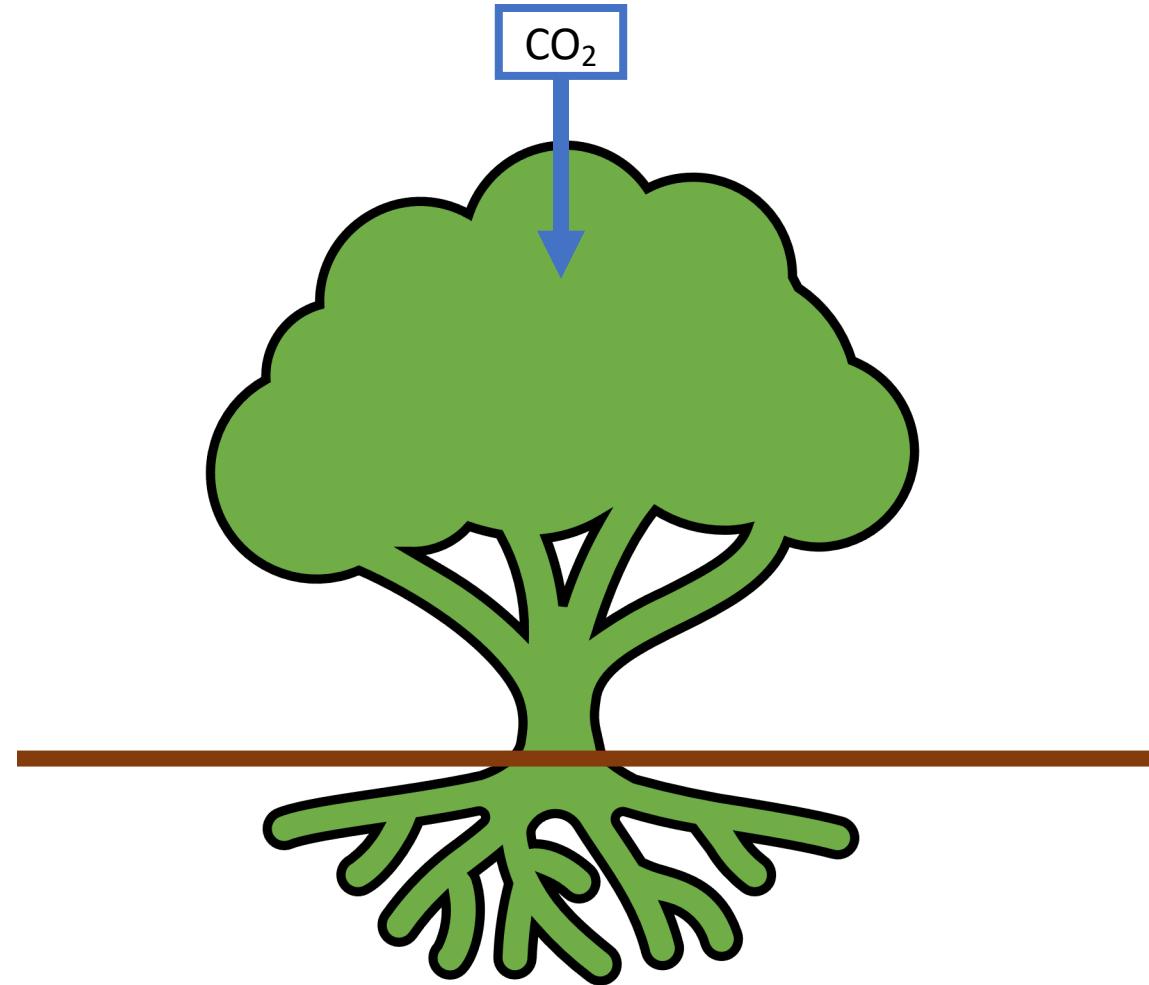


# Carbon costs to acquire nitrogen are determined by interactions between nitrogen availability and light availability in two species with different acquisition strategies

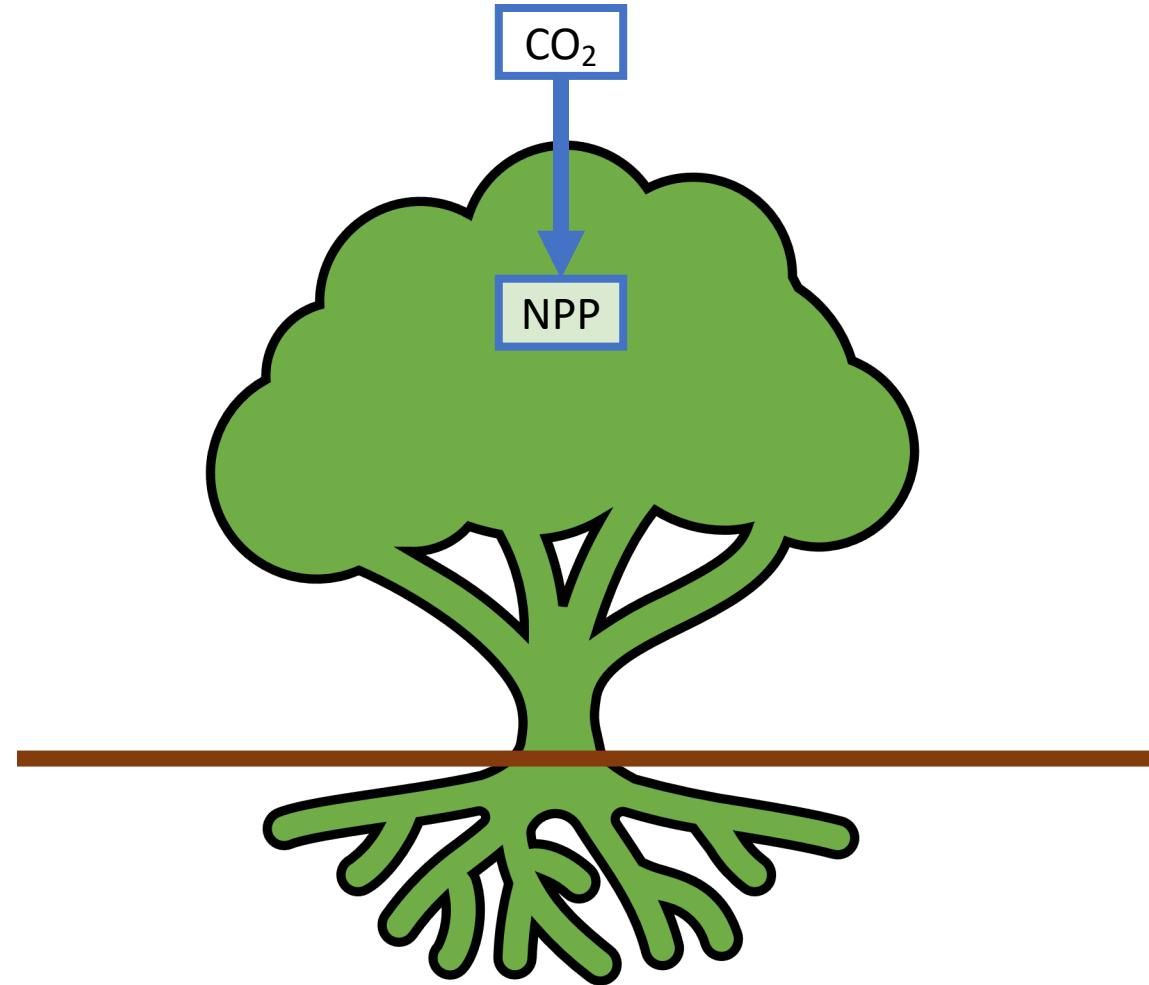
Evan A. Perkowski; Elizabeth F. Waring; Nicholas G. Smith

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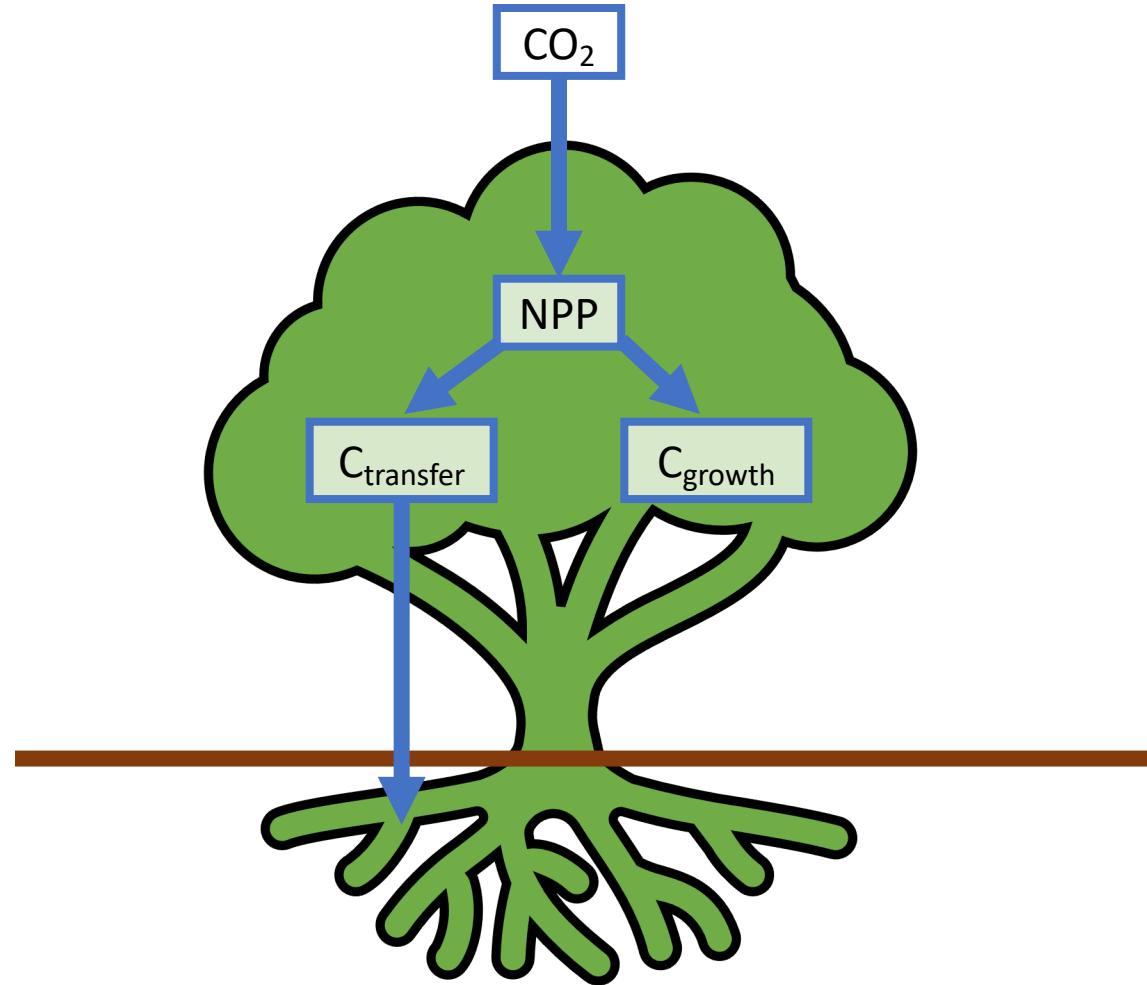
**Plant nitrogen acquisition is a process in terrestrial systems where carbon and nitrogen are tightly coupled**



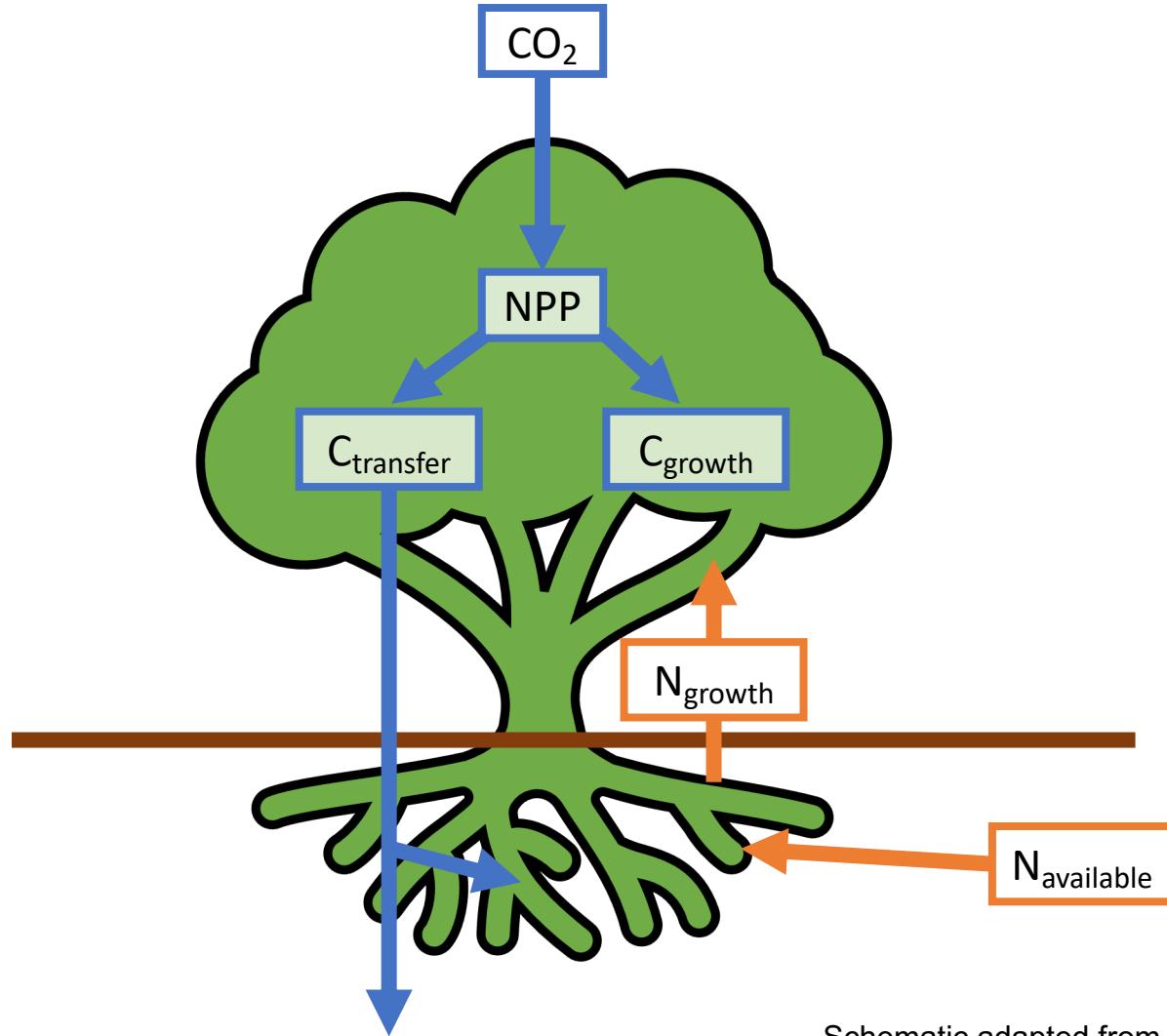
**Plant nitrogen acquisition is a process in terrestrial systems where carbon and nitrogen are tightly coupled**



# Plant nitrogen acquisition is a process in terrestrial systems where carbon and nitrogen are tightly coupled

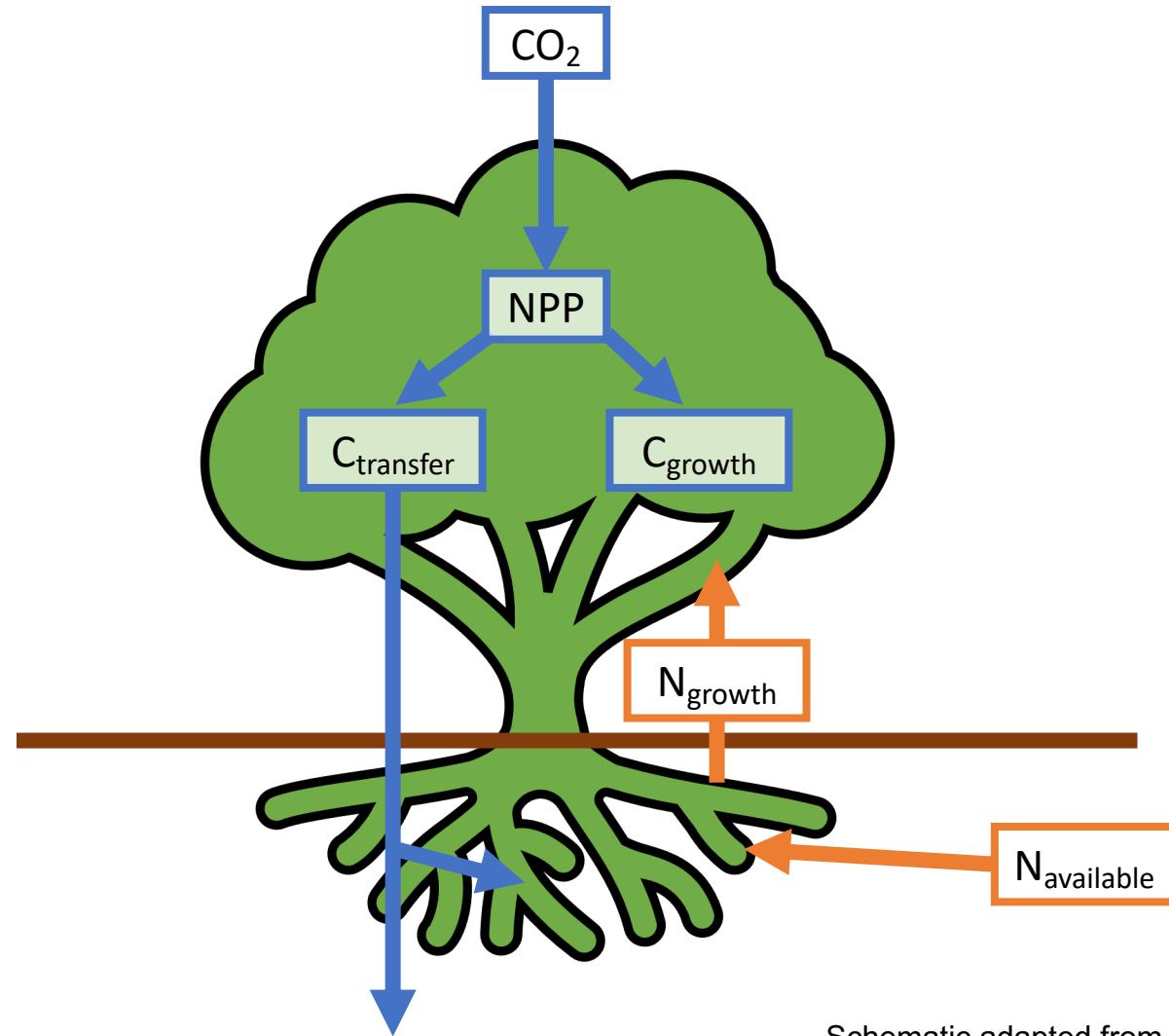


# Plant nitrogen acquisition is a process in terrestrial systems where carbon and nitrogen are tightly coupled



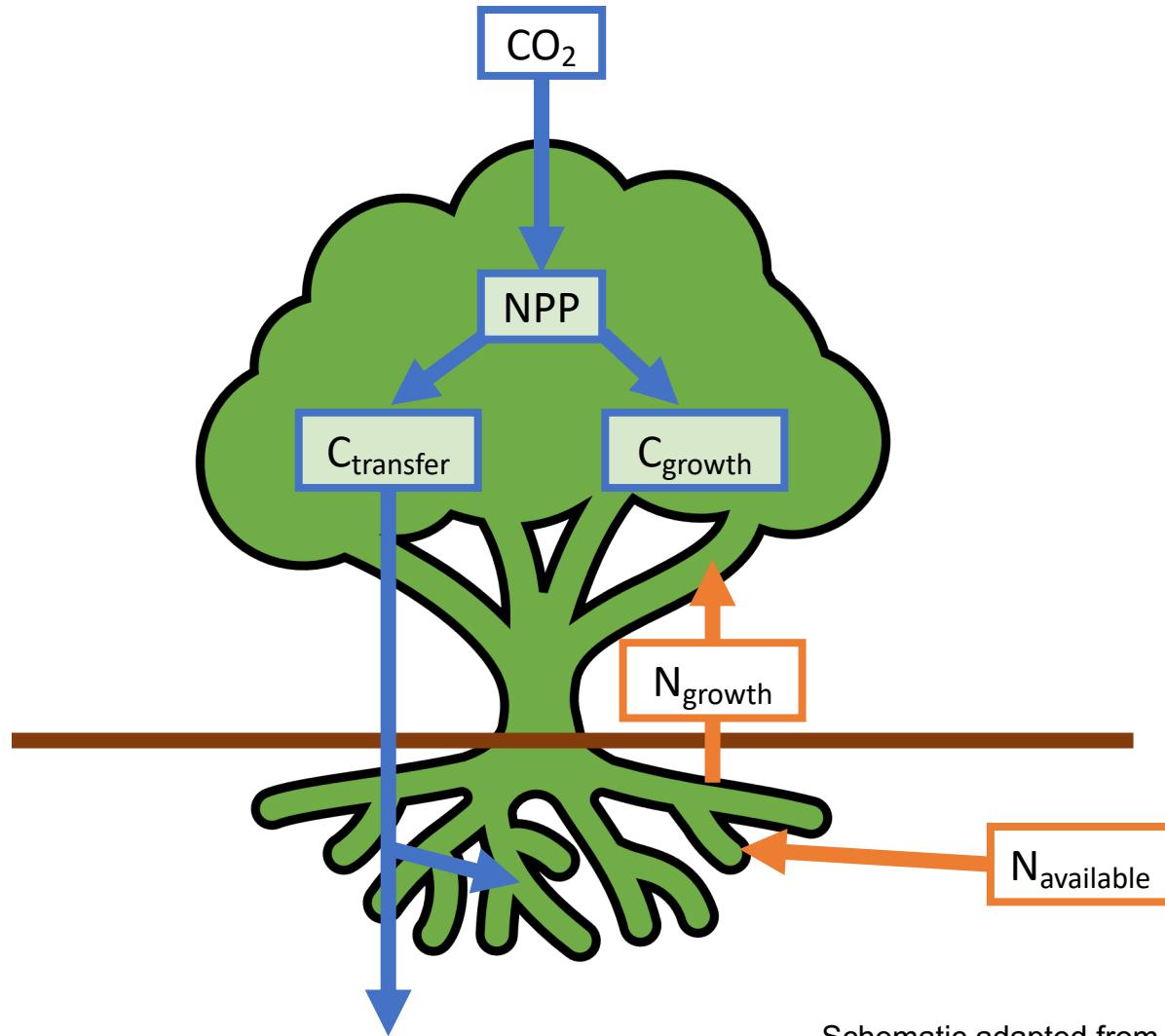
# Plant nitrogen acquisition is a process in terrestrial systems where carbon and nitrogen are tightly coupled

There are inherent  
carbon costs  
associated with  
acquiring nitrogen



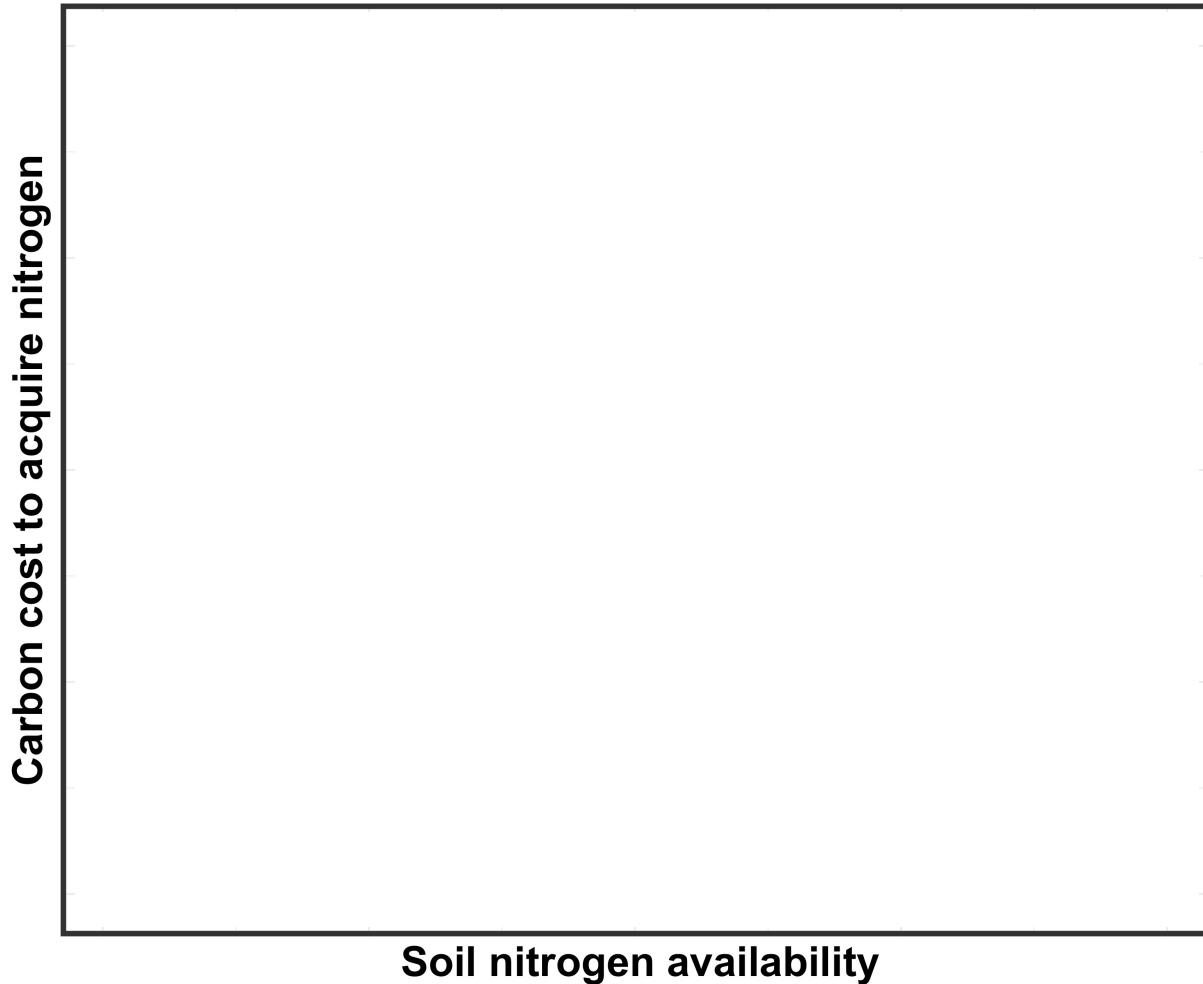
Schematic adapted from Brzostek et al. (2014) *JGR Biogeosciences*

# Soil nitrogen availability may decrease carbon costs to acquire nitrogen as a function of increased per-root nitrogen uptake

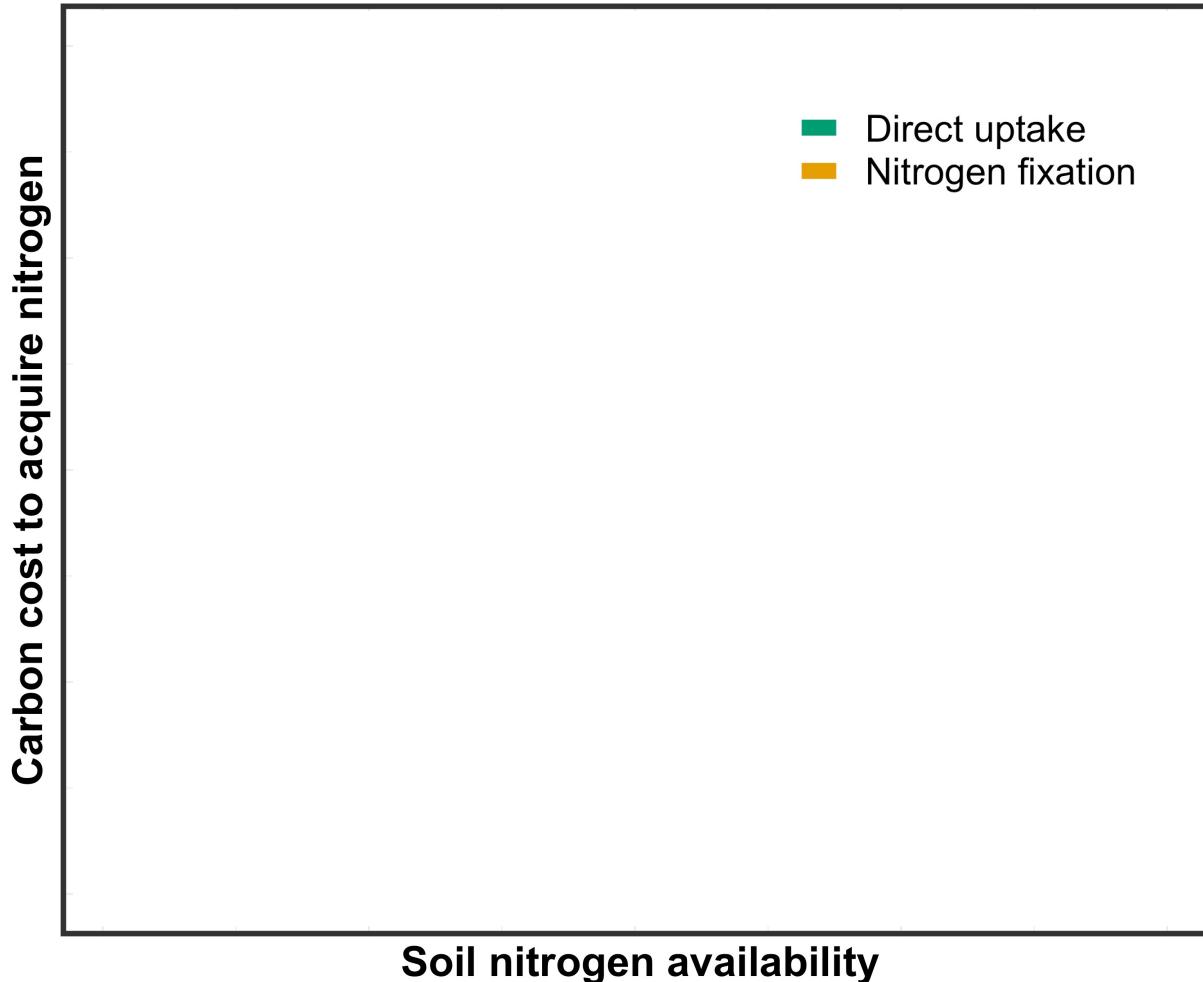


Schematic adapted from Brzostek et al. (2014) *JGR Biogeosciences*

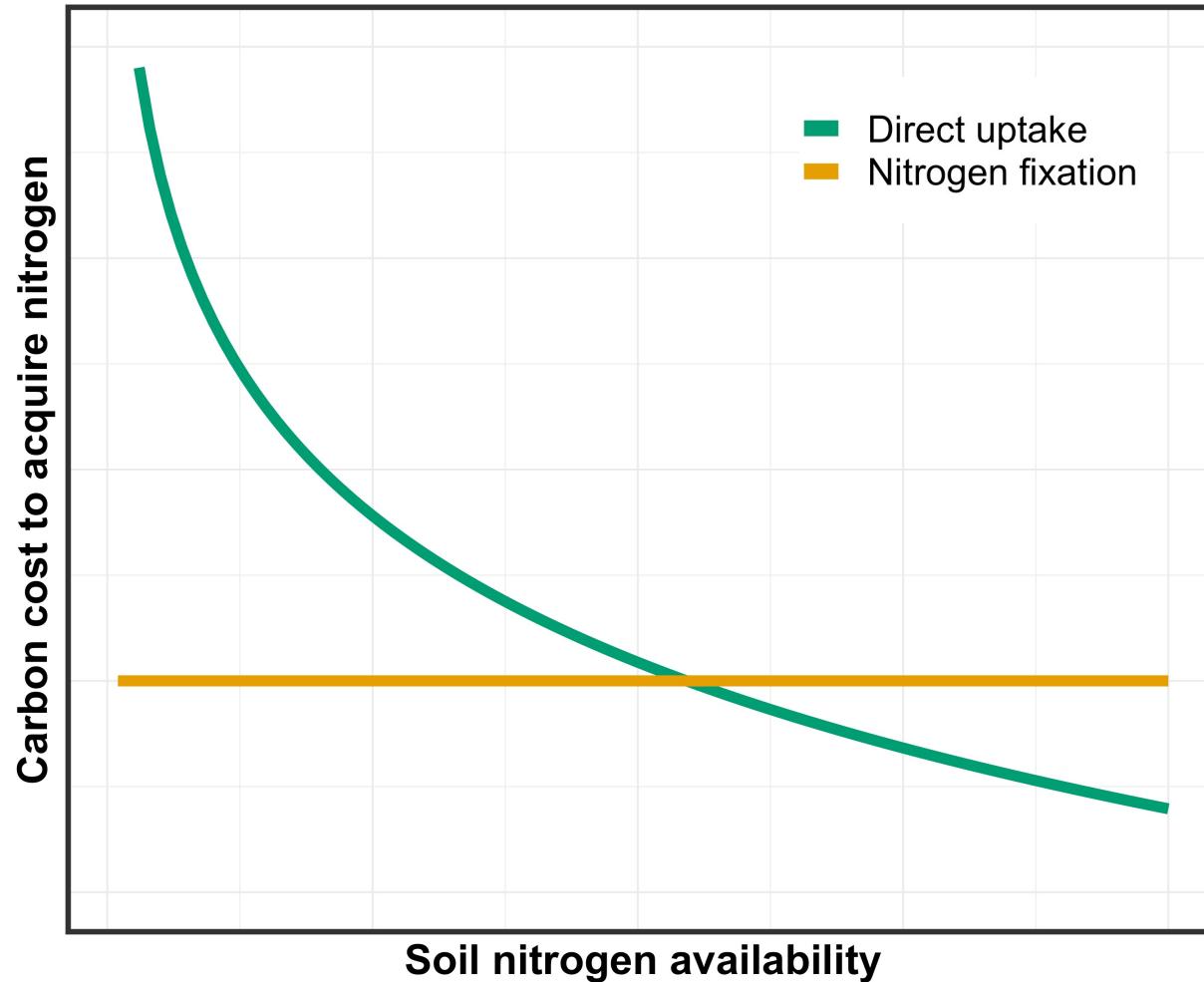
**However, effects of soil nitrogen availability on carbon costs to acquire nitrogen may be context dependent on species nitrogen acquisition strategy**



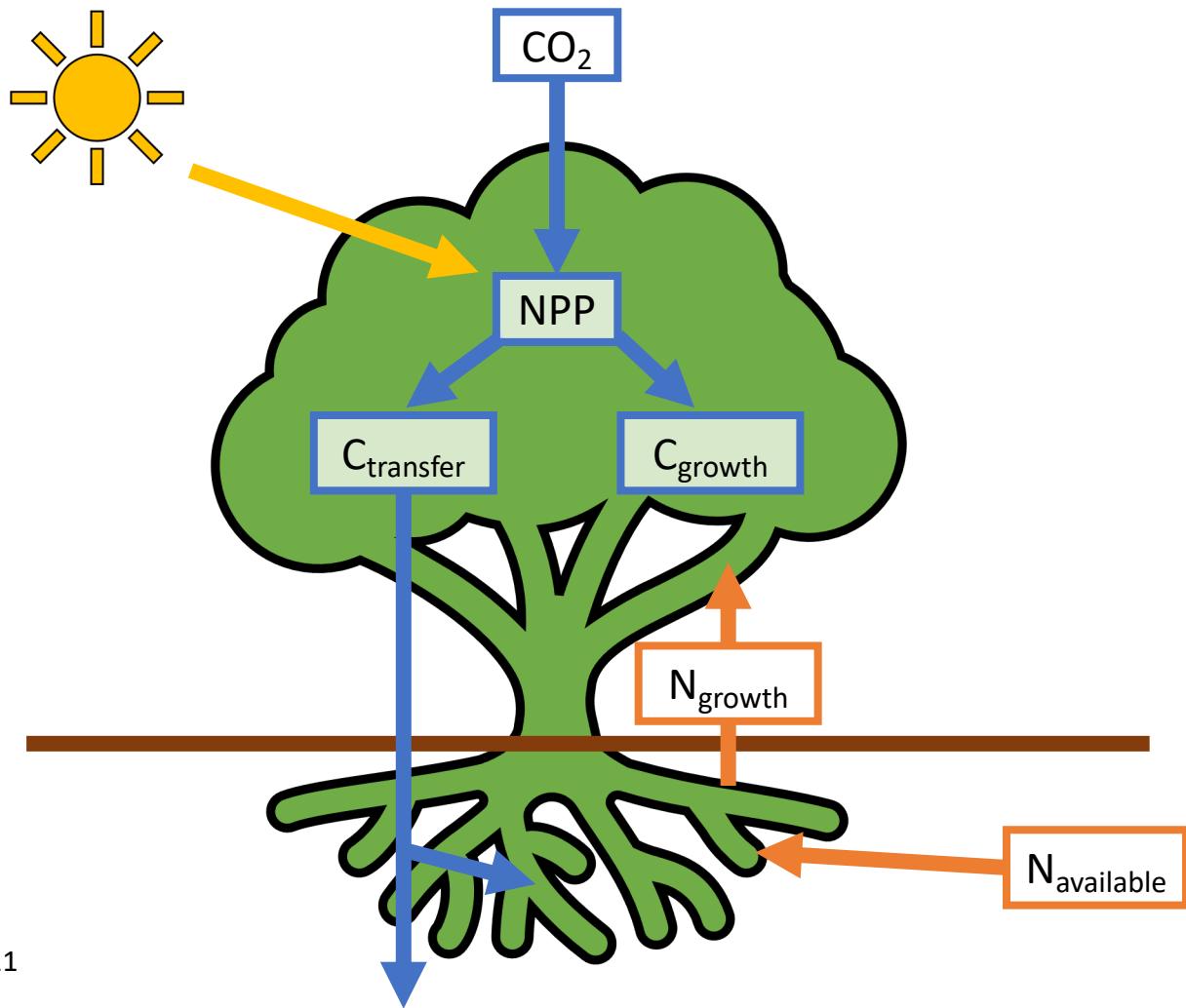
**However, effects of soil nitrogen availability on carbon costs to acquire nitrogen may be context dependent on species nitrogen acquisition strategy**



**However, effects of soil nitrogen availability on carbon costs to acquire nitrogen may be context dependent on species nitrogen acquisition strategy**



# Light availability may increase plant carbon costs to acquire nitrogen as a function of increased plant nitrogen demand



Increased plant nitrogen demand  
should increase belowground  
carbon investments

Over short temporal scales, this  
may not correspond with a  
simultaneous increase in plant  
nitrogen uptake

# **Primary Research Question**

**How does soil nitrogen availability and light availability influence plant carbon costs to acquire nitrogen?**

# Experimental setup

| Light availability treatments | Soil fertilization treatments | Species                   |
|-------------------------------|-------------------------------|---------------------------|
| 0% shade cover                | 0 ppm N                       |                           |
| 30% shade cover               | 70 ppm N                      | <i>Gossypium hirsutum</i> |
| 50% shade cover               | 210 ppm N                     | <i>Glycine max</i>        |
| 80% shade cover               | 630 ppm N                     |                           |

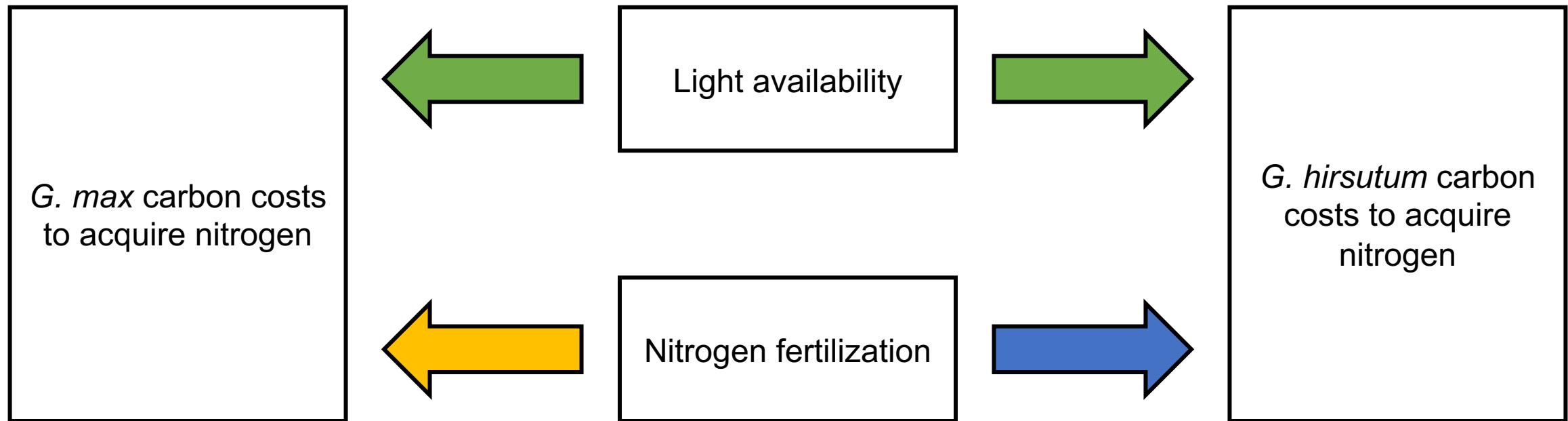
Carbon cost to  
acquire nitrogen

=

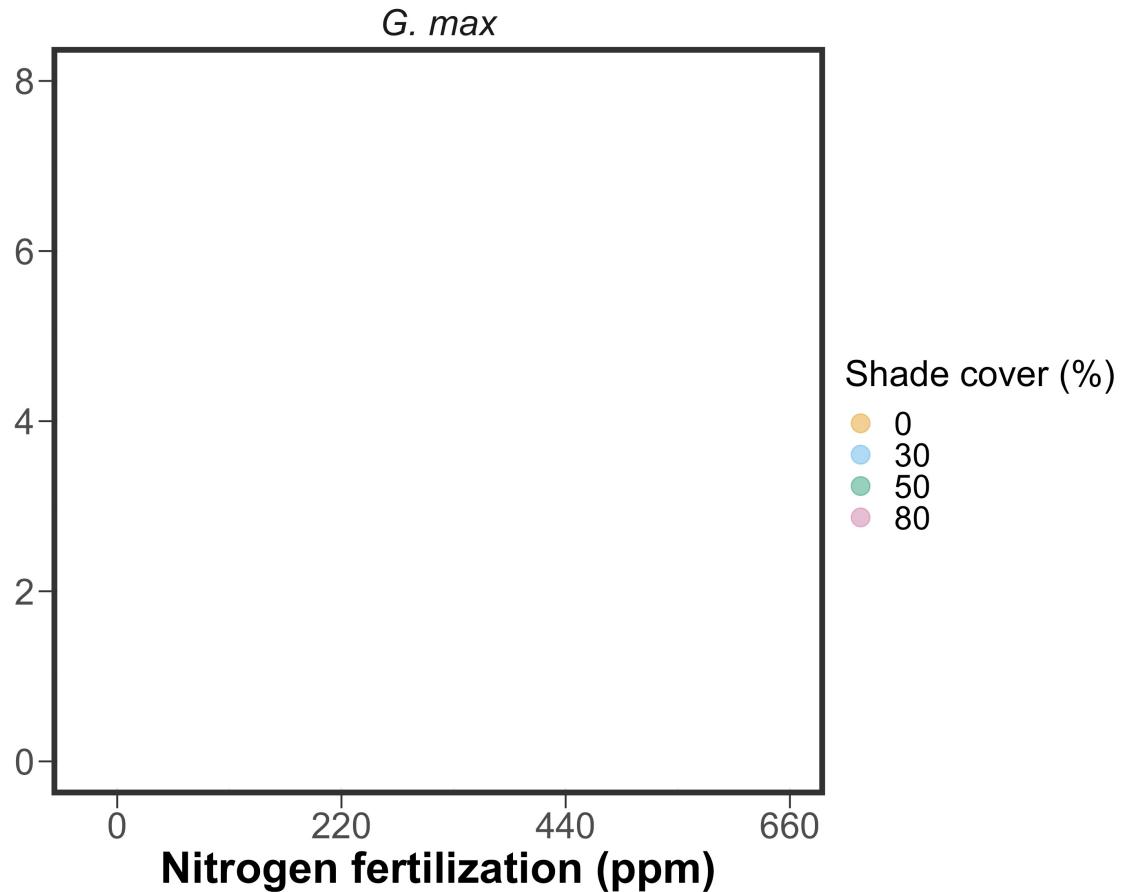
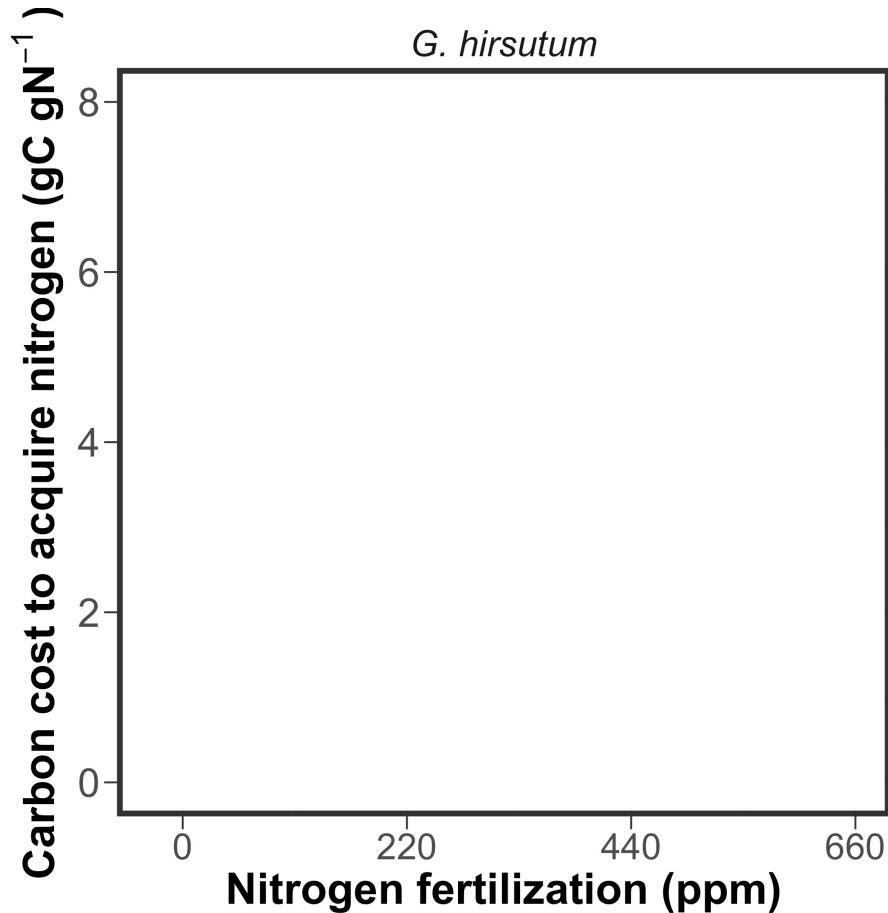
Root carbon biomass  
—  
Whole-plant nitrogen biomass

# Hypotheses

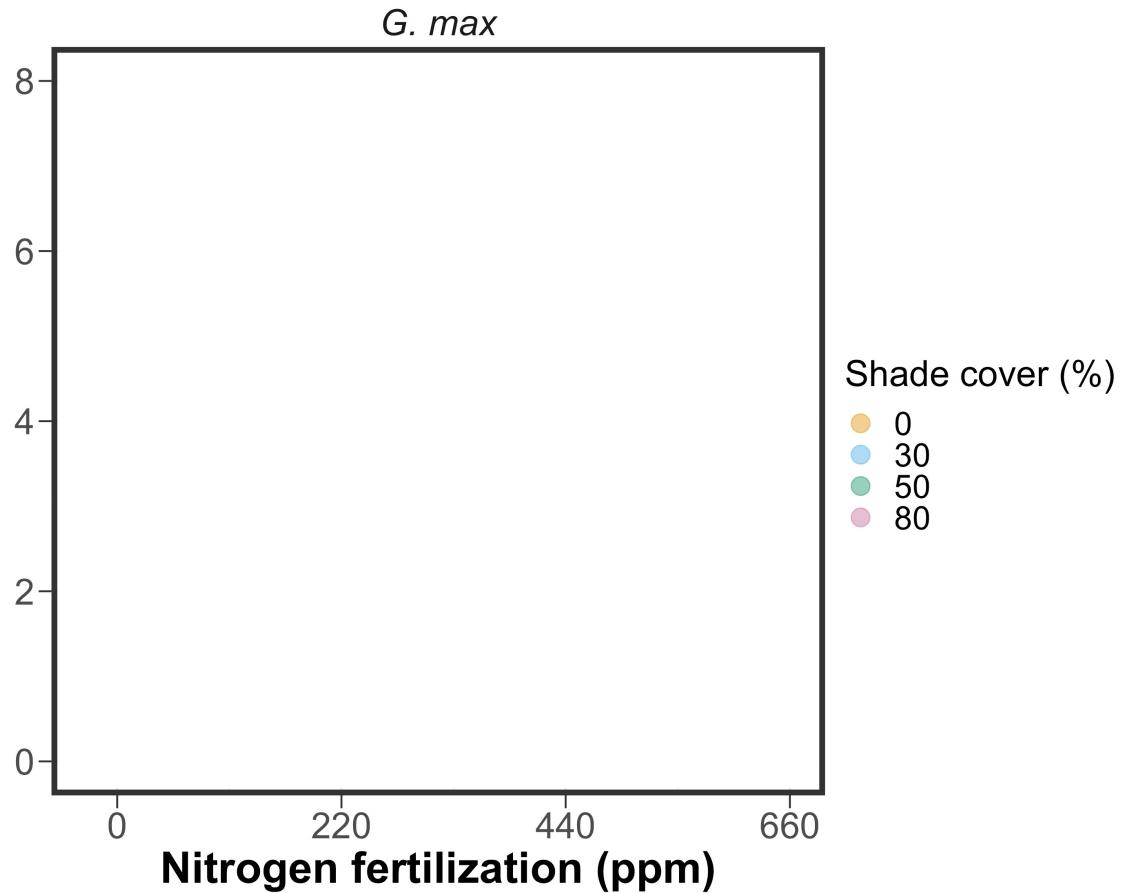
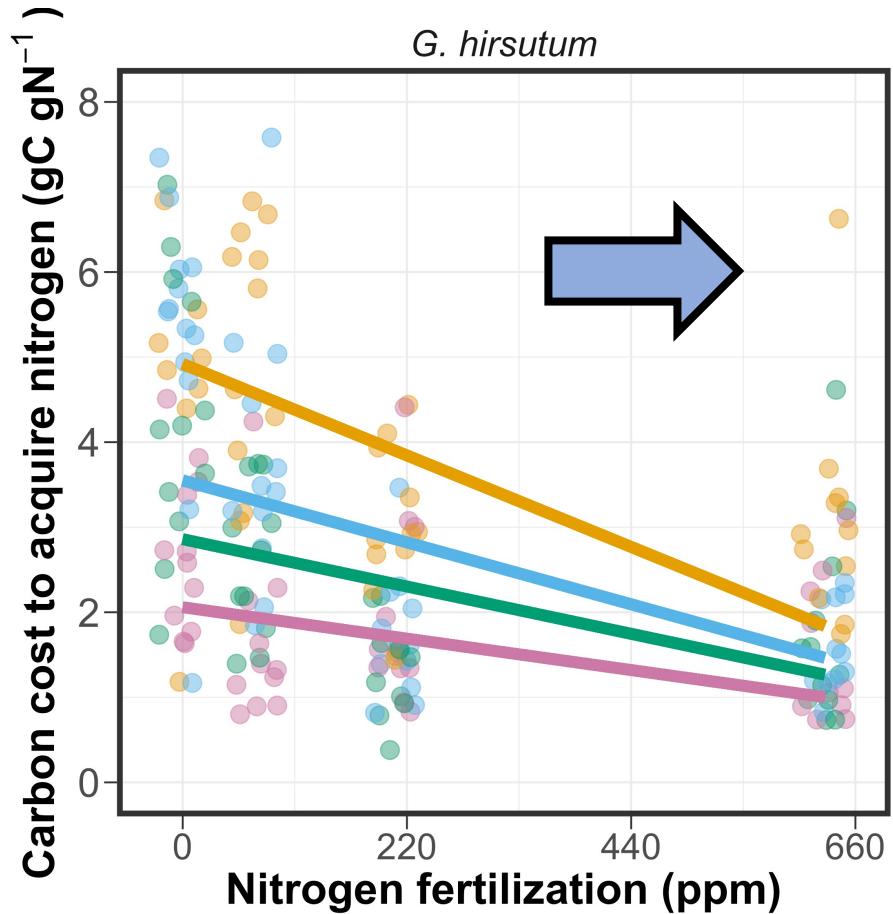
- Positive effect
- Neutral effect
- Negative effect



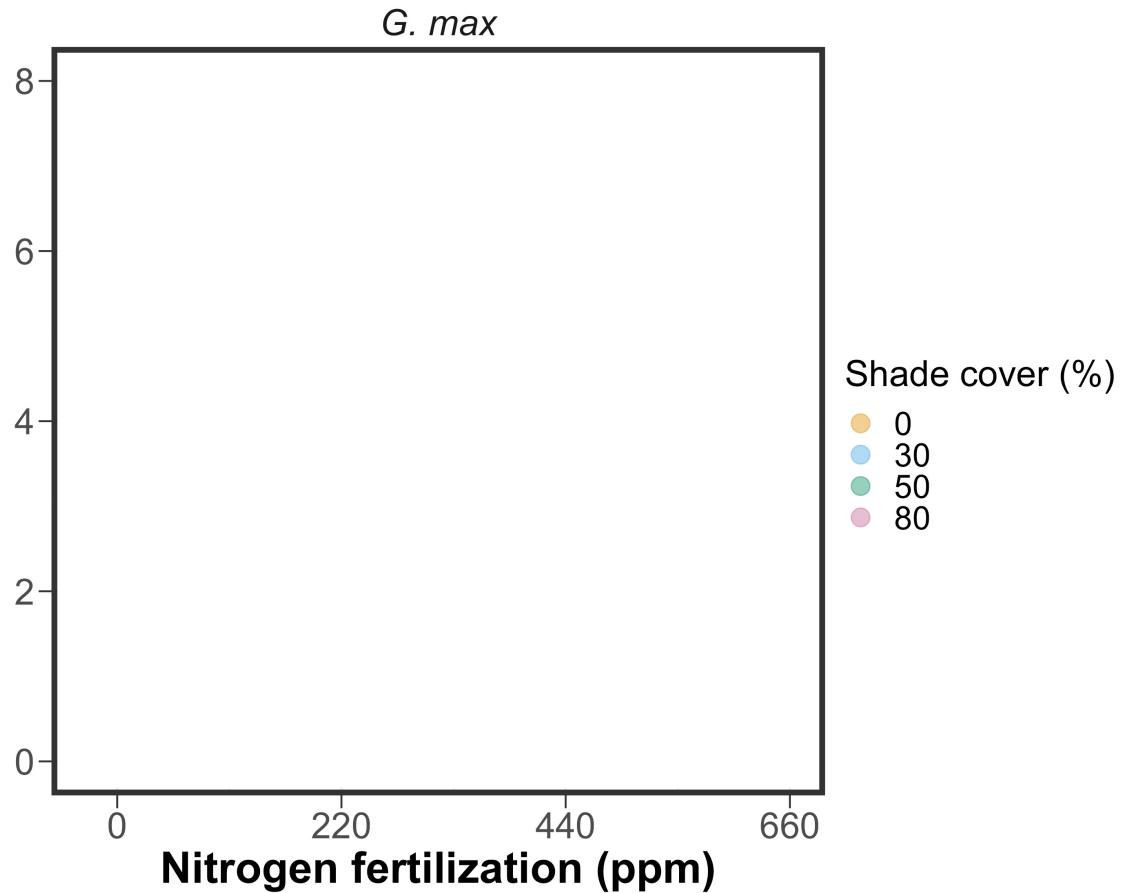
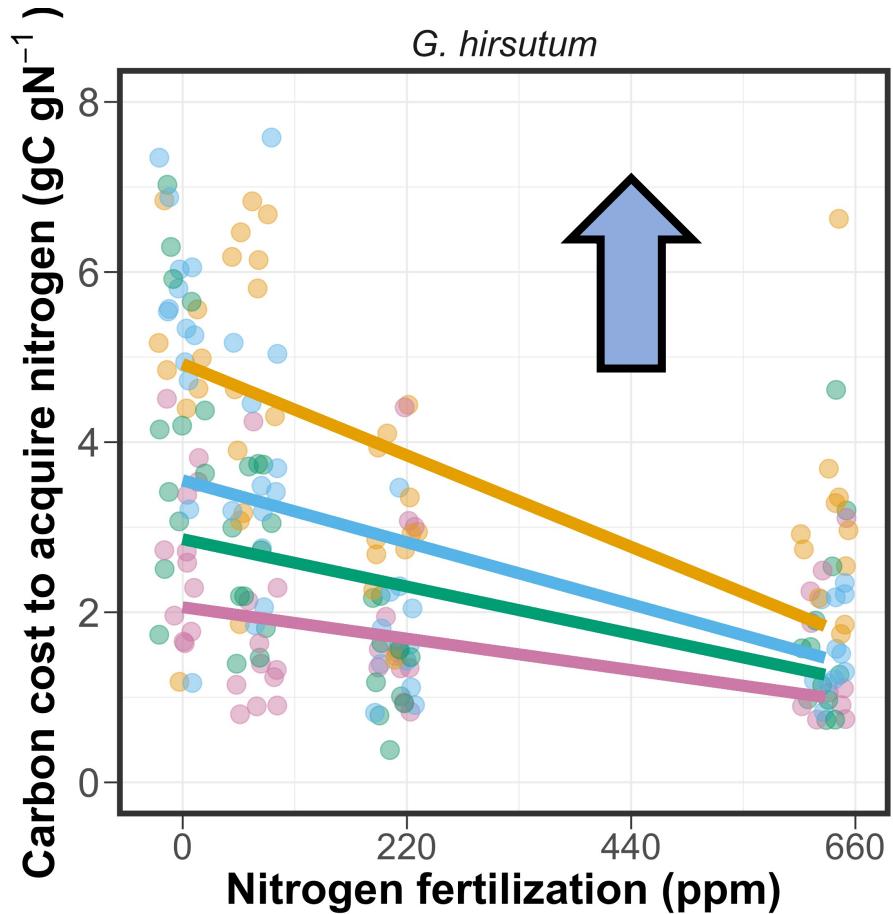
# Carbon costs to acquire nitrogen decreased with increasing nitrogen fertilization, but increased with increasing light availability



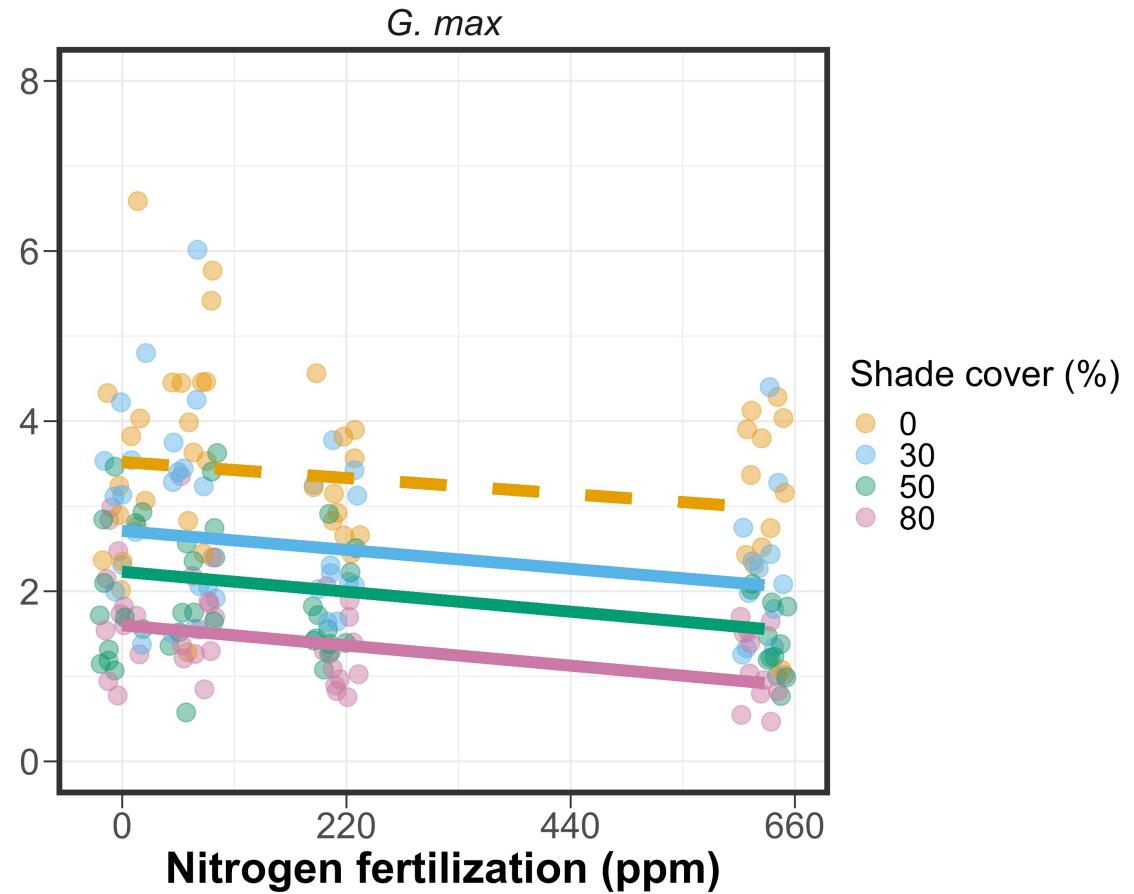
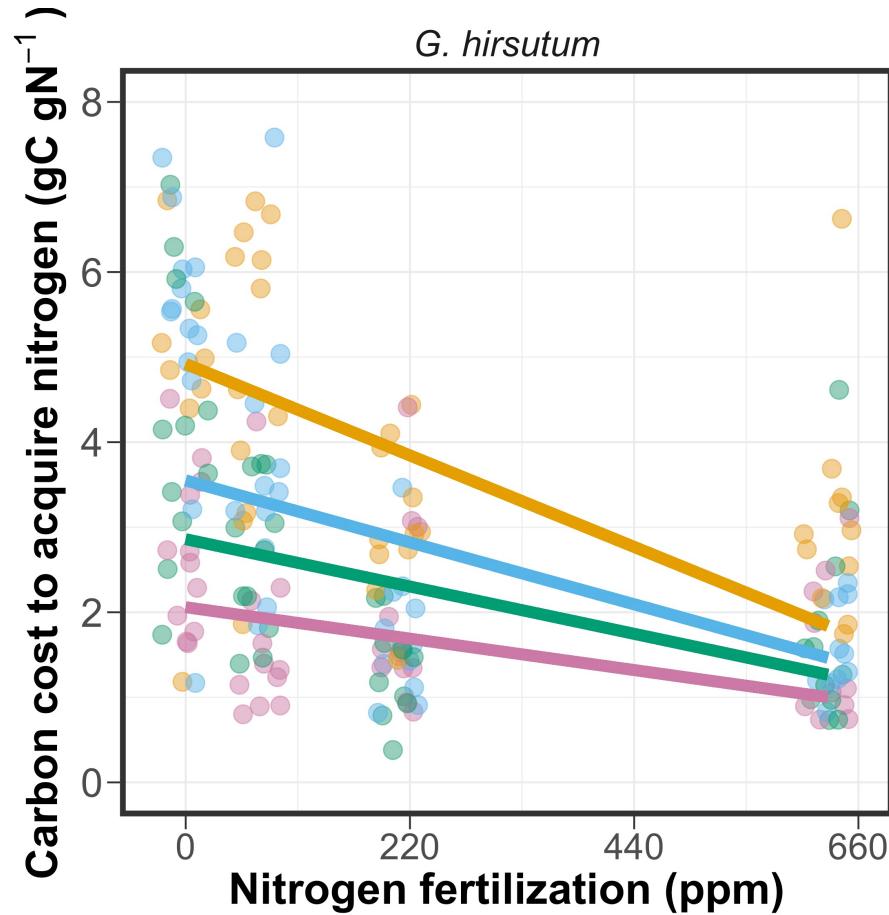
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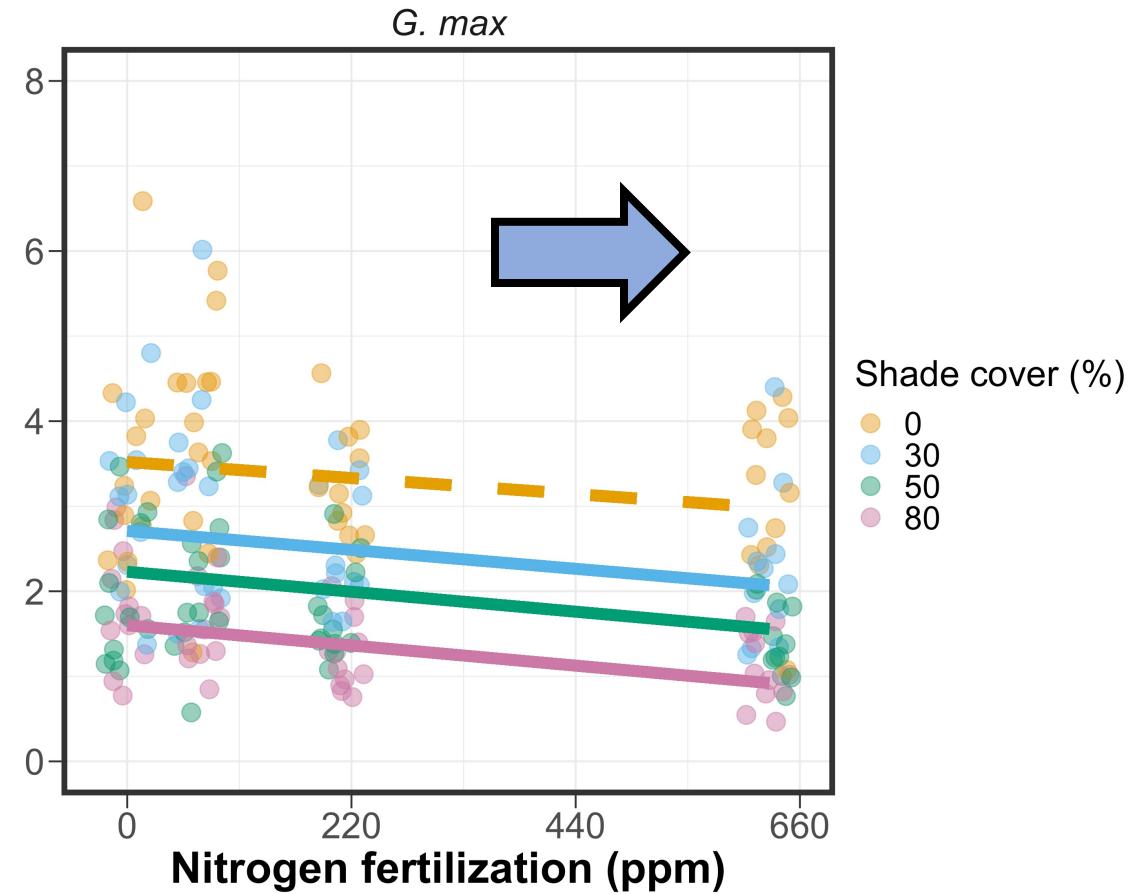
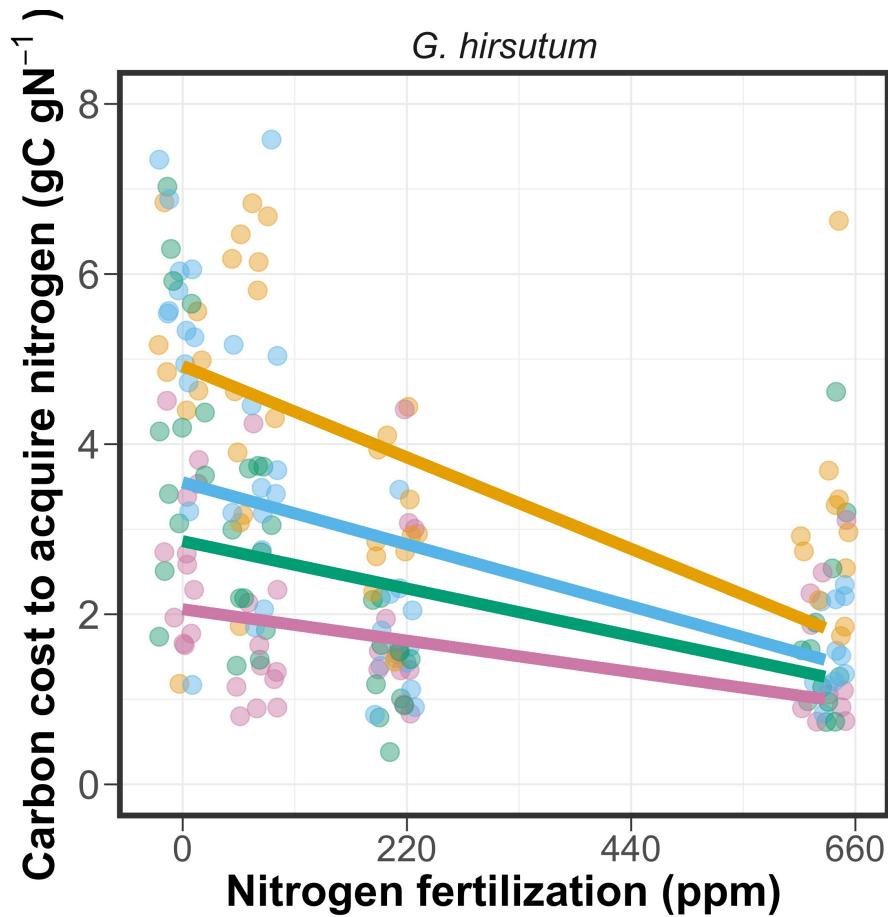
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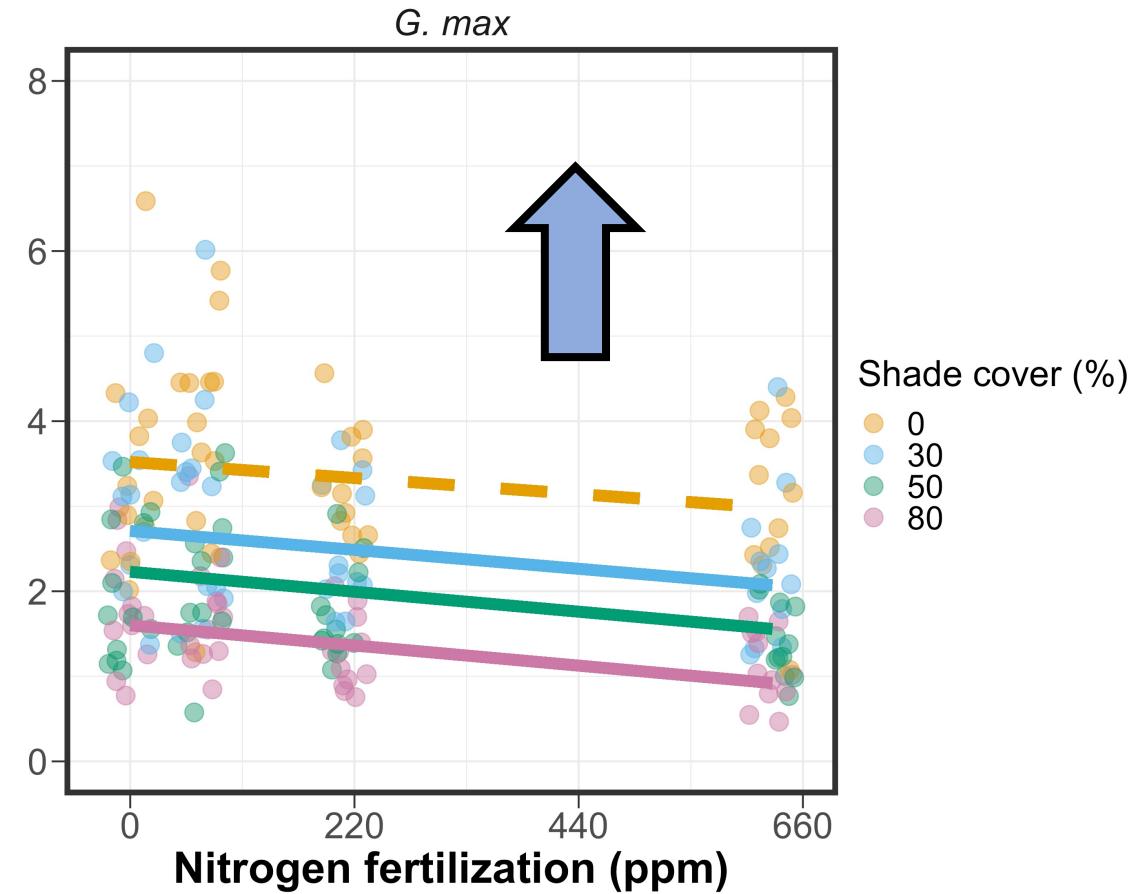
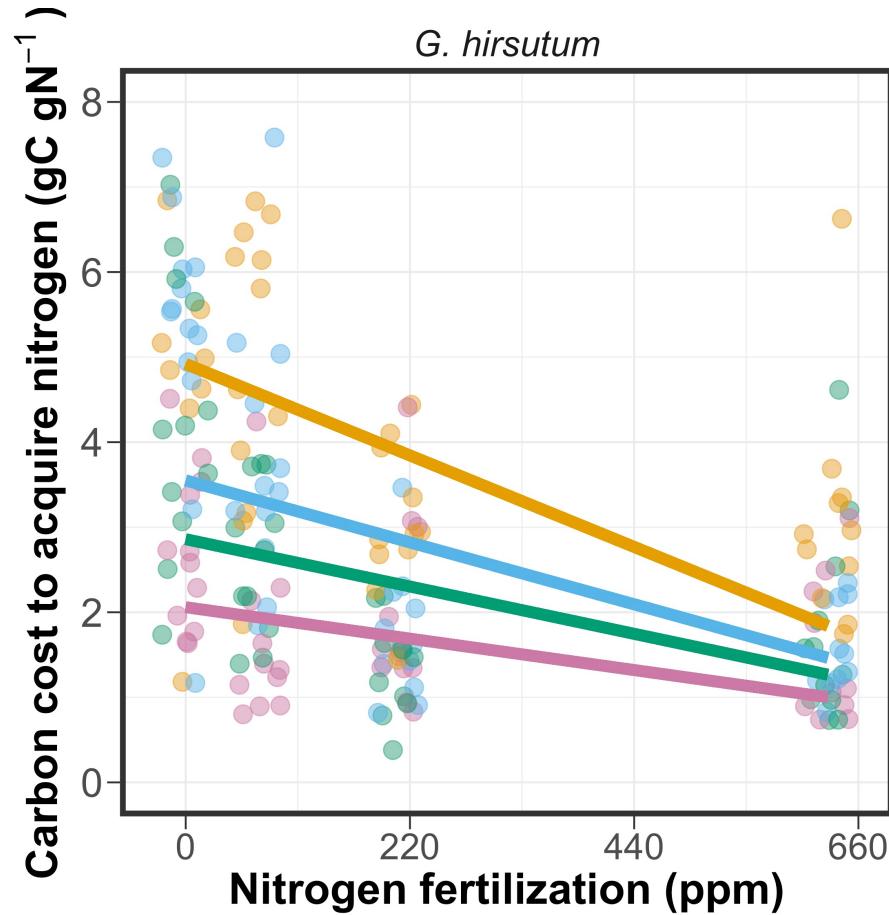
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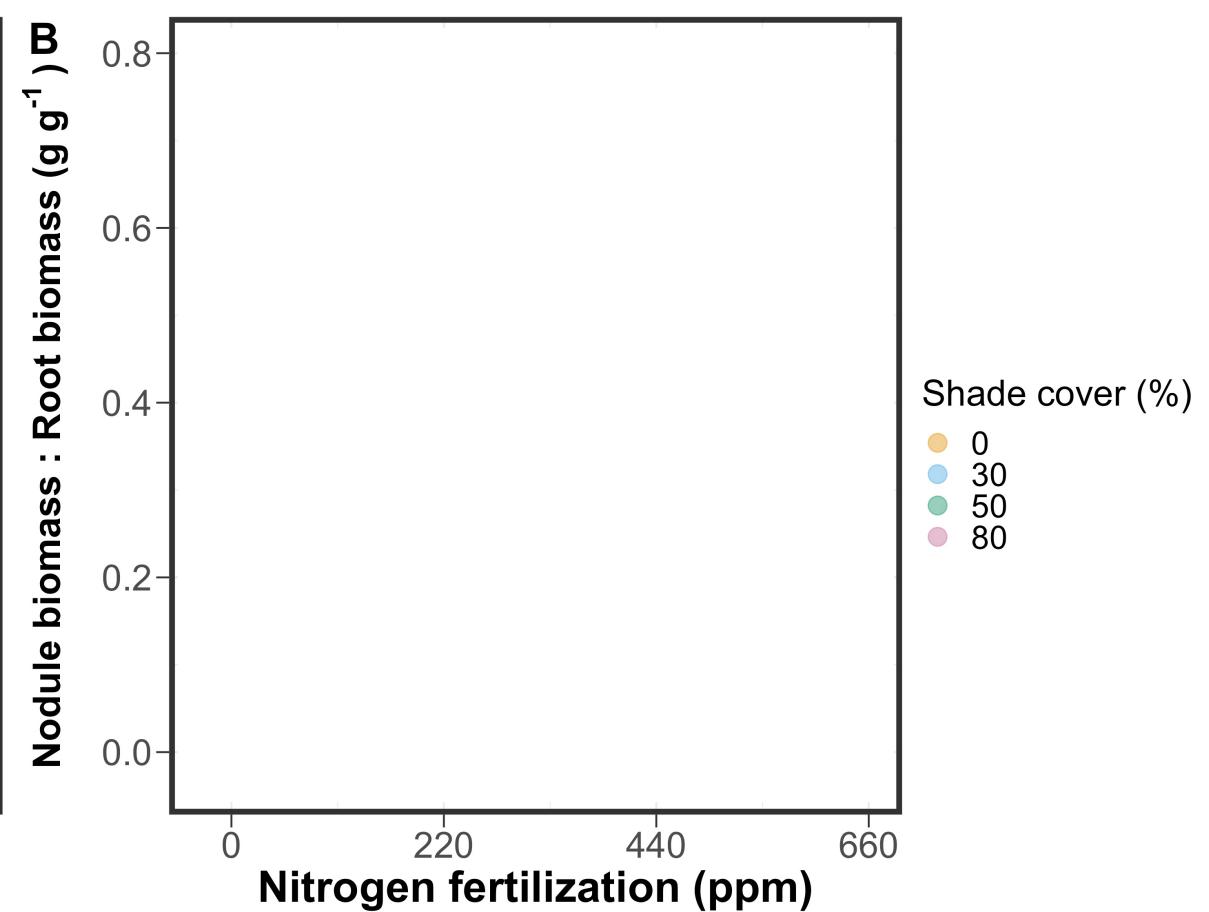
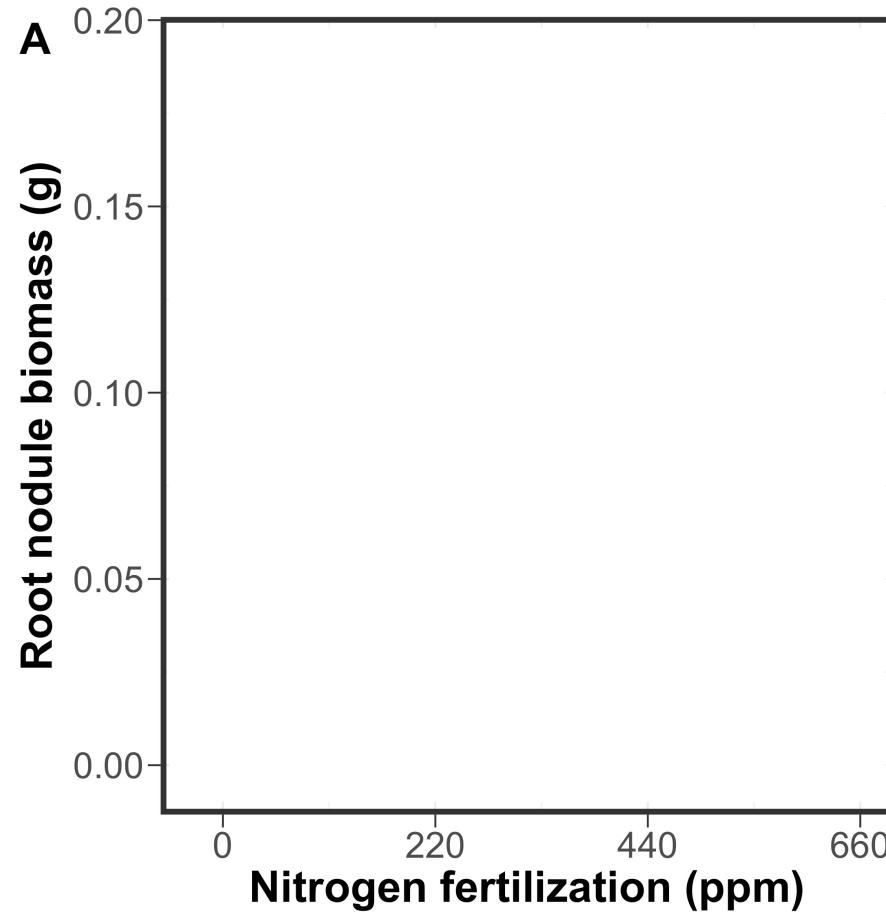
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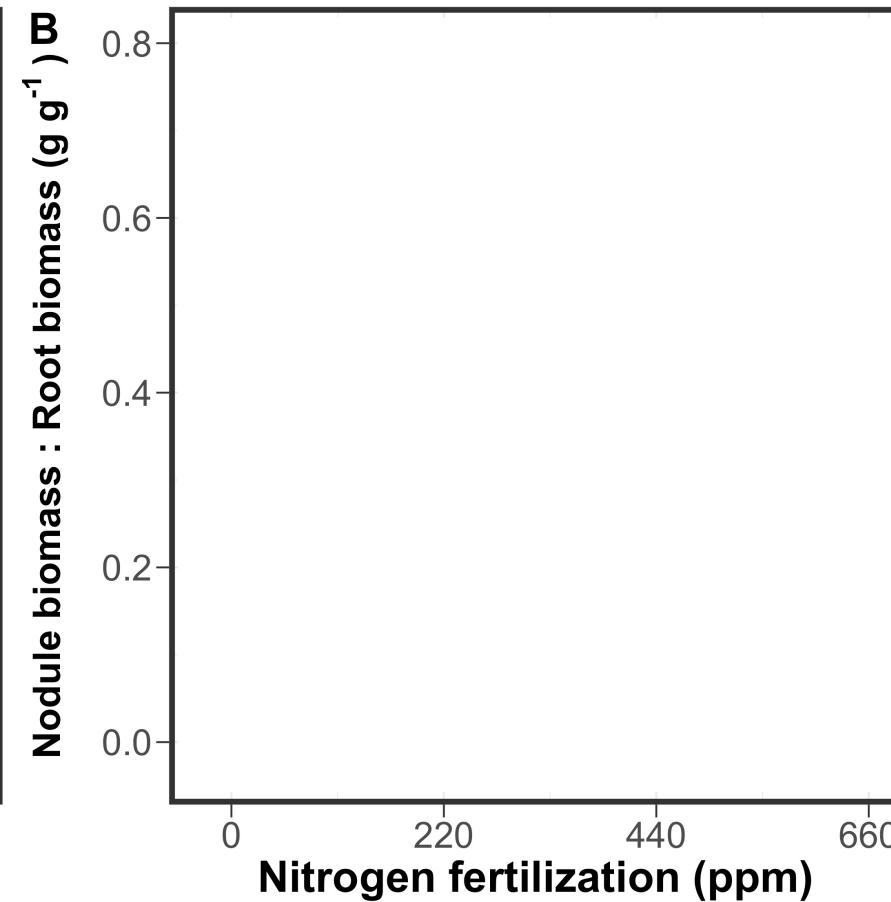
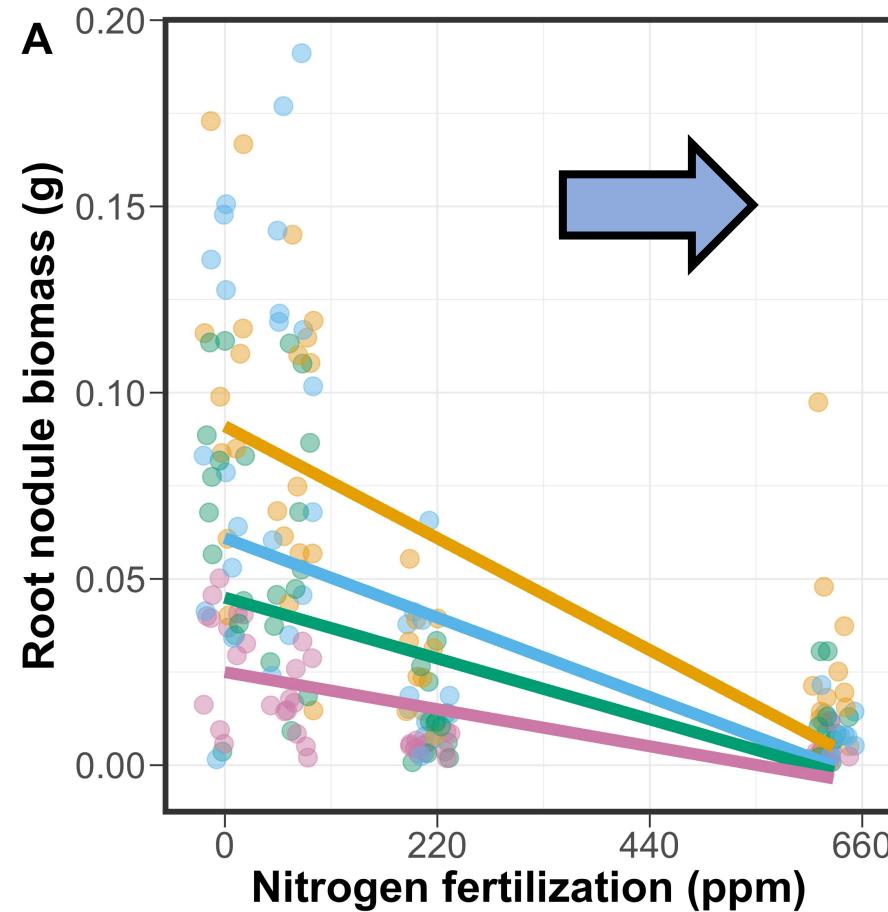
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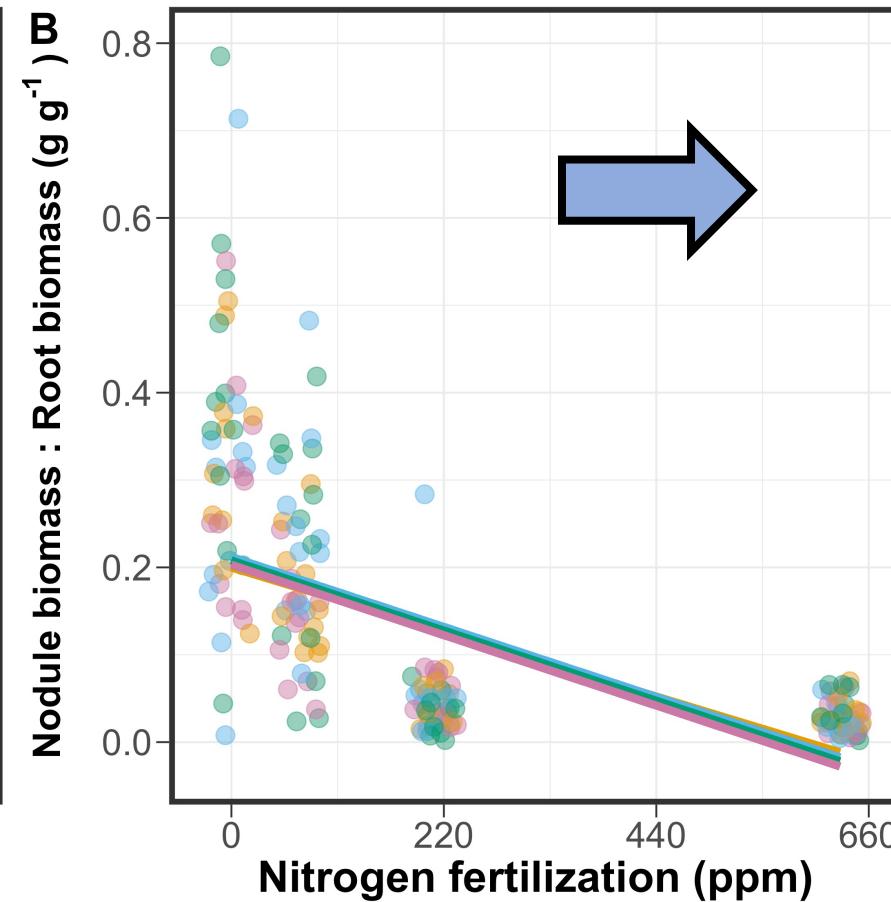
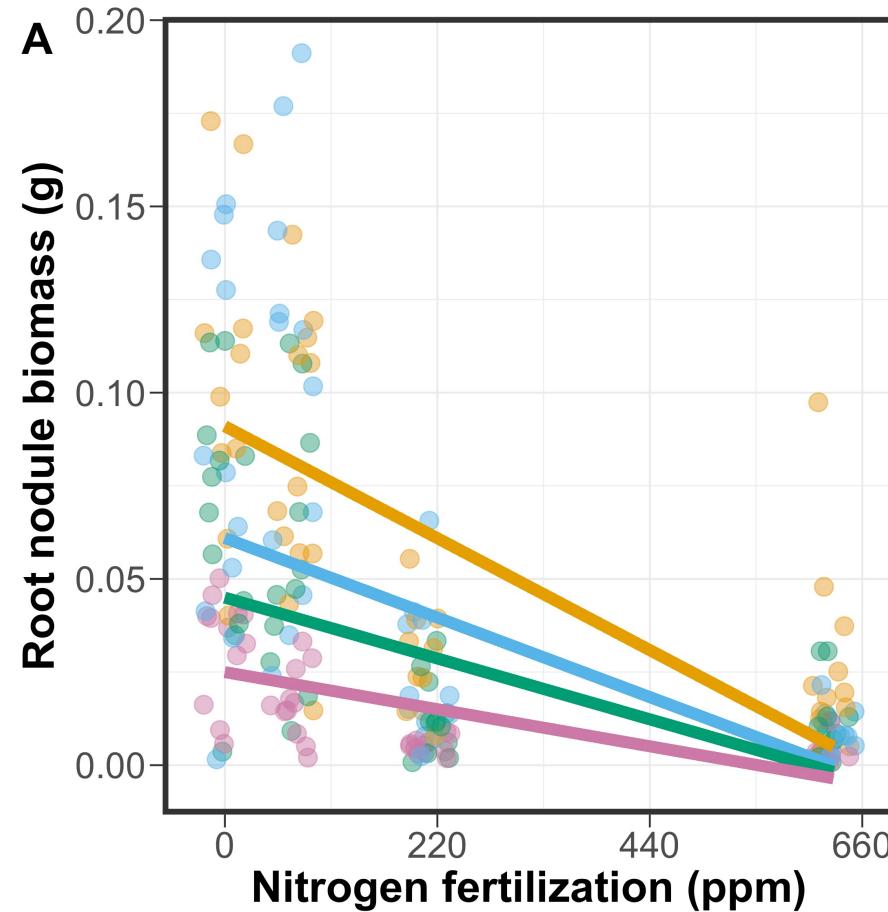
## ***G. max* decreased investment in root nodules with increasing nitrogen fertilization**



## *G. max* decreased investment in root nodules with increasing nitrogen fertilization

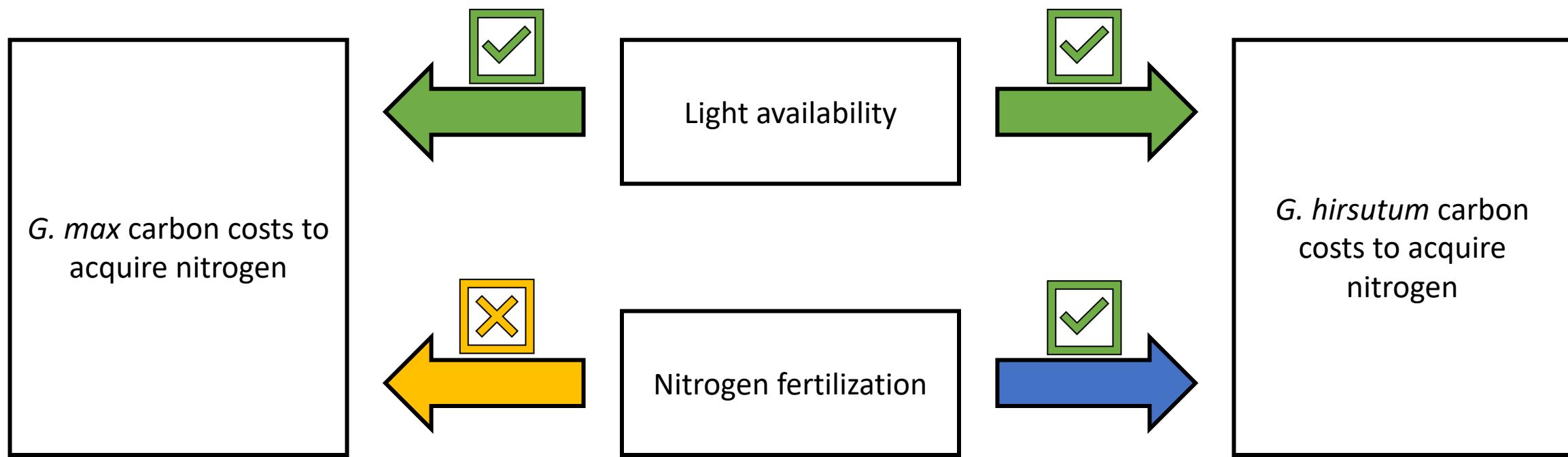


## *G. max* decreased investment in root nodules with increasing nitrogen fertilization



# Summary of Findings

- Positive effect
- Neutral effect
- Negative effect



# Future Work

- Larger range of taxonomically related species across multiple spatiotemporal scales to better understand generality of these patterns
- At what point do nitrogen-fixing species shift from nitrogen fixation to direct uptake? Is this in agreement with Earth system models?

# Acknowledgements

## Undergraduate Researchers:

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**Dr. Paxton Payton (USDA)**



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accepted manuscript:**



Thank you!

SM