

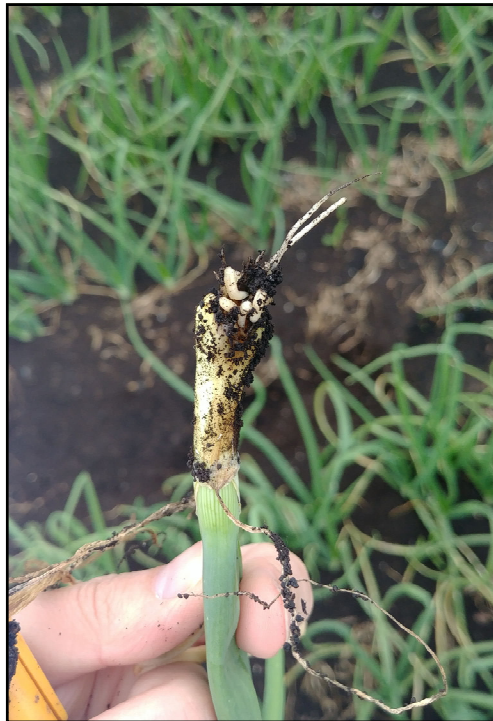


## Influence of environmental factors on onion maggot larval damage in commercial onion fields

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



Cornell AgriTech  
New York State Agricultural Experiment Station



## 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 90% if left unprotected

### Onion Maggot Management

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### Onion Maggot Management

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



Feeding damage can exceed 90% if left unprotected

### 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 central and western NY State

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



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- Others experience little to no damage



## Environmental factors influence pest dynamics

### Climate

- Temperature
- Precipitation



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Cool, moist conditions favor maggot damage

(Ellington, 1963)

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

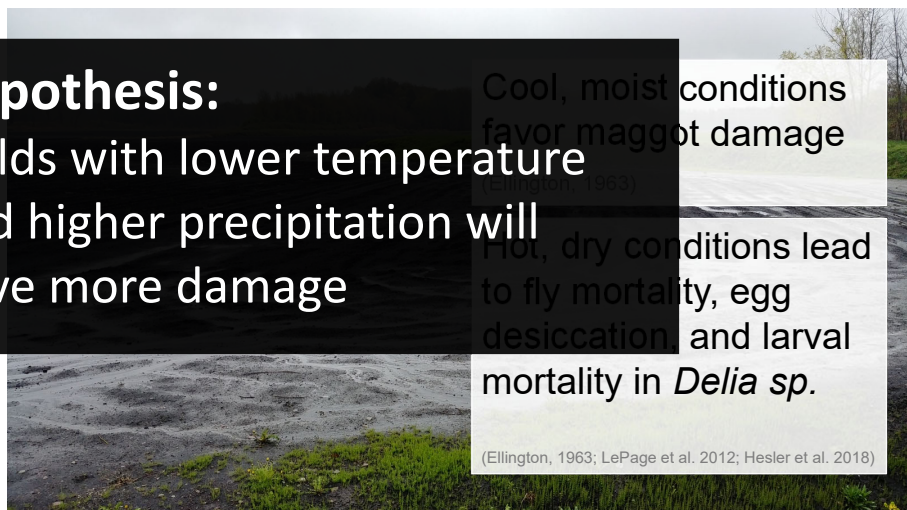
(Ellington, 1963; LePage et al. 2012; Hesler et al. 2018)

## 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)

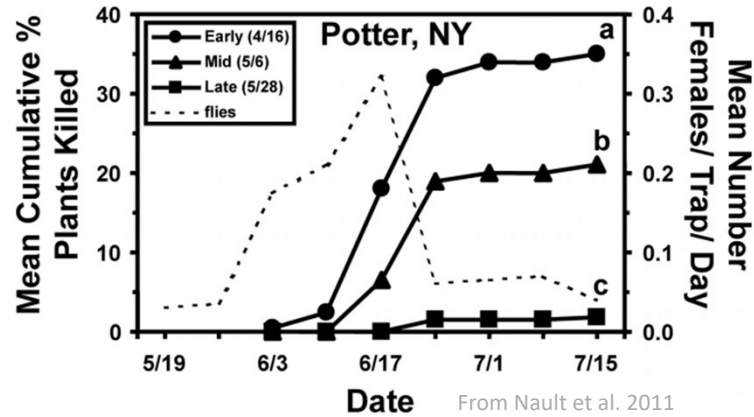
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## Environmental factors influence pest dynamics

### Timing

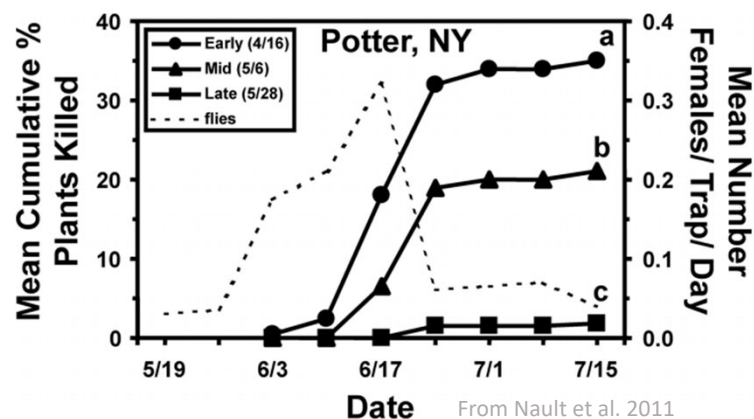
- Planting Date
- Ovipositional preference for larger onions



## 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)

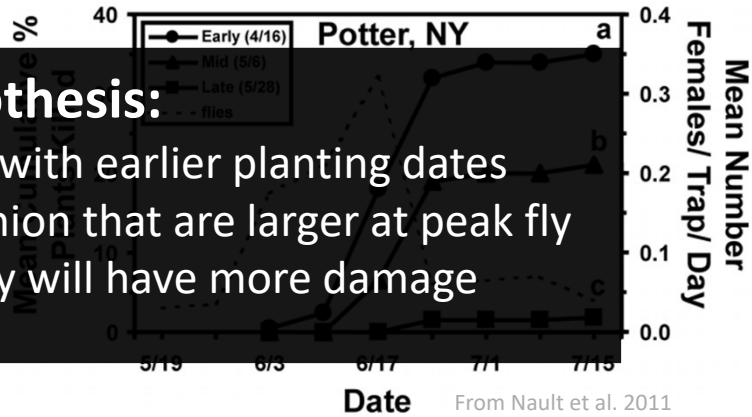
Delayed planting can reduce damage by first generation

flies (Nault et al. 2011)

# Environmental factors influence pest dynamics

- Timing
  - Planting Date
  - Ovipositional preference for larger onions

**Hypothesis:** Fields with earlier planting dates and onion that are larger at peak fly activity will have more damage



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

- Soil
  - Organic Matter

Organic matter mediates other soil properties (such as soil moisture) (Villani & Wright, 1990; Reeves, 1997)



## Environmental factors influence pest dynamics

### Soil

- Organic Matter

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

(Villani & Wright, 1990; Reeves, 1997)

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



## Environmental factors influence pest dynamics

### Soil

- Organic Matter

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





## Environmental factors influence pest dynamics

### Landscape

- Bordering habitat
- Forest vs Ag



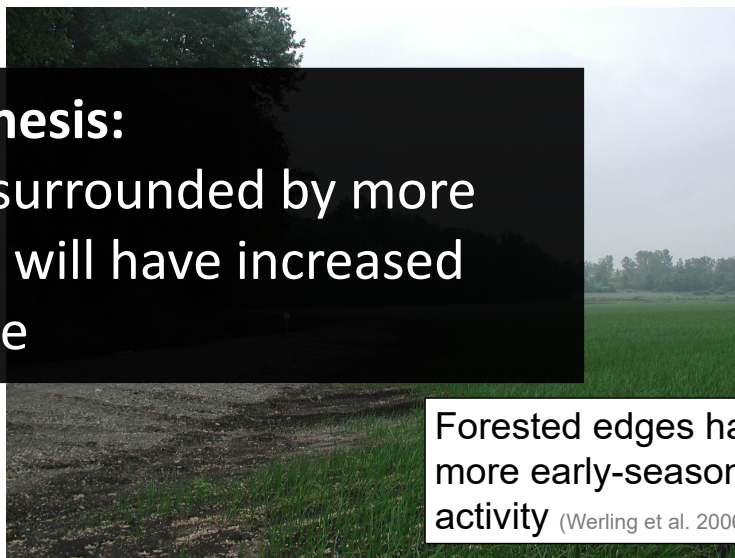
Forested edges have more early-season fly activity (Werling et al. 2006)

## 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

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

## Environmental factors influence pest dynamics

Climate	Timing	Soil	Landscape
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**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



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- Sampled mid-May to mid-July
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- Sticky cards (3 per site)
- **Measured plant growth**

## Methods: Damage Evaluation





## Methods: Data Collection

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



## Methods: Data Collection

- Sampled soil
- **Surveyed management**
  - Planting date
  - Cultivar
  - Insecticides
  - Years since rotation



## 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)

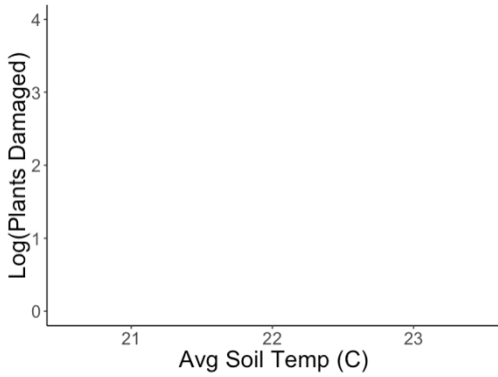


**What did we find?**

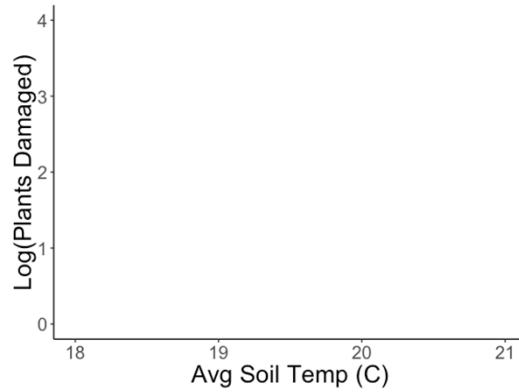


## Climate: Precipitation + Soil Temperature

2018

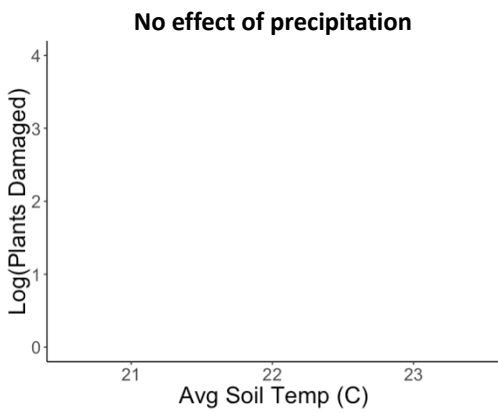


2019

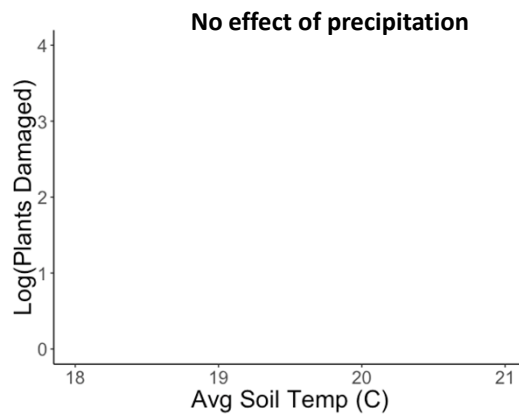


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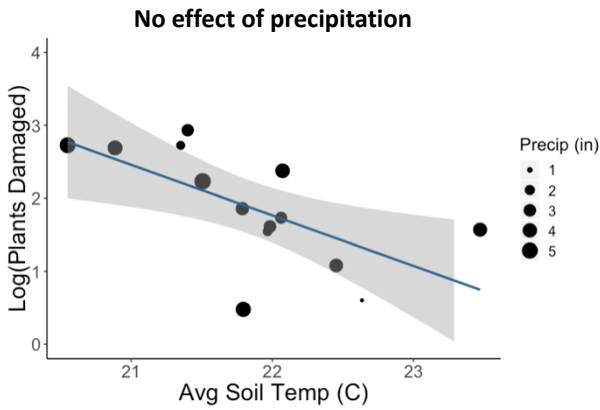


2019

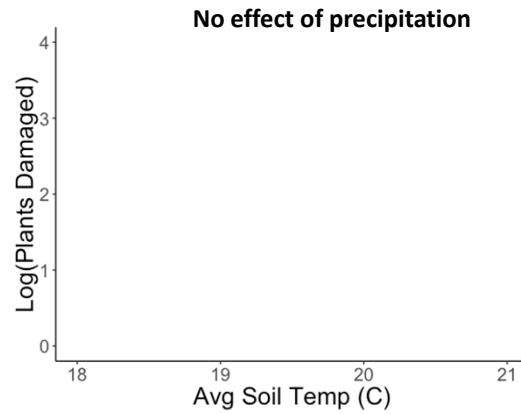


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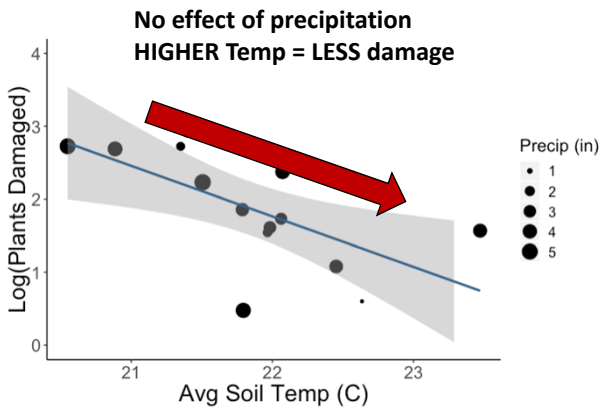


### 2019

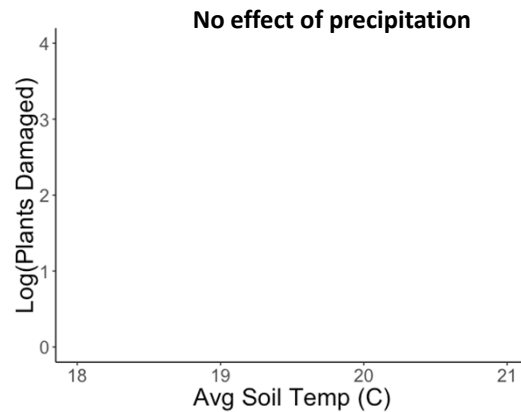


## Climate: Precipitation + Soil Temperature

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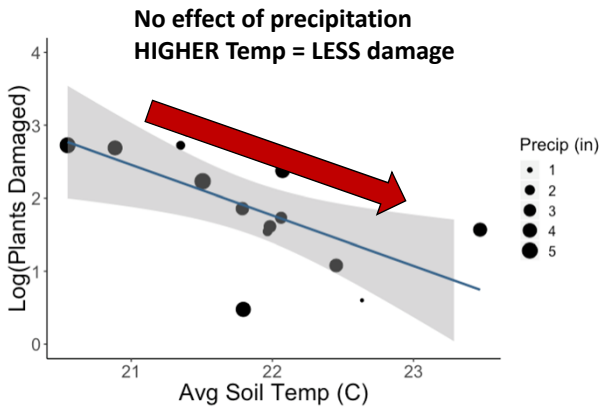


### 2019

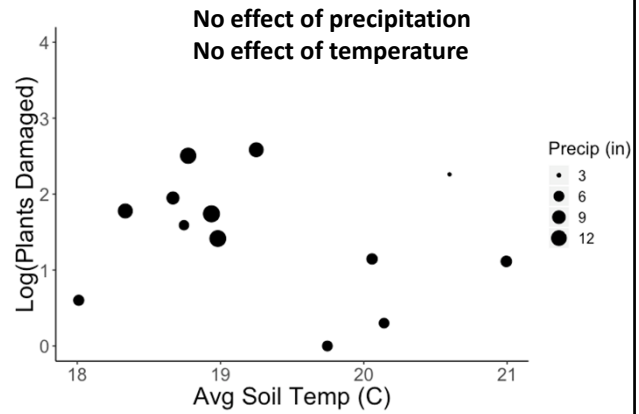


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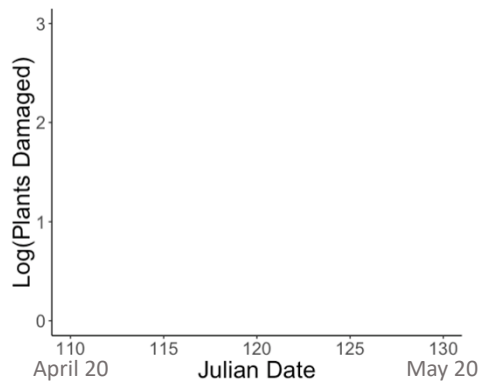


### 2019

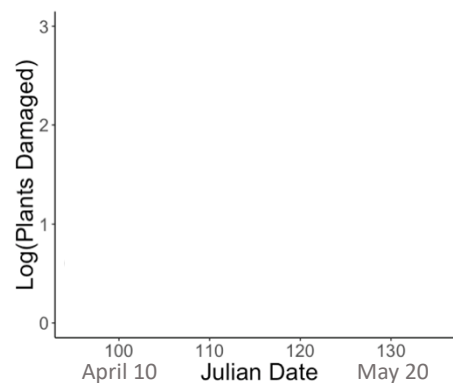


## Timing: Planting Date and Plant size at peak fly activity

### 2018



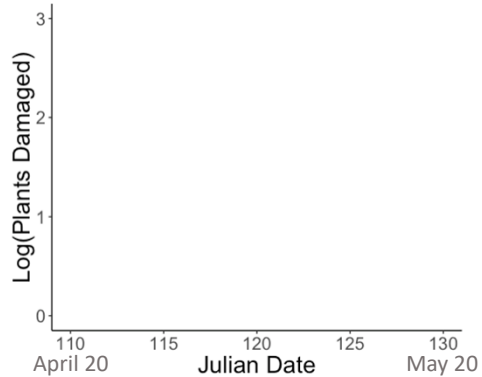
### 2019



## Timing: Planting Date and Plant size at peak fly activity

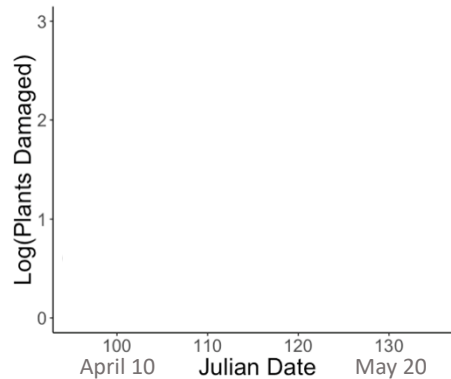
### 2018

No effect of plant size



### 2019

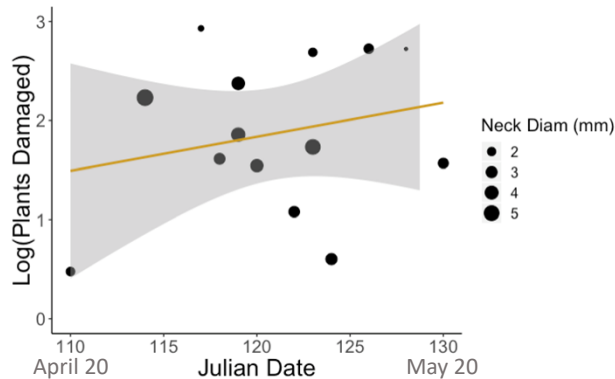
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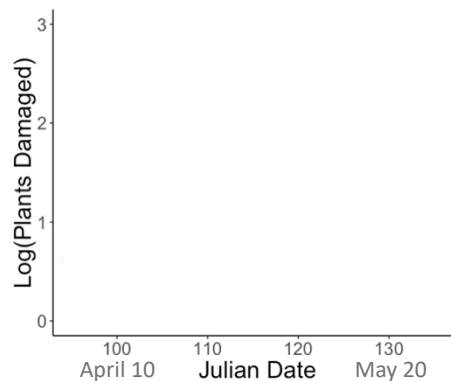
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### 2019

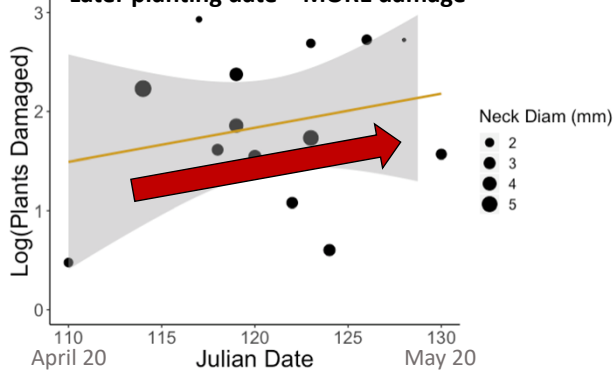
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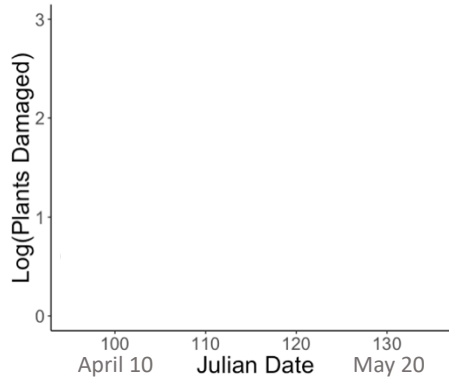
2018

No effect of plant size  
Later planting date = MORE damage



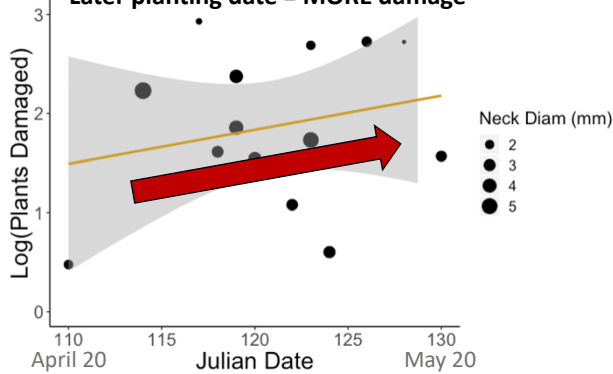
2019

No effect of plant size



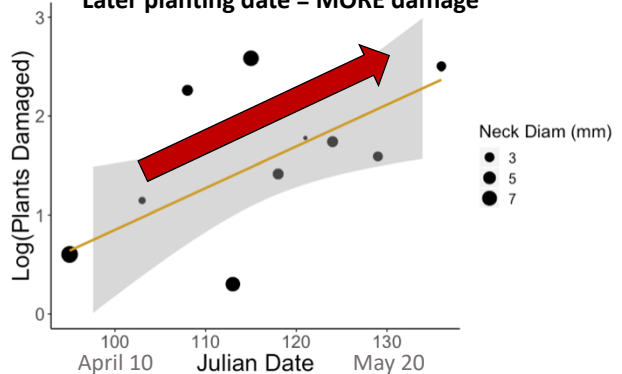
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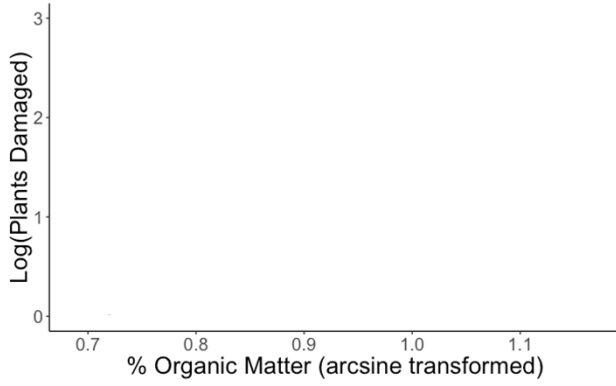
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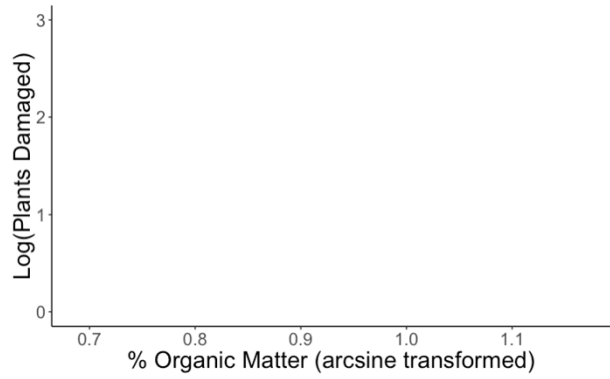


# Soil: Organic Matter

2018

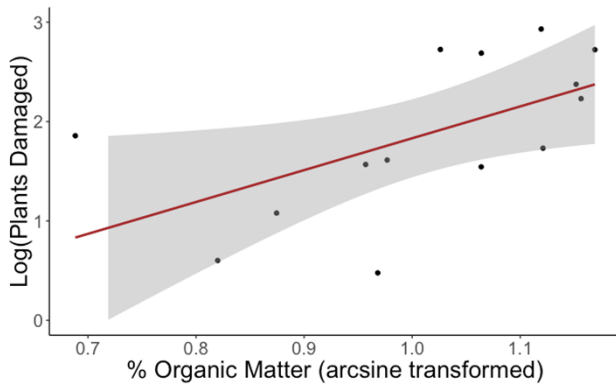


2019

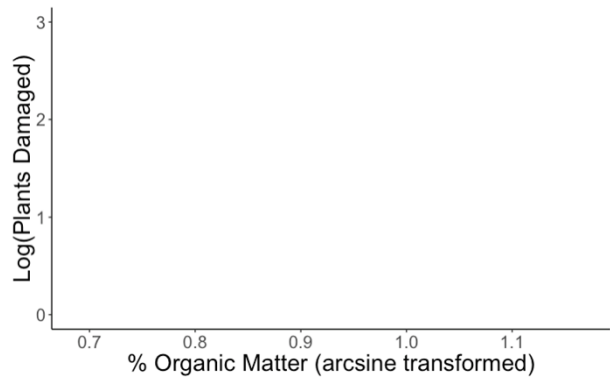


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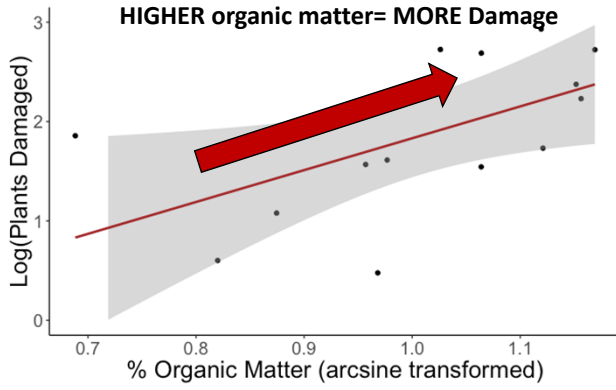


2019

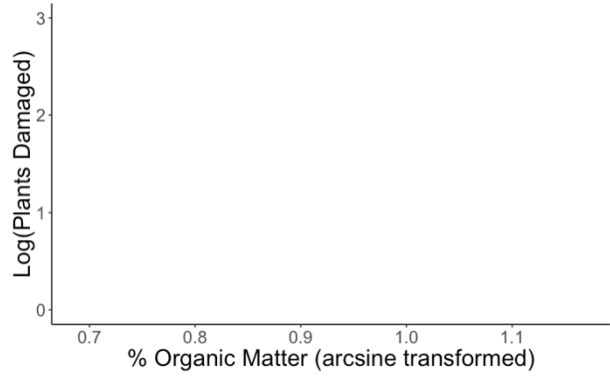


# Soil: Organic Matter

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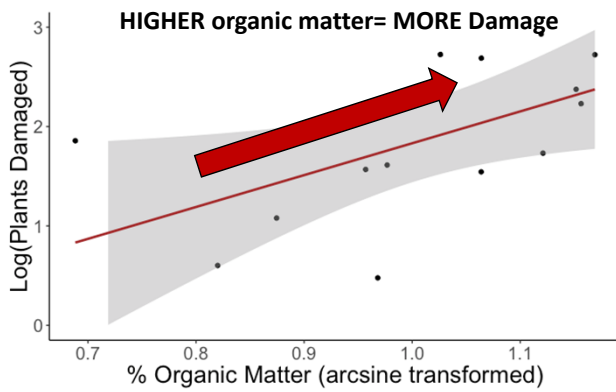


2019

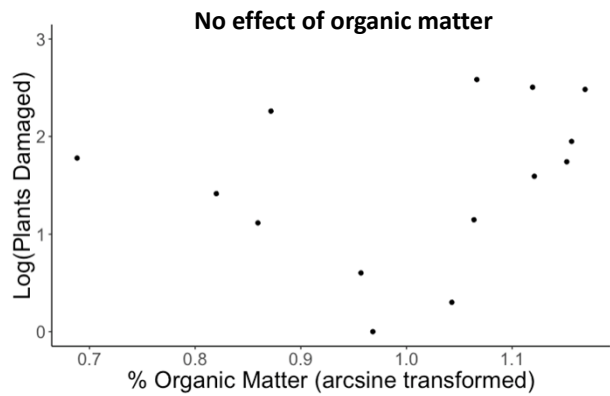


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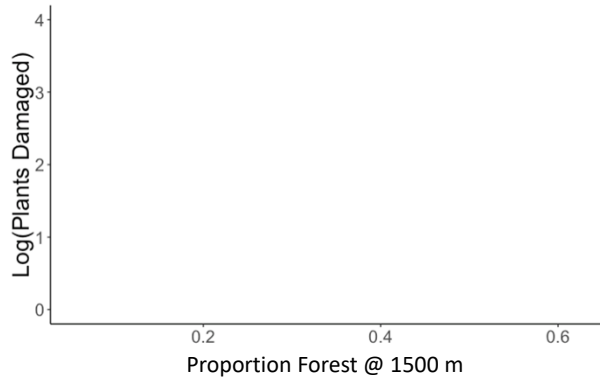


2019

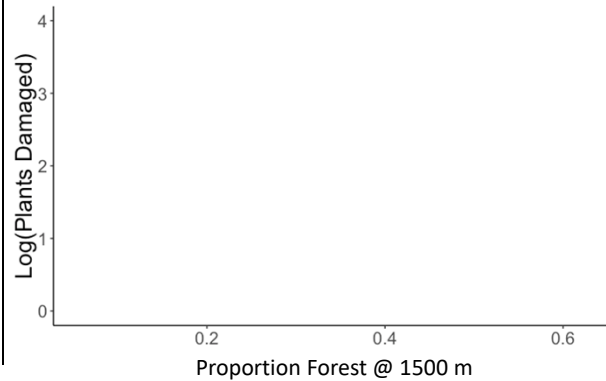


## Landscape: Percent Forest at 1500m

### 2018

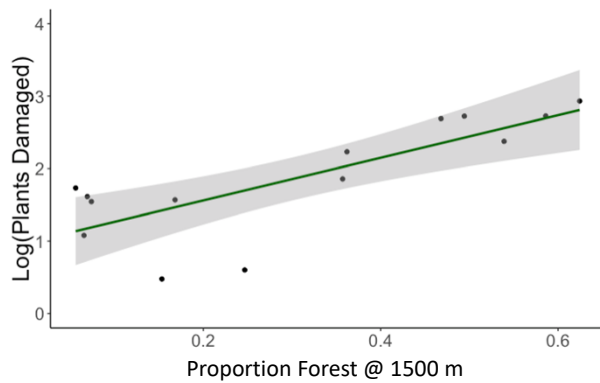


### 2019

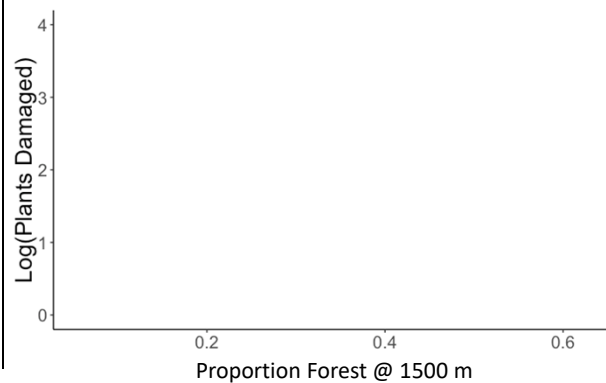


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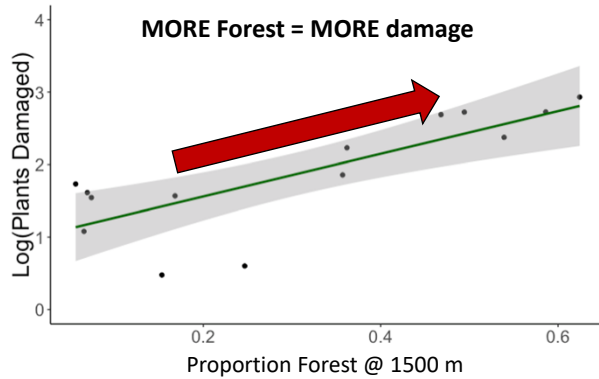
### 2019



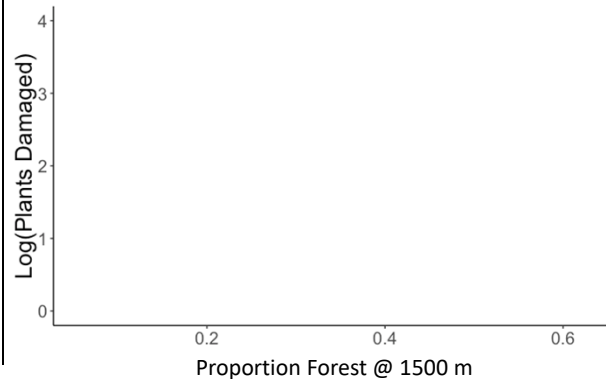


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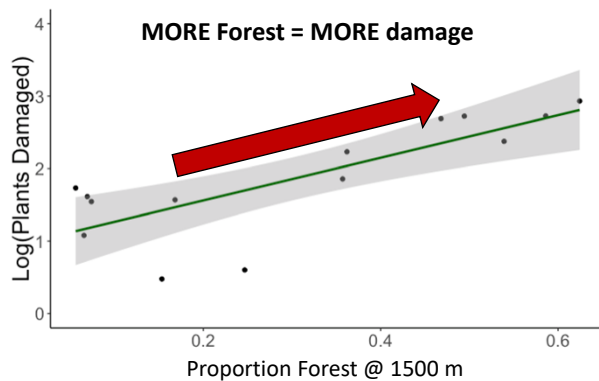


2019

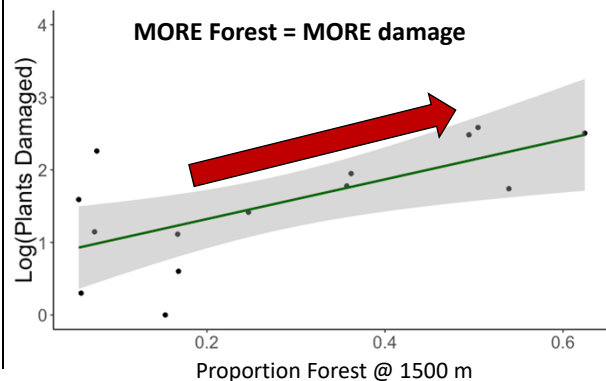


## Landscape: Percent Forest at 1500m

2018



2019



Results:

Which factors are associated with damage?

2018

2019

Results:

Which factors are associated with damage?

2018

2019

Soil OM

Plant Date

Percent Forest

Plant Date

Percent Forest

Results:

Which factors are associated with damage?

2018

2019

I. How are soil organic matter, planting date and landscape affecting maggot damage?

II. Management implications

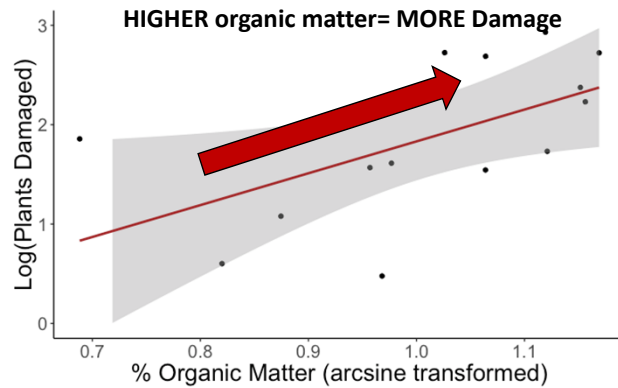
Percent Forest

Percent Forest

## Soil Organic Matter

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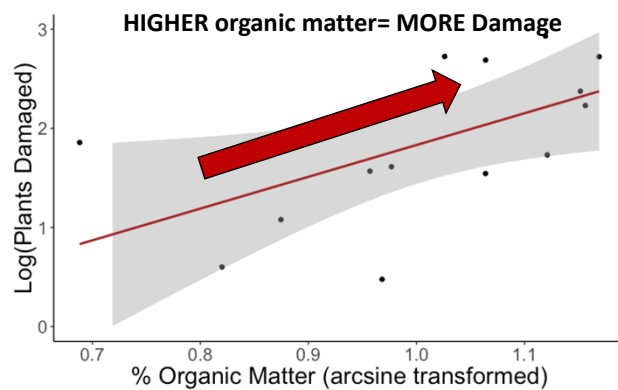
Why did we see an increase damage in fields with higher organic matter?



## Soil Organic Matter

Why did we see an increase damage in fields with higher organic matter?

- Organic matter is associated with water holding capacity

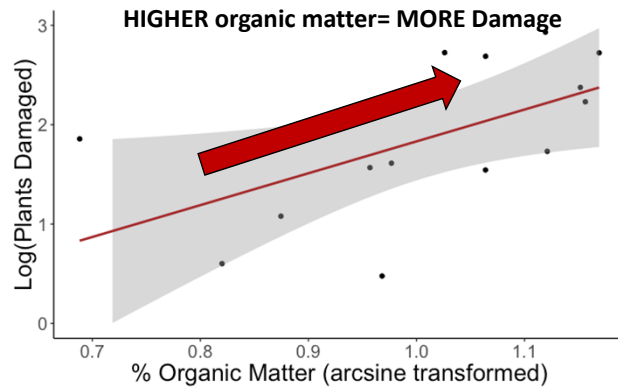


## Soil Organic Matter

Why did we see an increase damage in fields with higher organic matter?

- Organic matter is associated with water holding capacity

What does this mean for management?



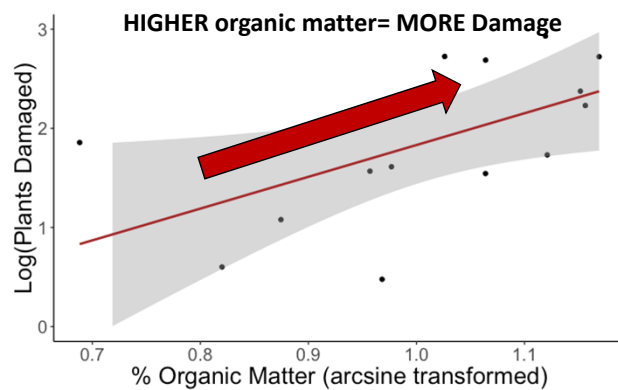
## Soil Organic Matter

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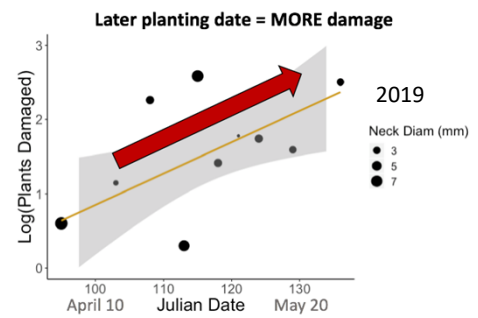
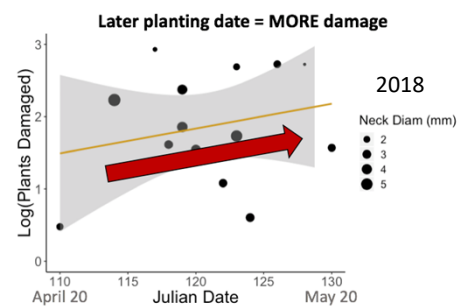
- Soil moisture control (tiling)



## Planting Date

## Planting Date

Why did we see the OPPOSITE result?

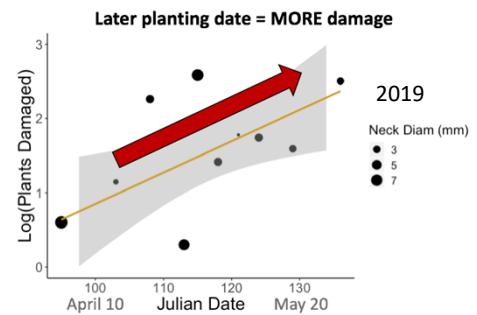
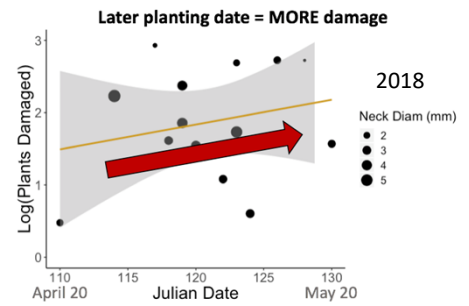


## Planting Date

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

Nault et al. 2011:

**Delayed planting = DECREASED damage**

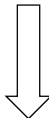


## Planting Date

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

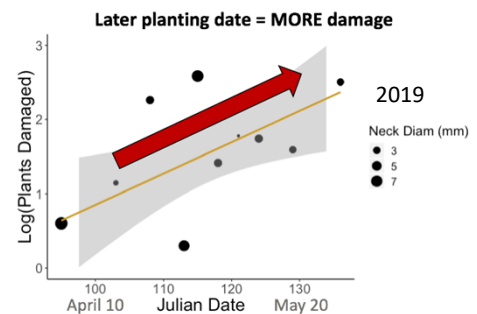
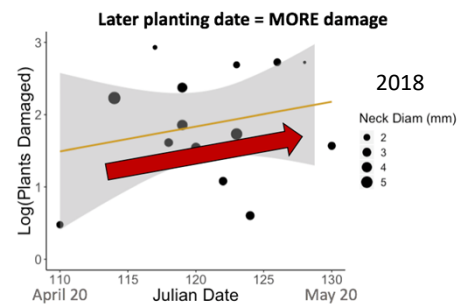
Nault et al. 2011:

**Delayed planting = DECREASED damage**



Our study (2018-2019):

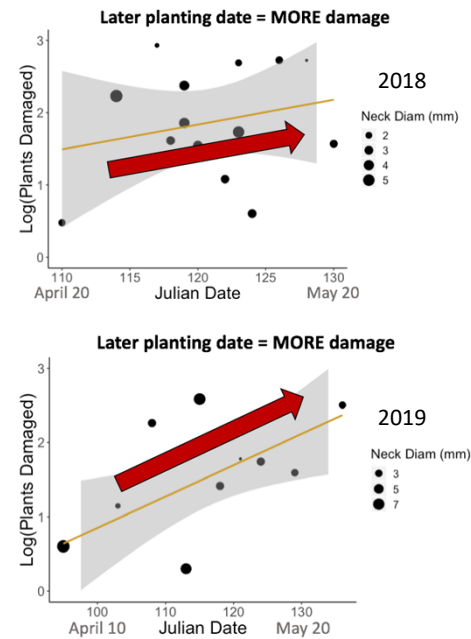
**Delayed planting = INCREASED damage**



## Planting Date

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

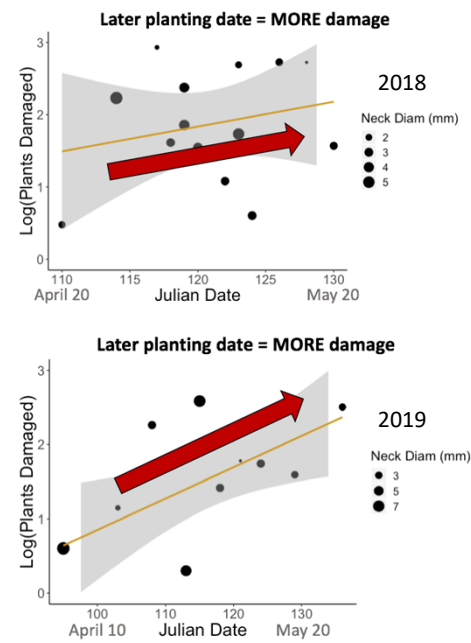
- No effect of plant size



## 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

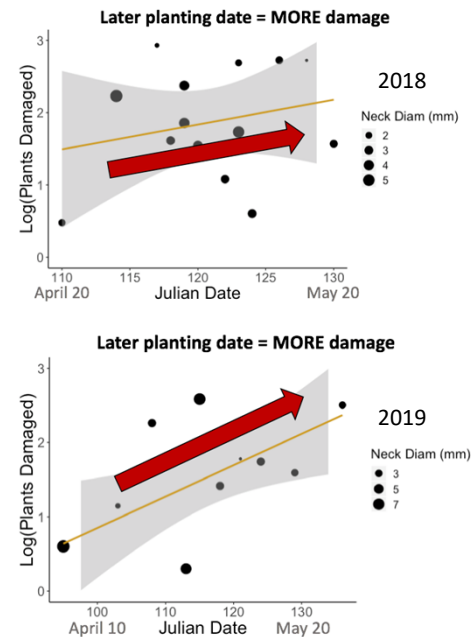




## Planting Date

### Why did we see the OPPOSITE result?

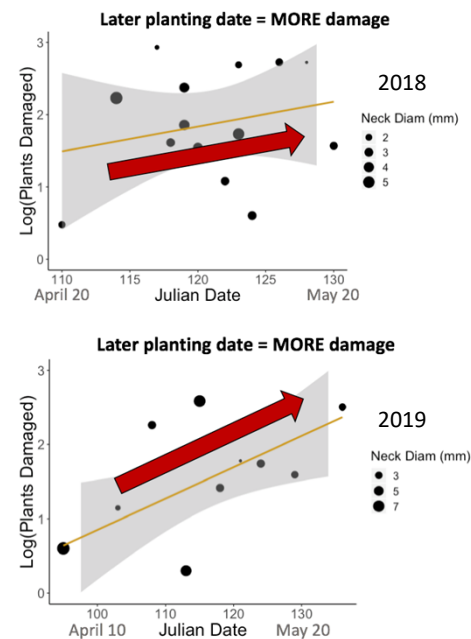
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  - Flies were making a choice



## Planting Date

### Why did we see the OPPOSITE result?

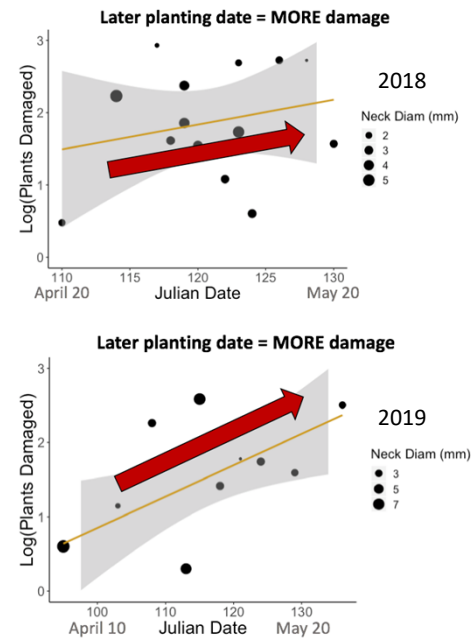
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  - In our study, flies did not have a choice



## Planting Date

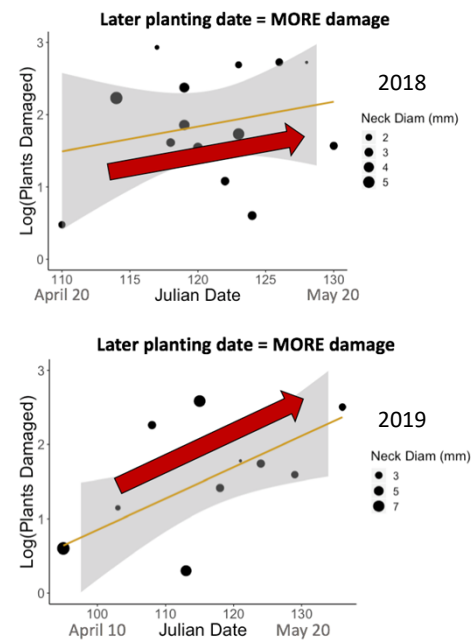
### Why did we see the OPPOSITE result?

- 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
- Unknown factor is driving this trend



## Planting Date

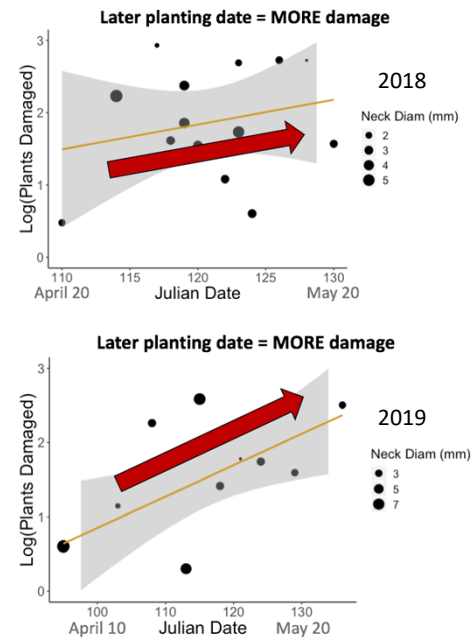
### What does this mean for management?



## Planting Date

### What does this mean for management?

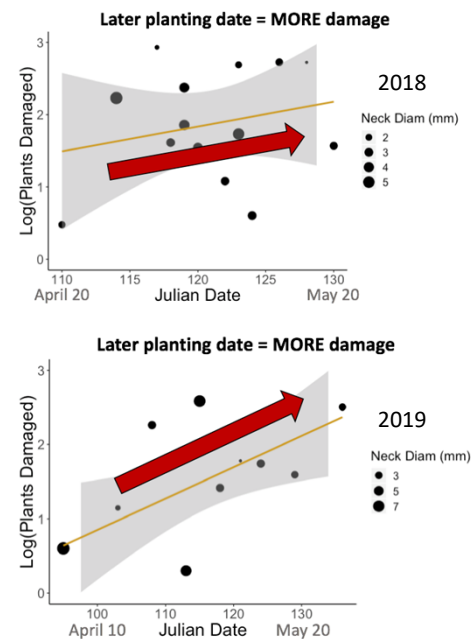
- Manipulating planting date may not be an effective approach to managing onion maggot



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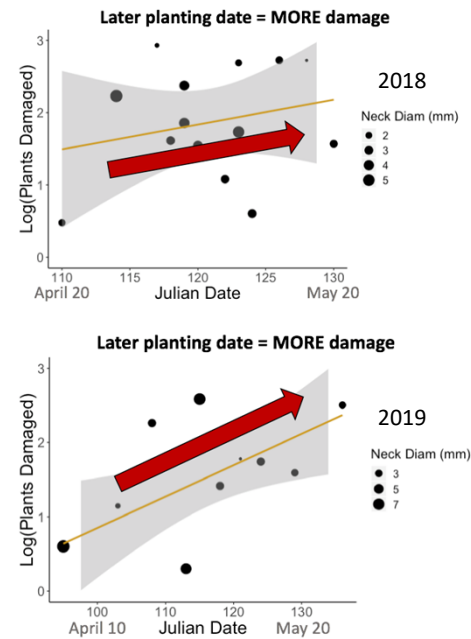
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- Other factors (e.g. field drying, weather) dictate planting date



## Planting Date

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- 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 small bulbs and delayed maturity



## 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



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  - Shade (Finch et al. 1986)



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- Forested edges may provide resources for flies
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  - Floral resources – pollen (Loosjes 1976)



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## 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



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- Candidate fields for transplanted onions

**Do Not Spray For Flies**





## Summary

Climate	Timing	Soil	Landscape

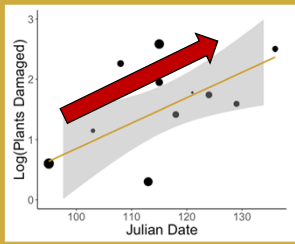
## Summary

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

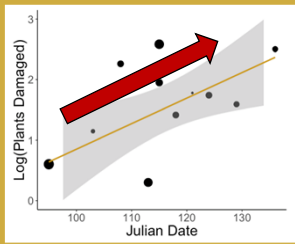
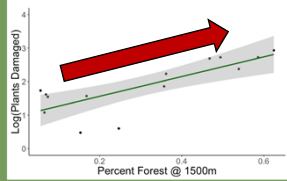
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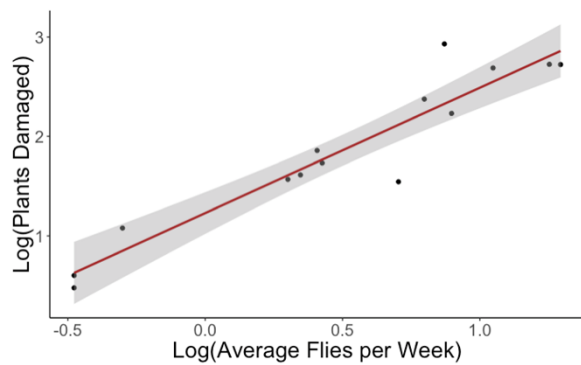
## Results: Fly abundance and damage

2018

$$F_{1,12} = 86.191$$

$$P < .001$$

$$R^2_m = 0.89$$



2019

$$F_{1,10} = 5.869$$

$$P = 0.015$$

$$R^2_m = 0.33$$

