

The Effects *Aphis echinacea* Have on Seed Set and Seed Weight of *Echinacea angustifolia*

By: Kyle Siverhus and Daniel Brown
Department of Biology, Lake Forest College, Lake Forest, IL
Chicago Botanic Garden, Glencoe, IL

Introduction

The purpose of this research is to look at the effects of aphids on fitness of *Echinacea angustifolia*. *Aphis echinacea* are unique to *E. angustifolia*⁴, and feed on the nutritious phloem of plants⁷. All herbivores are detrimental to the plant to some degree, however aphids tend to have a net positive result on *E. angustifolia* because of its mutualistic relationship with ants⁸. Ants tend to aphid colonies because aphids produce a sugary honeydew secretion⁹. When ants tend to aphids, larger herbivores stay away from the plant. Studies have shown that aphids can be beneficial and also detrimental to *E. angustifolia*^{1,10}. Due to severe loss of remnant prairies, habitat fragmentation is changing the dynamics of ecosystems. From this research we can better understand plant-herbivore interactions, eco-evolutionary dynamics, and habitat fragmentation.

Hypothesis

Aphid addition experiments deter herbivores allowing more resources to be directed towards seeds, leading to greater seed weight

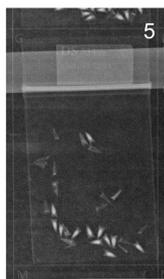
Organisms Studied

Echinacea angustifolia:

- “Narrow-leaved purple coneflower”
- Asteraceae: in the composite family
- ideal model organism
 - needs pollinator, cannot self pollinate
 - long life span
 - seed dispersal small



achene x-ray



cleaned and scanned achenes



Aphis Echinacea:

- recently discovered only specific to *Echinacea angustifolia*⁴
- feeds on phloem of plant
- excrete honeydew sugar that attracts ants



Methods

Field Experiment (conducted by Katherine Muller and Stuart Wagenius)¹

- Aphid addition and exclusion experiments were conducted on 100 *Echinacea angustifolia* plants in a remnant prairie in western Minnesota
 - Of the 100 *E. angustifolia* plants 50 had the addition treatment and 50 had the exclusion treatment
 - In the addition treatment 2-10 adult aphids were transferred to the underside of leaves
 - In the exclusion treatment *E. angustifolia* plants were manually inspected and aphids were removed
- Plants were assessed 12 times over 50 days
- Measured were aphid ant abundance, foliar herbivore damage, and vegetative characteristics

In Lab at Chicago Botanic Garden

- Dissected and cleaned *E. angustifolia* seed heads
- Organized achenes by top, middle, and bottom to keep weight differences constant
- X-rayed achenes according to location on seed head
- Counted whether achenes had seeds that were full, partial, or empty
- Weighed the achenes to assess differences between aphid addition versus exclusion

Results

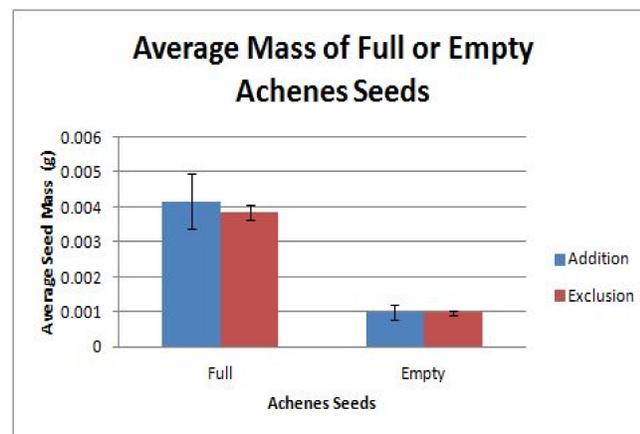


Figure 1. This graph shows the average weight size of full and empty achenes seeds in both the addition and exclusion groups. (T-test: $p = 9.703E-14$, $df = 35$). T-test is measuring the significance of seed mass of full achenes to empty.

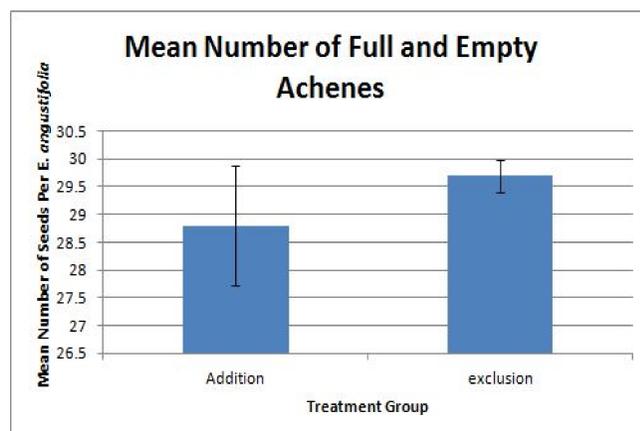


Figure 2. This graph shows the mean number of full and empty achenes per *E. angustifolia* of both the addition and exclusion treatment group. (T-test; $p = 0.136$, $df = 17$).

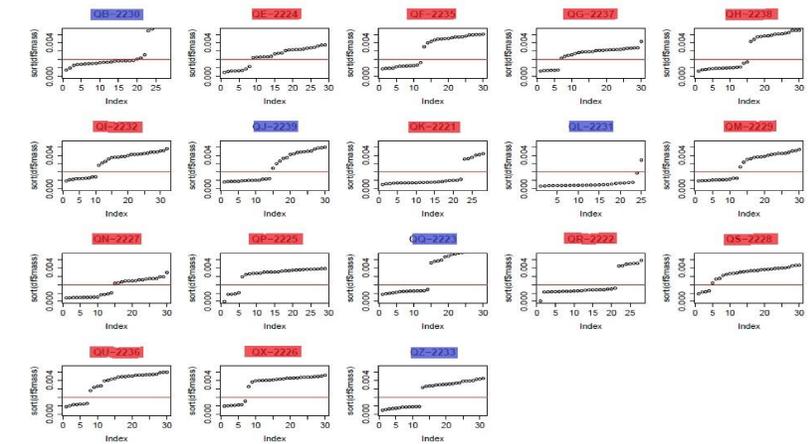


Figure 3. This chart displays the distribution of full and empty achene seeds of each individual *E. angustifolia* collected from both the addition (blue) and exclusion (red) group. The red horizontal line in each graph indicates the separation of full achenes from the empty achenes based from their measured weight.

Discussion

- There is a significant difference in the mass of full achenes compared to empty (figure 1. T-test: $p = 9.703E-14$).
- There is no significant difference in mass of achenes in Full achene seeds (T-test: $p = 0.296$), and the Empty achene seeds (T-test: $p = 0.427$) within the addition and exclusion treatment groups seen in figure 2.
- There was also no significant difference the mean number of full and empty achenes within the full and empty treatment groups (figure 2. T-test: $p = 0.136$).
- Achenes seeds of *E. angustifolia* have a slightly higher fitness potential in the exclusion group, compared to addition group (figure 3.).
- Overall, we can conclude that the benefits of aphids on *E. angustifolia* is very limited. This is supported from the difference of seed mass between the addition and exclusion groups.

Acknowledgments

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