Effects of Climatic and Edaphic Factors on Seedling Establishment of *Lespedeza virginica* and *L. capitata*

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Introduction

Predicted increases in future temperatures have the potential to alter the stability and geographic range sizes of plant populations. Rising temperatures will cause species to migrate to higher latitudes or elevations.[2] However, if the population migration rates are slow or if the species has a narrow niche breadth (i.e. can only tolerate a limited range of environments), the population risks extinction or a decrease in abundance.[1 2] A study on Rhododendron species in China found that climatic and edaphic (related to soil) factors, in particular, were important in their range distribution.[2]

The seedling establishment stage of plants includes early growth and survivorship, an important stage for colonization and population establishment. This life stage of a species is more sensitive to climatic variation and is thus more likely to impact the geographic range sizes and stability of populations than adult stages.[4] Understanding what soil factors may limit seedling growth under a changing climate will allow ecologists to predict the future distribution and stability of plant populations.

Hypotheses

#1) Higher temperatures will limit seedling growth of two prairie species: *Lespedeza virginica* and *L. capitata*.

#2) There will be no statistically different response between *L. virginica* and *L. capitata* under various temperature treatments.

#3) Nutrient levels and soil texture percentages will significantly affect seedling morphological traits.

Methods

Study Species and Source
Lespedeza virginica and *L. capitata* (Fabaceae) are native legumes, both with wide range distributions. Seeds were sourced from Prairie Moon Nursery and Roundstone Native Seed Company and collected from populations throughout each species' range.

Soil Sample Collection and Analysis
5 soil samples representing different characteristics were collected and analyzed. To quantify these differences, nutrient levels (NH_4, NO_3 , PO_4) and soil textures (%Sand, %Silt, %Clay) were measured through colorimetric methods and the hydrometer method, respectively.

Seedling Growth
Twenty four seeds for each species (twelve from each source) were placed on each of the 5 soil types in petri dishes, and then transferred to the same soil once germinated. This was replicated in three Precision 818 incubators set at the following temperature regimes: 17.5° / 9.5° C, 20.0° / 10.0° C, and 22.5° / 12.5° C. Water was provided as needed. The coldest (17.5° / 9.5° C) incubator was found to be warmer than expected (up to 22.5°C) halfway through the experiment.

Measurements
Days to Cotyledon for each seedling was tracked. After 3 weeks, seedlings were harvested and morphological traits were measured.

Data Analysis
Data analysis was completed in R version 3.3.1.

Results

Trait	Species	Soil	Temp
Shoot Length	NS	****	****
Root Length	***	****	*
Total Biomass	*	**	****
Shoot:Root	***	NS	**
%Hypocotyl	NS	**	****
Days to Cotyledon	****	*	****

*p<0.05; **p<0.01; ***p<0.001; ****p<0.0001

Table 1 The summarized results of a Three Factor ANOVA conducted on various measured seedling traits. There were no significant interactions between the three factors.

Temperature

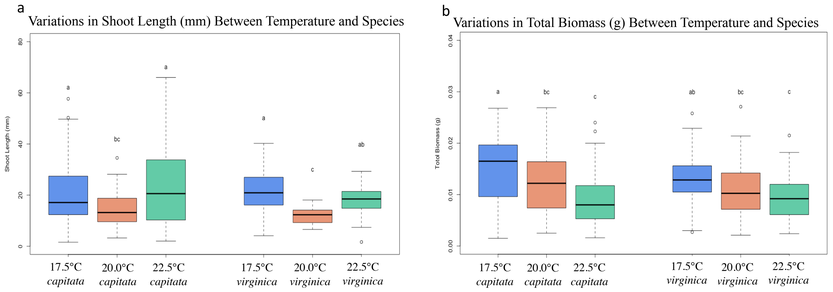

Figure 1(a, b) shows boxplots representing Tukey HSD Post Hoc tests run for Shoot Length and Total Biomass between species and temperature regimes. Different letters indicate significantly different responses to temperature.

Soil

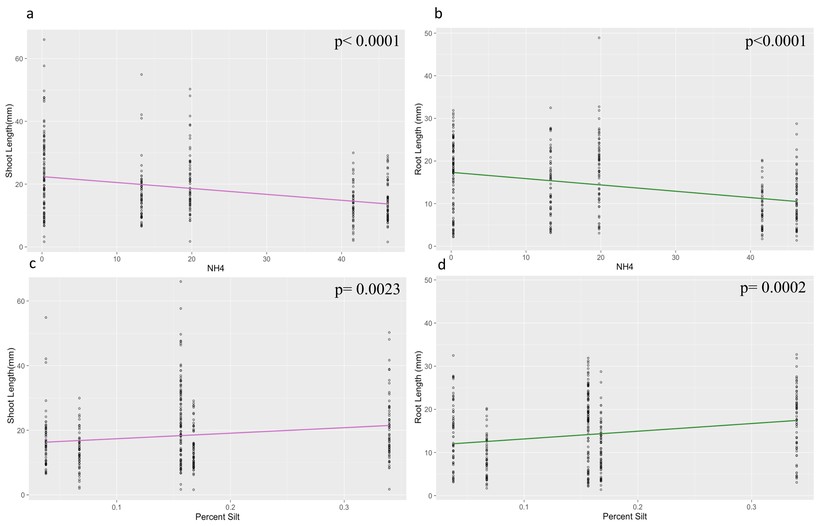

Figure 2 (a-d) shows the results of a Backwards Elimination Regression for Shoot Length and Root Length on various soil factors.

Discussion

Temperature: In the higher temperature regime, figure 1(a) shows an increase in shoot length while figure 1(b) shows a decrease in total biomass. This is an indication of faster growth in the higher temperatures but a potential decrease in vigor. This result matches observations of tall but frail seedlings in the 22.5°C incubator. Seedlings exhibiting this morphology may not survive well under stressful environmental conditions and populations may shift to higher latitudes or elevations. Both *L. virginica* and *L. capitata* responded similarly to different temperature treatments (Figure 1), indicating that these species may behave similarly in the face of climate change.

Soil: There was a significant negative correlation between shoot length and NH_4 and between root length and NH_4. Conversely, there was a significant positive correlation between these traits and % silt. Silt is characterized as having high water retention, and could be negatively correlated to NH4. It may be that seedling growth was driven by soil moisture rather than negatively impacted by NH_4.

Conclusion

#1) Higher temperatures resulted in higher shoot lengths but lower total biomass.

#2) While there were significant differences between measured traits for each species, the pattern of responses to temperature did not differ between the two species.

#3) Percent Silt and NH_4 levels in soils significantly explained differences in seedling growth.

References

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