# *Peas Out!* Whole-field Experiment at Palouse Conservation Farm

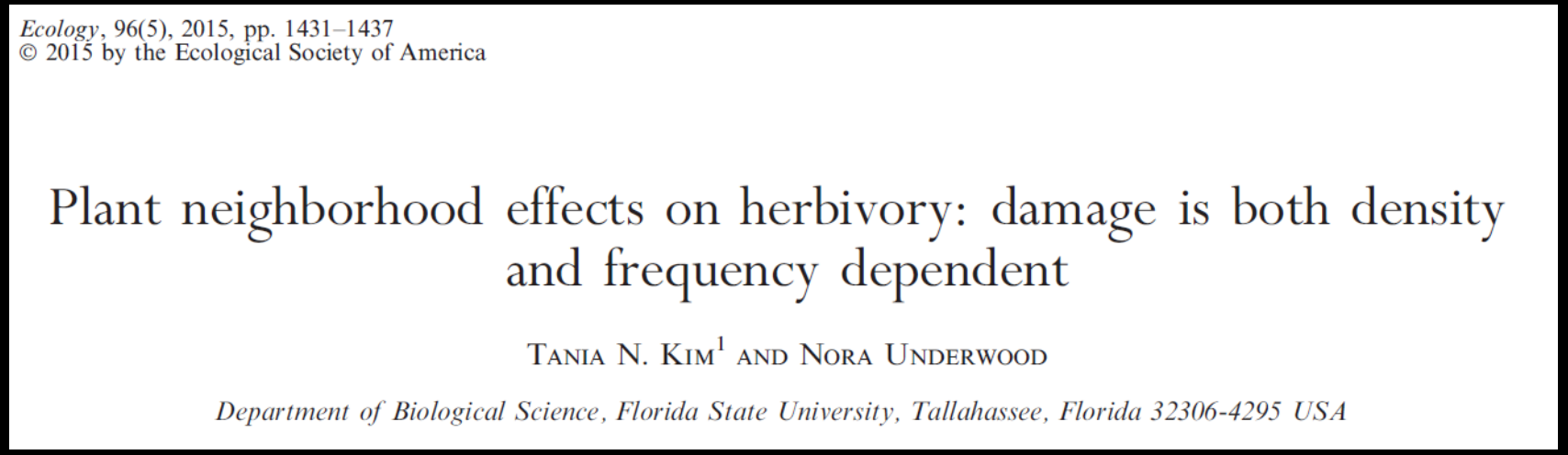
Rob Clark

# Lab meeting topics

- Experimental design
- Primary results
- Potential interpretations

# Associational effects and host-vector dynamics

- If plant traits determine herbivory and herbivore movement, it stands to reason traits of *nearby plants* can as well
  - Consider both herbivory and disease transmission
- Plant traits can also determine susceptibility of herbivores to natural enemies, this can also be influenced by nearby plants
  - Mechanisms can have opposing indirect effects



*Ecology*, 96(5), 2015, pp. 1431–1437


Plant neighborhood effects on herbivory: damage is both density and frequency dependent

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# We selected three species of pea aphid host plants representing different plant traits

Red Clover

Banner Pea

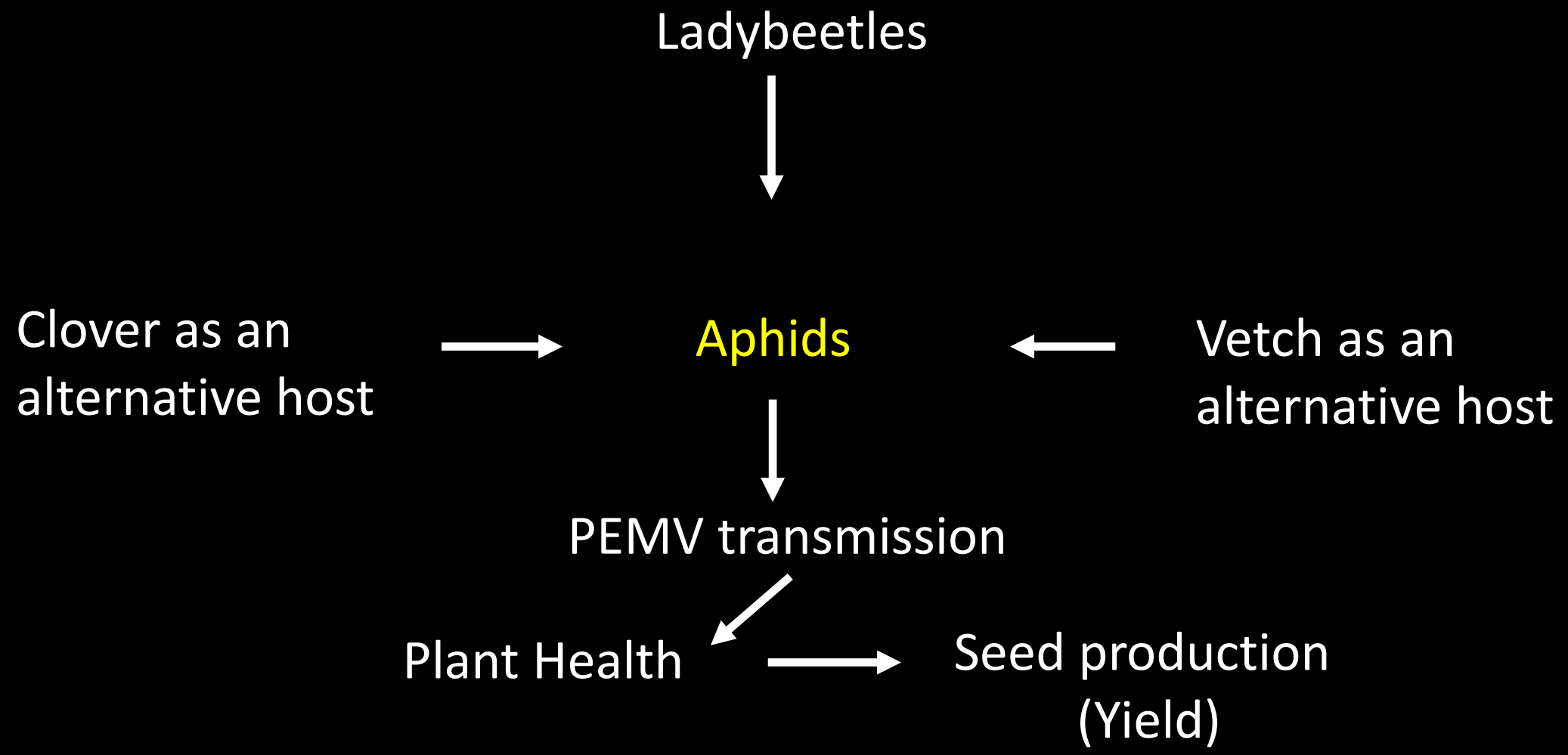
Common vetch

# Hypotheses and Predictions

- Horizontal associational effects
  - Plant-plant movement mechanisms based on herbivore response to plants
- Top-down associational effects
  - Mechanisms based on herbivore susceptibility to predators in the context of host-plant traits

- Aphids starting on clover will have slower growth due to lower plant quality compared to pea
- Aphids starting on vetch will have faster growth due to higher plant quality
  - Also, since vetch has a lower carrying capacity than pea, aphids will spread across pea plants faster compared to control dorms
- Predator effects will be strongest in control dorms (pea only) and relatively weaker on vetch and clover

# Farm experiment network diagram



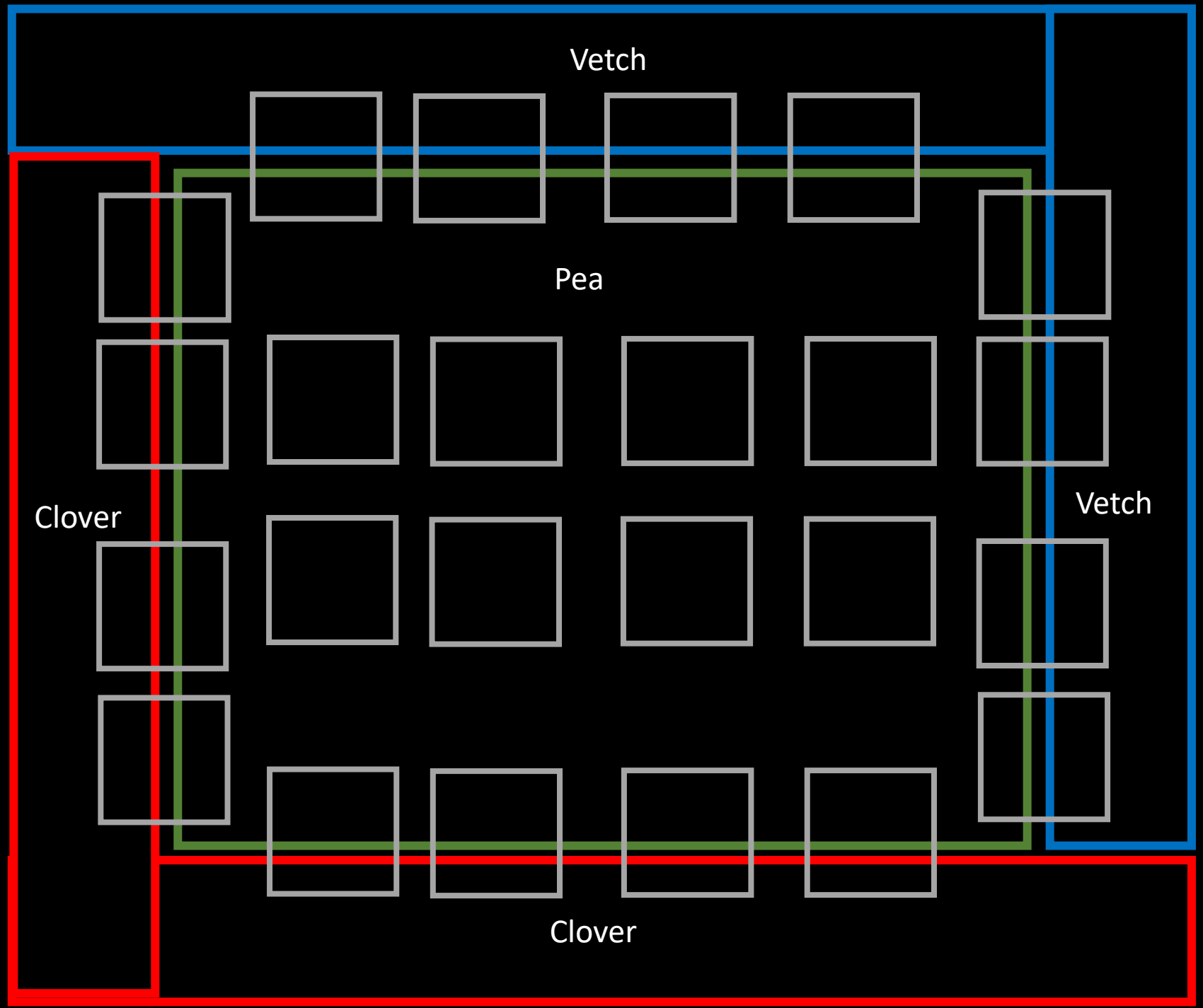
# Banner Pea, Vetch, and Clover Seeds Planted May 8

Total
32 meters
X
32 meters

Pea
24x24m

Each
edge
8x24m

Each
Edge
8x24m

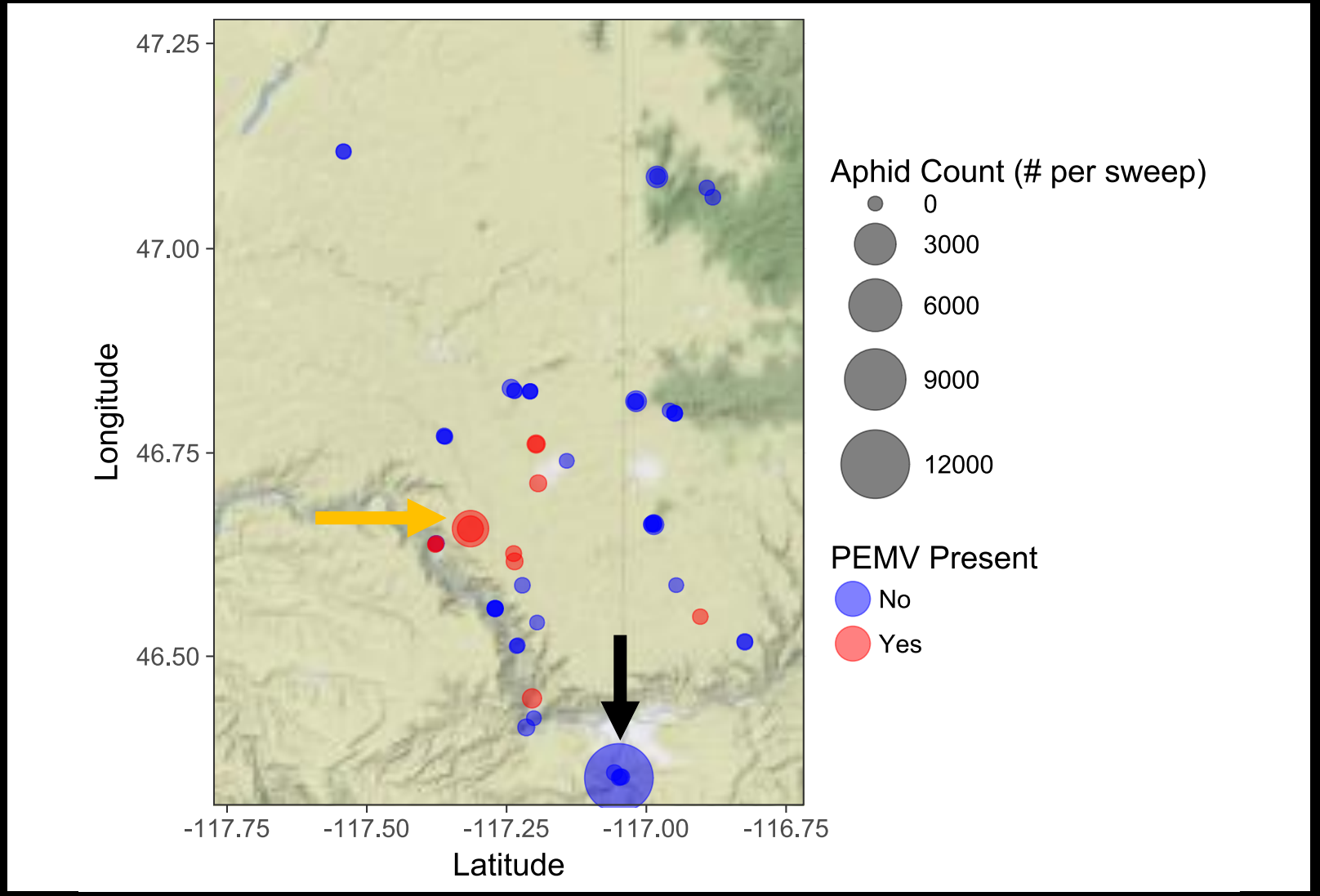


# 24 6’x6’ dorms setup on June 8

## 2x3 design

- Aphids start on clover, vetch, or pea
- Predators added or excluded

# We added ladybeetles to dorms July 2nd and 16th following major outbreaks in Snake River and lower Palouse

# Corner of dorms inoculated with infective aphids June 25

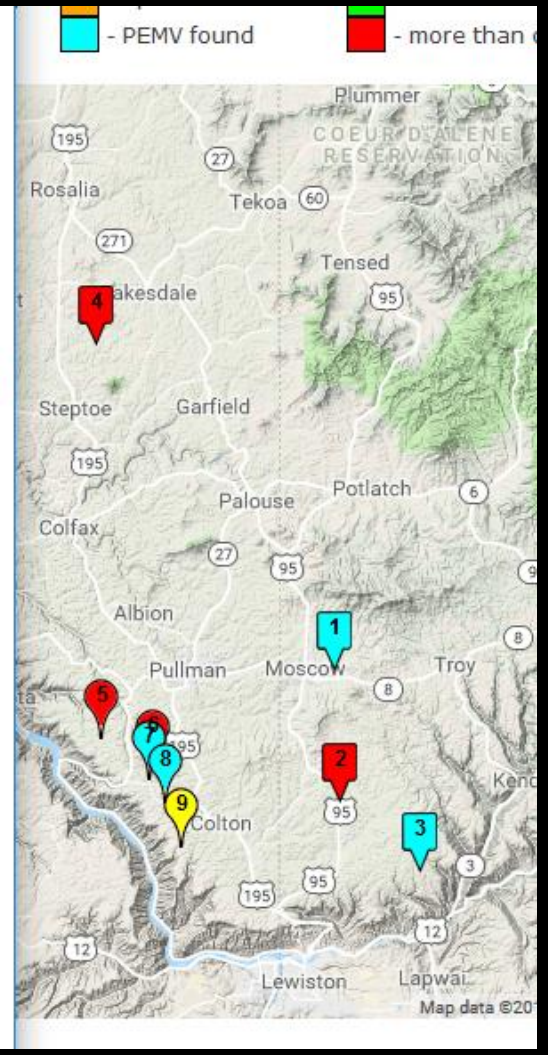
Aphid/Virus Tracker

## Site 1

Number of Aphids/ELISA Incidence by date. Colors indicate presence of PEMV, BLRV, PeSV or more than 1 virus present in collected aphids and/or ELISA samples. ELISA samples are taken sporadically in the season and only show virus presence/absence in plant samples only.

| PEMV | BLRV | PeSV | More |
|---|---|---|---|

| Date | # of Aphids | ELISA Incidence (PEMV% - BLRV%) |
|---|---|---|
| 10/12/2017 | 0 | n/a |
| 10/19/2017 | 0 | n/a |
| 10/26/2017 | 1 | n/a |
| 11/2/2017 | 0 | n/a |
| 11/9/2017 | 0 | n/a |
| 11/16/2017 | 0 | n/a |
| 11/23/2017 | 0 | n/a |
| 11/30/2017 | 0 | n/a |
| 4/17/2018 | 0 | n/a |
| 4/24/2018 | 0 | n/a |
| 5/1/2018 | 0 | n/a |
| 5/8/2018 | 0 | n/a |
| 5/15/2018 | 1 | n/a |
| 5/22/2018 | 2 | n/a |
| 5/29/2018 | 5 | n/a |
| 6/5/2018 | 3 | n/a |
| 6/12/2018 | 2 | n/a |
| 6/19/2018 | 10 | n/a |
| 6/26/2018 | 16 | n/a |
| 7/3/2018 | 9 | n/a |
| 7/10/2018 | 10 | n/a |



# Data collected so far

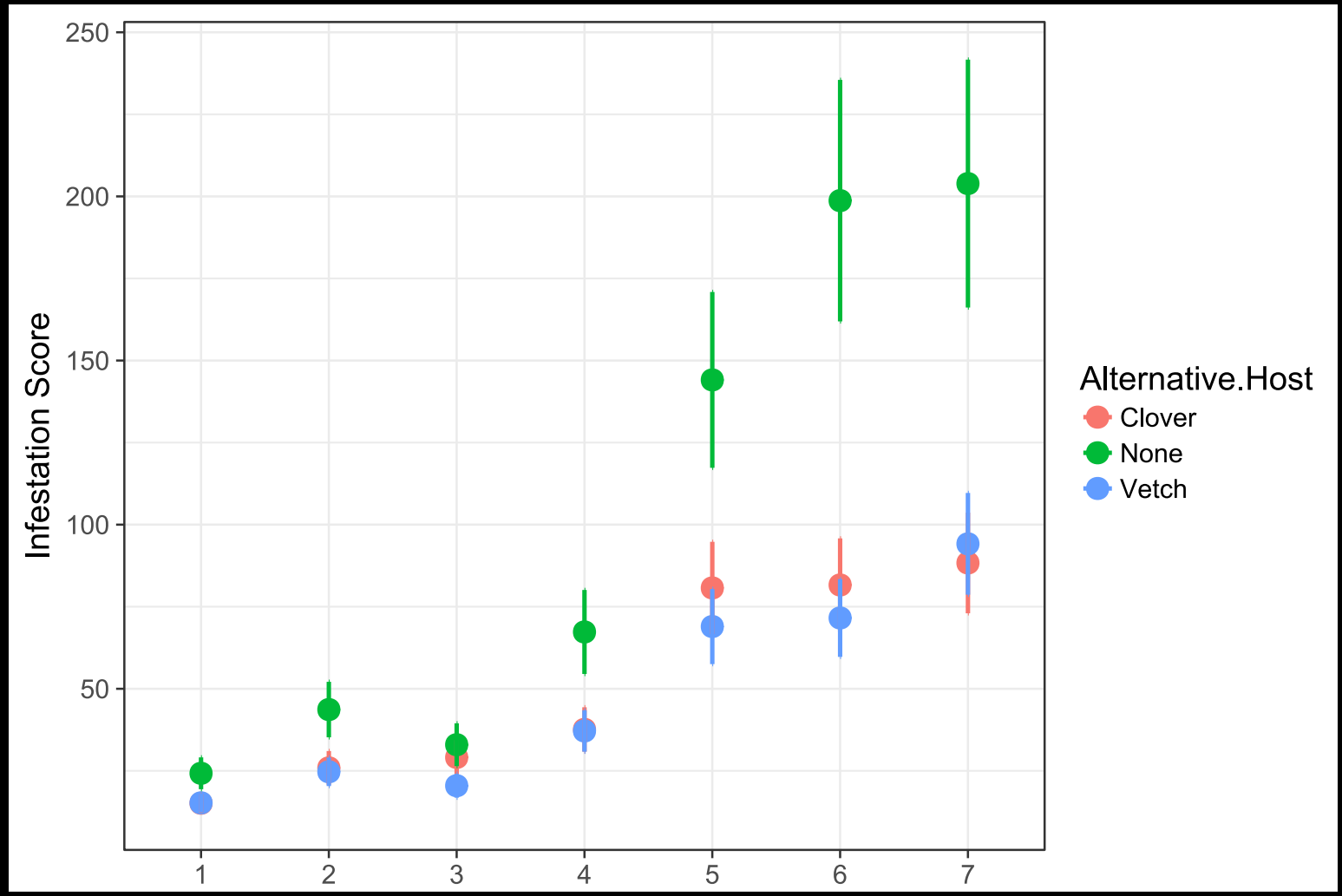
- Ranked aphid infestation and plant damage over time
  - None, Low, High, Chlorosis, Dead
- Ladybug reproduction
- Yield (# of pea pods)

- Upcoming: PEMV titer and soil Rhizobia

# Results

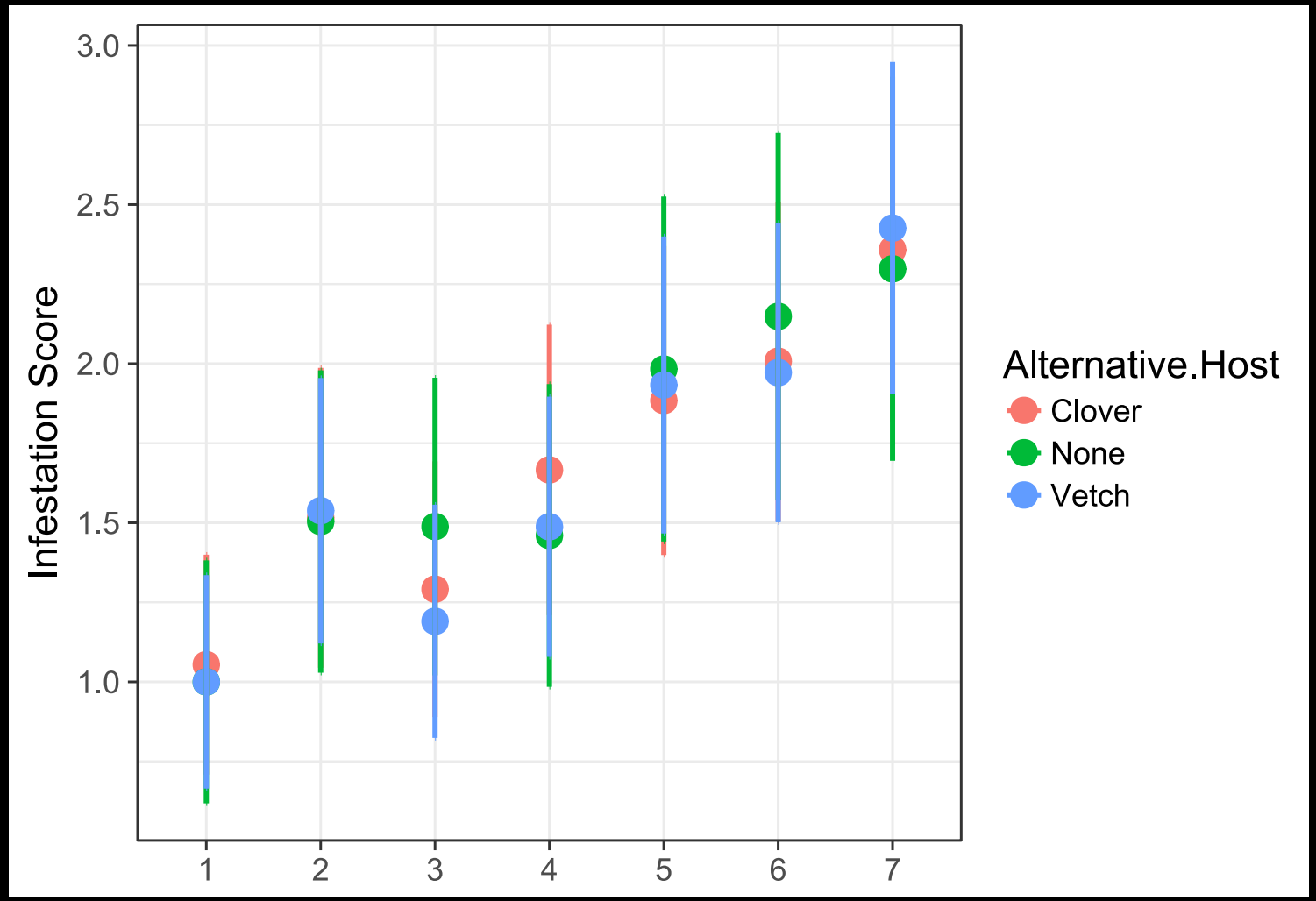
- Preliminary analysis just some negative binomial fit glm’s
- Time-series models (autoregression and such) coming soon!

# Aphid infestation was higher in control dorms



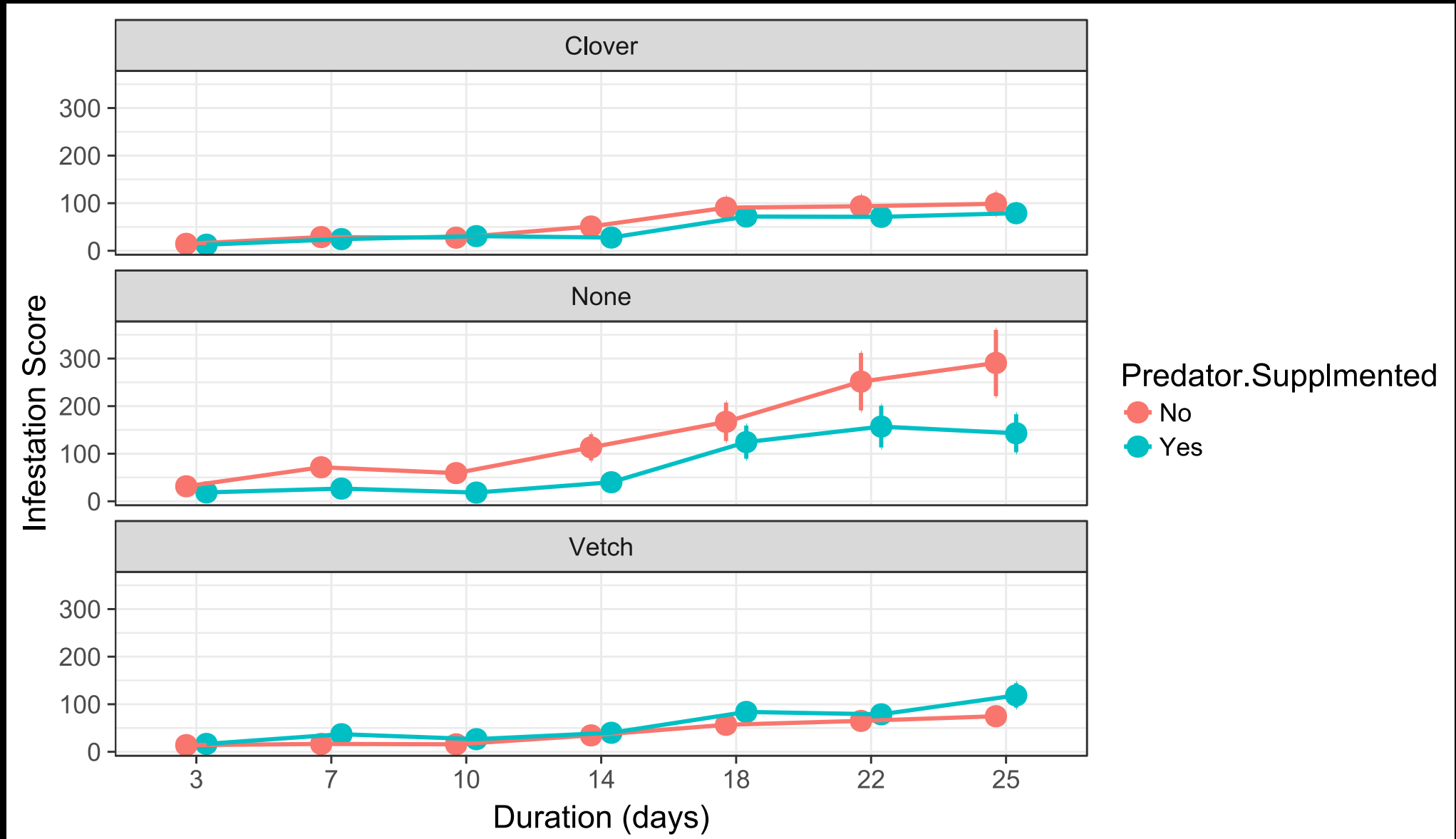

Intervals of measurements taken (every 3-4 days)

# If we use infestation score divided by plant counts, there is no effect of alternative hosts

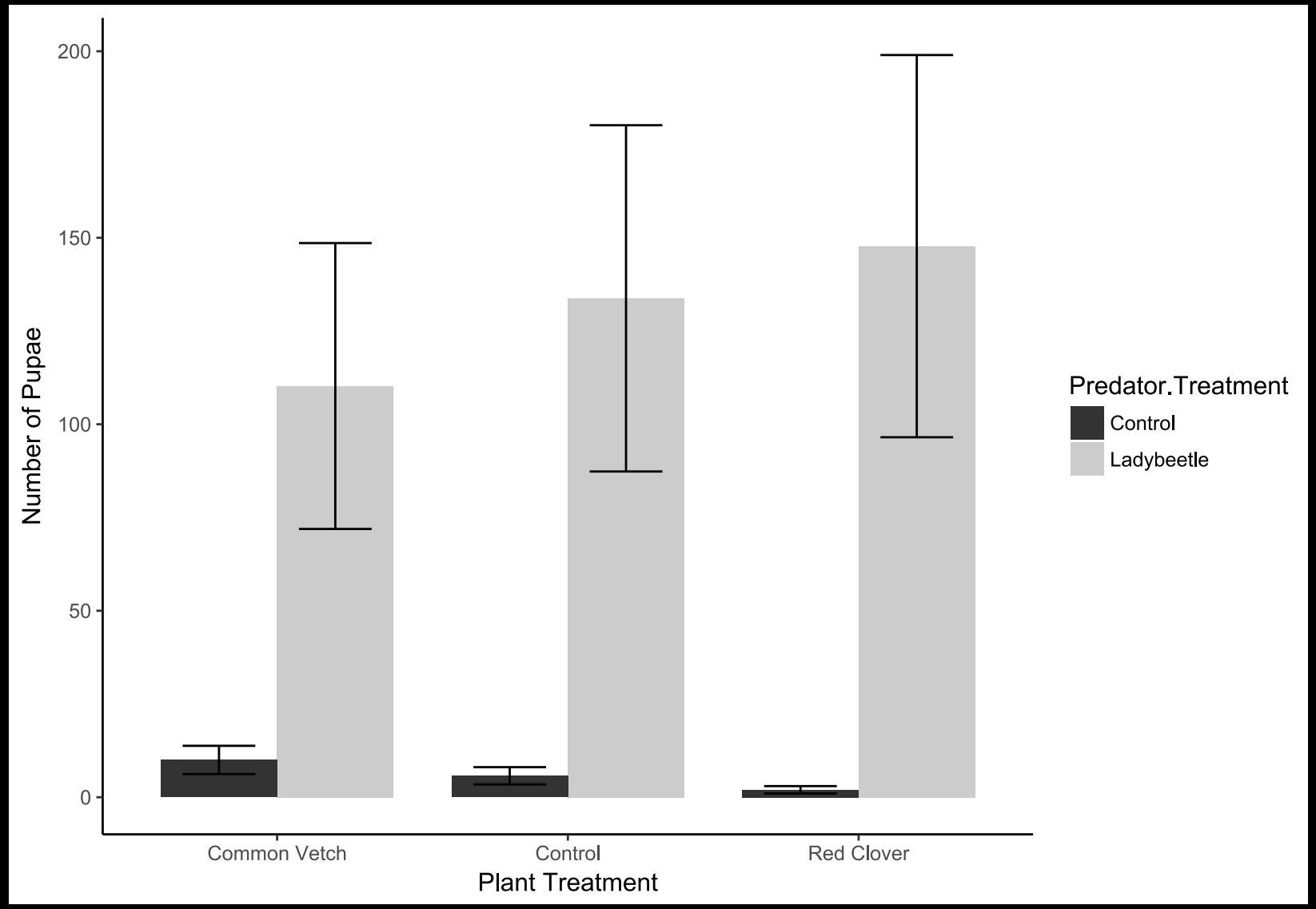



Intervals of measurements taken (every 3-4 days)

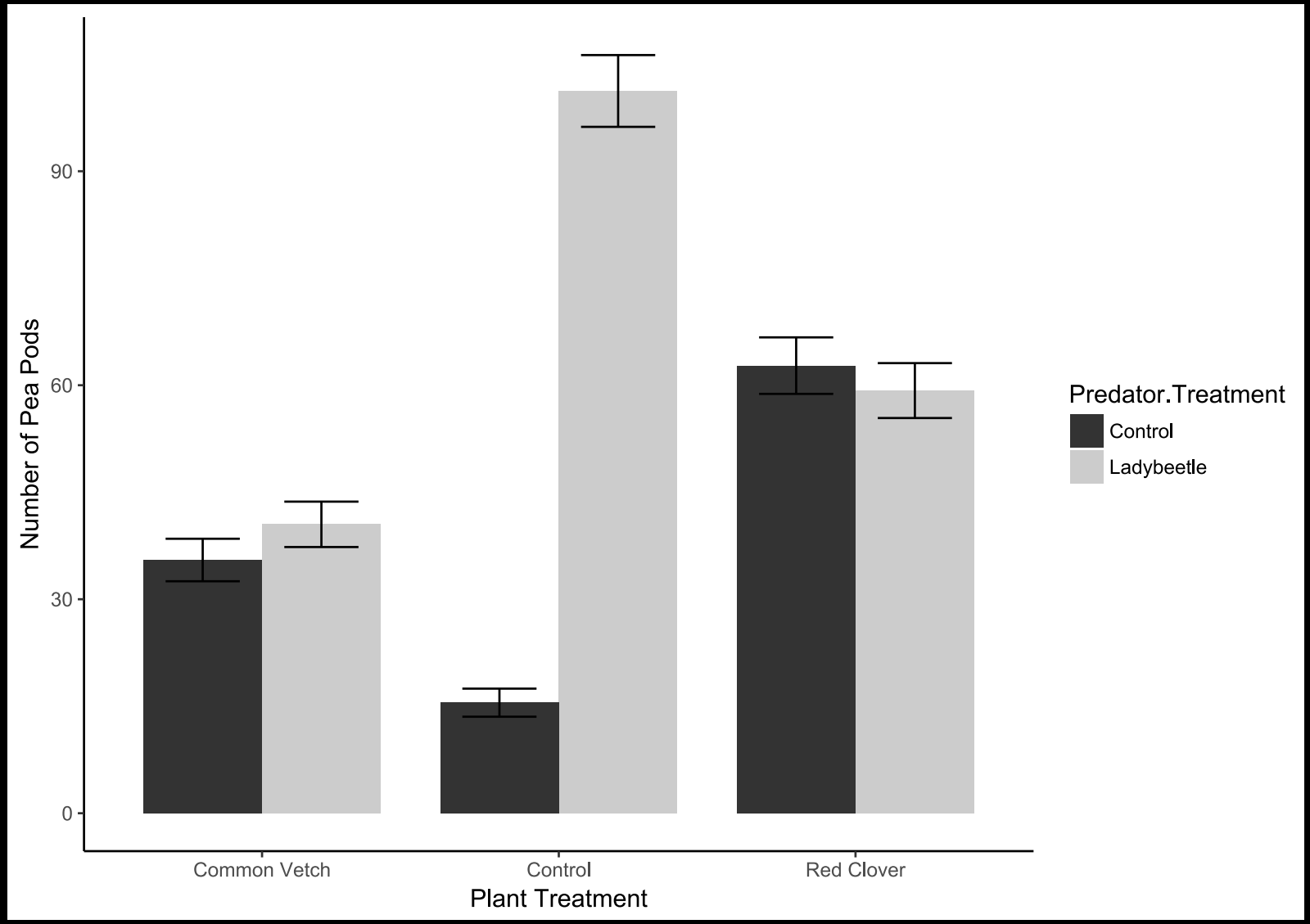
# Predator effects on infestation only significant in control dorms



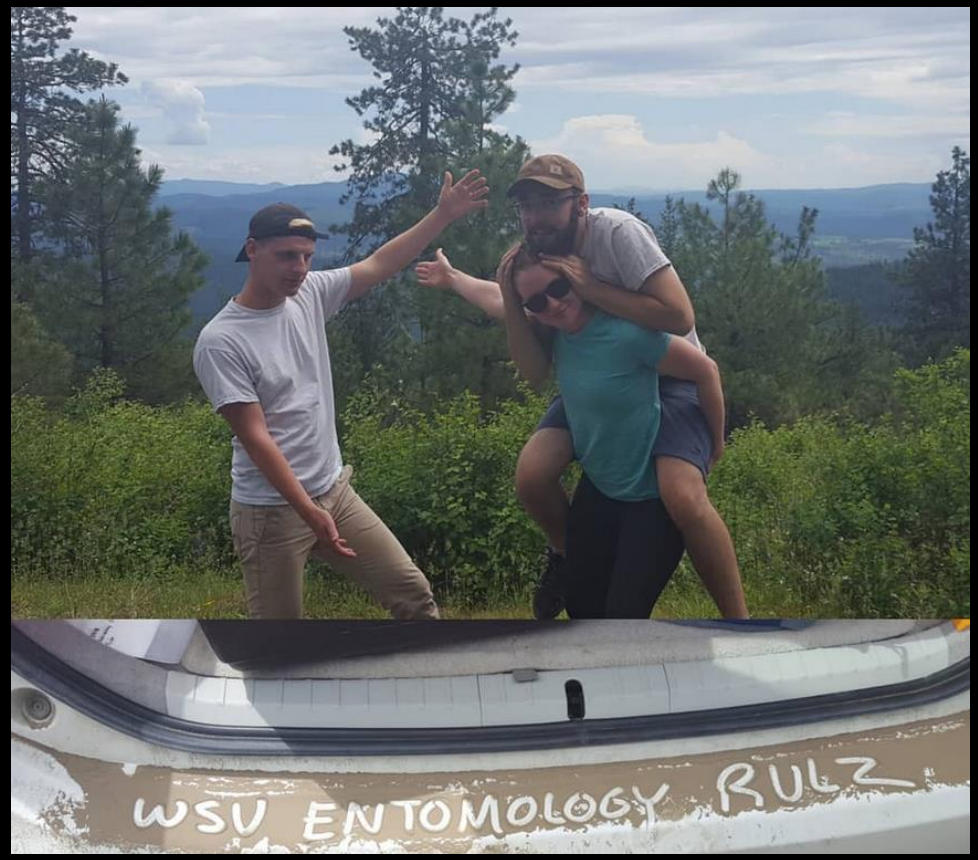
# There were not significantly more or less ladybugs in control dorms compared to other treatments



# Ladybugs increased yield in control dorms, but not vetch or clover dorms



# Thanks to my undergrads!

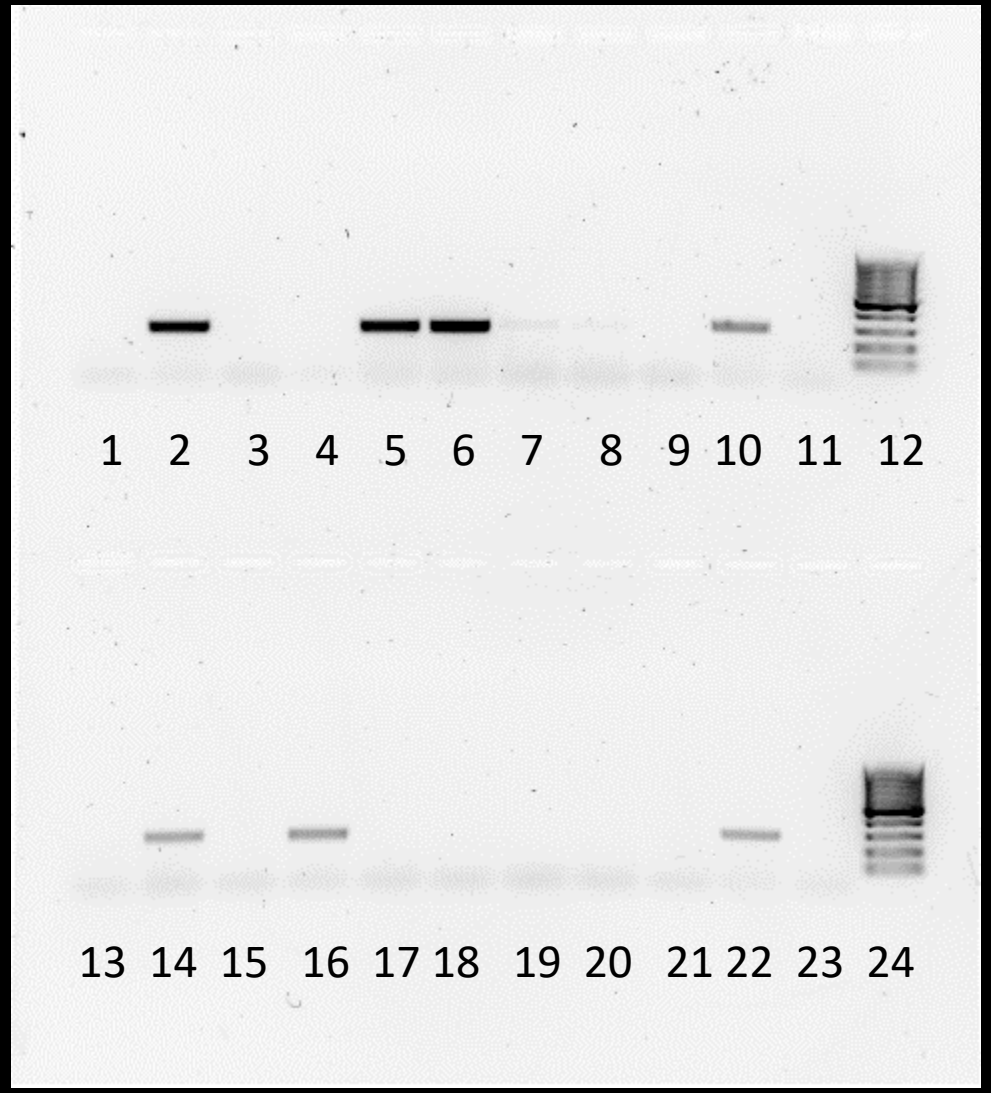



# Table of native and weedy legume associations with aphids and PEMV

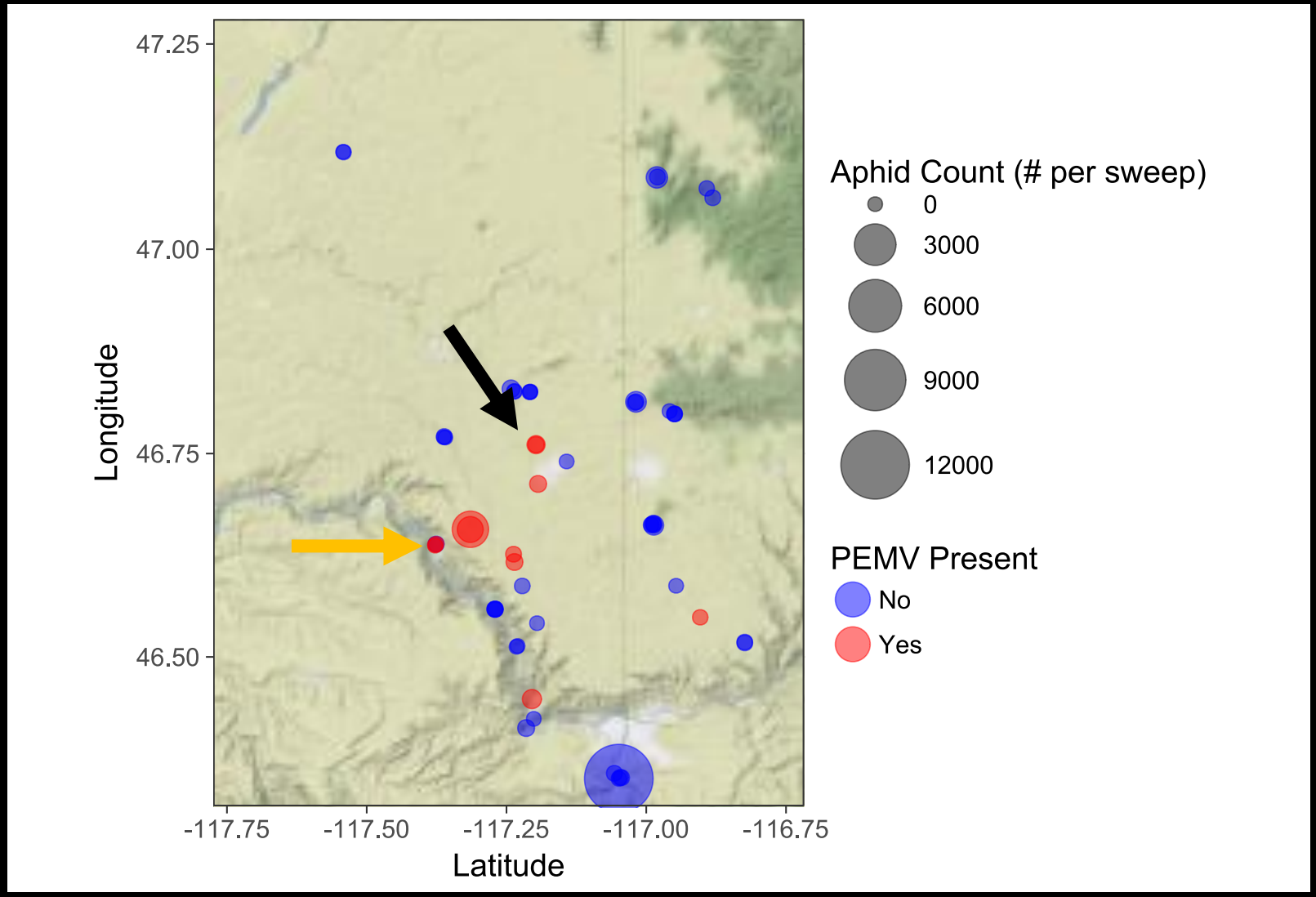
| Native range | Host-plant Species | Aphids on Plants Surveyed | Virus in Plants Surveyed | Aphids feed on host in greenhouse or farm experiments | Virus infects plants in greenhouse or farm experiments |
|---|---|---|---|---|---|
| **Eurasia** | *Pisum sativum* | Abundant | Yes | Yes | Yes |
| **Eurasia** | *Vicia villosa* | Abundant | Yes | *Not tested* | *Not tested* |
| **Eurasia** | *Vicia sativa* | Abundant | Yes | Yes | Yes |
| **Eurasia** | *Trifolium pratense* | Infrequently | No | Yes | No |
| **N. America** | *Astragalus pershii* | None | No | Yes | No |
| **N. America** | *Lupinus arbustus* | Infrequently | No | No | No |
| **N. America** | *Lupinus sericeus* | Infrequently | No | No | No |
| **N. America** | *Vicia americana* | Abundant | No | Yes | No |

# PEMV ramped up in farm plots in July and August

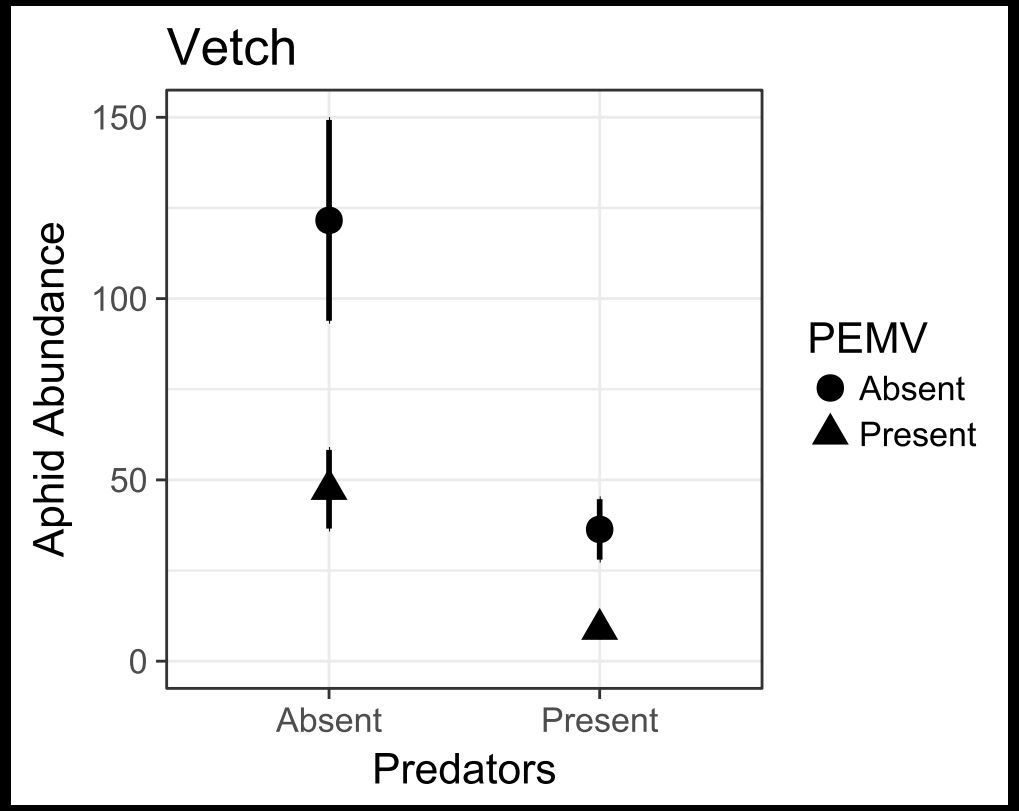
1. SK2
2. RY-SP
3. WW1
4. SH1
5. ROB5
6. ROB6
7. ROB7
8. ROB8
9. IR4
10. POSITIVE
11. NEGATIVE
12. LADDER
13. IR3
14. G1
15. TUBE A (Opp plants)
16. SR2B
17. L. Serieus (Rylee)
18. L. Albus (Rylee)
19. PLCF Lupines (Rylee)
20. A. Purshii (Rylee)
21. V. Americana (Rylee)
22. POSITIVE
23. NEGATIVE
24. LADDER



# Palouse conservation farm had feral aphids and PEMV arrive in July

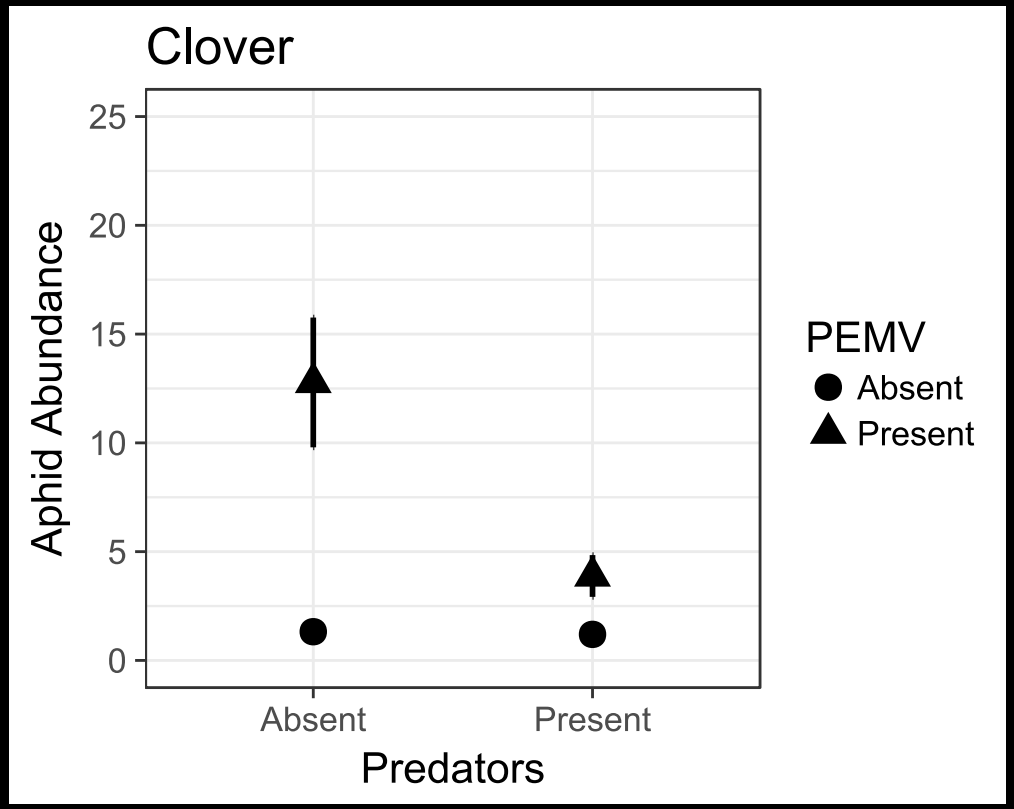


# Results match up somewhat with “switchy” experiment from early 2018



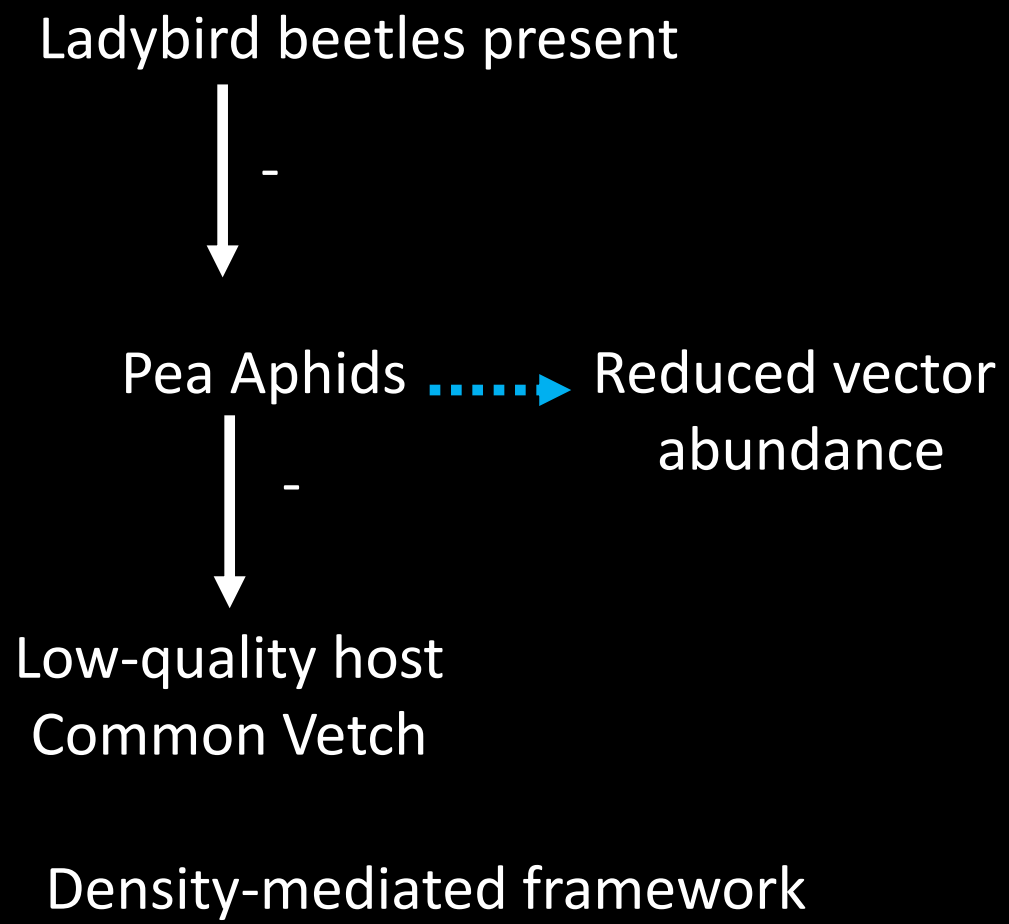

PEMV and Predators significantly reduced aphid abundance on Common Vetch

Predator effects were significant only the presence of PEMV, but overall, PEMV facilitated aphids on Red Clover

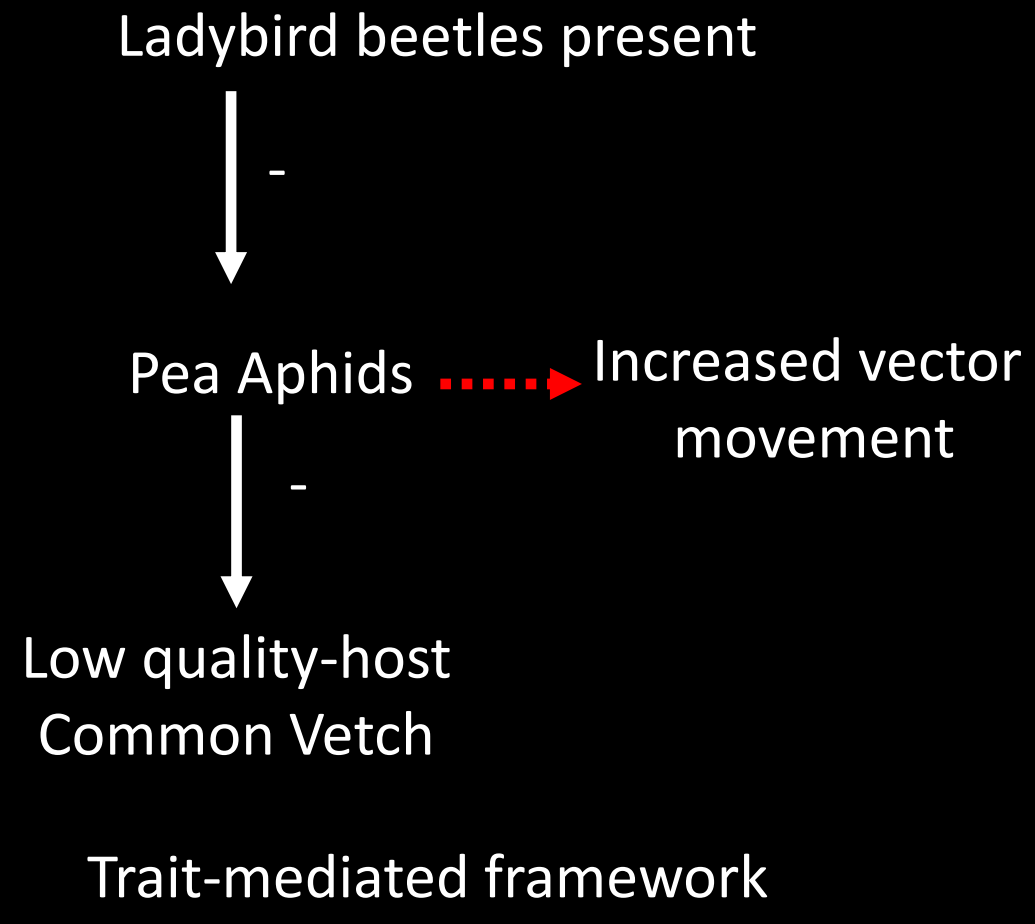



Points with non-overlapping error bars are significantly different (Tukey HSD, Sidak method for confidence-level adjustment)

# Density-mediated and trait-mediated effects make different predictions about virus spread

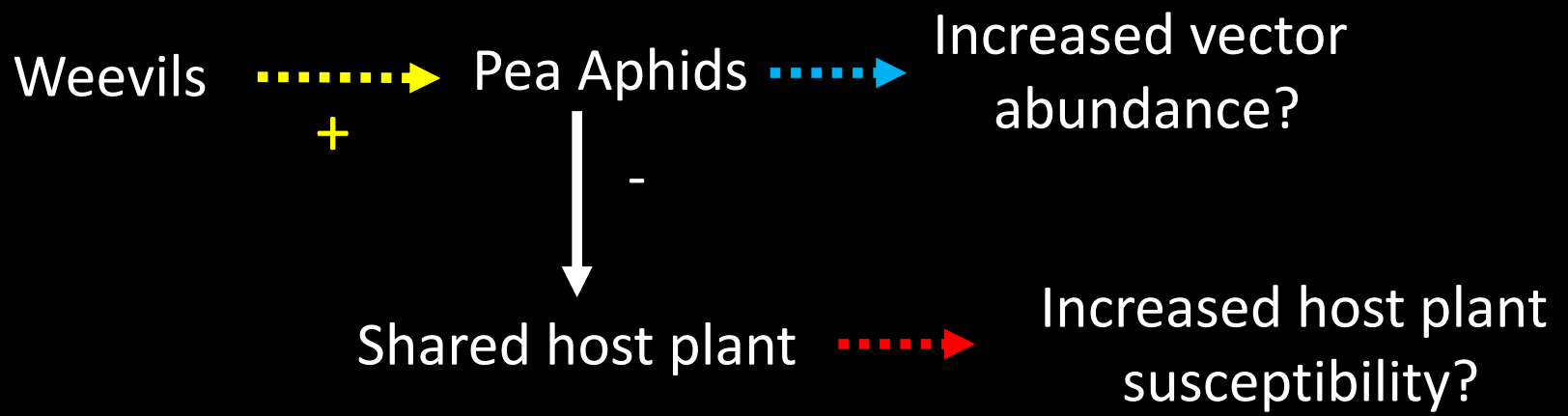



Density-mediated framework



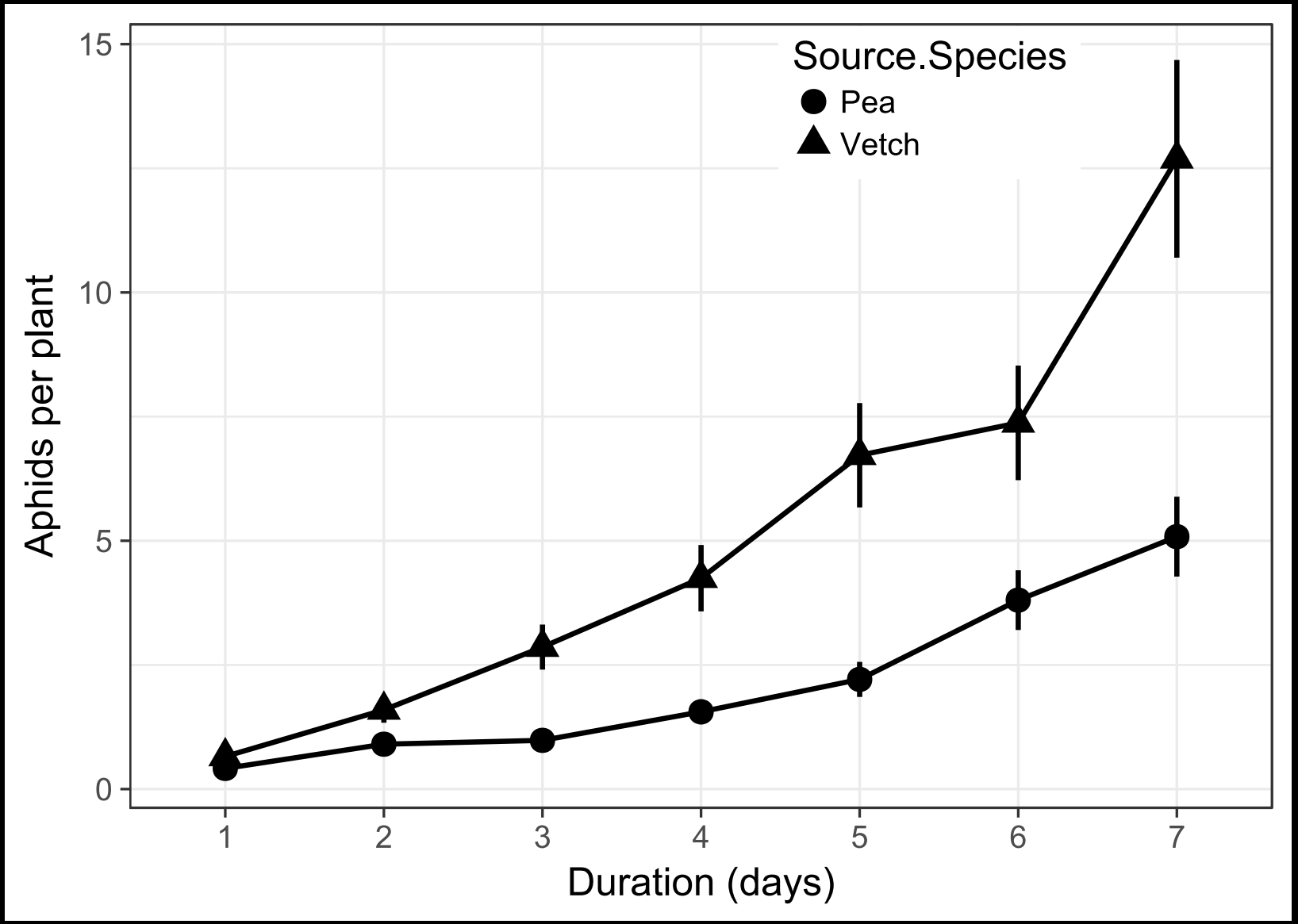

Trait-mediated framework

# Herbivore-herbivore interactions framework makes two different prediction as well, but the direct of the effect is the same

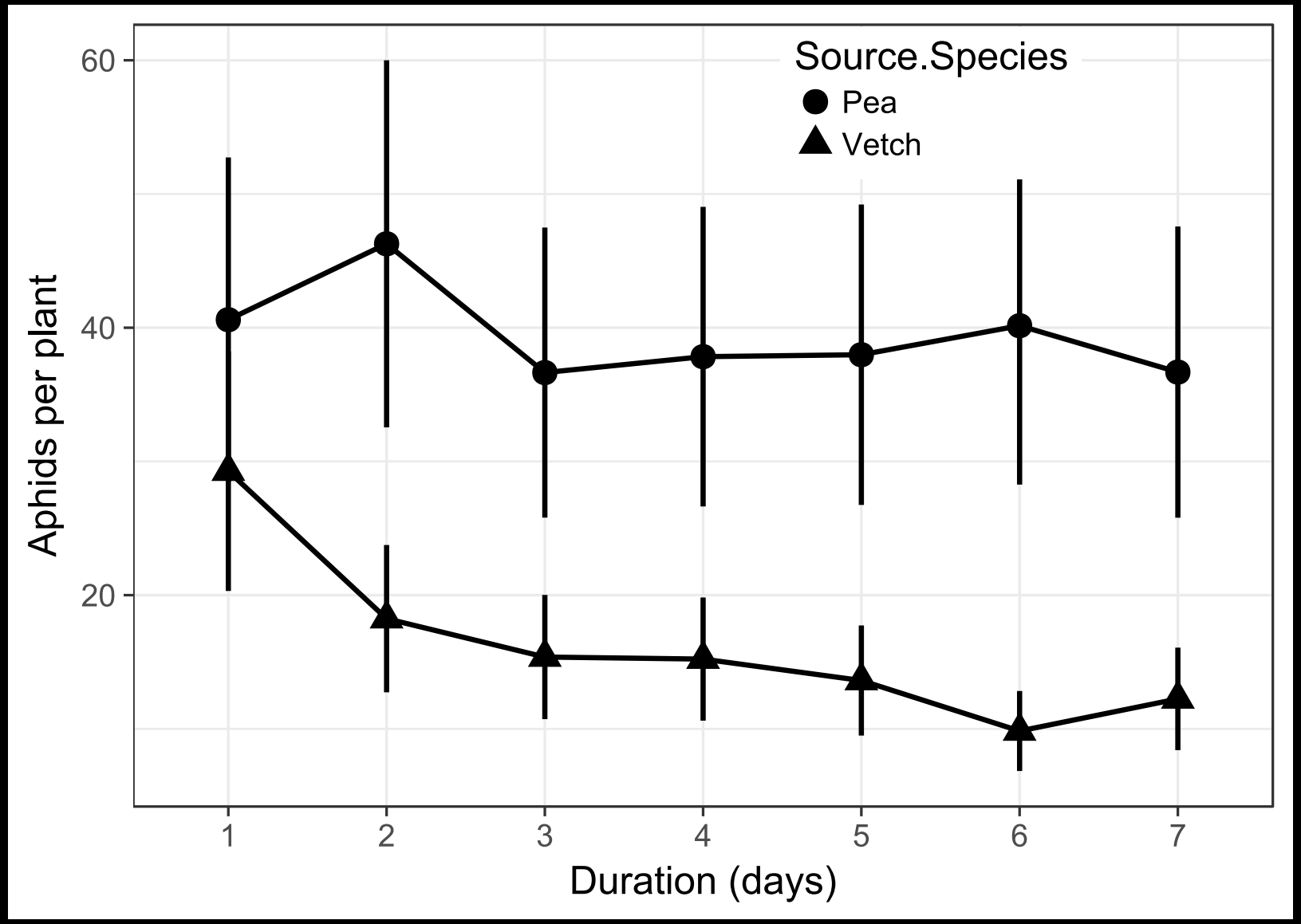



Herbivore indirect effects framework:
Herbivore or virus-based mechanisms operating?

# Recipient pea plants in “vetch” dorms had significantly more aphids



# Vetch had a lower carrying capacity than pea plants



# Predators did not induce increased aphid movement away from first row of plants