Leaf acclimation to elevated CO_2 is independent of soil nitrogen fertilization and rhizobial inoculation

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Abstract
Plants acclimate to increasing CO_2 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 CO_2, as nutrient availability commonly limits primary productivity and may decrease with increasing CO_2 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 CO_2 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 CO_2 and how nutrient acquisition strategy modifies these responses, we grew *Glycine max* L. (Merr) seedlings under two atmospheric CO_2 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, V_{cmax25}, and J_{max25} under elevated CO_2, patterns that were not causally linked to changes in soil nitrogen fertilization or inoculation treatment. A relatively stronger downregulation in leaf nitrogen content than V_{cmax25} increased the proportion of leaf nitrogen content allocated to photosynthesis, while a relatively stronger downregulation in V_{cmax25} than J_{max25} stimulated J_{max25}:V_{cmax25} under elevated CO_2. These leaf acclimation responses to elevated CO_2 corresponded with strong stimulations in total leaf area and total biomass, a pattern that was generally stronger with increasing fertilization and in inoculated pots. Whole plant acclimation responses to CO_2 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 CO_2.