Summer 2007

The effects of Alliaria petiolata and fertilization on the growth and survivorship of Quercus alba and Acer saccharum seedlings

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The effects of *Alliaria petiolata* and fertilization on the growth and survivorship of *Quercus alba* and *Acer saccharum* seedlings

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Overview

Alliaria petiolata has been shown to inhibit the growth of hardwood seedlings by disrupting mutualistic interactions with arbuscular mycorrhizal fungi (AMF) (Stinson et al. 2006). This study was designed to examine how *Alliaria* will affect forest community structure via its effects on species-specific seedling performance, survival and growth.

Background

Seedlings: We used two species *Quercus alba* and *Acer saccharum* to observe species-specific responses to *Alliaria*. While *Q. alba* has an ectomycorrhizal association, *A. saccharum* has an endomycorrhizal association, or AMF interaction.

Alliaria: Alliaria is one of the most invasive species in the deciduous forests of eastern North American (Stinson et al. 2006).

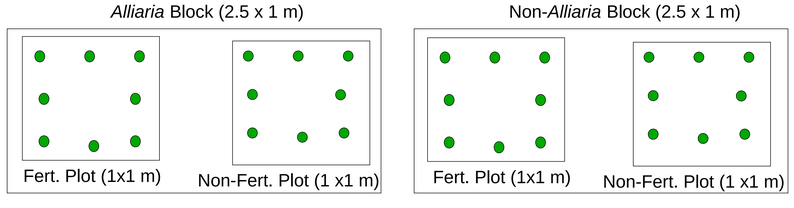
Alliaria has been only shown to affect AMF, suggesting that it will hinder the growth and survivorship of sugar maples, whereas it may or may not hinder the growth and survivorship of white oaks.

Methods

Study Site: The study was set up in a 1 ha area in the Bishop's Backbone Forest (BBF) at the Brown Family Environmental Center (BFEC) at Kenyon College, Gambier Ohio.

Experimental Setup: We established 10 experimental sites placed evenly throughout the 1 ha area. Each study site was divided into an Alliaria and non-Alliaria block. Each block was divided into a fertilizer and non-fertilizer plot. Block and plot treatments were randomly assigned.

Site Design:



Data Collection: We took two rounds of growth and survival measurements. The first round took place from May 21-23; the second round took place from July 18-20. We measured the survivorship on a 1-3 scale, 1=thriving, 2=struggling, 3=dead. For surviving seedlings we also measured their stem height and diameter.

Data Analysis: For the survivorship analysis we calculated the proportion of thriving seedlings in each site for each treatment. We analyzed the survivorship and growth data by using an ANOVA GLM to determine treatment effects.

Results

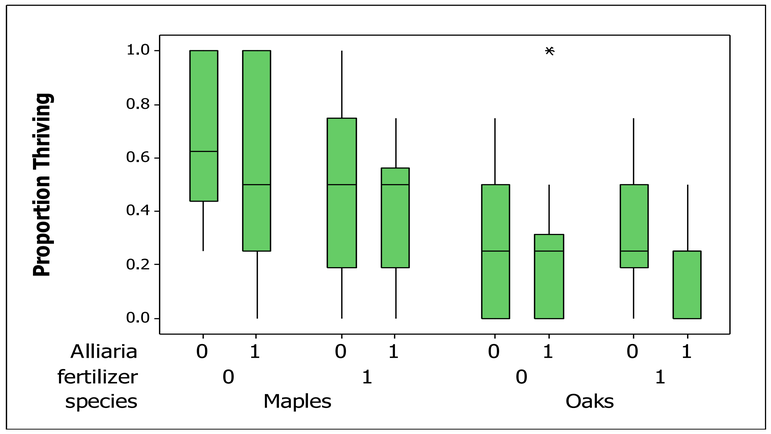


Figure 1. The effects of fertilizer and *Alliaria* presence on the proportion of thriving *Quercus alba (Oaks)*, and *Acer saccharum (*Maples) seedlings in the 2nd round of survivorship measurements (GLM, $F_{fertilizer}$=4.04, $F_{species}$=20.12, $P_{fertilizer}$=0.049, $P_{species}$=0.000).

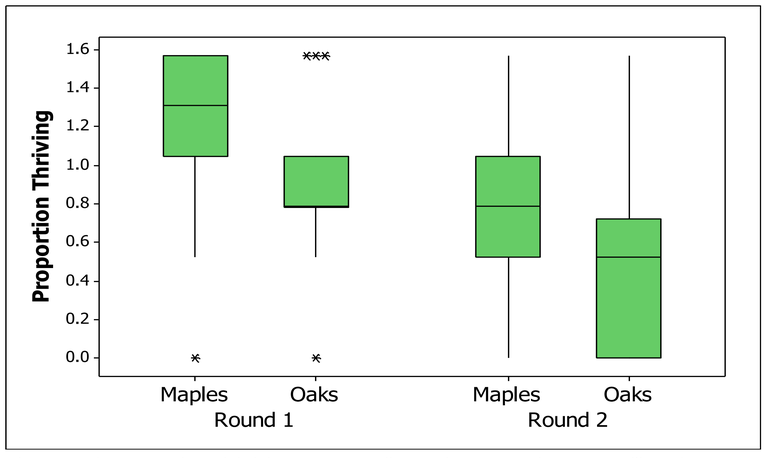


Figure 2. The proportion of thriving *Quercus alba*, and *Acer saccharum* seedlings from both round one and round two (GLM, $F_{round\ one}$=18.25, $F_{round\ two}$=20.12, $P_{round\ one}$=0.000, $P_{round\ two}$=0.000).

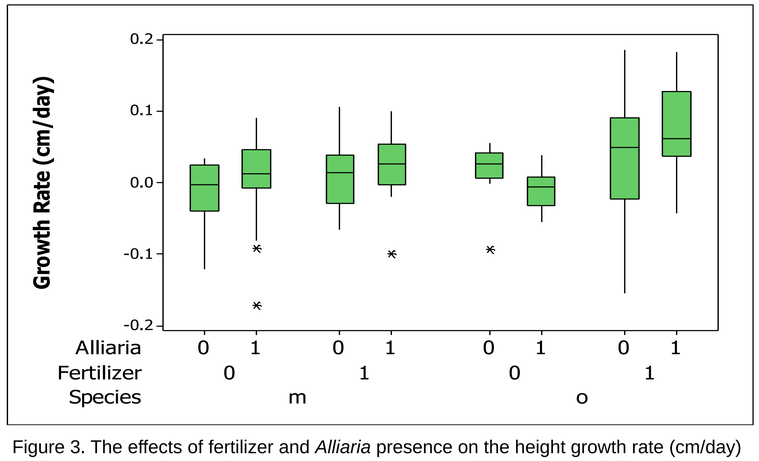


Figure 3. The effects of fertilizer and *Alliaria* presence on the height growth rate (cm/day) of *Quercus alba* (o), and *Acer saccharum* (m) seedlings (GLM, $F_{fertilizer}$=6.84, $F_{species}$=4.63, $P_{fertilizer}$=0.011, $P_{species}$=0.035).

Discussion

In the beginning of the study, while the maples thrived, the oaks appeared to struggle. The maples invested in their height growth early on, whereas the oaks did not invest in height growth until later in the season, due to later leaf emergence. However, towards the end of the study, many of the maples that had been thriving started to die.

For the greater part of our study there was a drought in Gambier, OH, which may help explain the mortality patterns of the oaks and maples. Due to the limited water supply brought upon by the drought, the maples could not maintain their early growth and began to struggle. The oaks however, did not have as much growth to maintain and did not suffer as greatly later on.

- Height growth increased in the presence of *Alliaria* in both species
- *Alliaria* with fertilizer increased the height growth rate for oaks
  - This may suggest that *Alliaria* did not place significant stress on the oak seedlings through mycorrhizal disruption, but instead bolstered height growth as a competitive response, which was further bolstered by fertilization.

Corresponding Experiments

- *Alliaria* negatively affected the maple photosynthetic rate, but had no effect on the oak photosynthetic rate.
- Insect herbivory on maples was reduced in the presence of *Alliaria*.
  - The inhibited photosynthetic rate caused by *Alliaria* in maples may have compounded the stress the maples faced in maintaining their height growth during the drought, but this effect may have been countered by reduced herbivory. Only further study will resolve these speculations.
- The summer 2007 experiments are part of a long-term study on how *Alliaria* will affect forest community structure.

Acknowledgments

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References

Stinson, K.N., S.A. Campbell, J.R. Powell, B.E. Wolfe, R.M. Callaway, G.C. Thelsen, S.G. Hallett, D. Prati, and J.N. Klironomos. 2006. Invasive plant suppresses the growth of native tree seedlings by disrupting belowground mutualisms. *Plos Biology* 4:727-731.