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

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INTRODUCTION

- Elevated CO_2 (eCO_2) reduces stomatal conductance and photosynthetic capacity, but mechanisms driving these responses remain unclear
- **Progressive nitrogen (N) limitation** – **leaf responses to eCO_2 are a function of** progressive **declines in soil N availability**. Soil N is hypothesized to decline over time under eCO_2 due to chronic increases in plant N uptake associated with increased plant N demand
- **Optimal coordination theory** – **leaf responses to eCO_2 are** driven by optimal investment to photosynthetic capacity. This allows net photosynthesis rates to be equally co-limited by Rubisco carboxylation and RuBP regeneration, but responses are **independent of soil N availability**

EXPERIMENT DESIGN

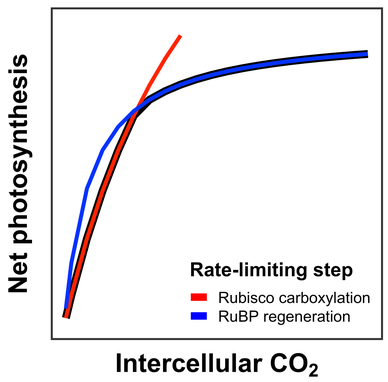
1 Species (*Glycine max*)

2 CO_2 concentrations (420 ppm, 1000 ppm)

2 Inoculation treatments (+/- *B. japonicum*)

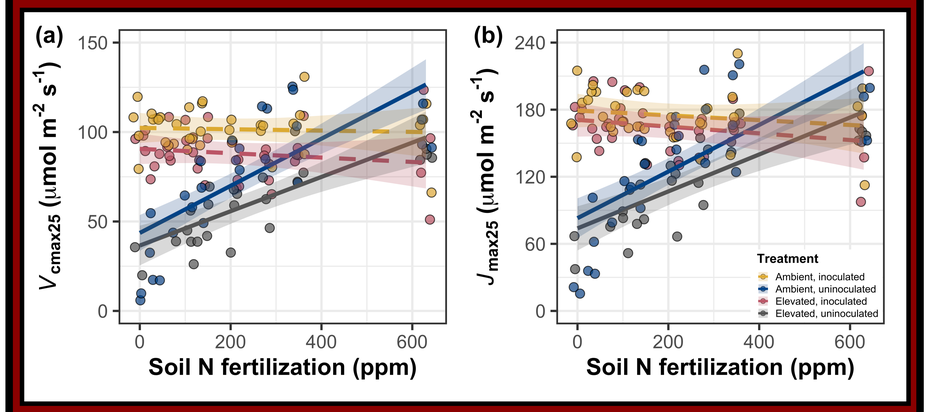
9 Fertilization treatments (0-630 ppm N)

MEASUREMENTS AND CALCULATIONS

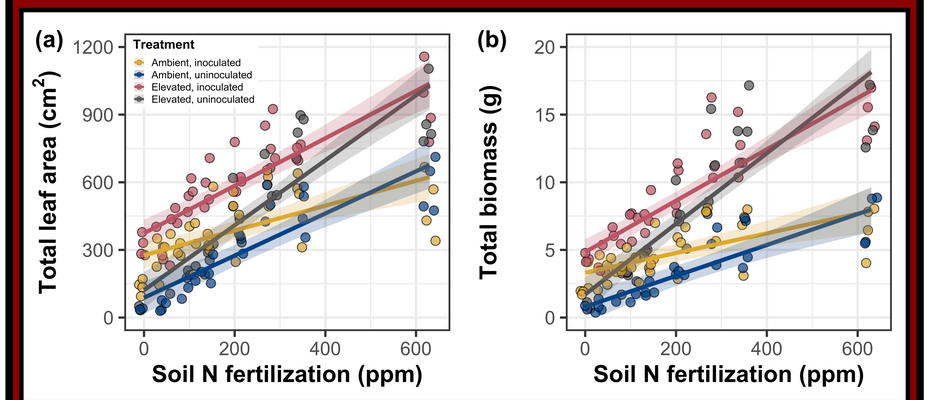


- **CO_2 response curves**
  - Maximum rate of Rubisco carboxylation (V_{cmax25})
  - Maximum rate of RuBP regeneration (J_{max25})
- **Total leaf area, total biomass**
- Cost to acquire N (N_{cost})
- % N fixed from the atmosphere ($\%N_{dfa}$)

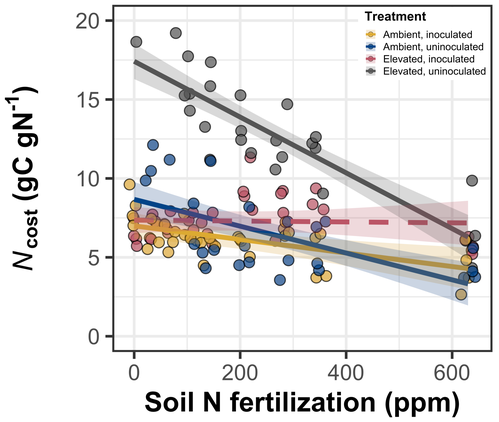
eCO_2 **reduced** investment in photosynthetic capacity **independent** of fertilization



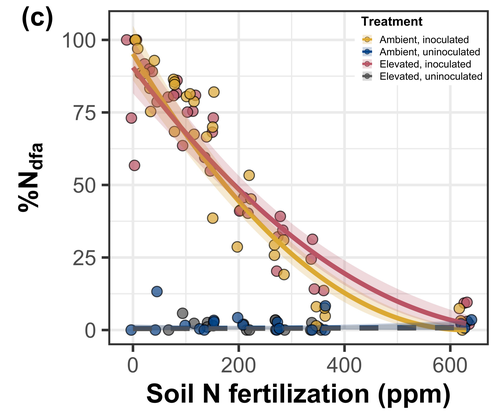
Increasing fertilization **increased** the **positive** effect of eCO_2 on whole plant growth



Elevated CO_2 **increased** costs of N acquisition, while increasing fertilization **decreased** costs of N acquisition



Increasing fertilization **reduced** investment in symbiotic N fixation **similarly** between CO_2 treatments



DISCUSSION AND CONCLUSIONS

Leaf responses to CO_2 support patterns expected from optimal coordination theory

- Reductions in V_{cmax25} and J_{max25} under eCO_2 were independent of fertilization or inoculation
- V_{cmax25} experienced stronger reductions under eCO_2 than J_{max25}, allowing net photosynthesis rates to approach optimal coordination of Rubisco carboxylation and RuBP regeneration

Whole plant responses to CO_2 support patterns expected from progressive N limitation

- Increased growth under eCO_2 was enhanced with increasing fertilization and in inoculated pots under low fertilization
- Elevated CO_2 increased whole plant N uptake

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