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Echinacea Project Summer 2012

The effects of a specialist herbivore, *Aphis echinaceae,* on its host plant, *Echinacea angustifolia*

Introduction

Aphis echinaceae was identified in 2009 as a specialist herbivore unique to the native prairie plant, *Echinacea angustifolia* (Lagos and Voegtlin 2009). While this host plant is not endangered, *E. angustifolia* has experienced severe habitat fragmentation due to the loss of nearly 99% of the native tallgrass prairie in Minnesota. Understanding this specialized herbivore interaction between *A. echinaceae* and *E. angustifolia* can shed light on whether the presence of aphids are detrimental or beneficial to *E. angustifolia* and how this in turn will effect fragmented population dynamics.

Although there have been multiple studies examining the bottom-up effects of plant genotype and characteristics on aphid abundance (Johnson 2008; Ridley et al. 2011), there's been less looking at the top down effects of aphid infestation on plant performance. Of the studies existing there is evidence that aphids and their ant-tending mutualists can be beneficial since they deter other generalist herbivores (Ando and Ohgushi 2008; Zhang et al. 2012), or that they can be detrimental to plant fitness in the presence of pollinators (Valdivia and Niemeyer 2005). Since aphids are herbivores themselves, there exists a tradeoff between their damage to leaf tissue and possible indirect effects on fitness and protection from damage from other insects. It is unclear what the overall effect of aphid presence is on plants, and more explicitly what effect *Aphis echinaceae* has on *Echinacea angustifolia*, and therefore it is important to examine this relationship more closely.

My goal for this summer is to continue the work of Katherine Muller in analyzing the effect of aphids on three plant traits (fitness, foliar herbivory, and leaf senescence). Additionally, I'm interested in whether after three years of manipulation plants that have had aphids added to them have up-regulated defenses like trichome density and how this may compare to plants that are naturally being infested in the common garden. Finally, I'd like to see if *Aphis echinaceae* is able to colonize *Echinacea angustifolia* and *Echinacea pallida* hybrid crosses.

Questions and Hypotheses

1. Does aphid infestation have an effect on plant fitness over a three-year period?
    a. Null hypothesis: the addition of aphids to plants will not affect plant fitness (as measured by achene count)
    b. Alternate hypothesis: aphid addition will lower plant fitness after the three years of experimental manipulation.
2. Does aphid infestation affect senescence of *Echinacea* plants?
    a. Null hypothesis: aphid addition and removal will not affect the proportion of leaves senesced at the end of the growing season.
    b. Alternate hypothesis: aphid addition will increased the proportion of senesced leaves on plants at the end of the growing season (as supported by Katherine Muller's 2012 data).
3. Does the presence of aphids increase the number of trichomes on the plant?

    a. Null hypothesis: Aphid addition and exclusion will not alter the trichome density on plants.
    b. Alternate hypothesis: Aphid addition will increase the number of trichomes (as measured during the middle/end of the growing season).
4. Does aphid addition affect the level of foliar herbivory on *E. angustifolia*?
    a. Null hypothesis: The addition of aphids will not alter the level of foliar herbivory.
    b. Alternate hypothesis: The addition of aphids will reduce the level of foliar herbivory relative to the exclusion of aphids (as supported by Katherine Muller's 2011 data).
5. Are the specialized aphid *Aphis echinaceae* able to infest hybrid crosses between *Echinacea angustifolia* and *Echinacea pallida*?

Protocol/Procedure

Addition/Exclusion experiment

I will begin adding and excluding aphids the week of July 1st (see schedule below for more details) to 100 plants in the common garden, continuing the work of Katherine Muller in 2011 and 2012. I will continue to add aphids twice a week and exclude aphids once a week from study plants until aphid infestation significantly tapers off (approximately mid September). I will follow Katherine's protocol for collecting, adding, and excluding aphids. In addition to noting the number of aphids and ants on plants before adding or excluding more aphids, I will record the basal leaf count and the length of the longest leaf. I will also keep track of foliar herbivory throughout the summer in terms of number of leaves damaged per plant. At the end of the summer (August/September) I will record leaf senescence as number of yellow/purple leaves per plant.

Common garden aphid survey

In order to get a clear idea of aphid abundance and spatial distribution as well as the phenology of infestations, I would like to continue the aphid surveys that Katherine designed in the common garden every 3-4 weeks. These surveys would take place in between rows 26-46 and positions 881-900. The plants surveyed would be separate from those in the addition and exclusion experiment and I would (hopefully) enlist the help of the rest of Team Echinacea. This survey would record information such as plant status (flowering, basal, etc.), the number of wrinkled leaves, the number of ants and aphids present, and the amount of herbivory damage. Since flowering phenology data will be available for the common garden, this survey will also help connect flowering phenology with aphid phenology.

Materials (adapted from Katherine Muller's protocol, 2012):

- Portable cooler with ice packs
- 2 petri dishes per cooler
- 2 paint brushes (camel hair, trimmed to a few hairs)

- toothpicks
- clip-board, writing utensils, and data sheets
- meter stick

Proposed Schedule (adapted from Katherine Muller):

Week 1 (Jun 24): initial prepping
day 1) Record status of all plants in addition and exclusion groups, record initial foliar herbivore damage.

Week 2 (Jul 1): 2 addition treatments, 1 exclusion treatments, 1 CG survey:
day 1) Survey common garden
day 2) Add and exclude aphids (optional: if aphids are rare, skip exclusion)
day 3) Add aphids

Week 3 (Jul 8): 2 addition treatments, 1 exclusion treatments.
day 1) add and exclude aphids
day 2) add aphids

Week 4 (Jul 15): 1 addition treatment, 1 exclusion treatment
day 1) add and exclude aphids
day 2) exclude aphids? (depends on flowering phenology)

Week 5 (Jul 22): 1 addition treatment, 2 exclusion treatments
day 1) add and exclude aphids,
day 2) exclude aphids

Week 6 (Jul 29): 1 addition treatment, 2 exclusion treatments
day 1) add and exclude aphids, check foliar herbivore damage
day 2) exclude aphids

Week 7 (Aug. 5): 1 addition treatment, 2 exclusion treatments
day 1) add and exclude aphids
day 2) exclude aphids

Week 8 (Aug. 12): 1 addition treatment, 2 exclusion treatments
day 1) add and exclude aphids
day 2) exclude aphids

Week 9 (Aug. 19): 1 addition treatment, 2 exclusion treatments (maybe 1, if it seems like aphid infestation has peaked)
day 1) add and exclude aphids--if it seems like aphid infestation is in decline, skip the addition treatment.
day 2) exclude aphids

Week 10 (Aug. 26): skip? depends on whether aphid infestation is declining

Week 11(September 2nd): check for foliar herbivore damage and senescence
—OR—
Week 12 (September 9): check for senescence (depending on how green the leaves are)

Literature Cited

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