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Influence of light intensity on germination, vegetative development, and reproduction of three species of Asteraceae native to Kansas

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Abstract

Plants are strongly influenced by a continuously changing light environment and their ability to detect light provides them vital information for their survival. However, most of the studies on photobiology are about commercial species and little is known about species native to Kansas and its region. Therefore, our objective was to analyze responses of three Asteraceae species native to Kansas under different light intensities during germination, vegetative development, and flowering. Seeds of *Ageratina altissima*, *Eupatorium purpureum*, and *Solidago ulmifolia* were measured for germination daily in conditions of dark, approximately 10%, 50%, and 100% of natural light. Seeds were later planted in soil and exposed to the same light conditions, and height, number of leaves, and chlorophyll (SPAD) were measured. Preliminary results show that *A. altissima* was the fastest species for germination and its germinability was consistent across light treatments. Germination in *S. ulmifolia* was also consistent across light treatments. For *E. purpureum*, germinability was higher in the light treatments than in the dark. *A. altissima* plants growing in 50% and 100% of light were taller and had more leaves than plants growing under 10% of light. Conventional plant responses to low light include growing taller under shaded conditions, although these plants responded differently. Most habitats in the prairie are exposed to bright sunlight and these results indicate these Asteraceae species are adapted to live and grow under bright light.

Introduction

Light is the most important environmental signal and the primary source of photosynthetic energy for plants (Bian *et al*., 2014) and their ability to detect light provides them vital information for their survival (Franklin, 2008). Under low light intensities, many plants grow taller, have more leaves, and leaves are usually larger and thinner (Smith and Whitelam, 1997). Light is also an important environment signal for flowering transition (Bäurle and Dean, 2006). Therefore, understanding of plant responses to light intensities is useful in aspects of conservation and management of species (Chanyenga *et al*., 2012). However, most of the studies on photobiology are about commercial species and little is known about species native to Kansas and its region.

Objectives

Our objectives were 1) to analyze plant responses to different light intensities during germination, vegetative development, and flowering, and 2) to compare those responses between species.

Hypotheses

Our hypotheses were: 1) Higher light intensities would result in higher germination rates; 2) Shade conditions would result in taller plants with more leaves; 3) Shade conditions would result in higher photosynthesis rates; 4) Shade conditions would promote early flowering time; 5) Higher light intensities would increase number of flowers and fruits.

Methods

Plant material

Ageratina altissima (White Snakeroot), *Eupatorium purpureum* (Sweet Joe-Pye), and *Solidago ulmifolia* (Elmleaf Goldenrod) were studied.

Figure 1: *Ageratina altissima*.

Figure 2: *Eupatorium purpureum*.

Figure 3: *Solidago ulmifolia*.

Methods

Light treatment

Achenes (treated as seeds) and young plants were exposed to dark, approximately 10%, 50%, and 100% of natural light intensities, in the FHSU greenhouse conditions of temperature and humidity.

Germination

The germination experiment consisted of placing 20 cold-stratified seeds, per treatment, on filter paper moistened with 5 ml of distilled water, inside 9 cm petri dishes and exposed to the light treatments. Germination of seeds was checked daily, and light intensities were checked three times per day until the end of the experiment.

Vegetative development

The vegetative development experiment consisted of exposing 30 replicates of one-month-old *A. altissima* plants to each of the light treatments. We measured height, number of leaves, and chlorophyll concentration (SPAD) once a week.

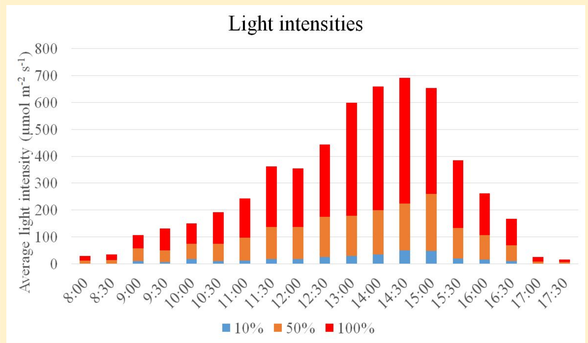

Figure 4: Average light intensities through the day across treatments.

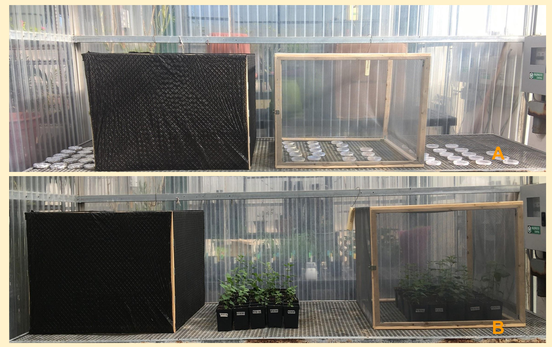

Figure 5a: Petri dishes exposed to dark, 10%, 50% and 100% of natural light. **Figure 5b:** *A. altissima plants* exposed to 10%, 50% and 100% of natural light.

Results

I. Germination

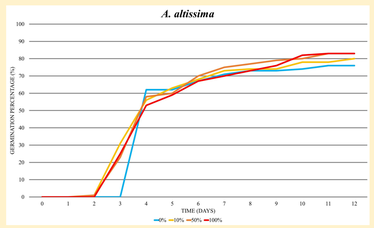

Figure 6: Germination percentage of *A. altissima* over time across light treatments.

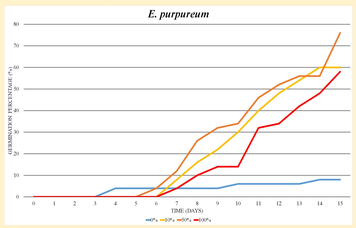

Figure 7: Percentage of germination of *E. purpureum* over time across light treatments.

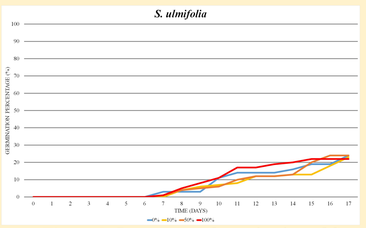

Figure 8: Percentage of germination of *S. ulmifolia* over time across light treatments.

II. Vegetative development

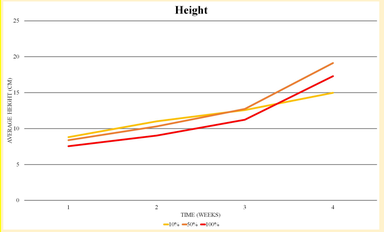

Figure 9: Average height of *A. altissima* over time across light treatments.

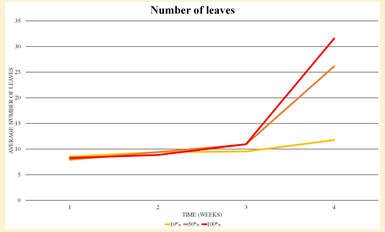

Figure 10: Average number of leaves of *A. altissima* over time across light treatments.

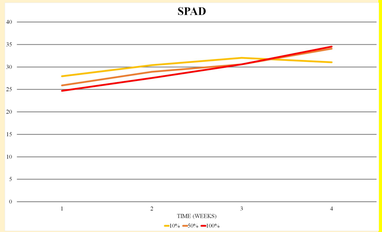

Figure 11: SPAD measurements of *A. altissima* over time across light treatments.

Discussion

Germination

Although all the species tested are closely related, they responded differently to the light intensities tested during germination. Previous studies state that small seeded-plants tend to have light as germination requirement (Milberg *et al*, 2007); however, only *E. purpureum* had this characteristic.

A. altissima was the fastest of the three species to germinate, it also had the greatest germinability percentage. *S. ulmifolia* was the slowest to germinate and had the least germinability.

Vegetative development

Conventional plant responses to low light intensities include taller plants with greater number of leaves, thinner leaves, and with higher photosynthesis rates (Smith and Whitelam, 1997), although *A. altissima* responded differently.

Conclusions

Most habitats in the prairie are exposed to bright sunlight and these results indicate these Asteraceae species are adapted to live and grow under bright light.

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Acknowledgments

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