The Phenology of Native and Invasive Species' Chlorophyll Levels

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ABSTRACT

Invasive species threaten biodiversity and, as a result, ecosystem stability. One hypothesis for invasive species success in Connecticut forests is that they are active earlier and later in the growing season than native species. As such, they may have more time to capture light for growth. The amount of light available can also be affected by canopy species: different tree species flush and drop their leaves at different times of the year, determining periods of light and shade in the understory.

This study focuses on patterns of autumn chlorophyll loss in invasive and native species in the understory. I hypothesize that increased chlorophyll will result in greater success due to increased sunlight retention. Four invasive species–burning bush, Multiflora rose, oriental bittersweet, Japanese barberry–and four native species–common blackberry, mountain laurel, spicebush, Virginia creeper–were grown in common gardens under three forest covers: Ash, Maple, and Oak. Chlorophyll levels were measured every other day from July to November.

Overall, invasive species have higher amounts of chlorophyll than their native counterparts. Native species sharply dropped after 18 October, except Virginia creeper, which steadily declined from August. Vines lost chlorophyll earlier and roses kept their chlorophyll later than other plant functional groups.

Keeping their chlorophyll later in the growing season may allow invasive species to gain additional sunlight, especially under tree species that drop their leaves earlier in the fall.

INTRODUCTION

Some invasive species are able to successfully thrive in deciduous forest ecosystems where the canopies cause lower light intensity during the growing season. Their success may oppress native species and lead to decreased biodiversity and native species' decline. With a need for healthy forest communities, it is in our best interests to determine what factors may be contributing to invasive species success in these ecosystems and differences in invasive and native species responses.

One key component to invasive success may be their unique phenology, or seasonal cycles. In deciduous forests of New England many plants senesce leaves during the autumn months. Under heavy forest canopies little light penetrates, making it difficult for younger plants to thrive; therefore, species that can obtain light by having their leaves out when the canopy is bare may have much greater success than their counterparts. Some studies have shown that invasive species have different phenologies than native species and senesce at different time periods.[4,5] If invasive plants keep their leaves on later in the fall, after the canopy has dropped its leaves, they could have a distinct advantage in gaining more resources– light– than natives.

In this project, the chlorophyll levels of native and invasive species were compared during the transition from summer to winter dormancy; through this the activity levels of the species can be compared to find trends. I hypothesize that higher chlorophyll levels will be present in invasive species since they will be able to utilize more light than native species.

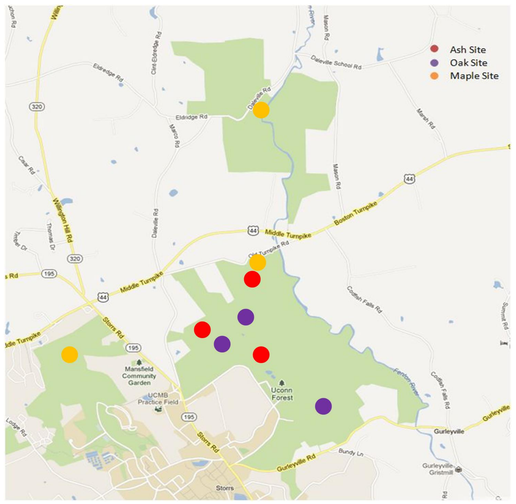

Fig 1. A map of the sites in Uconn Forest. Red: Ash sites; Purple: Oak sites; Orange: Maple sites.

MATERIAL AND METHODS

I measured chlorophyll levels of invasive and native plants under three different tree type canopies via SPAD-502 Plus Chlorophyll Meter (Fig. 2)–LED lights are shone through the leaf at wavelengths absorbed by chlorophyll a and b. The light that passes through the leaf is measured to calculate the amount of chlorophyll.

Study Area and Organisms

Sites:

- UConn Forest (Temperate Deciduous) (Fig. 1)
- 3 under Maple (*Acer saccharum*), 3 under Ash (*Fraxinus americana*), 3 under Oak (*Quercus rubra*) – These are common tree species in Connecticut and have different phenologies (Fig. 1)

Species:

- Invasive vine (Oriental bittersweet: *C. orbiculatus*), two shrubs (burning bush: *Euonymus alata* and Japanese barberry: *Berberis thunbergii*), and a rose (Multiflora rose: *Rosa multiflora*) and their native counterparts; Virginia creeper: *Parthenocissus quinquefolia*, mountain laurel: *Kalmia latifolia,* spicebush: *Lindera benzoin*, and common blackberry: *Rubus allegheniensis*, respectively. (Fig. 4) All species are commonly found in Connecticut forests.

Data Collection

In each of the three plots, the chlorophyll levels were measured every other day for each of the species listed above from late July until leaf senescence (Fig. 2). The measurements were compared between species over the season and also contrasted to canopy phenology.

Fig 2. (Left) The chlorophyll meter. (Right) Use of the chlorophyll meter within a test site.

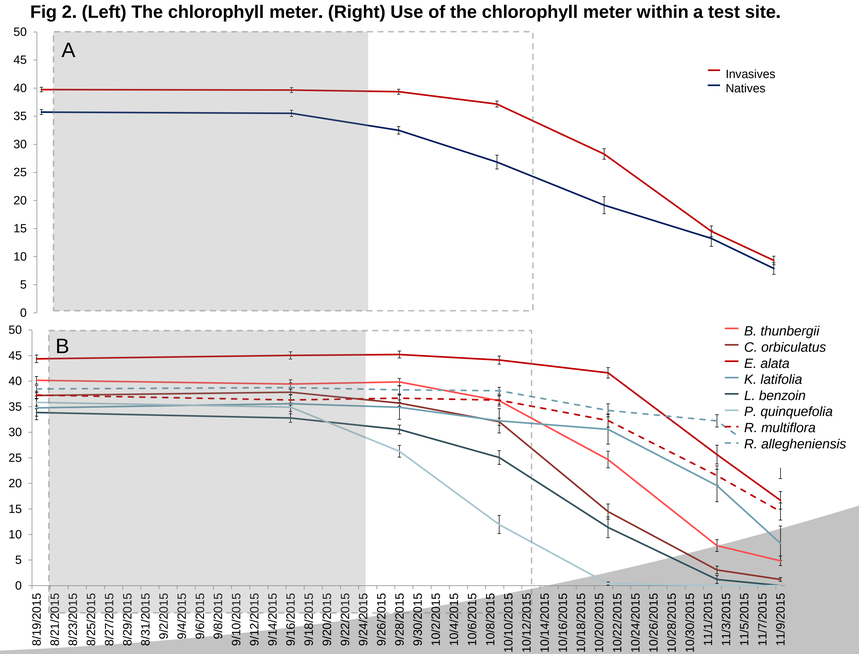

Fig 3. Average chlorophyll levels of A) invasive and native species groups and B) all species separately from October to November. The shaded box represents the Ash and Maple canopy, while dotted-line box represents the Oak canopy

RESULTS

Invasive species chlorophyll levels averaged approximately 35 (Fig 3a). *E. alata* remained higher than the average at 42 (Fig 3b). Native species chlorophyll levels averaged approximately 33 (Fig 3a). Chlorophyll content began to drop after 19 October, in natives especially, decreasing from a 37 average (September-October) to a 22 average in early November; it may be deduced that dormancy and reabsorption begins in mid-late October (Fig 3). Chlorophyll levels in *E. alata* decreased slightly later, at 23 October (Fig 3b). Contrarily, chlorophyll in the two roses (*R. multiflora*, and *R. allegheniensis*) remained effectively constant throughout late October and early November. *P. quinquefolia* was most unique, decreasing at a low rate (about 15 total from 18 September to 19 October) following 18 September, much earlier in the season than other species (Fig 3b).

When native trees drop their leaves, retaining its leaves allows *E. alata* to still receive ample light, furthering its success. *R. multiflora* and *R. allegheniensis* employ similar tactics, producing a second set of leaves to take advantage of the fallen Ash and Maple canopies.

Fig. 4 (Top) invasive species *B. thunbergii, E. alata, C. orbiculatus, R. multiflora* and (Bottom) native species *L. benzoin, K. latifolia, P. quinquefolia, R. allegheniensis*

CONCLUSIONS

My hypotheses put forth that invasive species would have higher chlorophyll levels and retain chlorophyll later in the growing season, leading to ability to utilize more sunlight. Invasive species may fill a unique niche[3,4,5] in that their leaves continue to be active when many native species are inactive, giving them an advantage; they would have access additional light and resources. Invasive species tend to retain chlorophyll longer and have higher levels than their counterparts.[4,5] This pattern holds when comparing native and invasive species of the same functional group. For example, *C. orbiculatus*, a woody vine, had similar levels of chlorophyll as native vine *P. quinquefolia*, but retained its chlorophyll significantly longer.[2,4] For roses, seasonal chlorophyll patterns in the invasive species, *Rosa multiflora*, closely resembled that of native *R. allegheniensis*. However, I observed that the invasive rose produces a second set of leaves late in the fall (not included in data), which would allow it to take advantage of senesced canopies alike *E. alata*.

Species that retain high levels of chlorophyll after the Ash and Maple canopies fall are able to take advantage of the resulting available sunlight. The Oak canopy falls in late October when all tested species' levels began to drop with exception of the roses. Under this late-senescing canopy, species alike *R. multiflora* that retain chlorophyll much longer than average may experience increased success over species whose levels decline before or as the canopies senesce.

Previous studies suggest that shade tolerance is an especially important factor for invasive species[4,5]; furthermore, two highly prevalent invasives[4], *C. orbiculatus* and *E. alata*, are effective under shade. Perhaps more important than shade is native and invasive phenologies and their changes: as global temperatures change, phenological patterns may also change, potentially proving beneficial or detrimental to many species.[3,5]

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