 1963; LePage et al. 2012; Hesler et al. 2018)

Environmental factors influence pest dynamics

Climate

- Temperature
- Precipitation

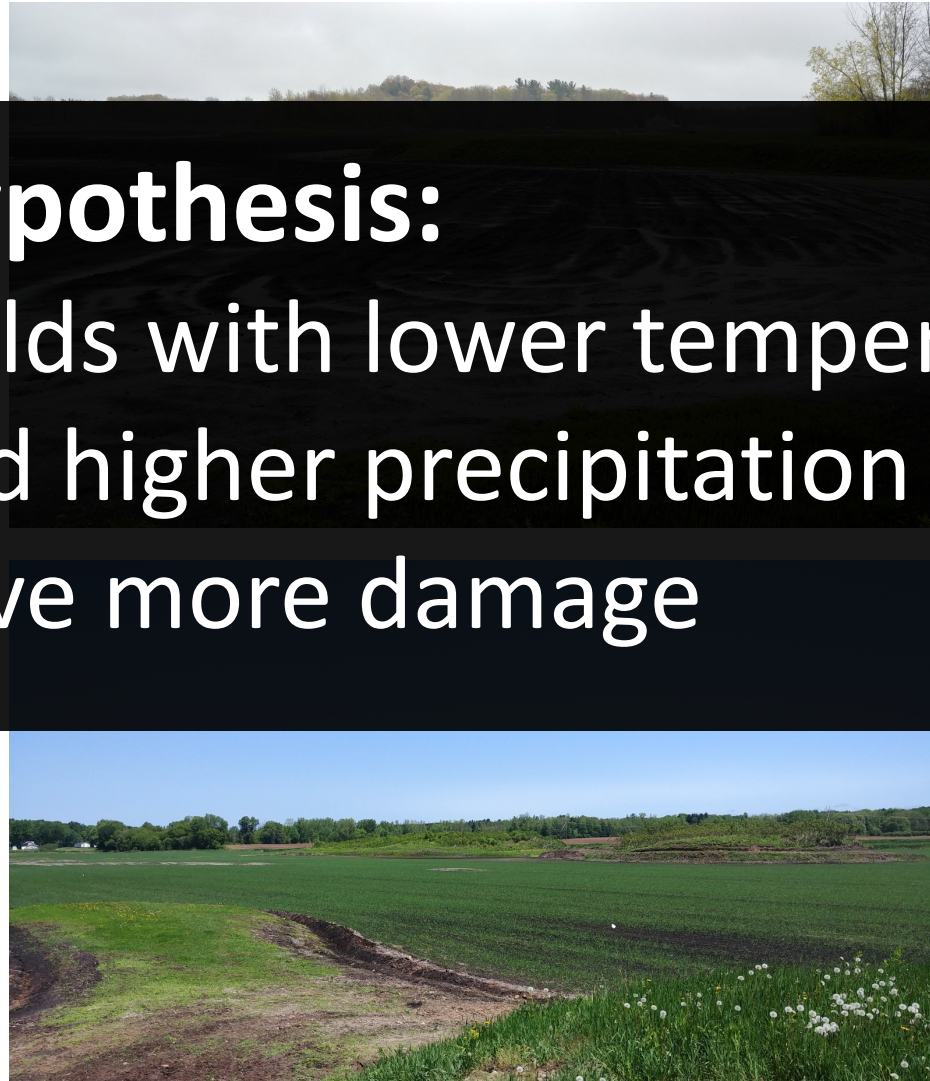
Hypothesis:
Fields with lower temperature
and higher precipitation will
have more damage

Cool, moist conditions
favor maggot damage

(Ellington, 1963)

Hot, dry conditions lead
to fly mortality, egg
desiccation, and larval
mortality in *Delia* sp.

(Ellington, 1963; LePage et al. 2012; Hesler et al. 2018)



Environmental factors influence pest dynamics

Timing

- Planting Date
- Ovipositional preference for larger onions

Female flies prefer to oviposit on larger onions

(Nault et al. 2011; Harris & Miller, 1988)

Delayed planting can reduce damage by first generation flies (Nault et al. 2011)



Environmental factors influence pest dynamics

Timing

- Planting Date
- Ovipositional preference for larger onions

Hypothesis:
Later planting date and small onions will be associated with decreased damage

generation flies (Nault et al. 2011)



Environmental factors influence pest dynamics

Landscape

- Bordering habitat
- Forest vs Ag



Forested edges have more early-season fly activity (Werling et al. 2006)

Environmental factors influence pest dynamics

Landscape

- Bordering habitat
- Forest vs Ag

Hypothesis:
Fields surrounded by more forests will have increased damage

Forested edges have more early-season fly activity (Werling et al. 2006)

Environmental factors influence pest dynamics

Soil

- Organic Matter

Organic matter mediates other soil properties (such as soil moisture and pH)

(Villani & Wright, 1990; Reeves, 1997)



Environmental factors influence pest dynamics

Soil

- Organic Matter

Organic matter mediates other soil properties (such as soil moisture and pH)

(Villani & Wright, 1990; Reeves, 1997)

Soil moisture directly impacts belowground insects (Villani & Wright, 1990)



Environmental factors influence pest dynamics

Soil

- Organic Matter

Organic matter mediates other soil properties (such as soil moisture and pH)

(Villani & Wright, 1990; Reeves, 1997)

Soil moisture directly impacts belowground insects (Villani & Wright, 1990)

Soil pH influences soil arthropod communities, but is understudied

(Barnett & Johnson, 2013)



Environmental factors influence pest dynamics

Soil

- Organic Matter

Hypothesis:
Soil properties will have an effect on onion maggot damage

Soil pH influences soil arthropod communities, but is understudied
(Barnett & Johnson, 2013)



Environmental factors influence pest dynamics

Climate	Timing	Landscape	Soil
<ul style="list-style-type: none">▪ Temperature▪ Precipitation	<ul style="list-style-type: none">▪ Planting Date▪ Ovipositional preference for larger onions	<ul style="list-style-type: none">▪ Bordering habitat▪ Forest vs agriculture	<ul style="list-style-type: none">▪ Organic Matter

Environmental factors influence pest dynamics

Climate	Timing	Landscape	Soil
<ul style="list-style-type: none">▪ Temperature▪ Precipitation	<ul style="list-style-type: none">▪ Planting Date▪ Ovipositional period	<ul style="list-style-type: none">▪ Bordering habitat▪ Onion agriculture	<ul style="list-style-type: none">▪ Organic Matter

Objectives:

- I. Determine if these factors are associated with onion maggot damage
- II. Identify which factors are the best predictors of onion maggot damage

Methods: Research Sites



2018: 15 sites

2019: 12 sites





Methods: Data Collection

- Sampled mid-May to mid-July
- Rain gauge
- Soil temperature probes (i-button)
- Sticky cards (3 per site)
- Measured plant growth



Methods: Data Collection

- **Sampled mid-May to mid-July**
- Rain gauge
- Soil temperature probes (i-button)
- Sticky cards (3 per site)
- Measured plant growth



Methods: Data Collection

- Sampled mid-May to mid-July
- **Rain gauge**
- Soil temperature probes (i-button)
- Sticky cards (3 per site)
- Measured plant growth



Methods: Data Collection

- Sampled mid-May to mid-July
- Rain gauge
- **Soil temperature probes (i-button)**
- Sticky cards (3 per site)
- Measured plant growth



Methods: Data Collection

- Sampled mid-May to mid-July
- Rain gauge
- Soil temperature probes (i-button)
- **Sticky cards (3 per site)**
- Measured plant growth



Methods: Data Collection

- Sampled mid-May to mid-July
- Rain gauge
- Soil temperature probes (i-button)
- Sticky cards (3 per site)
- **Measured plant growth**

Methods: Damage Evaluation

50 m transects





Methods: Data Collection

- **Sampled soil (OM)**
- Surveyed management
- Landscape Analysis



Methods: Data Collection

- Sampled soil
- **Surveyed management**
- Landscape Analysis



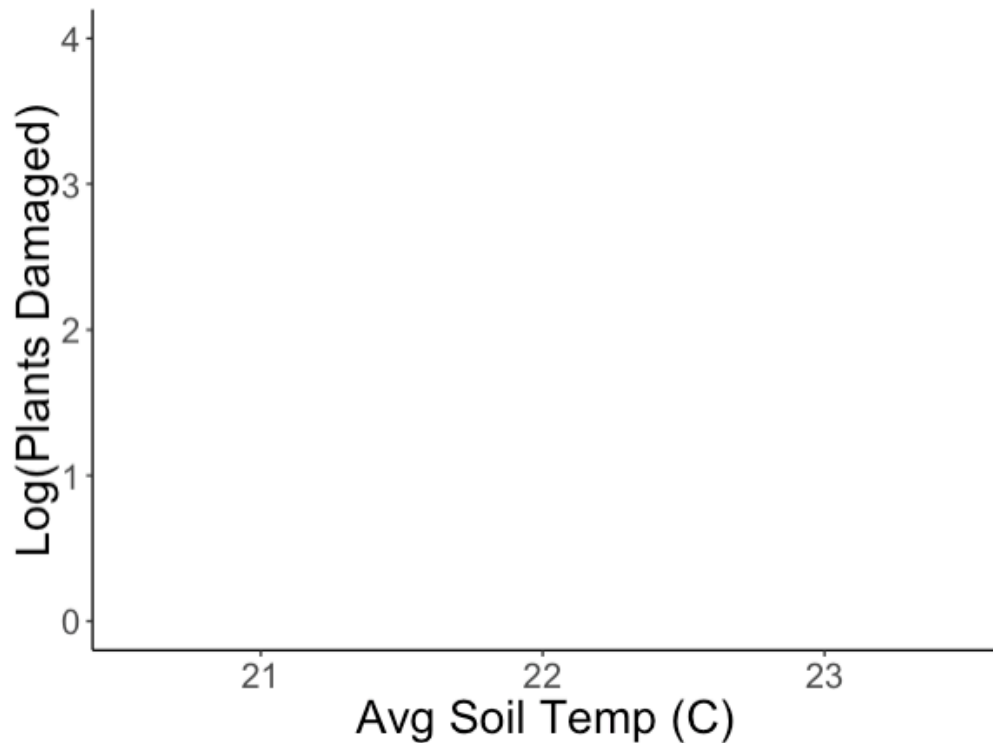
Methods: Data Collection

- Sampled soil
- Surveyed management
- **Landscape Analysis**
 - ArcMap 10.7.1
 - CropScape 2018 Cropland data layer
 - Calculated percent Forest and Ag in 1500m radius around each site

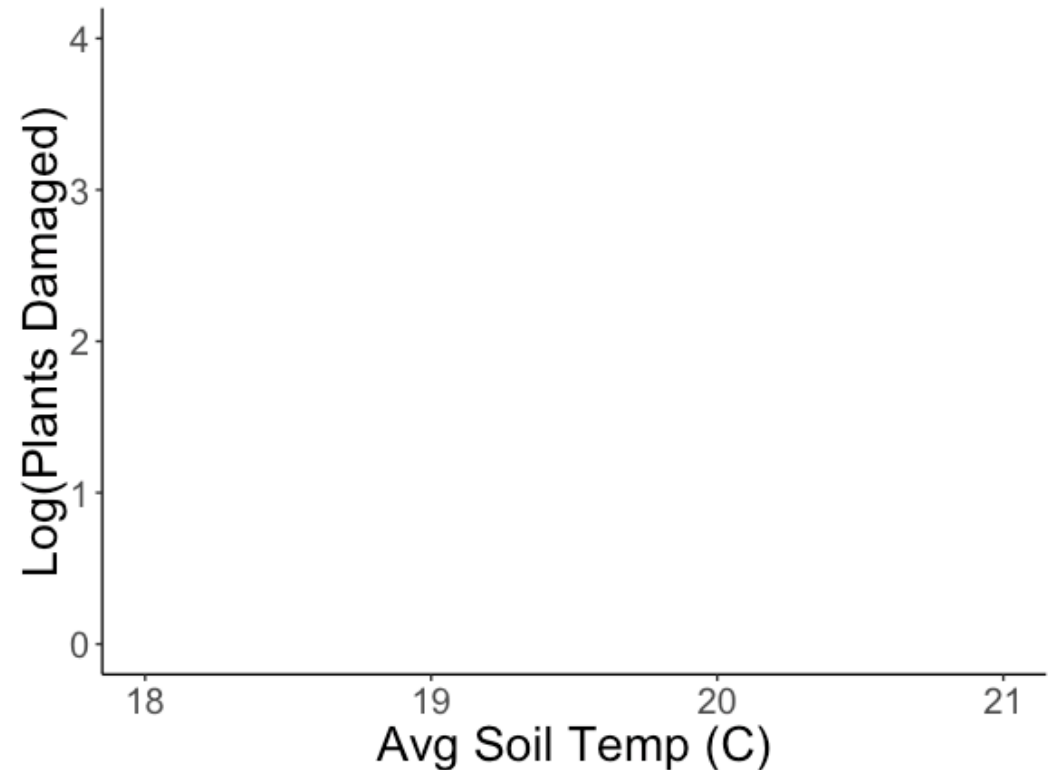
(Martinson et al. 1988)

Climate: Precipitation + Soil Temperature

2018

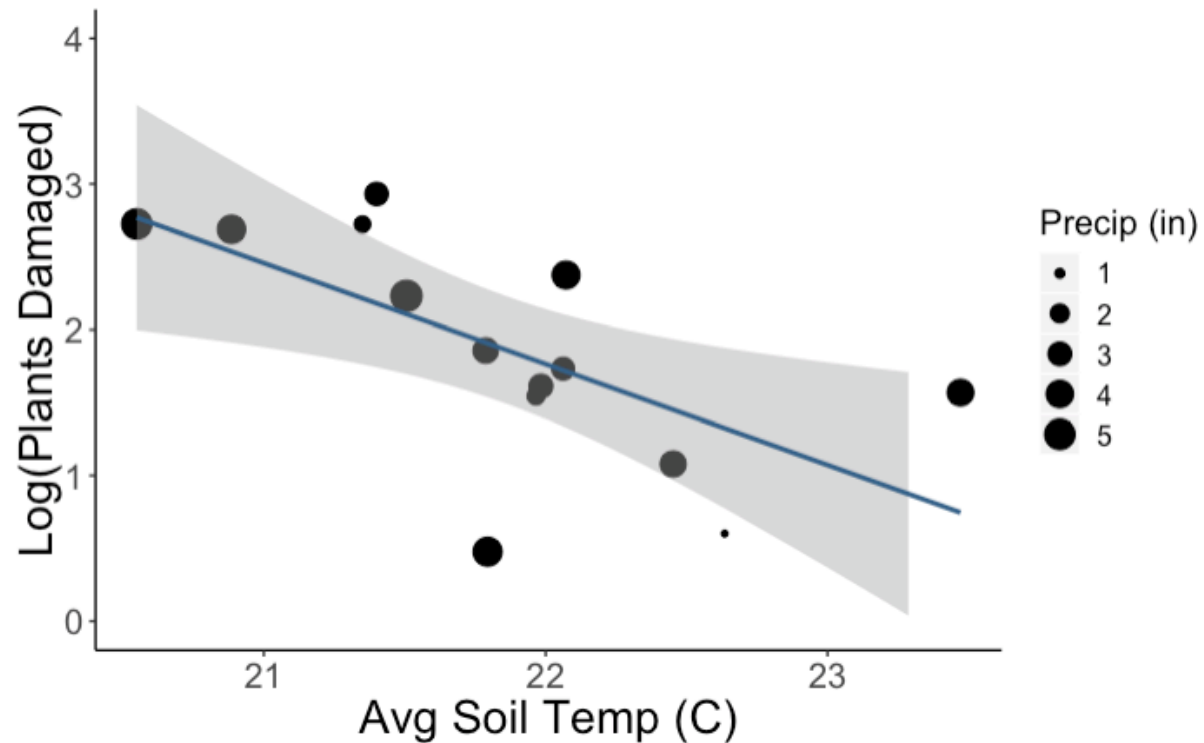


2019

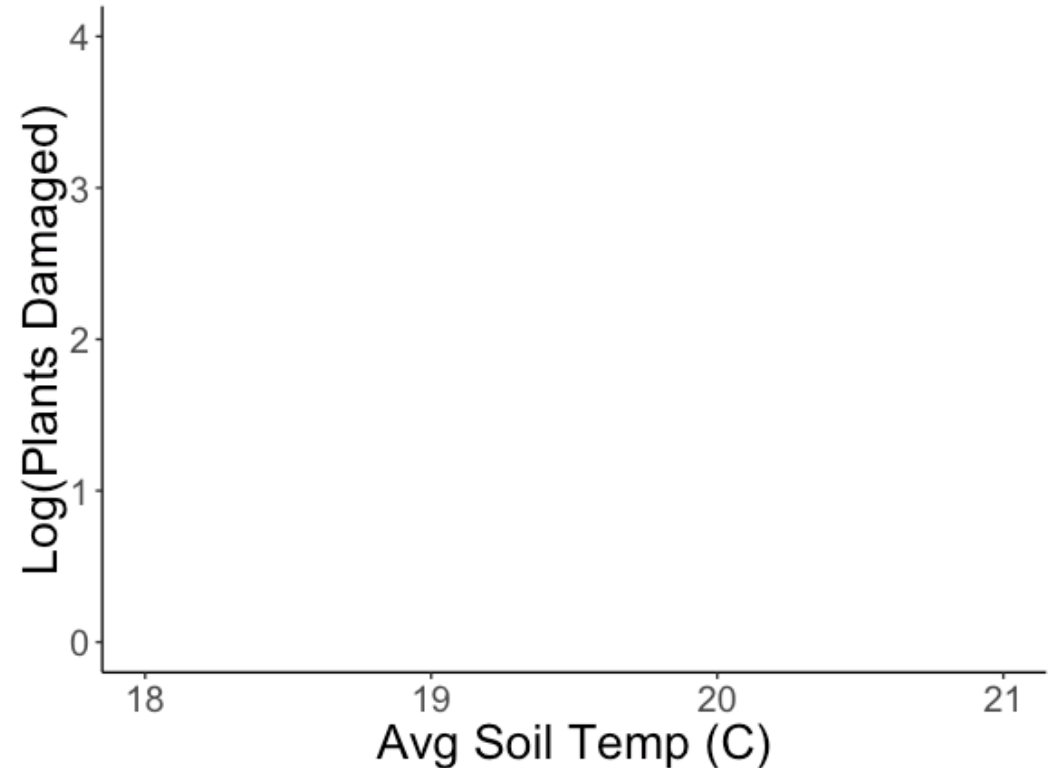


Climate: Precipitation + Soil Temperature

2018



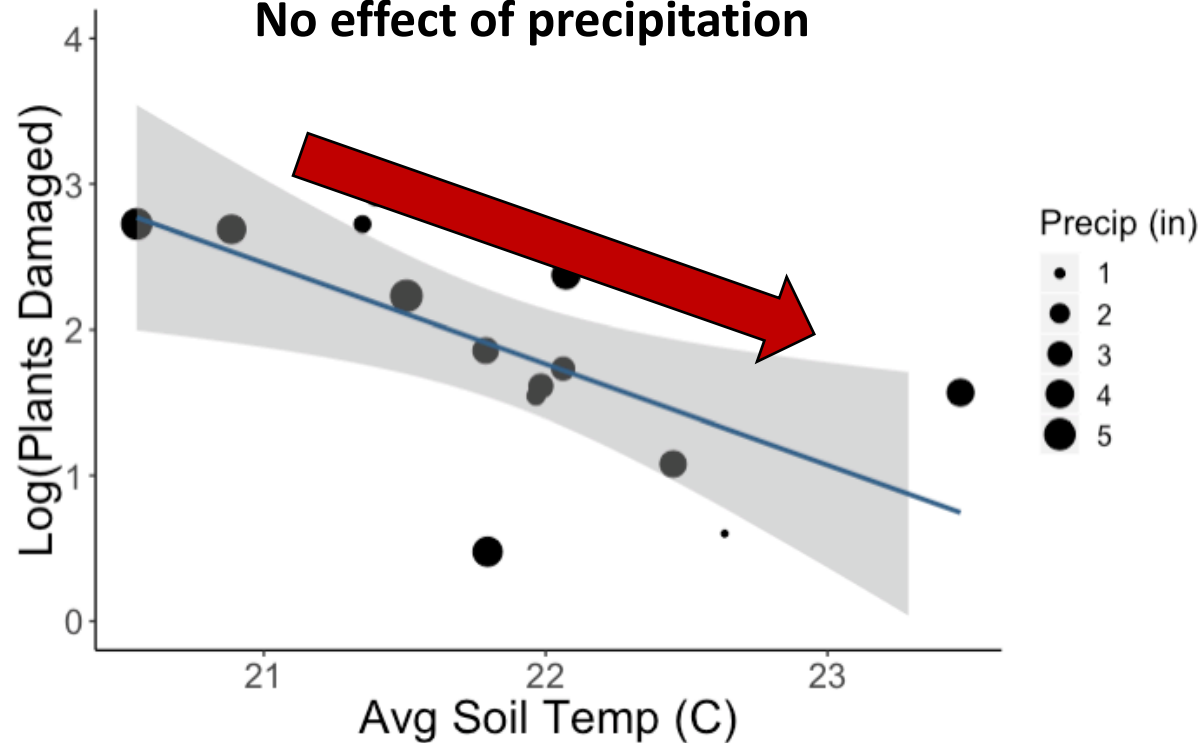
2019



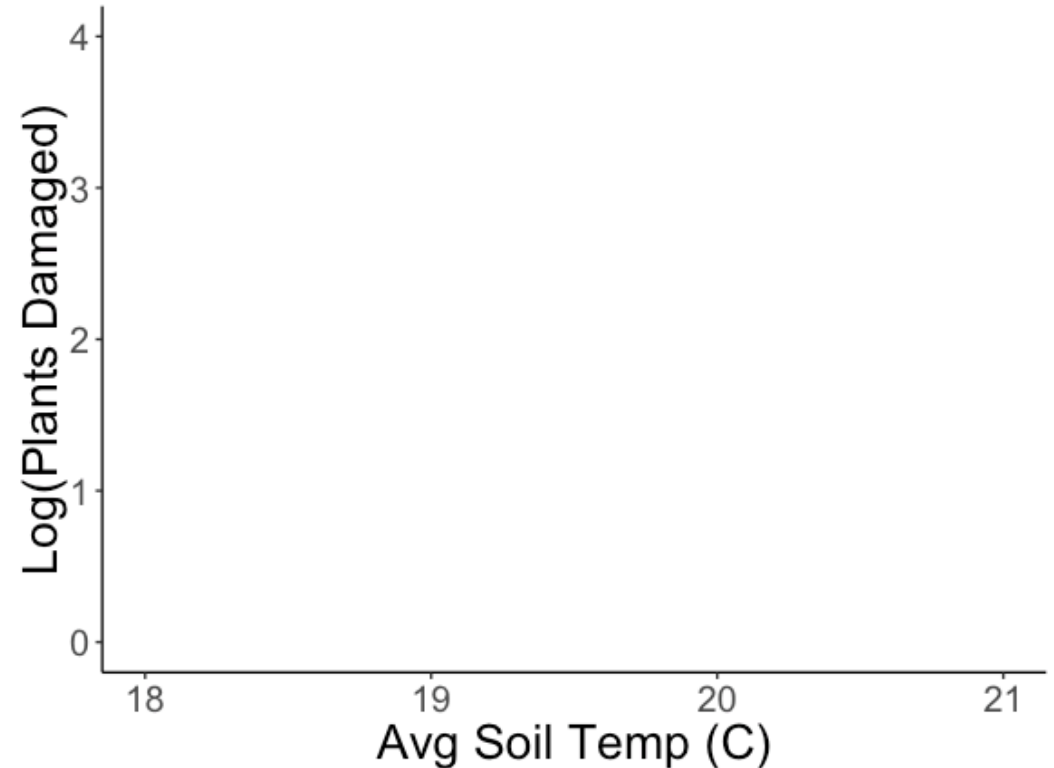
Climate: Precipitation + Soil Temperature

2018

HIGHER Temp = LESS damage
No effect of precipitation



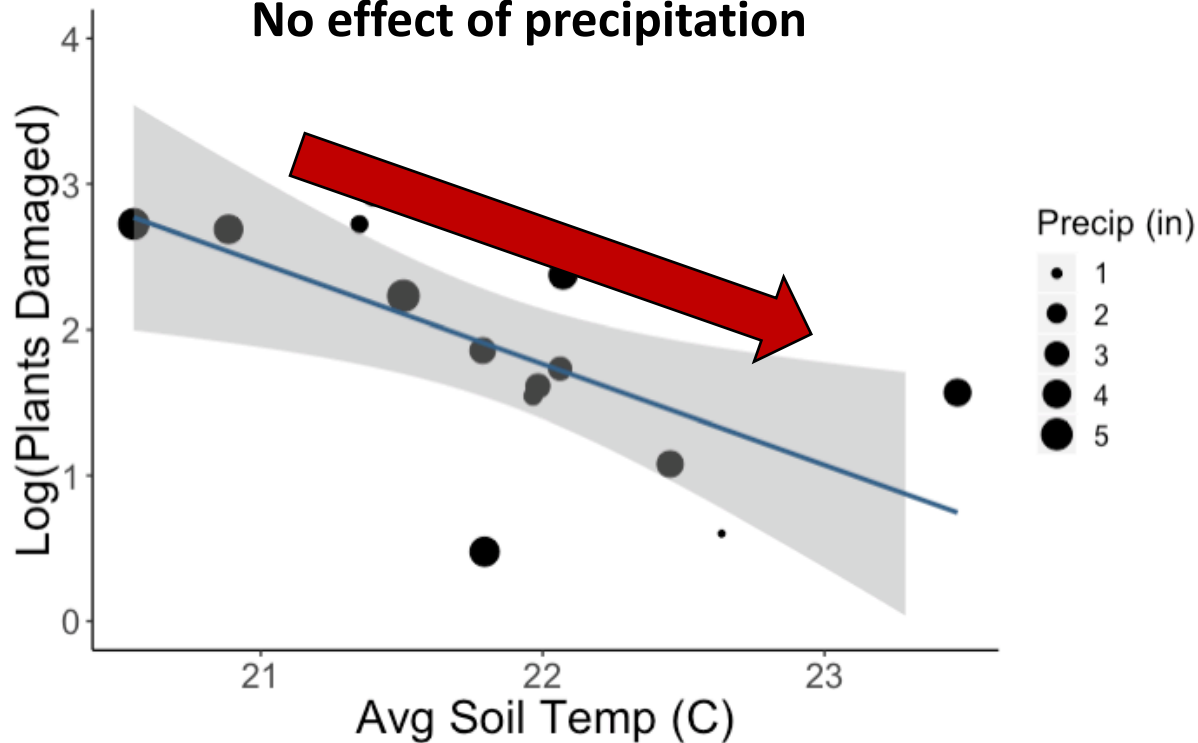
2019



Climate: Precipitation + Soil Temperature

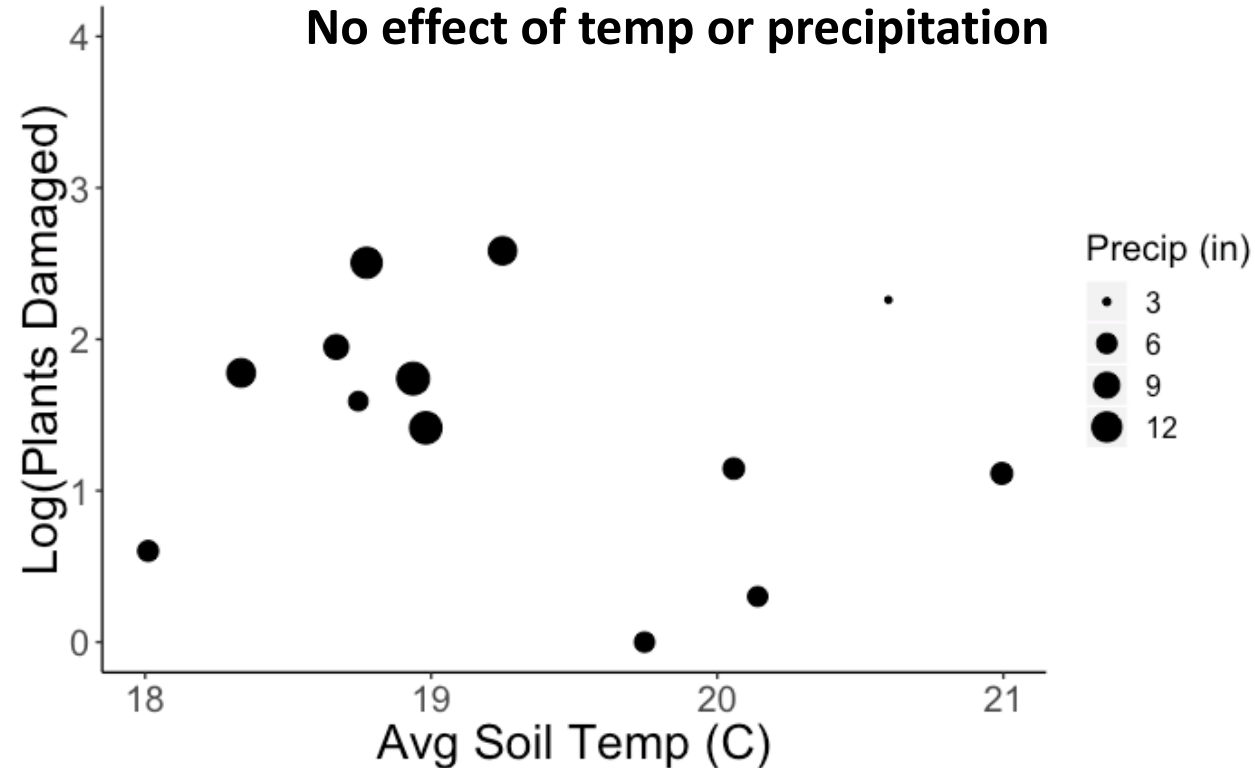
2018

HIGHER Temp = LESS damage
No effect of precipitation



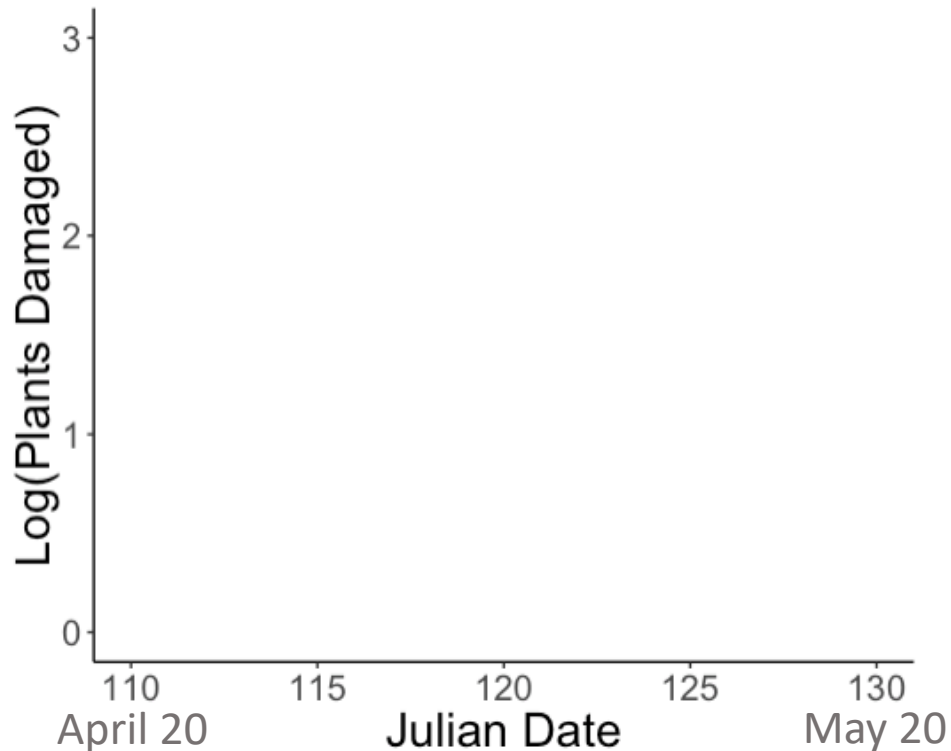
2019

No effect of temp or precipitation

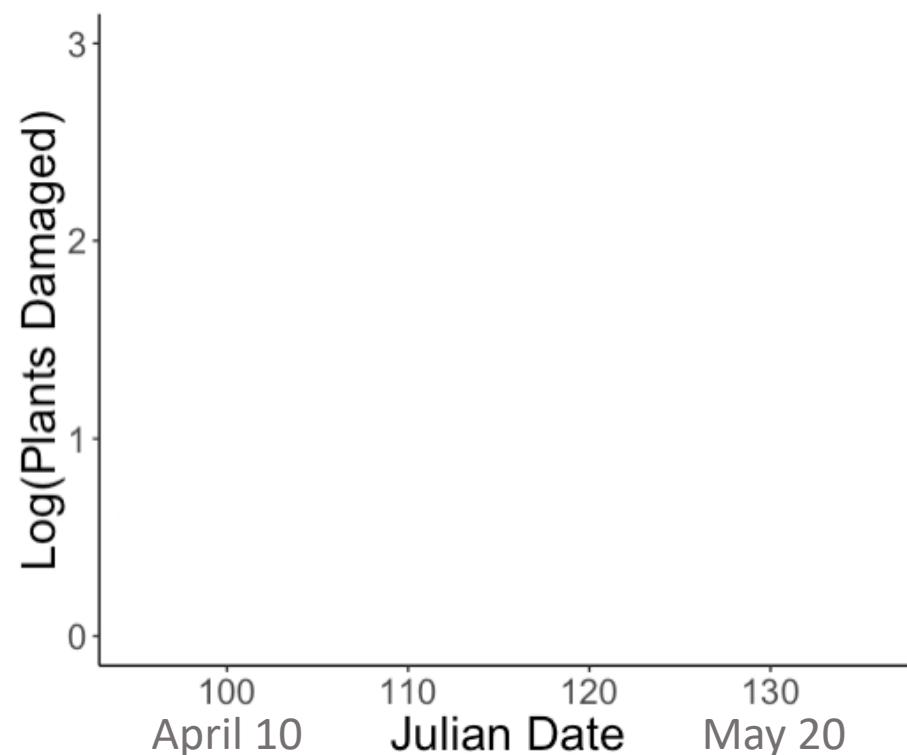


Timing: Planting Date and Plant size at peak fly activity

2018

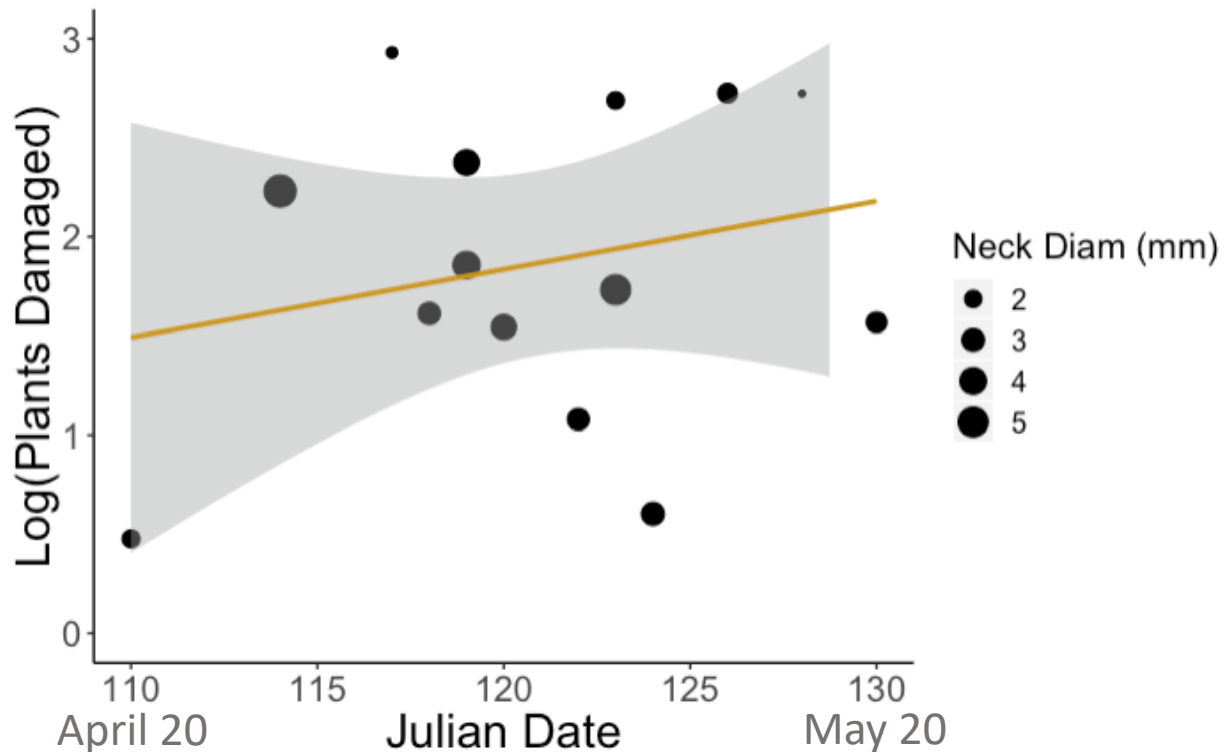


2019

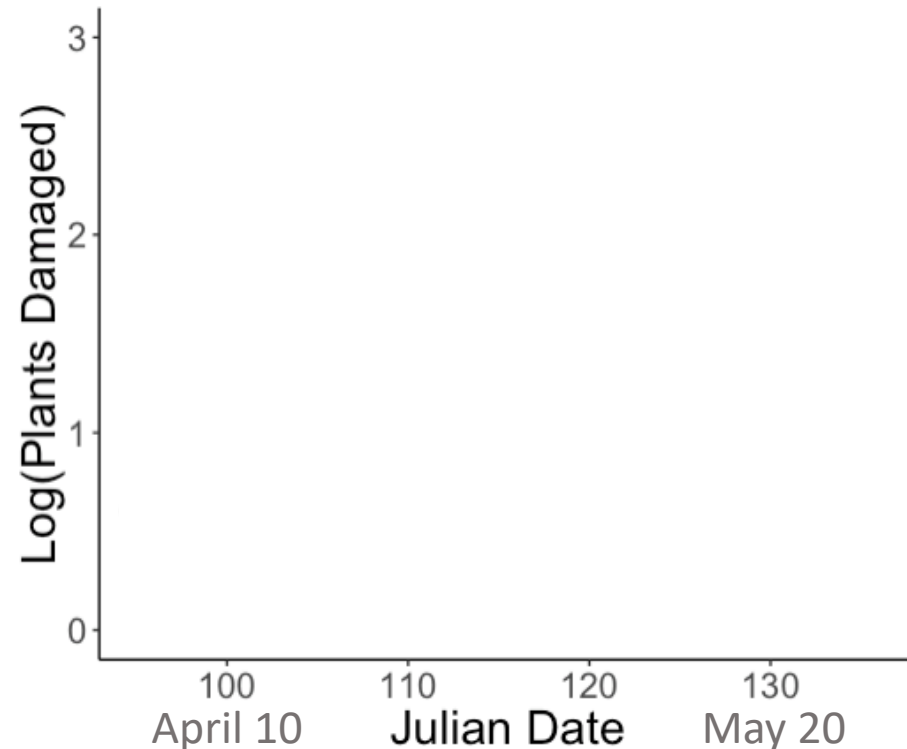


Timing: Planting Date and Plant size at peak fly activity

2018



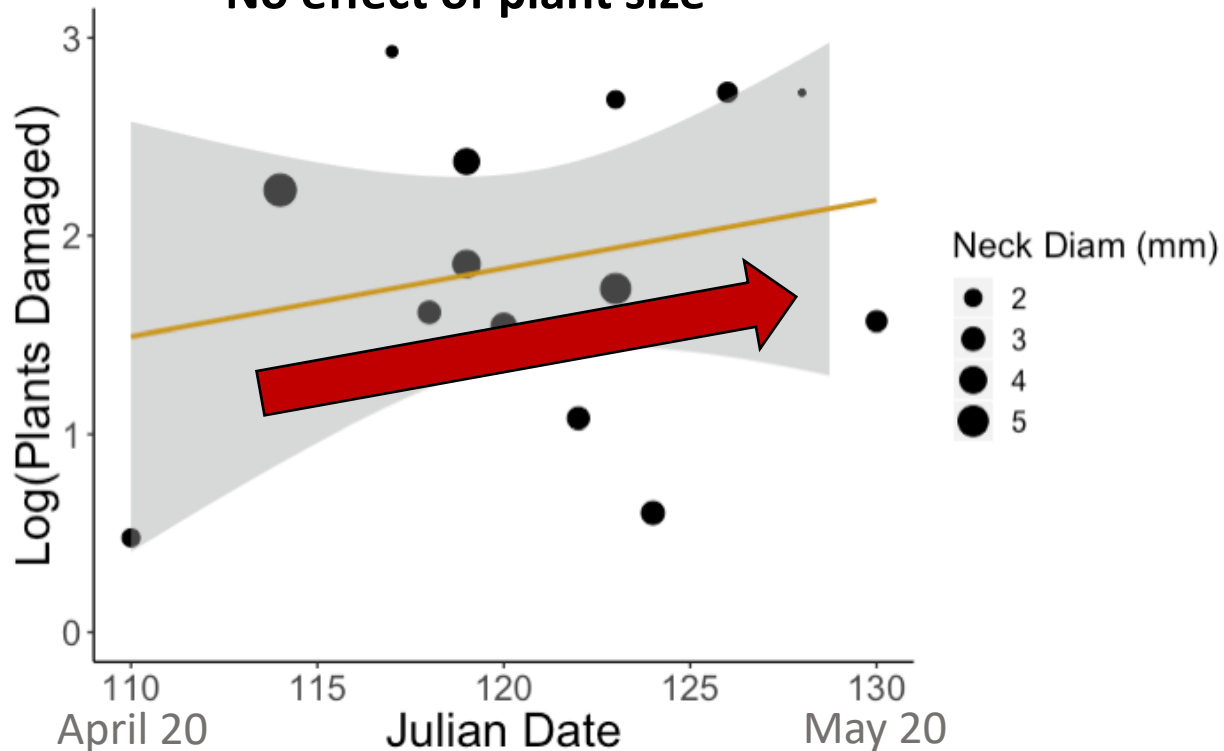
2019



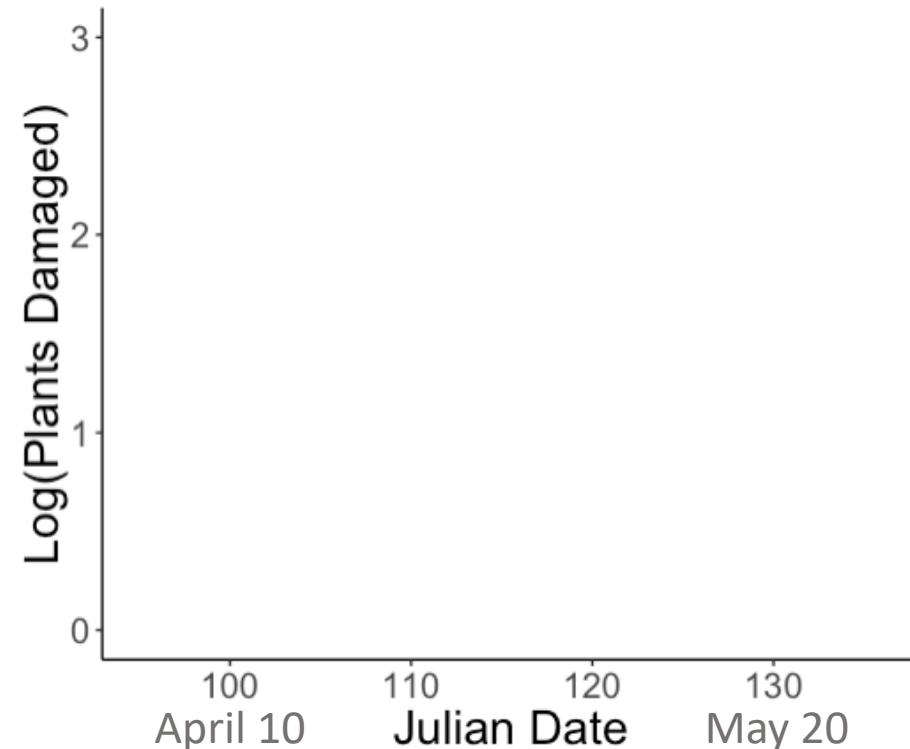
Timing: Planting Date and Plant size at peak fly activity

2018

Later planting date = MORE damage
No effect of plant size



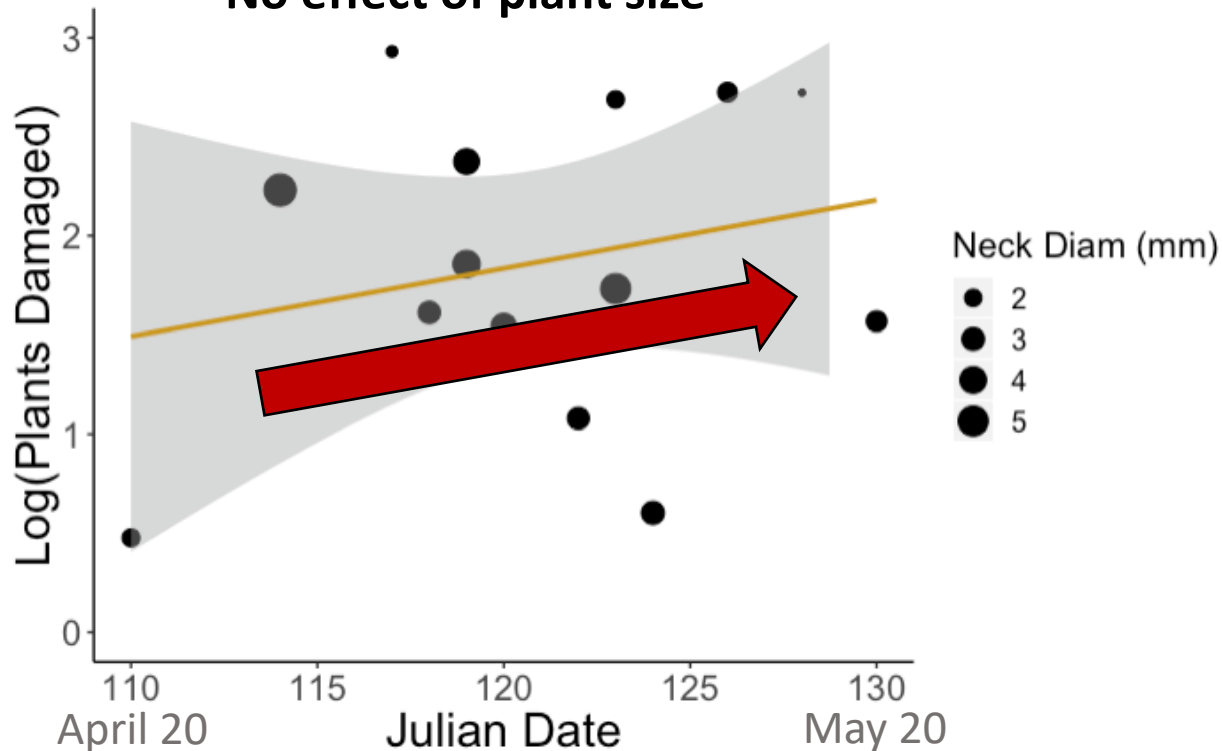
2019



Timing: Planting Date and Plant size at peak fly activity

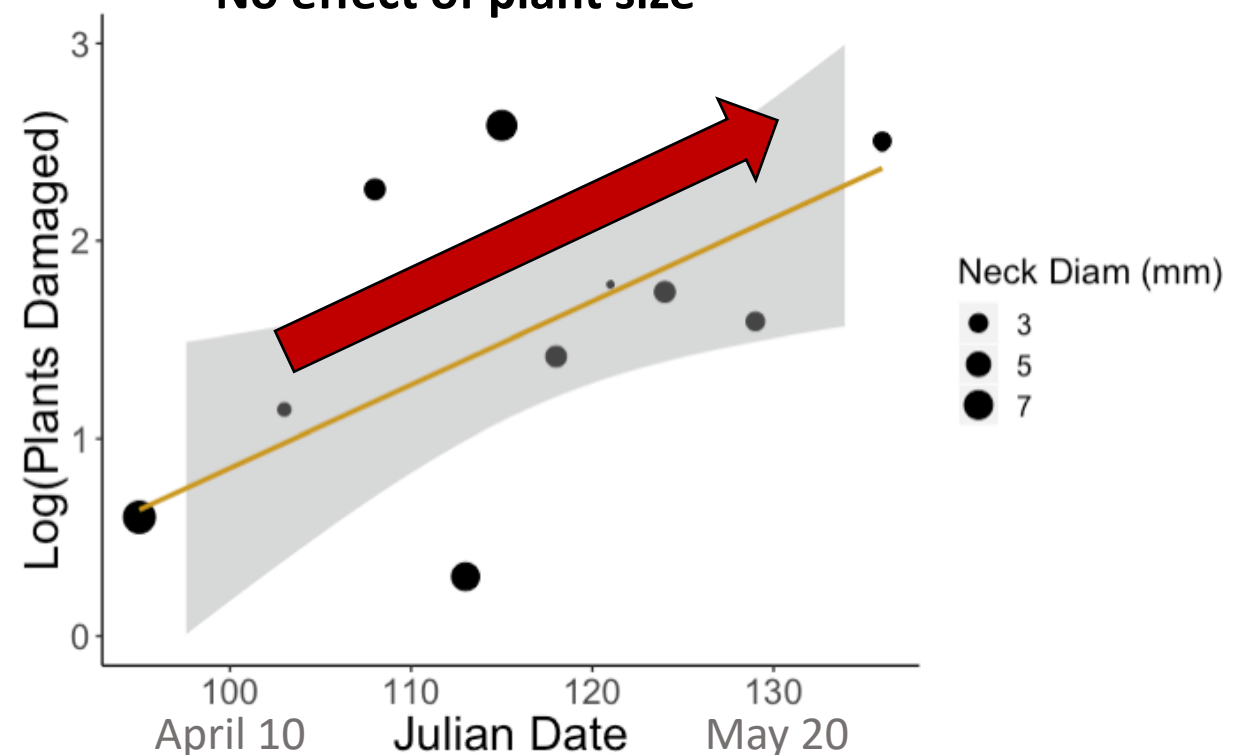
2018

Later planting date = MORE damage
No effect of plant size



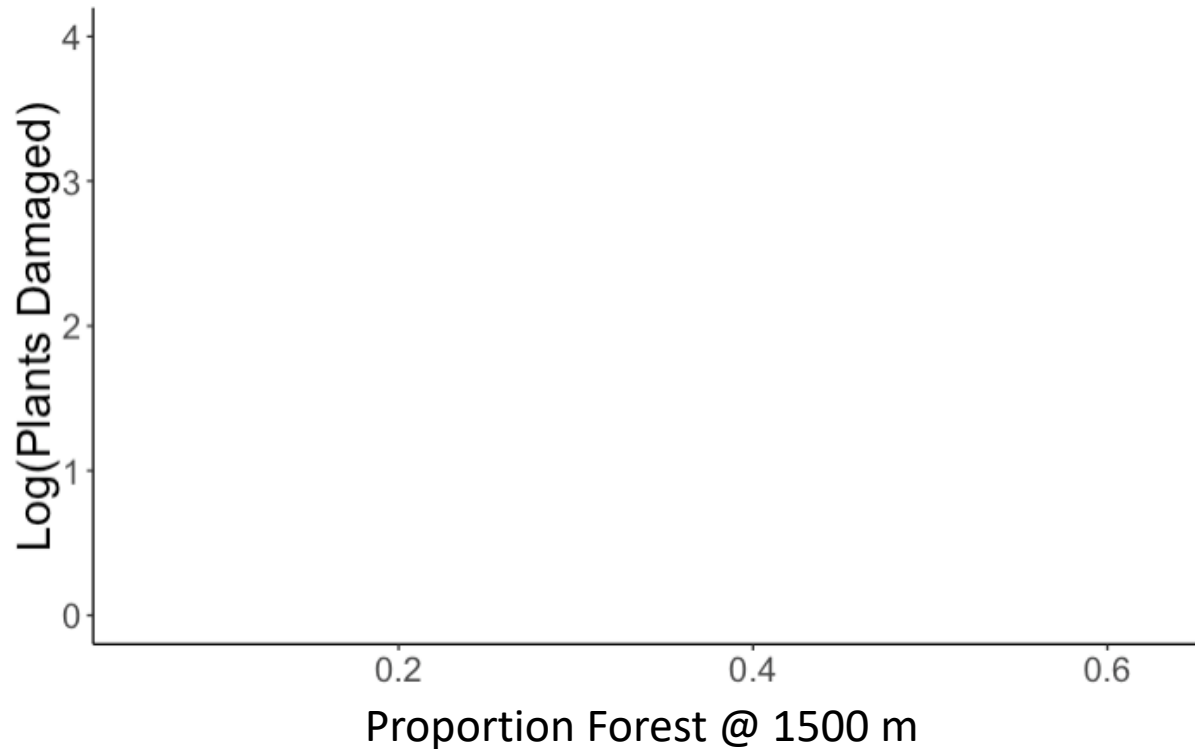
2019

Later planting date = MORE damage
No effect of plant size

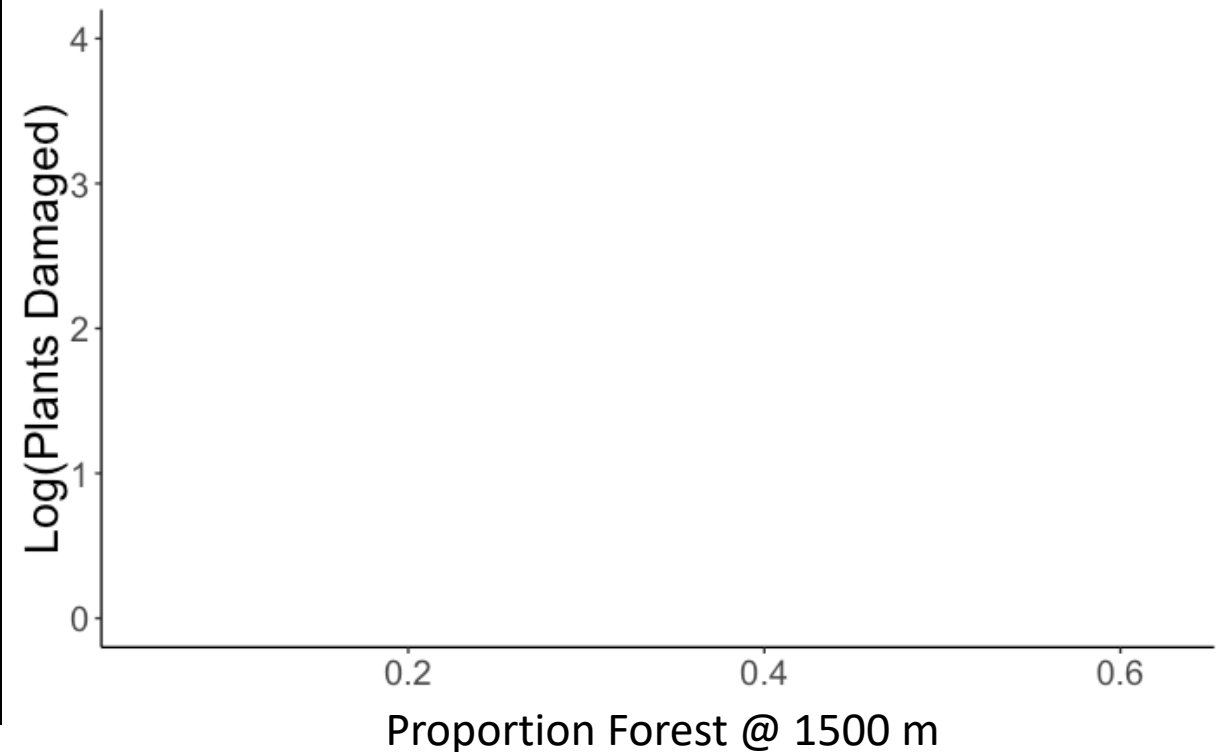


Landscape: Percent Forest at 1500m

2018

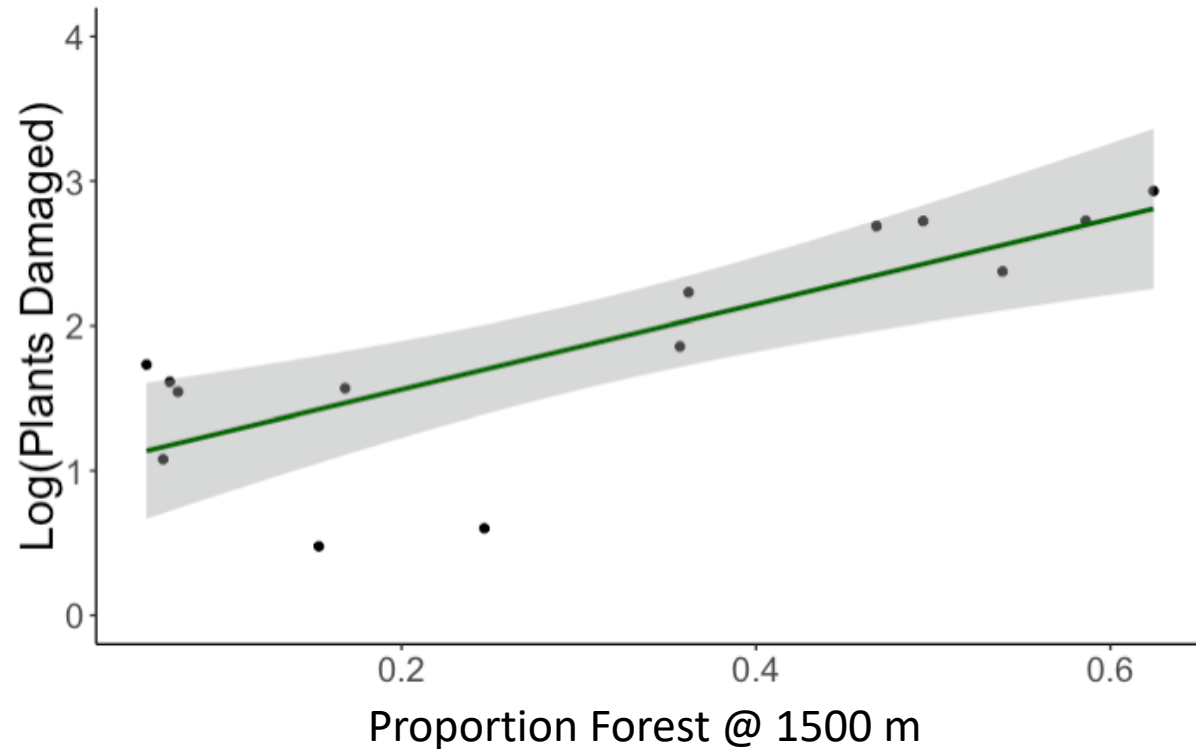


2019

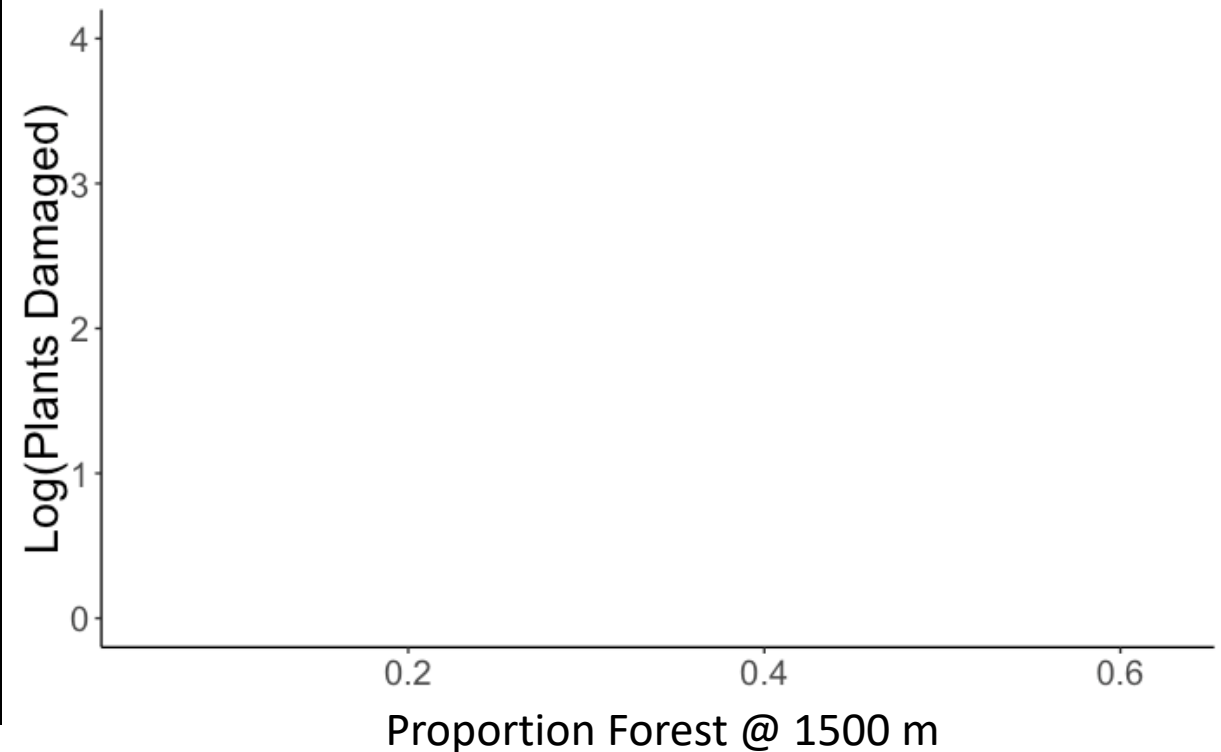


Landscape: Percent Forest at 1500m

2018

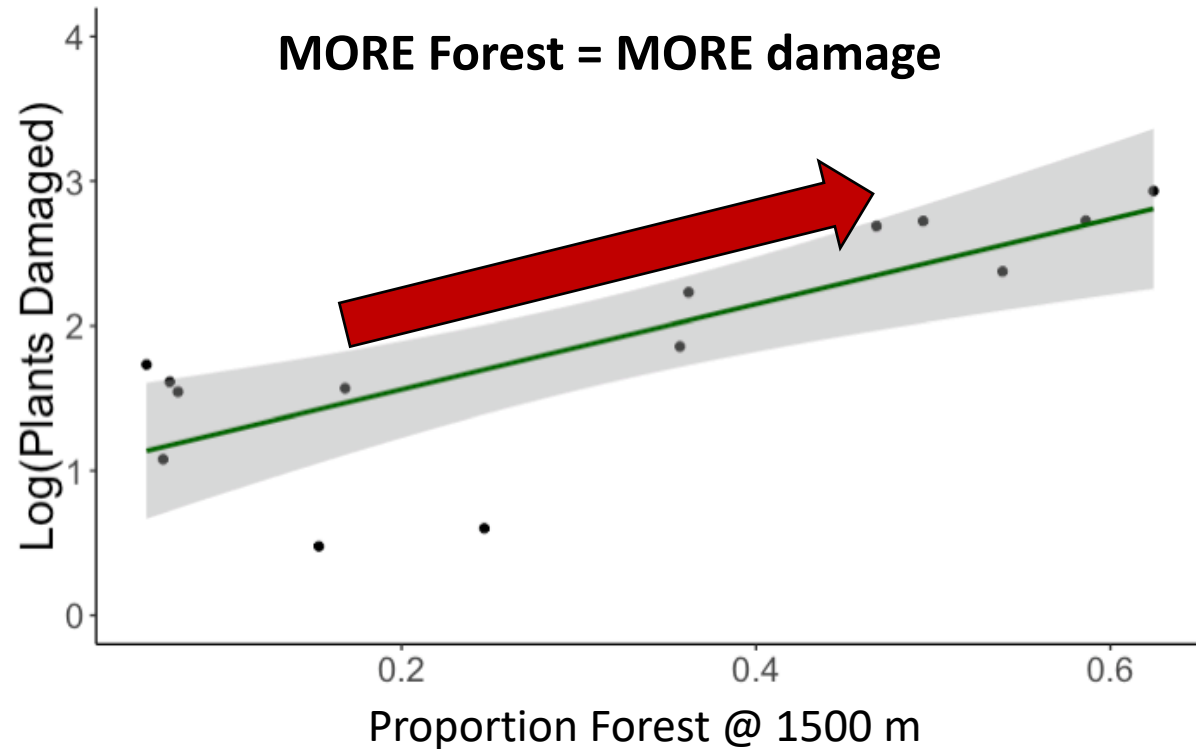


2019

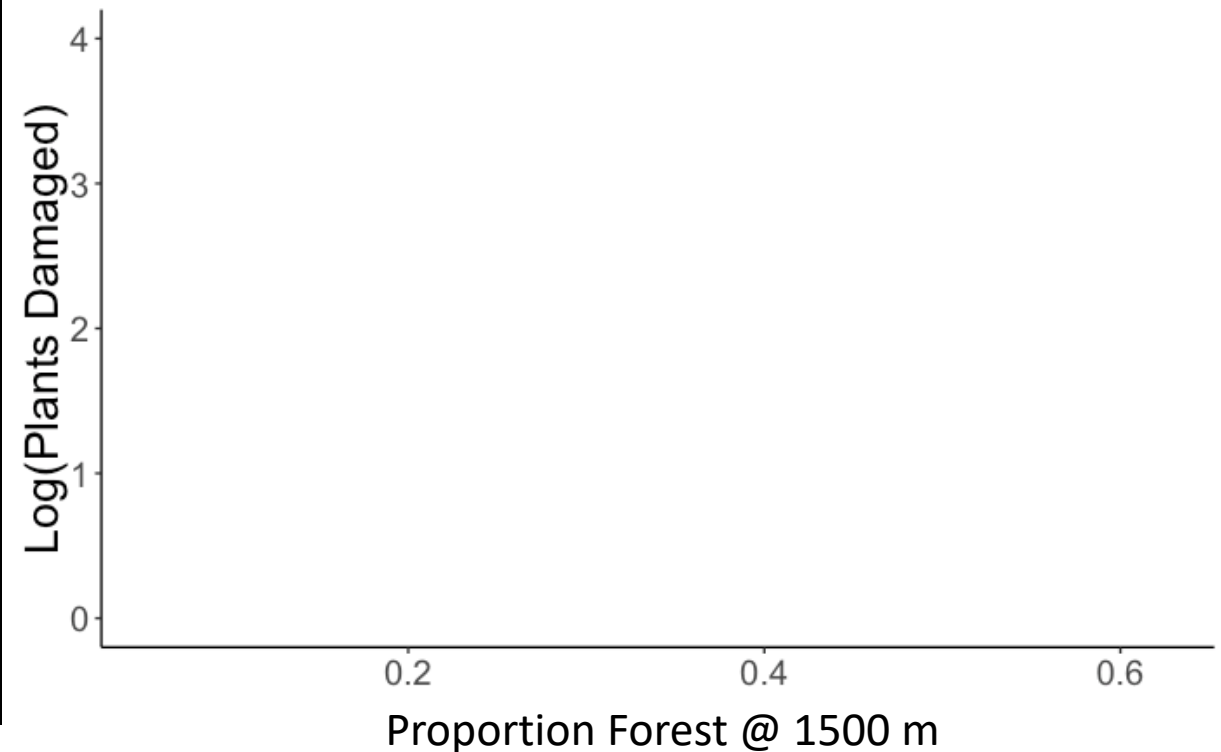


Landscape: Percent Forest at 1500m

2018

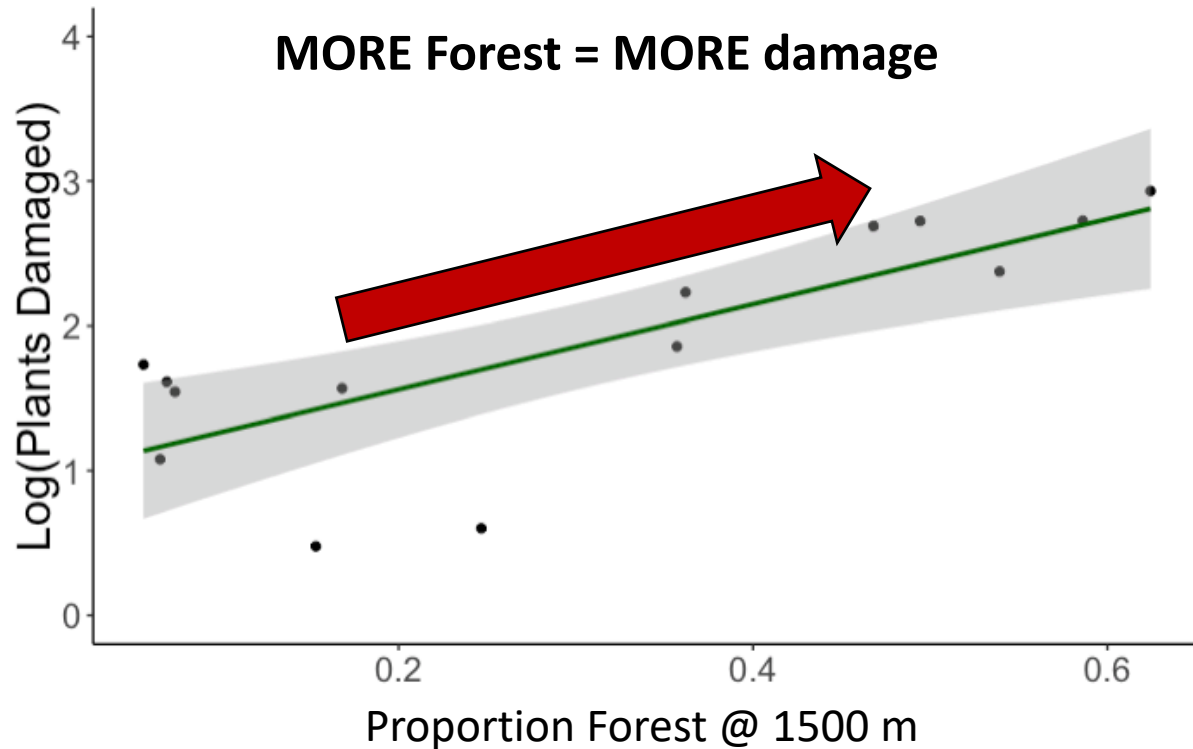


2019

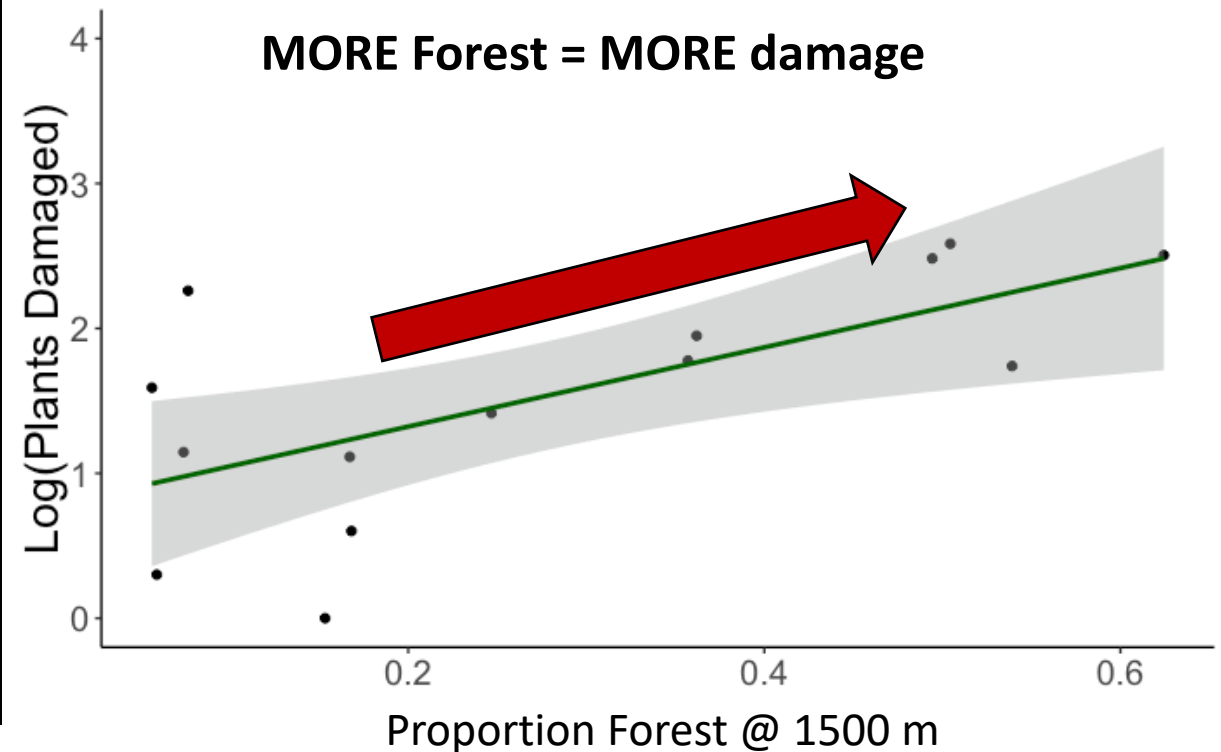


Landscape: Percent Forest at 1500m

2018

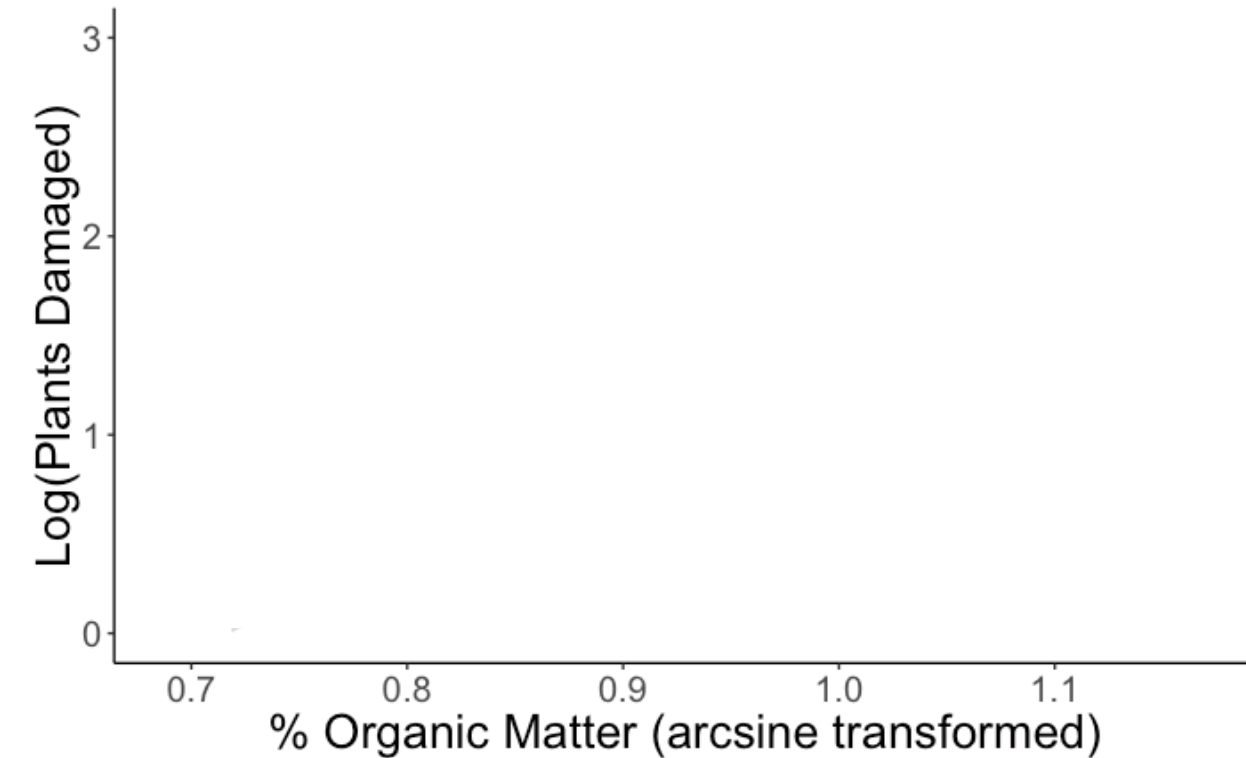


2019

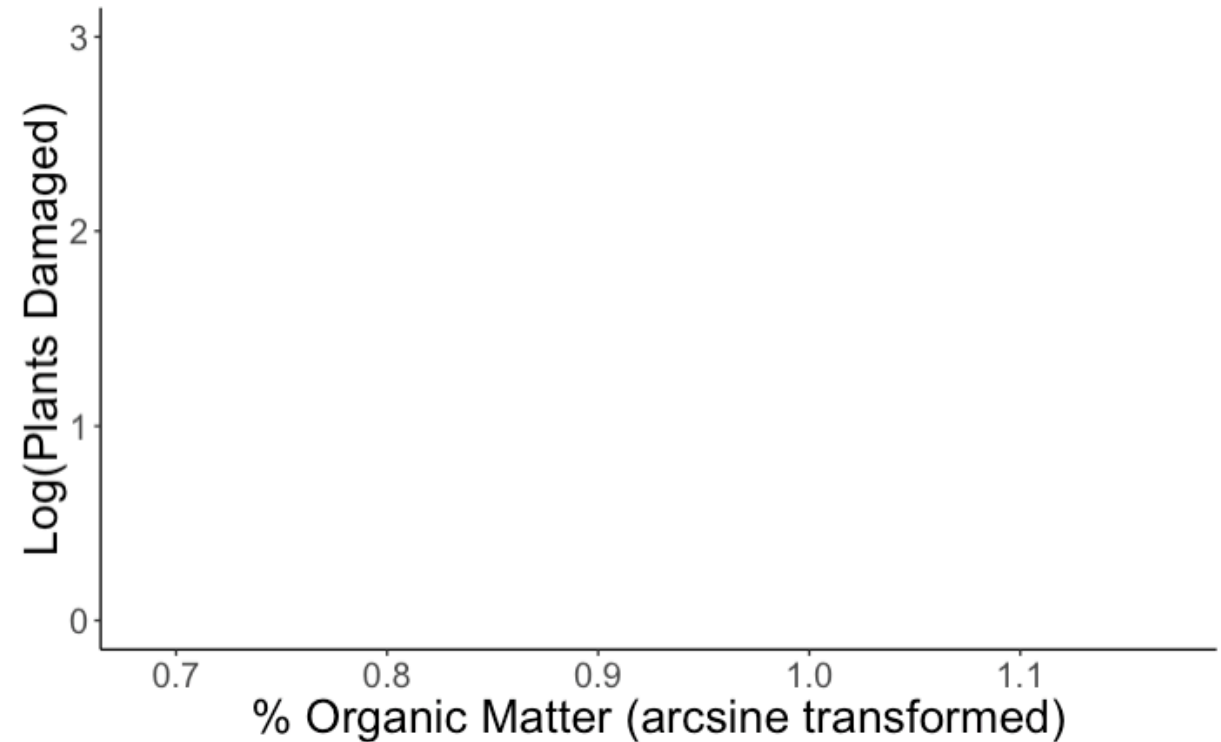


Soil: Organic Matter

2018

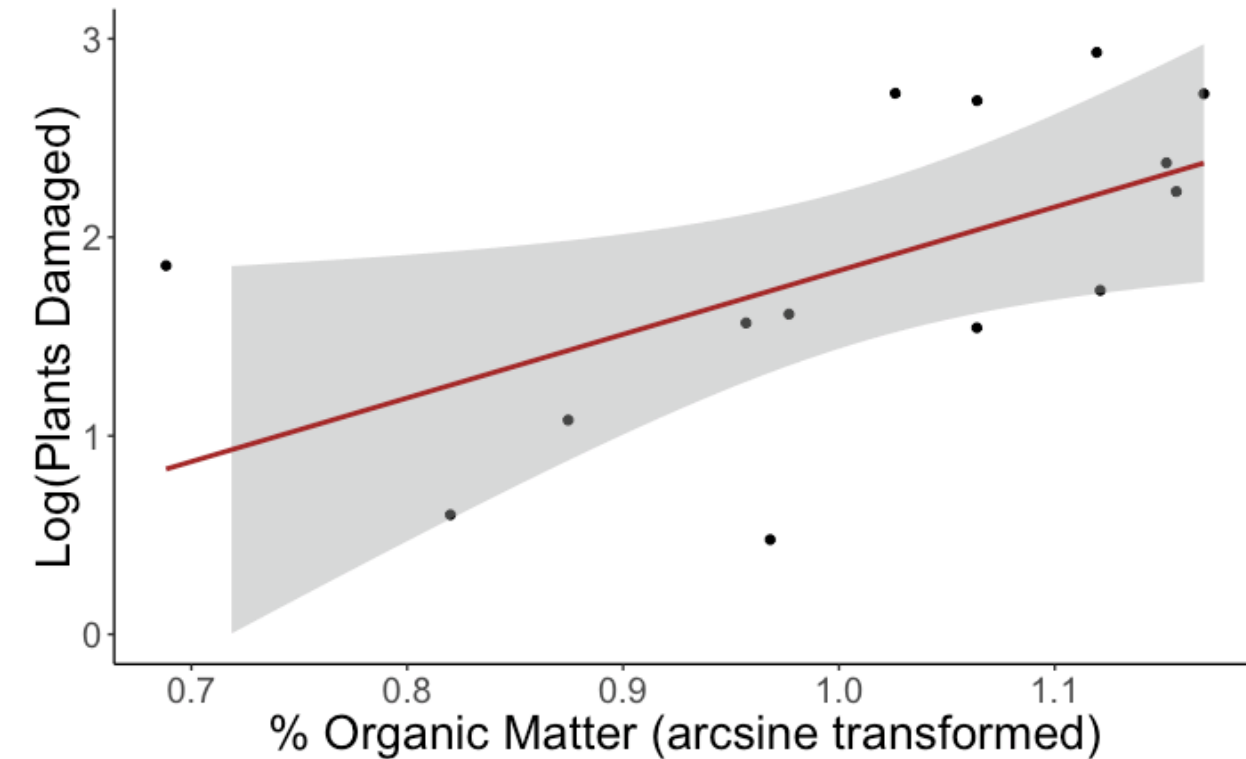


2019

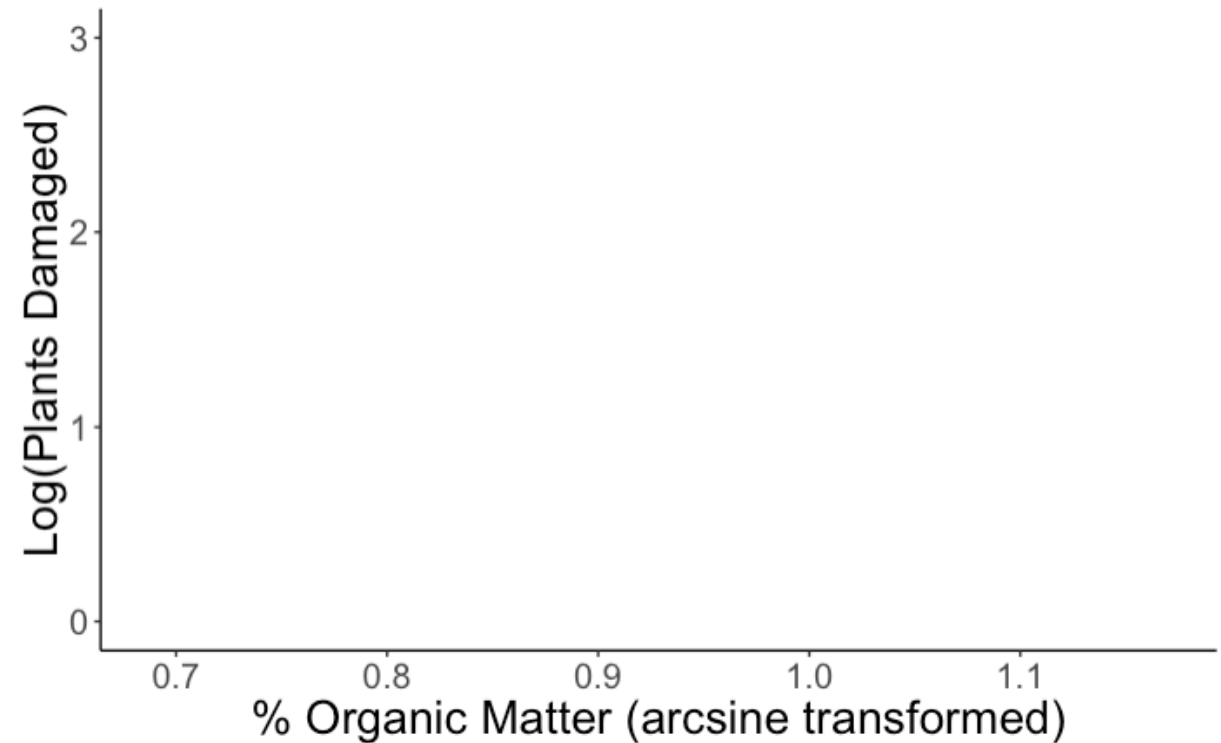


Soil: Organic Matter

2018

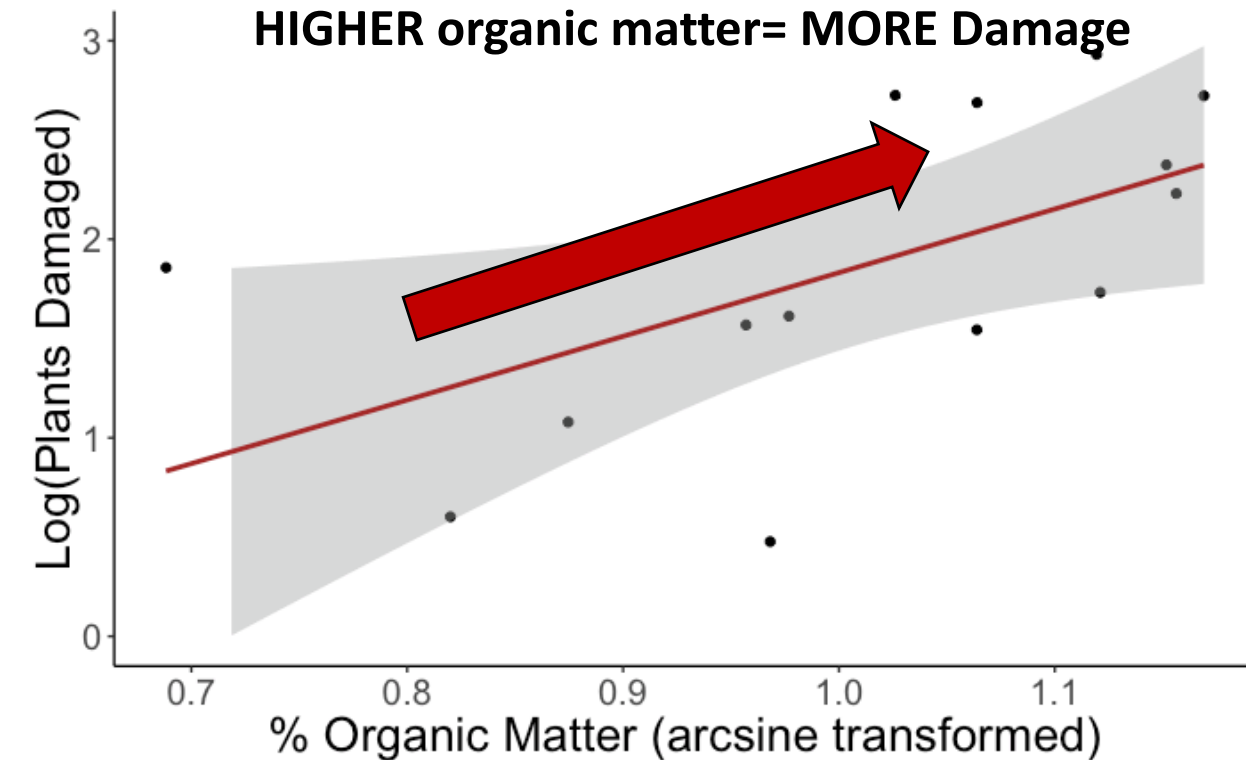


2019

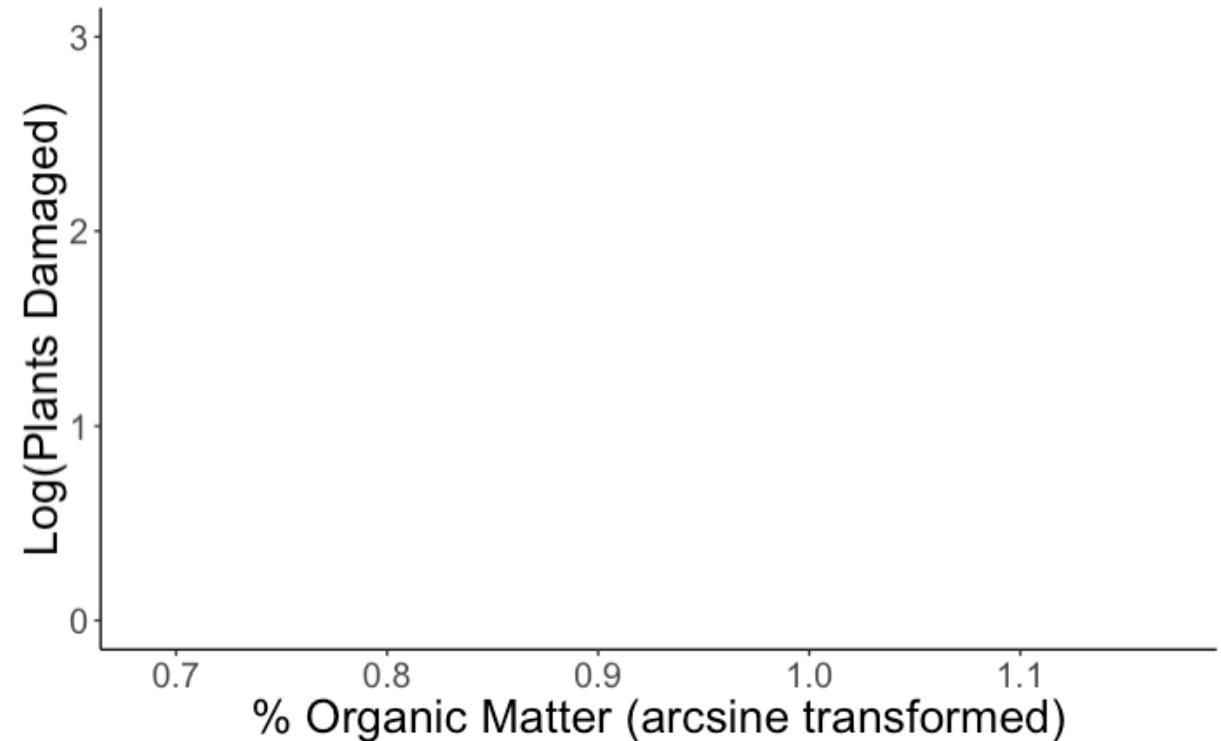


Soil: Organic Matter

2018

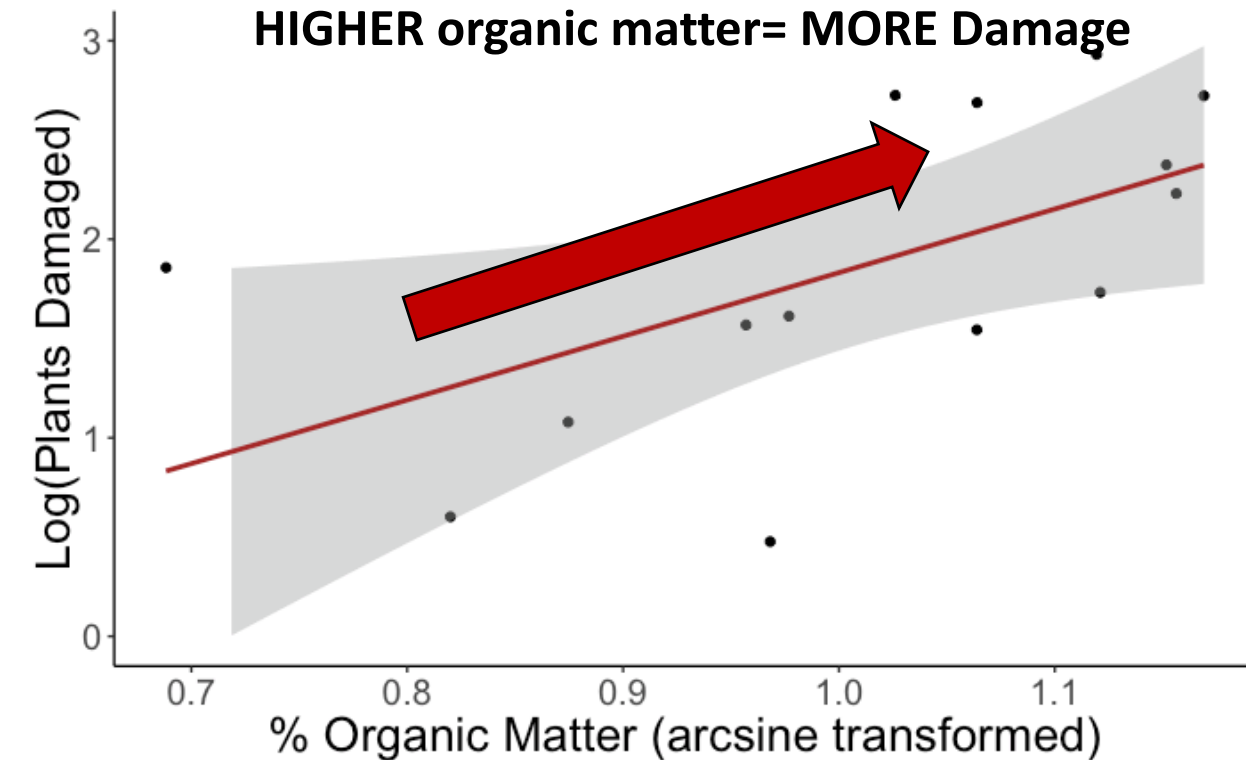


2019

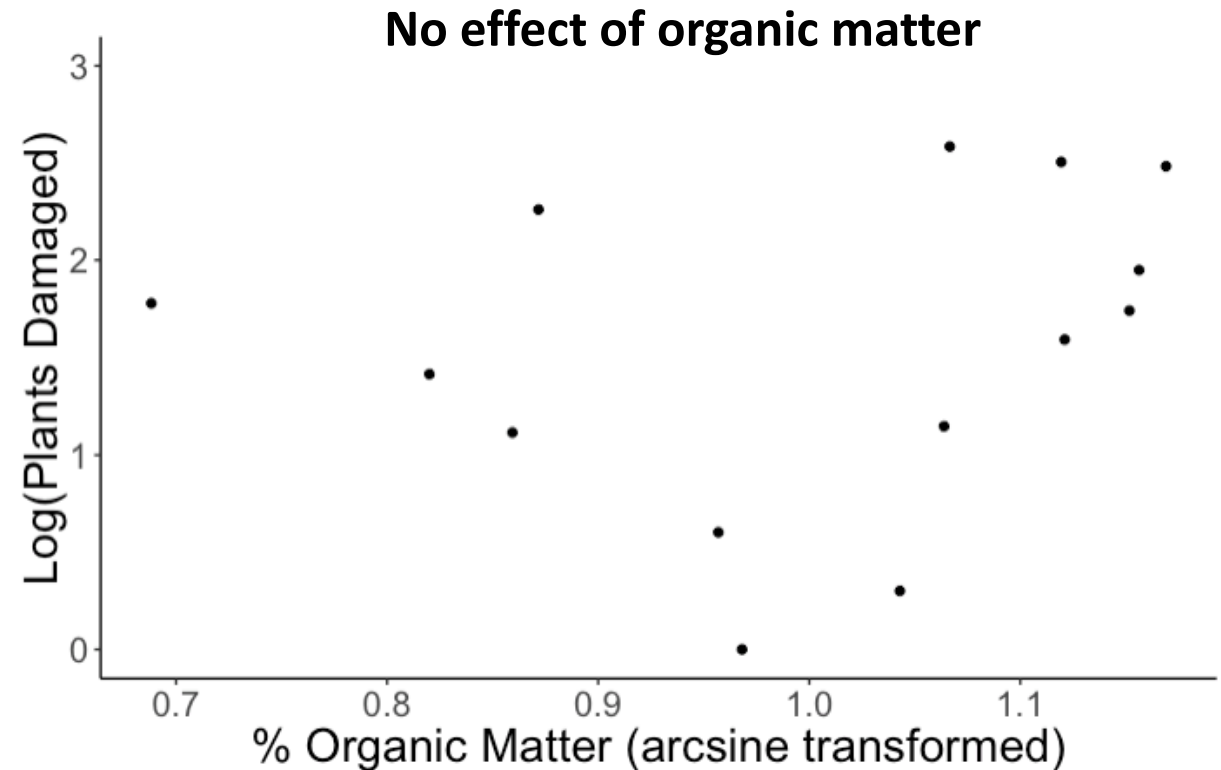


Soil: Organic Matter

2018



2019



Results:

Which factors are associated with damage?

2018

2019

Results:

Which factors are associated with damage?

2018

Percent Forest

Plant Date

Soil Temp

2019

Percent Forest

Plant Date

Results:
Which factors are associated with damage?

2018

2019

Percent Forest

Plant Date

Soil Temp

Percent Forest

Plant Date

Results:

Which factors are associated with damage?

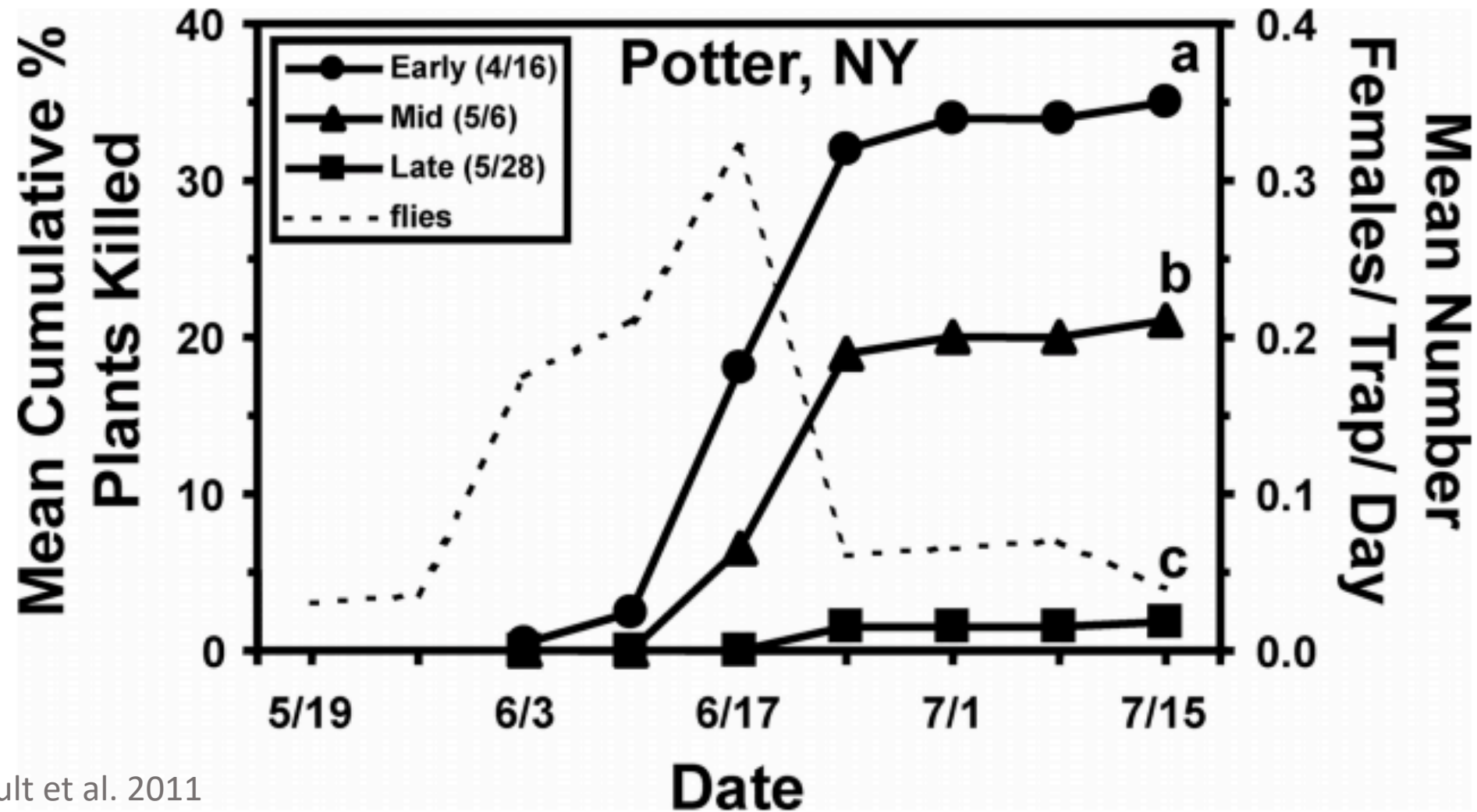
2018

2019

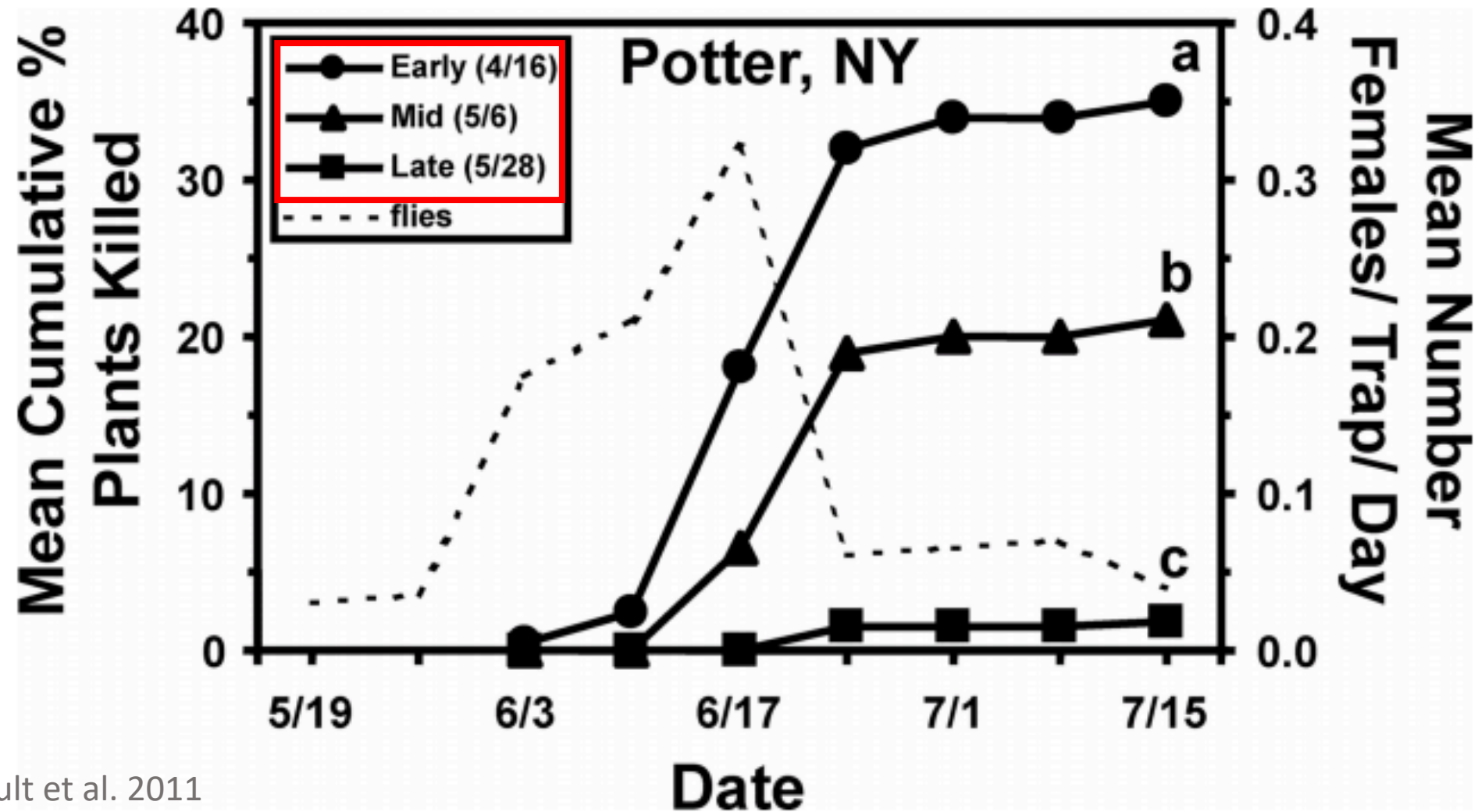
-
- I. How are **planting date** and **landscape** affecting maggot damage?
 - II. Management implications

Planting Date

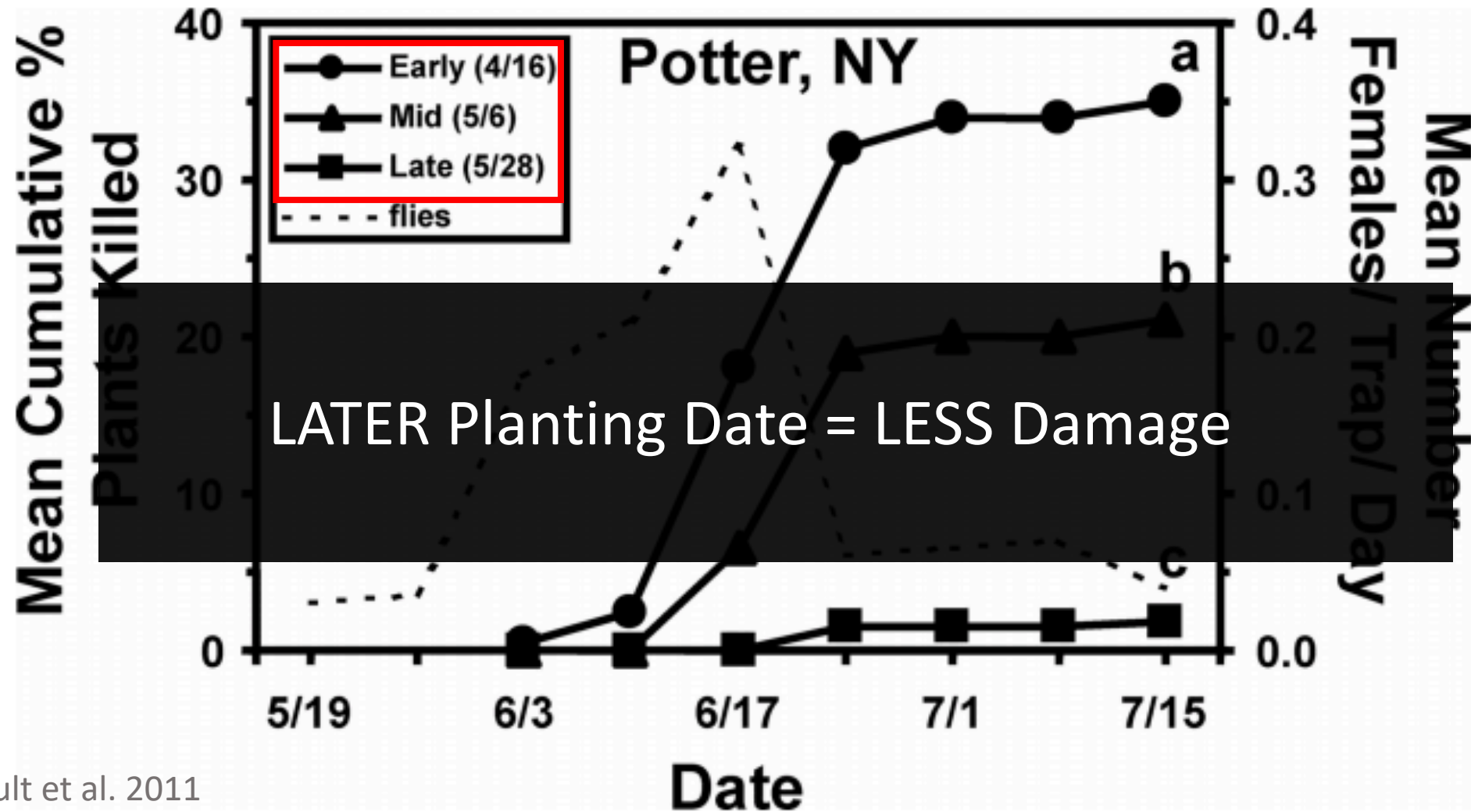
Planting Date



Planting Date

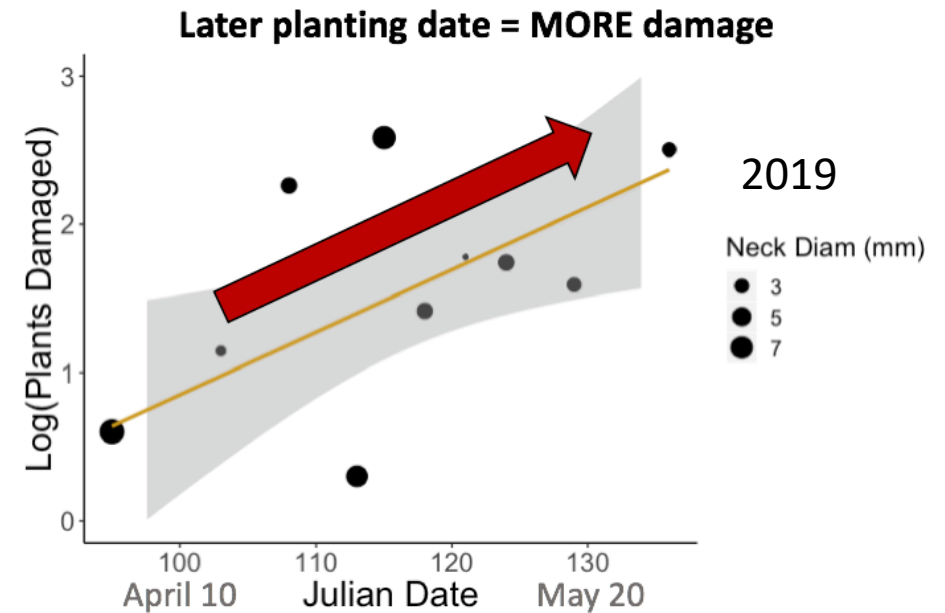
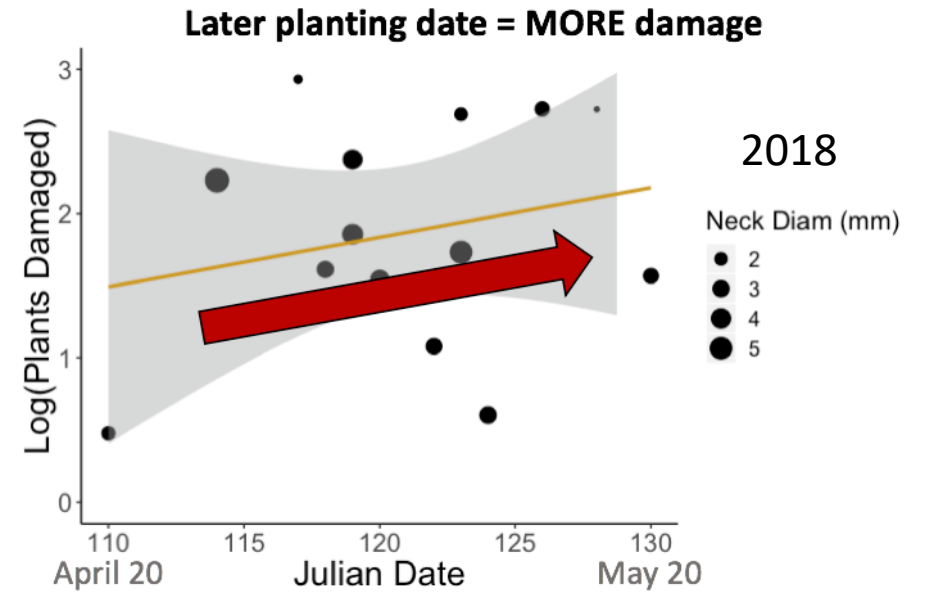


Planting Date



Planting Date

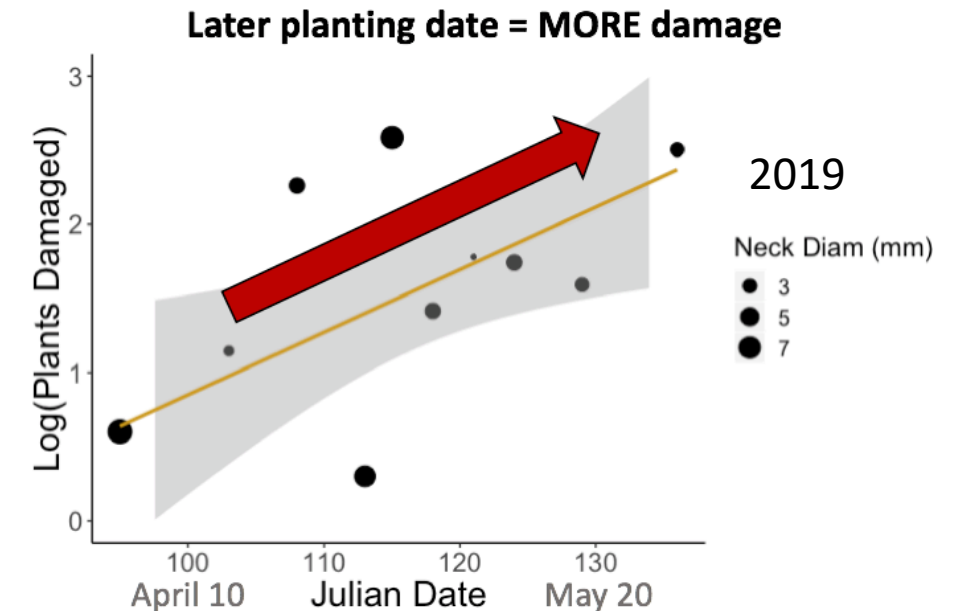
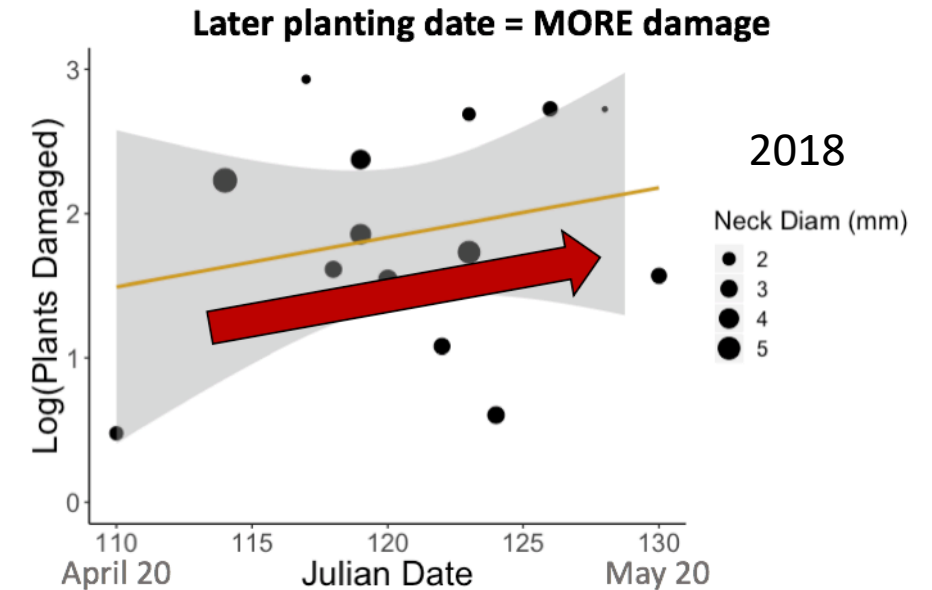
Why did we see the **OPPOSITE** result?



Planting Date

Why did we see the **OPPOSITE** result?

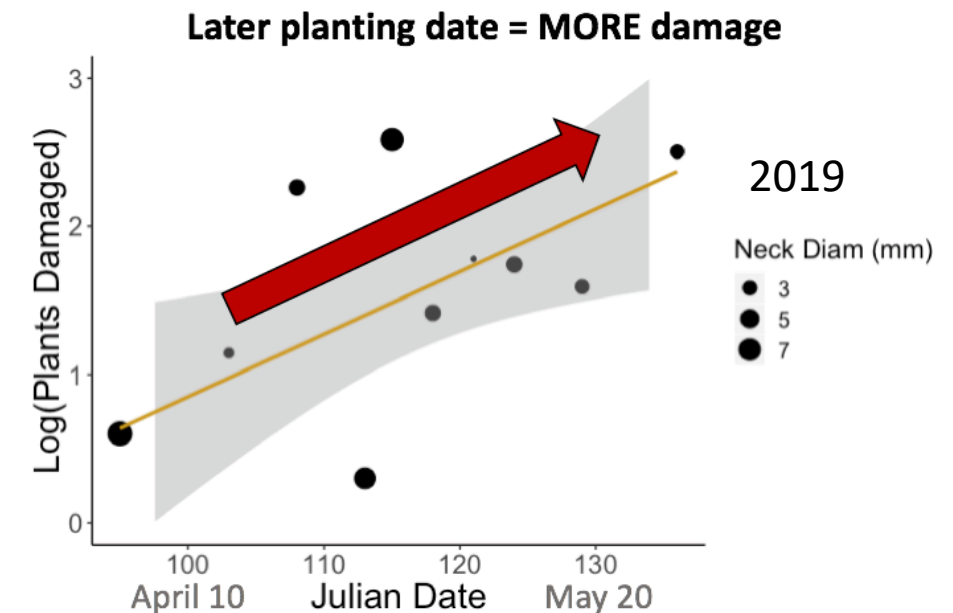
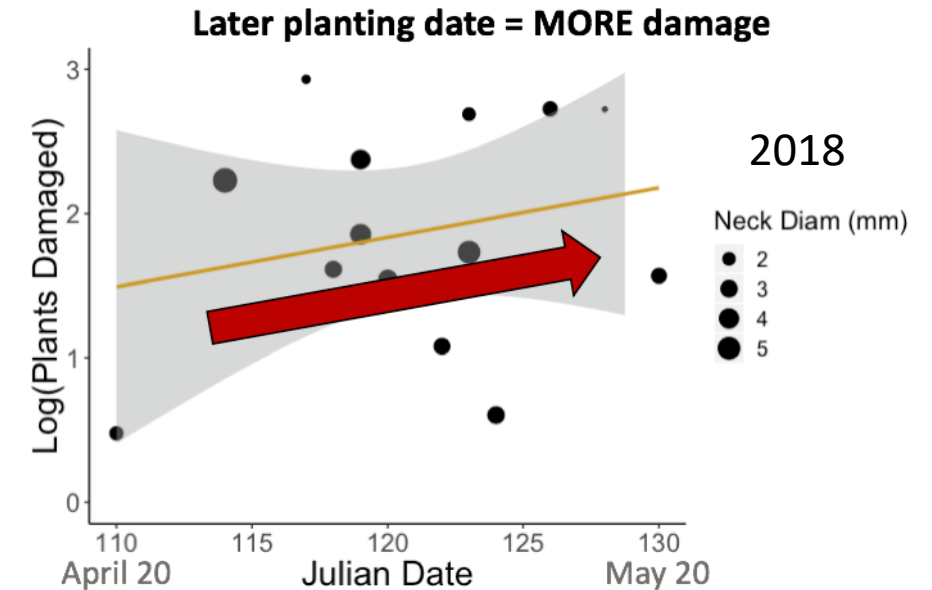
- No effect of plant size



Planting Date

Why did we see the OPPOSITE result?

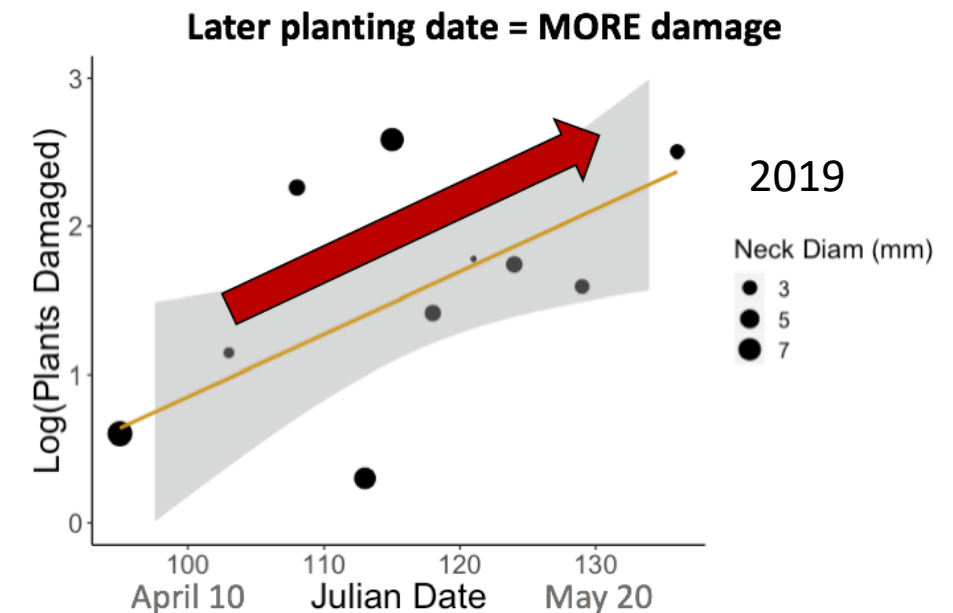
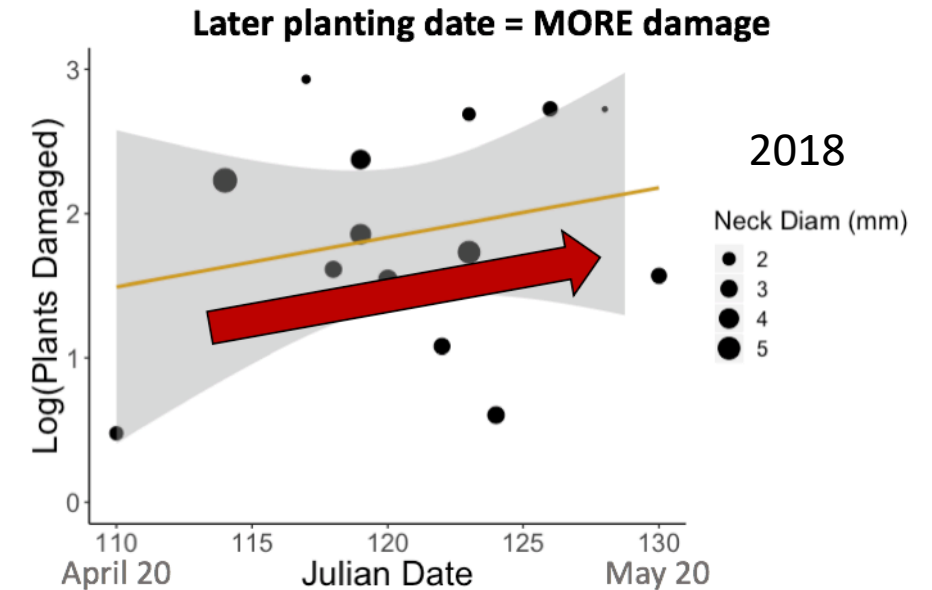
- No effect of plant size
- In previous study (Nault et al. 2011), different planting dates were used in the same field



Planting Date

Why did we see the OPPOSITE result?

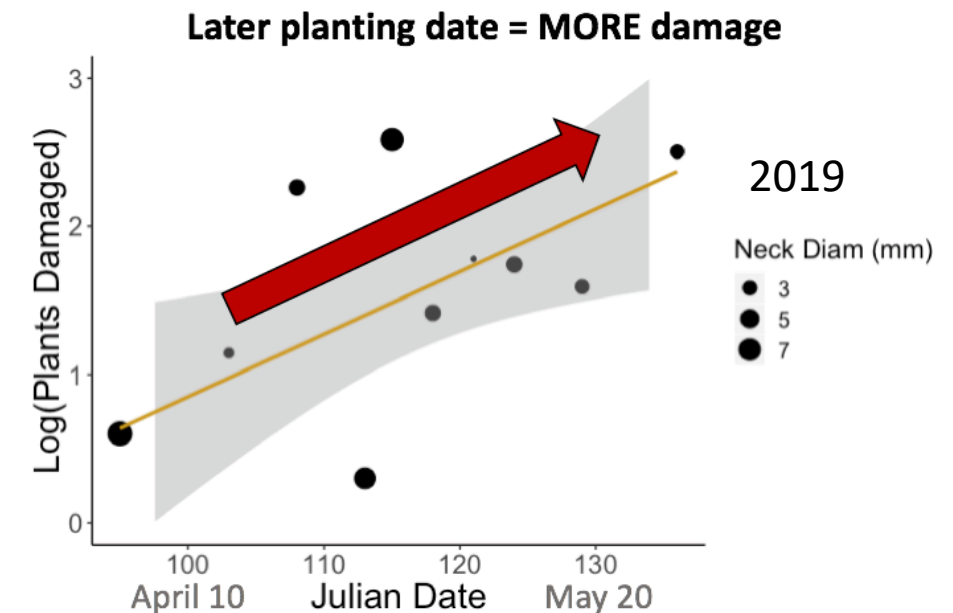
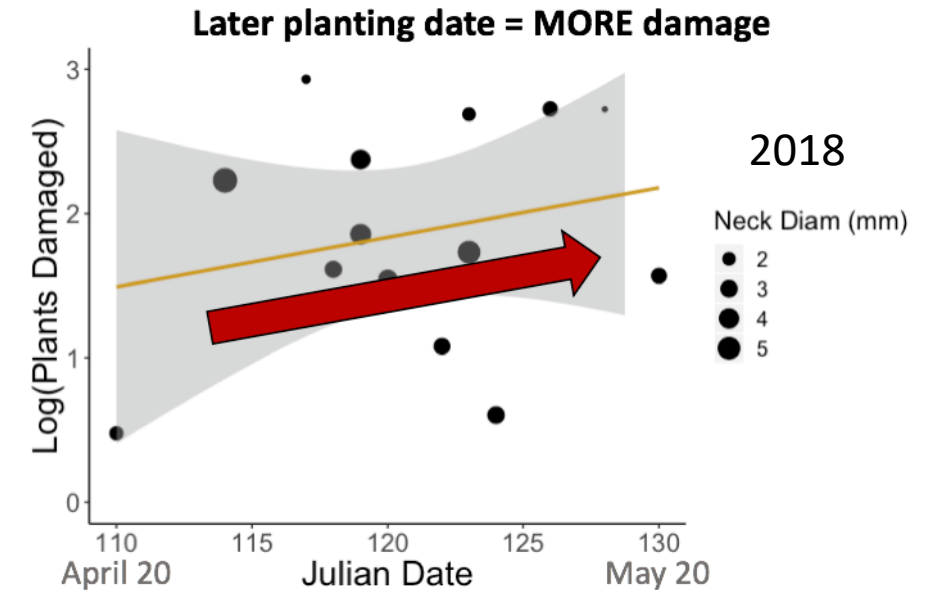
- No effect of plant size
- In previous study (Nault et al. 2011), different planting dates were used in the same field
 - Flies were making a choice



Planting Date

Why did we see the OPPOSITE result?

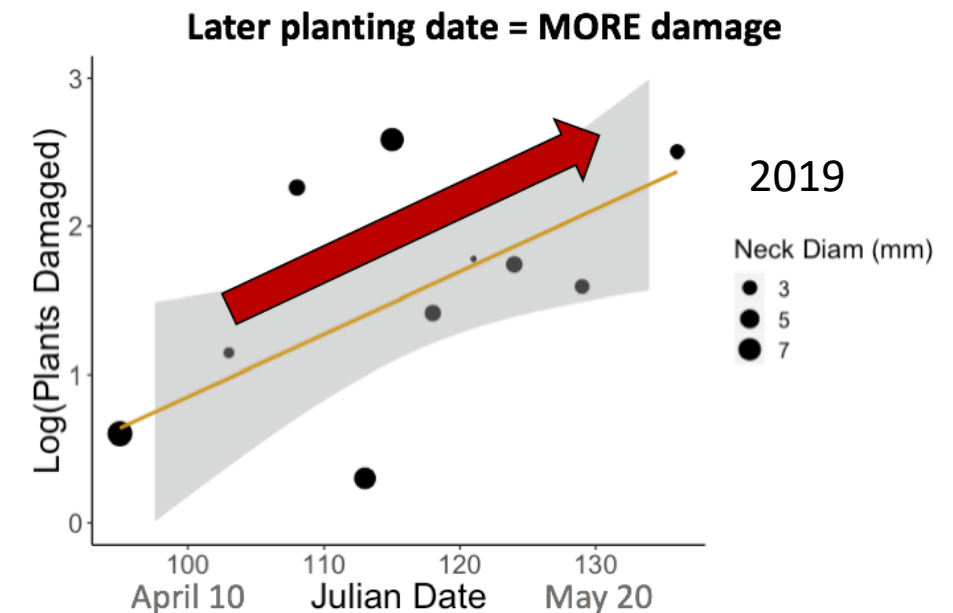
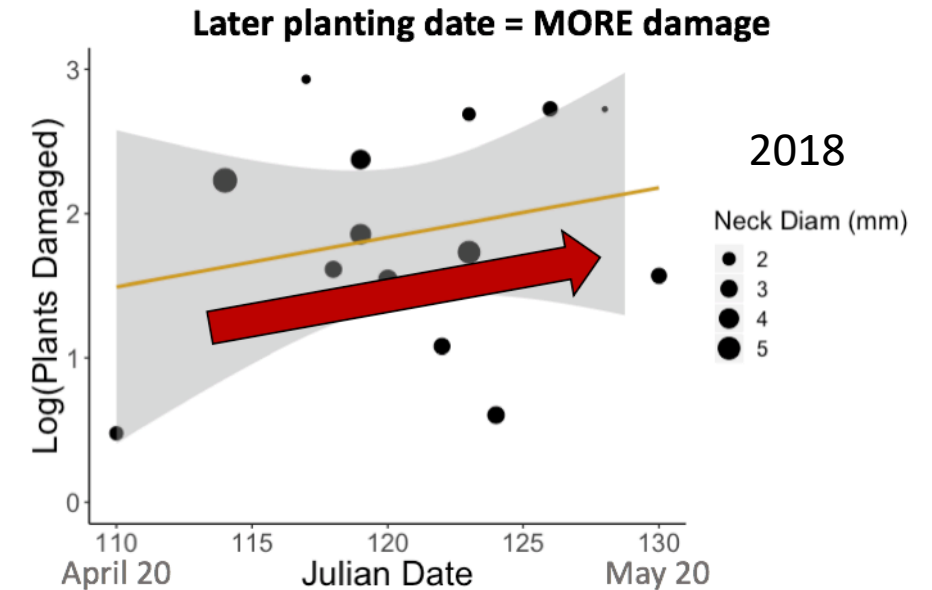
- No effect of plant size
- In previous study (Nault et al. 2011), different planting dates were used in the same field
 - Flies were making a choice
 - In our study, flies did not have a choice



Planting Date

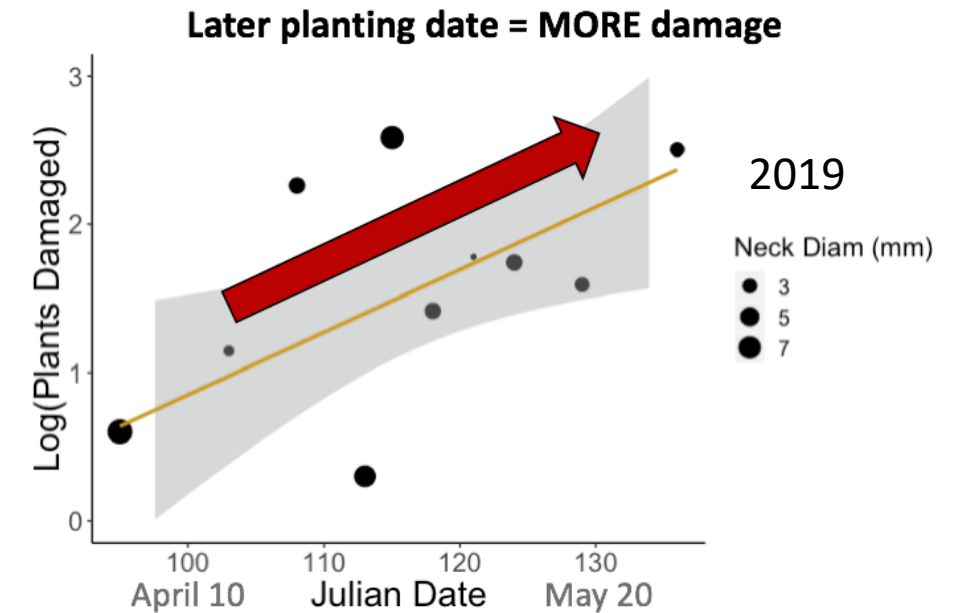
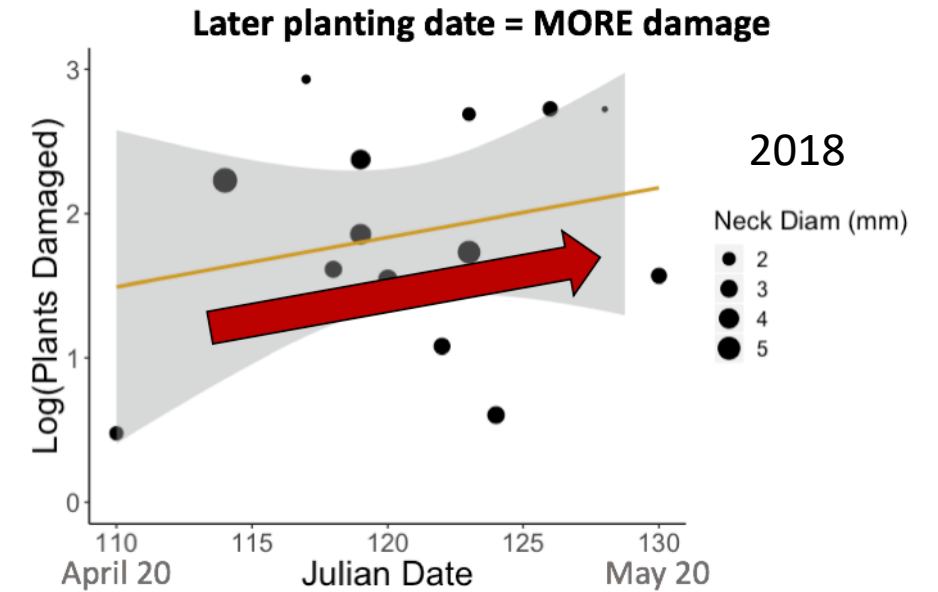
Why did we see the OPPOSITE result?

- No effect of plant size
- In previous study (Nault et al. 2011), different planting dates were used in the same field
 - Flies were making a choice
 - In our study, flies did not have a choice
- Factors other than plant size impact planting dates' effect on maggot damage (ex. fly activity)



Planting Date

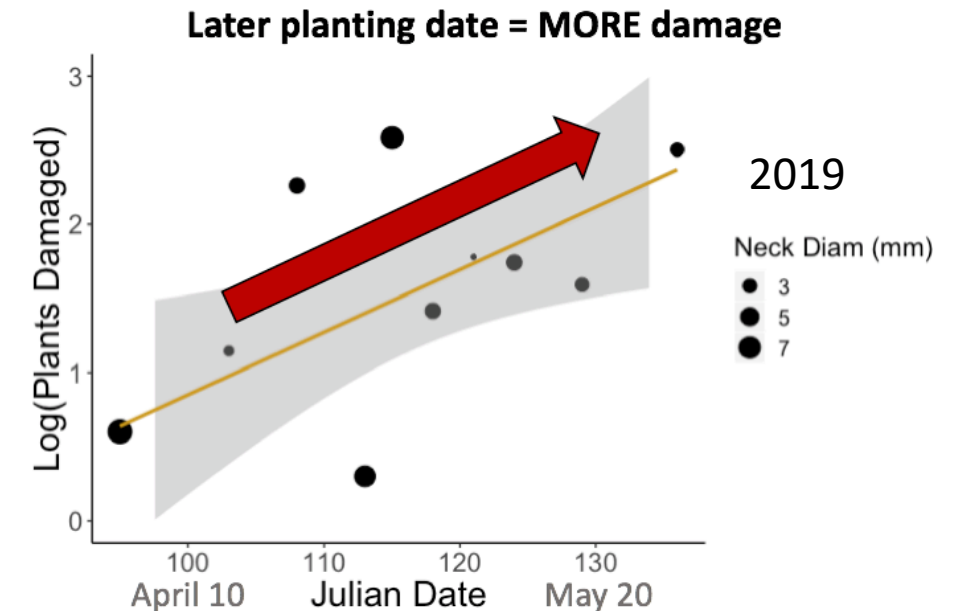
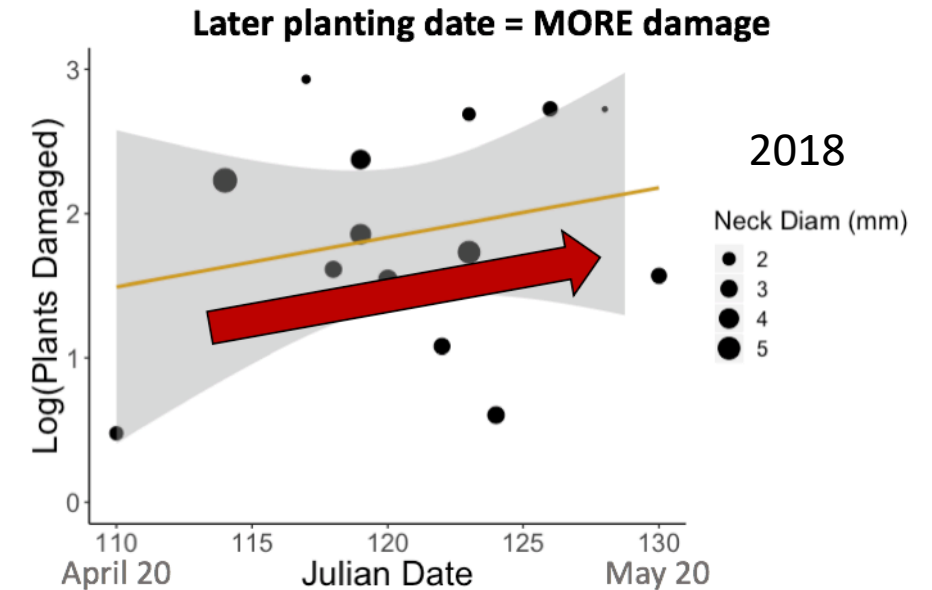
What does this mean for management?



Planting Date

What does this mean for management?

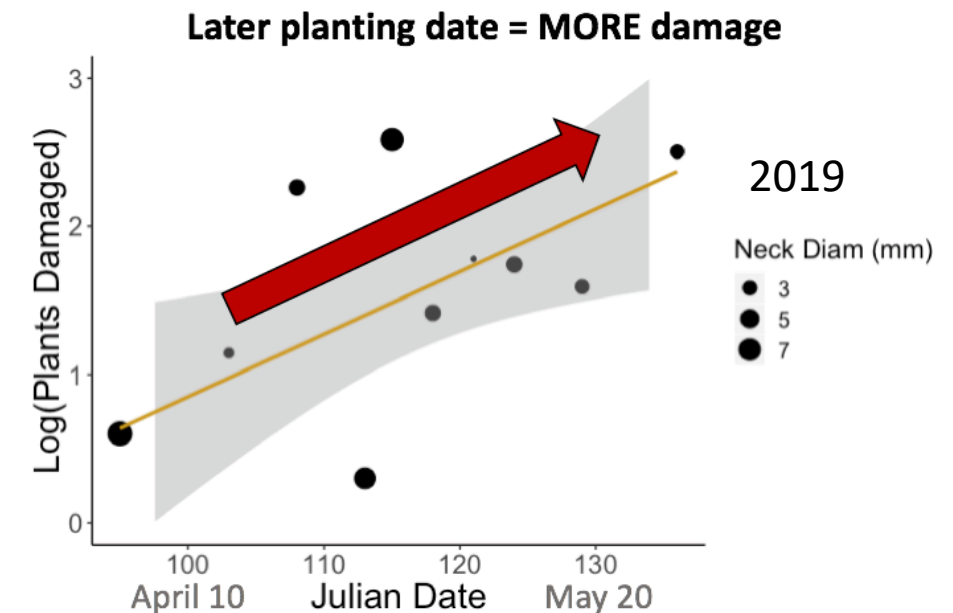
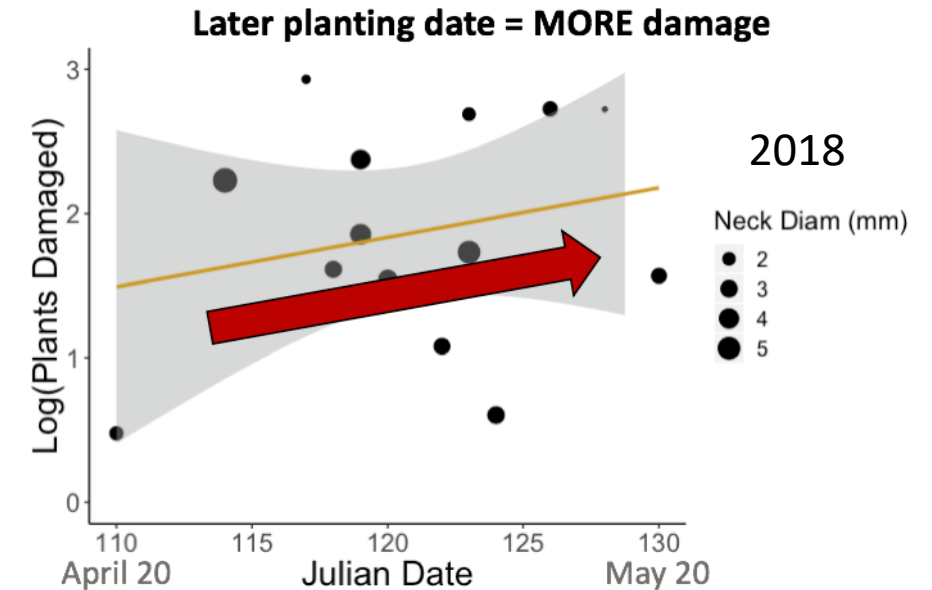
- Manipulating planting date may not be an effective approach to managing onion maggot



Planting Date

What does this mean for management?

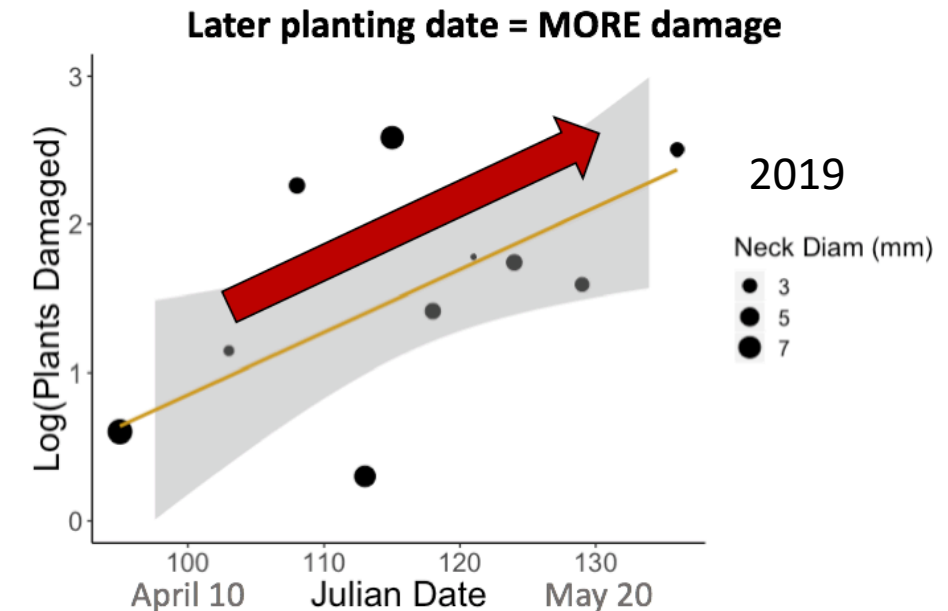
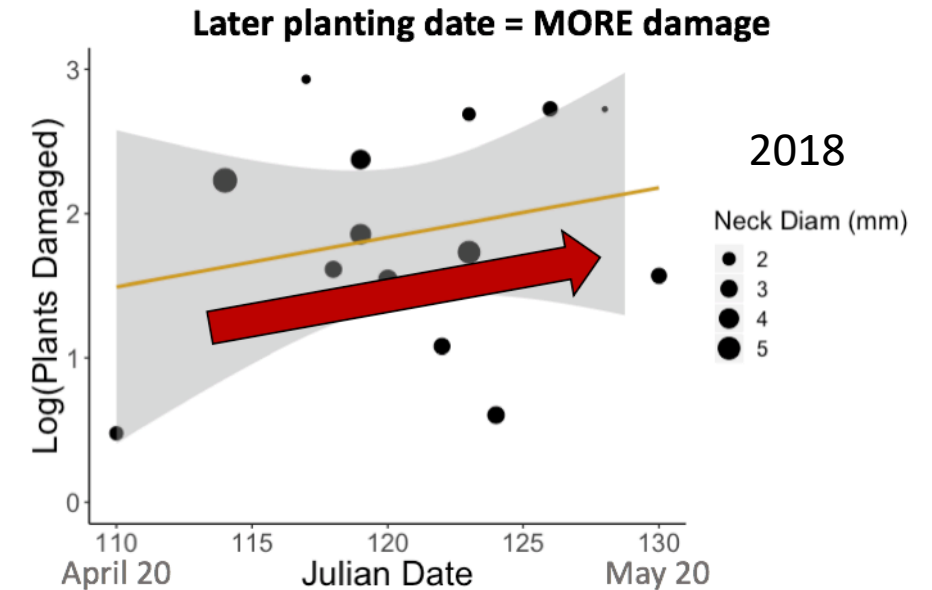
- Manipulating planting date may not be an effective approach to managing onion maggot
- Other factors (e.g. field drying, weather) dictate planting date



Planting Date

What does this mean for management?

- Manipulating planting date may not be an effective approach to managing onion maggot
- Other factors (e.g. field drying, weather) dictate planting date
- Late planting (end of May) risks incomplete onion development



Landscape

Why do we see an effect of forest on damage?



Landscape

Why do we see an effect of forest on damage?

- Forested edges may provide resources for flies



Landscape

Why do we see an effect of forest on damage?

- Forested edges may provide resources for flies
 - Shade (Finch et al. 1986)



Landscape

Why do we see an effect of forest on damage?

- Forested edges may provide resources for flies
 - Shade (Finch et al. 1986)
 - Floral resources (Loosjes 1976)



Landscape

**What does this mean for
management?**



Landscape

What does this mean for management?

- Candidate fields for rotation



Landscape

What does this mean for management?

- Candidate fields for rotation
- Candidate fields for transplanted onions



Landscape

What does this mean for management?

- Candidate fields for rotation
- Candidate fields for transplanted onions

Do Not Spray For Flies



Summary

Climate	Timing	Landscape	Soil

Summary

Climate	Timing	Landscape	Soil
<ul style="list-style-type: none">▪ Temperature▪ Precipitation	<ul style="list-style-type: none">▪ Planting Date▪ Plant Size	<ul style="list-style-type: none">▪ Bordering habitat▪ Forest vs agriculture	<ul style="list-style-type: none">▪ Organic Matter


Summary

Climate	Timing	Landscape	Soil
<ul style="list-style-type: none">▪ Temperature▪ Precipitation	<ul style="list-style-type: none">▪ Planting Date▪ Plant Size	<ul style="list-style-type: none">▪ Bordering habitat▪ Forest vs agriculture	<ul style="list-style-type: none">▪ Organic Matter



Summary

Climate	Timing	Landscape	Soil
<ul style="list-style-type: none">▪ Temperature▪ <u>Precipitation</u>	<ul style="list-style-type: none">▪ Planting Date▪ Plant size	<ul style="list-style-type: none">▪ Bordering habitat▪ Forest vs agriculture	<ul style="list-style-type: none">▪ Organic Matter

Summary

Climate	Timing	Landscape	Soil
<ul style="list-style-type: none">▪ Temperature▪ <u>Precipitation</u>	<ul style="list-style-type: none">▪ Planting Date▪ Plant size  <p>Planting date may not be an effective management tool for onion maggot</p>	<ul style="list-style-type: none">▪ Bordering habitat▪ Forest vs agriculture	<ul style="list-style-type: none">▪ Organic Matter

Summary

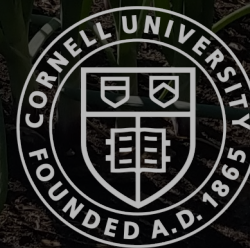
Climate	Timing	Landscape	Soil
<ul style="list-style-type: none">▪ Temperature▪ <u>Precipitation</u>	<ul style="list-style-type: none">▪ Planting Date▪ Plant size  <p>Planting date may not be an effective management tool for onion maggot</p>	<ul style="list-style-type: none">▪ Bordering habitat▪ Forest vs agriculture  <p>Identify at risk fields for rotation or transplants</p>	<ul style="list-style-type: none">▪ Organic Matter



Acknowledgements:

Special thanks to all our grower collaborators

Nault Lab members: Mason Clark, Kellie Damann, Riley Harding, Nate Hesler, Lily Sellers, Megan Kelley, Lindsay Iglesias, and Ashley Leach



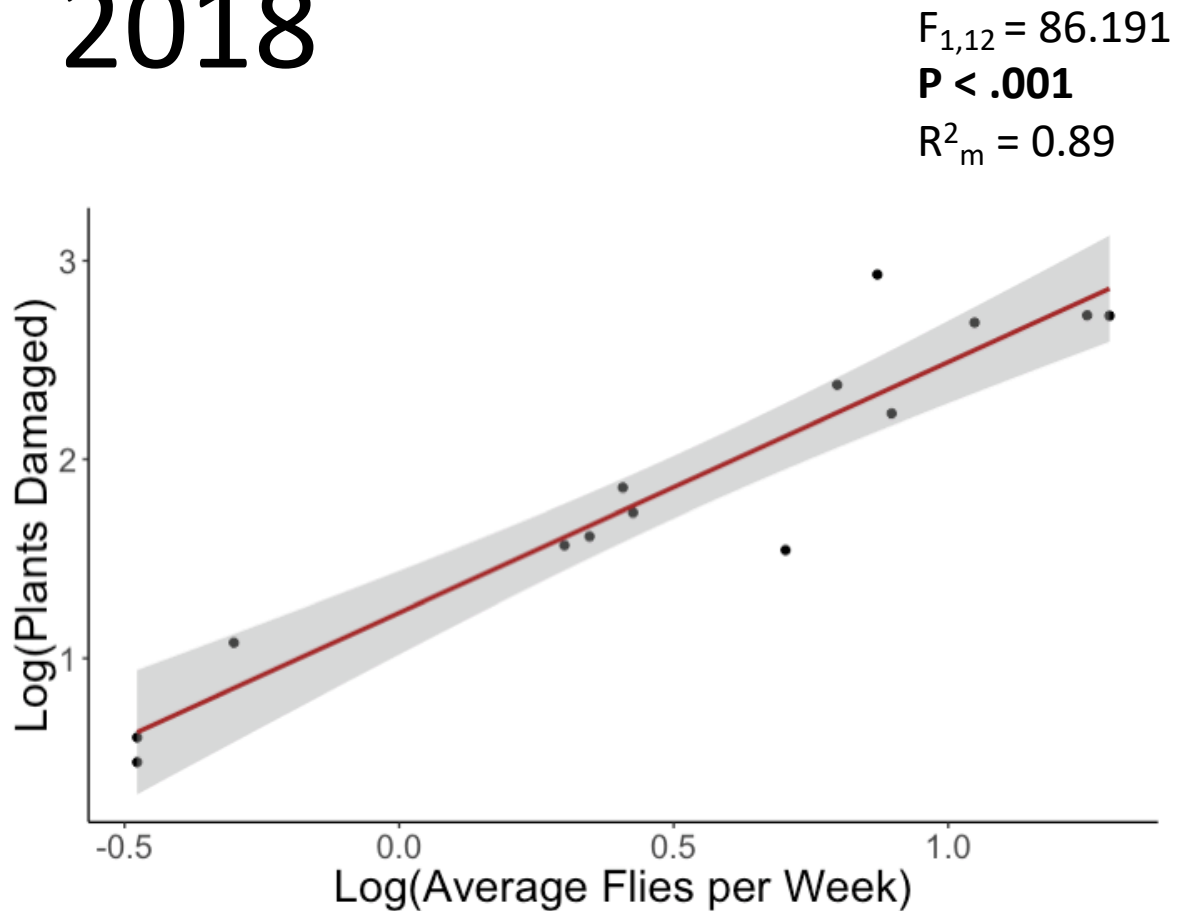
Cornell **AgriTech**
New York State Agricultural Experiment Station

Questions?

Results:

Fly abundance and damage

2018



2019

