Effects of Light Availability and Order of Arrival on Oak Woodland Species' Competitive Interactions

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Introduction

- Oak woodlands in the Midwest U.S. provide a significant source of plant biodiversity, but many of these woodlands have been degraded (Leach and Givnish 1999).
- Native seed mixes are commonly used to restore these woodlands, but little empirical research has been done into the competitive interactions among the species in seed mixes.
- Priority effects—the effects that an early arriving plant species can have on the establishment and growth of a later arriving species—likely play a part in these interactions, and they can vary depending on the abiotic conditions of the environment (Chase 2003).
- The goal of this research is to investigate how resource availability and order of arrival impact the competitive interactions between species found in seed mixes.

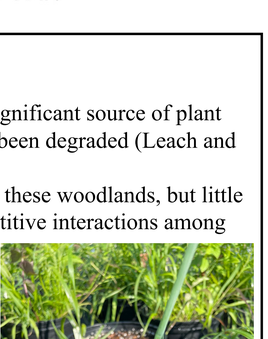
Bromus kalmii

Research Question and Hypothesis

- How does light availability and species' order of arrival impact growth rates?
- It is hypothesized that early arrival, especially in the resource rich (light) environment will lead to the fastest growth rate. Additionally, late arrival in these conditions is expected to show the slowest growth rate.

Materials and Methods

- 180 12" pots were planted with 12 species found in local seed mixes.
- Three light conditions (light, moderate, shade) were created with shade cloths.
- Per each light condition:
  - 18 pots were initially planted with 4 species and the remaining 8 were added a 3 weeks later.
  - 6 pots were planted with all 12 species at once.
  - 36 pots acted as controls with individuals of each species grown (3 per species).
- Measurements of plant height and leaf count at the time of planting and two weeks later were taken for both early and late arrivers.
- Growth rates of leaves per day were found by taking the difference in leaf count between the initial planting and the measurement at two weeks and dividing by the 14-day period.
- Analysis focused on the conservative graminoid species *Bromus kalmii* (C=10) and *Diarrhena obovate* (C=10) and non-conservative *Panicum virgatum* (C=3) and *Glyceria striata* (C=4).
  - Conservatism relates to a species' response to disturbance, with non-conservative species showing higher disturbance tolerance (Davit 2020).
- Statistical analyses included ANOVA for light treatment, arrival order, and conservatism status compared to growth rate and post hoc Tukey's HSD.



Moderate and Shade treatments

Results

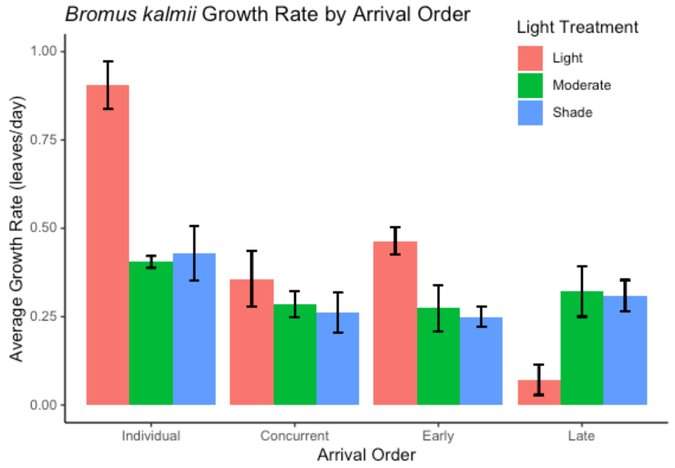


Figure 1. Late arrival in light treatment shows the slowest growth rate

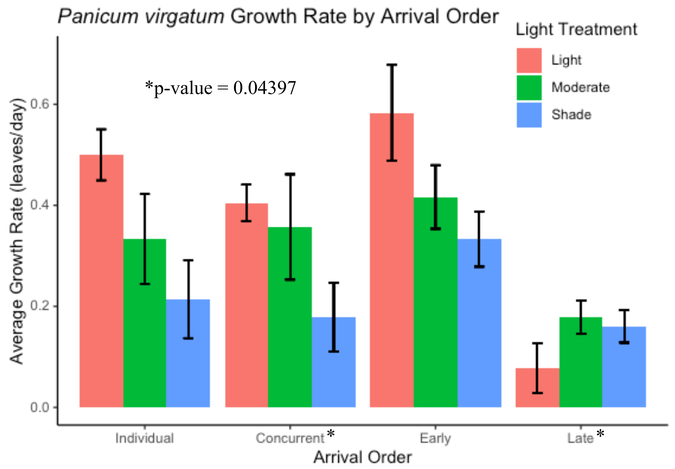


Figure 2. Late arrival causes the slowest growth rates regardless of light treatment

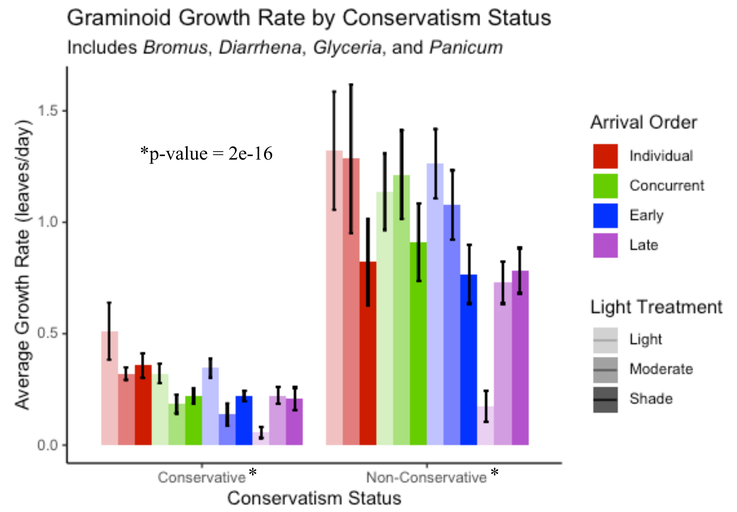


Figure 3. Non-conservative species have faster growth rates than conservative

Growth Rate ~ Light Treatment

Species	p-value
Bromus kalmii	NS
Panicum virgatum	NS

Figure 4. Table of ANOVA p-values. Light treatment does not affect growth

Growth Rate ~ Arrival Order

Species	p-value
Bromus kalmii	NS
Panicum virgatum	8.26e-5

Figure 5. Table of ANOVA p-values. Arrival order affects *Panicum* growth

Growth Rate ~ Conservatism * Arrival Order

Conservatism	p-value
Conservatism * Arrival Order	0.0151

Figure 6. Table of ANOVA p-value. Conservatism impacts the effects of arrival order on growth

Discussion

Bromus kalmii showed the slowest growth rate from late arrival in the light treatment, but there were no statistically significant results for arrival order or light treatment (Fig. 1). Early arrival for *Panicum virgatum* did not significantly impact growth rates, but late arrival was significant, leading to slower growth compared to concurrent arrival regardless of the light treatment (Fig. 2). The conservatism status for the four graminoid species was significant for growth, with non-conservative species showing higher growth rates (Fig. 3). The effect of arrival order on growth rates was dependent on conservatism status (Fig. 6); the establishment of conservative species was not significantly impacted by arrival order, but late arrival held a cost in growth rates for non-conservative species. These results suggest that species order of arrival into a community may impact the successful establishment of the plant, and conservatism can alter the extent of this impact. Future research into different life history strategies of these species may provide additional insight into the workings of priority effects.

References

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