**Negative effects of an allelopathic invader on native plant species’ carbon assimilation are driven by species-specific mechanisms**

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**Abstract**

Invasive plants exploit strategies that maximize their competitive success for establishment in novel ecosystems. Allelopathy, a ‘novel weapon’ defined as a secondary compound produced by a plant that negatively impacts neighboring plant species and soil microbial communities, has gained traction as a mechanism to explain the widespread success of invasive plant species. Previous work estimates that ~72% of invasive plant species demonstrate the ability to produce and secrete allelopathic compounds. Allelopathy-mediated plant invasion reorganizes belowground arbuscular mycorrhizal (AM) fungal communities, which may have important consequences for native plant species resource provisioning, uptake, and allocation to organs that support primary productivity and reproduction. Recent work indicates that altered AM fungal community composition due to allelopathic plant invasion can modify plant water and nutrient economies. However, mechanisms that drive these responses have not been well characterized, limiting our ability to make inferences about the role of allelopathic plant invasion on native plant physiology, primary productivity, and survivorship.

Here, we show that Alliaria petiolata, an allelopathic invader that reorganizes AM fungal communities by secreting glucosinolates belowground, negatively affected leaf gas exchange in two native understory AM-associating plant species (Maianthemum racemosum and Trillium spp.) growing in a long-term A. petiolata field manipulation experiment. Alliaria petiolata presence decreased M. racemosum net photosynthesis and stomatal conductance and increased stomatal limitation of net photosynthesis. The positive effect of *A. petiolata* presence on *M. racemosum* stomatal limitation was only observed after the tree canopy closed and soil nitrogen availability decreased. In contrast, A. petiolata presence decreased maximum rates of Rubisco carboxylation and electron transport for RuBP regeneration in Trillium spp., but this pattern was also only apparent after the tree canopy closed and soil nitrogen availability decreased. Reduced photosynthetic capacity in Trillium spp. was observed despite no effect of A. petiolata presence on net photosynthesis or stomatal conductance. Overall, results indicate that mechanisms that drove the negative effects of A. petiolata presence on native plant physiology were species-specific. Reduced net photosynthesis rates in M. racemosum may have been the result of changes in water use that increased stomatal limitation, while reduced photosynthetic capacity in Trillium spp. may have been the result of reduced nitrogen uptake that reduced allocation to photosynthetic leaf tissue

**Optimal resource investment to photosynthetic capacity controls leaf and whole plant acclimation responses to elevated CO2**

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Plants acclimate to increasing CO2 by reducing leaf nutrient allocation and photosynthetic capacity at the leaf level, a response that often occurs alongside growth stimulation at the whole plant level. Nutrient limitation has been hypothesized to be the primary mechanism driving leaf and whole plant acclimation responses to CO2, as nutrient availability commonly limits primary productivity and may decrease with increasing CO2 over time. However, recent work leveraging photosynthetic least-cost theory indicates that these acclimation responses may instead be the result of optimal resource investment toward photosynthetic capacity, which maximizes nutrient allocation to whole plant growth. Acclimation responses to CO2 may also vary in species with different nutrient acquisition strategies, but few studies have examined these responses across a soil nitrogen availability gradient and in species with different nutrient acquisition strategies. To test whether nutrient limitation or optimal leaf resource investment controls leaf and whole plant acclimation responses to CO2 and how nutrient acquisition strategy modifies these responses, we grew Glycine max L. (Merr) seedlings under two atmospheric CO2 levels, with and without Bradyrhizobium japonicum inoculation, and across nine soil nitrogen fertilization treatments in a full factorial growth chamber experiment. After seven weeks, G. max demonstrated a strong downregulation in leaf nitrogen content, Vcmax25, and Jmax25 under elevated CO2, patterns that was not causally linked to changes in soil nitrogen fertilization or inoculation treatment. A relatively stronger downregulation in leaf nitrogen content than Vcmax25 increased the proportion of leaf nitrogen content allocated to photosynthesis, while a relatively stronger downregulation in Vcmax25 than Jmax25 stimulated Jmax25:Vcmax25 under elevated CO2. These leaf acclimation responses to elevated CO2 corresponded with strong stimulations in total leaf area and total biomass, a pattern that was generally enhanced with increasing fertilization and in inoculated pots. Whole plant acclimation responses to CO2 were driven by reductions in the cost of acquiring nitrogen with increasing fertilization and inoculation. Overall, these results provide strong support for patterns expected from photosynthetic least-cost theory, showing that optimal resource investment is the primary mechanism governing G. max acclimation responses to elevated CO2.

**Recent precipitation diversifies the root and rhizosphere bacterial microbiome of two Texas prairie grasses: Implications for future field sample analysis**

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**Abstract**

The long-term impacts of annual precipitation on the plant rhizosphere and endophytic microbiome have been thoroughly investigated, but the short-term impacts of precipitation events have received less focus. Understanding the shifts in the plant microbiome in response to short-term perturbances like rain events may reveal a key confounding factor in microbiome studies, and understanding how the reactions of the microbiome differ between species may elucidate differences in how those species interact with their environment. In this study, leaf, root, and rhizosphere samples from two Texas prairie grass species – King Ranch bluestem (*Bothriochloa ischaemum* (L.) Keng.), an invasive species, and little bluestem (*Schizachyrium scoparium* (Michx.) Nash.), a native species – were collected from sites across the state of Texas with varying periods of time passing since a rain event. Upon sequencing the 16S rRNA gene to reveal bacterial microbiomes of those samples, a strong increase in diversity immediately following a rain event was found in the rhizosphere. The root endophytic microbiomes of the two grasses showed a similar, but weaker, response, with class Alphaproteobacteria enriched in root samples of both species collected during a rain event. The leaf endophytic microbiome showed the weakest response to the number of days since precipitation, but a strong increase in bacterial diversity was seen in samples that experienced a high amount of precipitation in the previous month. The observed strong difference in the root and rhizosphere microbiomes reveals time since precipitation as a key factor in microbiome composition in grass roots and the near-root microbiome, one that should be considered by field studies moving forward.