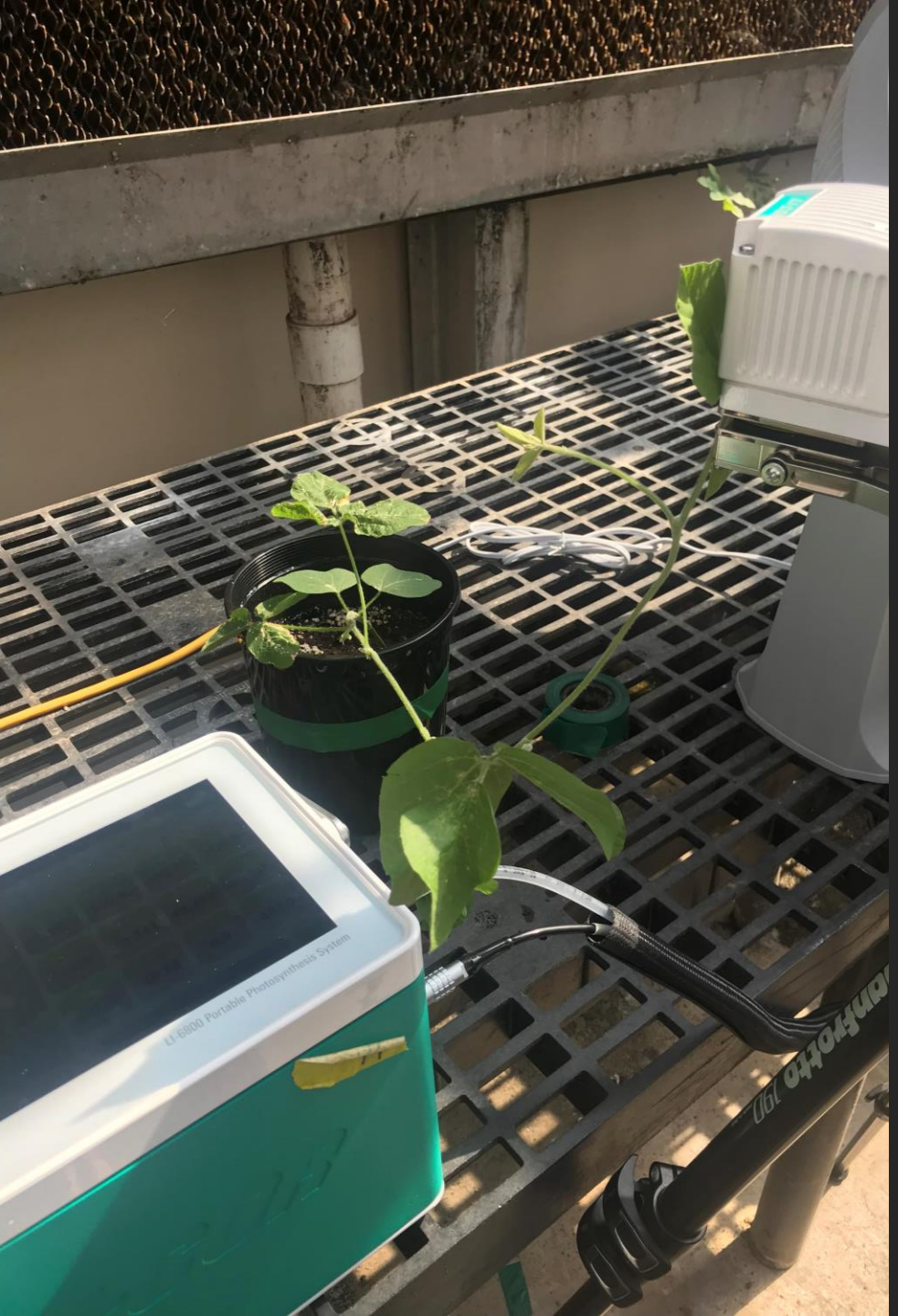
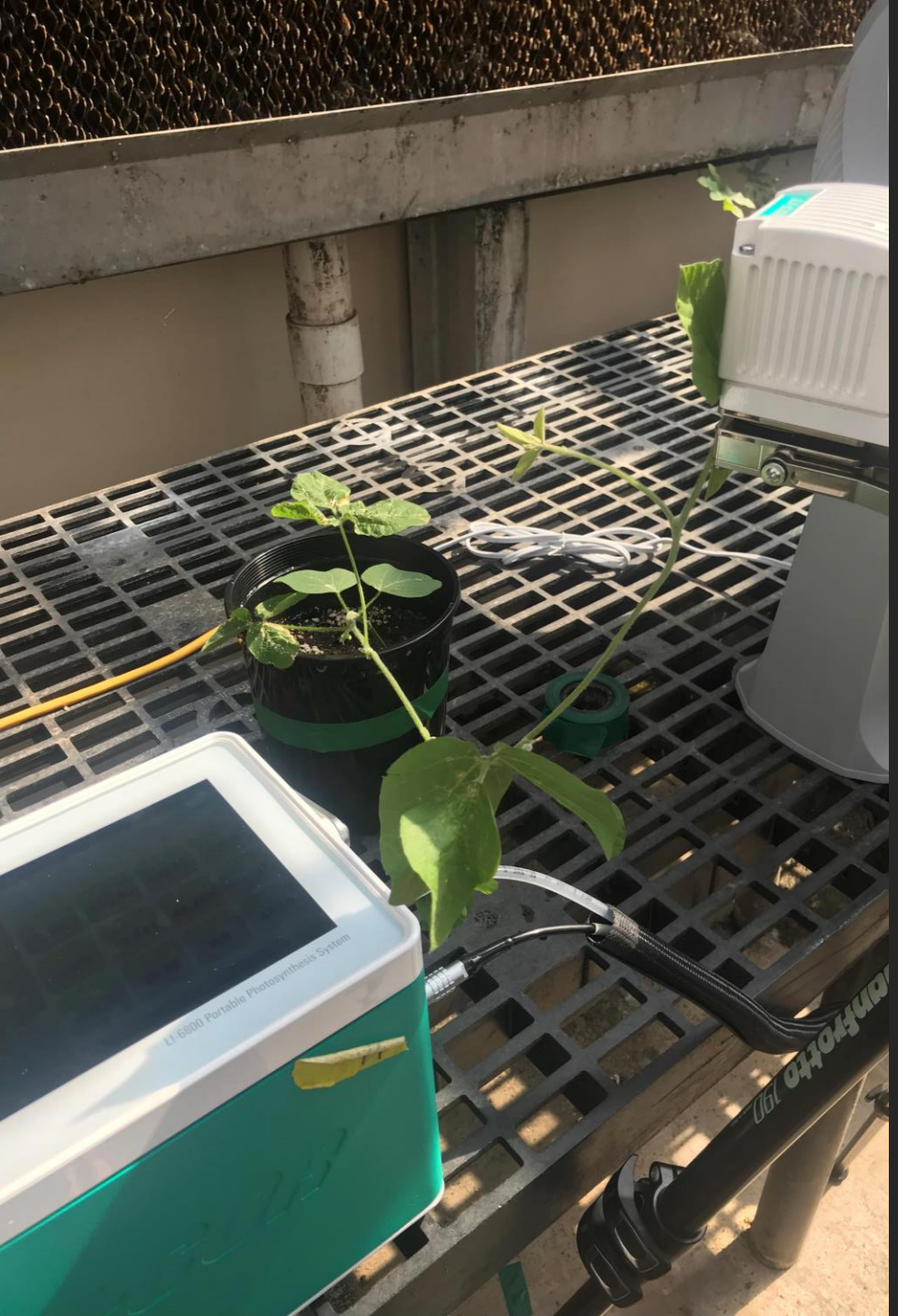


Allocation responses to nitrogen addition depend on photosynthetic demand and nitrogen acquisition strategy

Elizabeth Waring and Nick Smith

Texas Tech University

@LizzWaring



Nitrogen Fertilization Does Not Increase Leaf-Level Carbon Assimilation

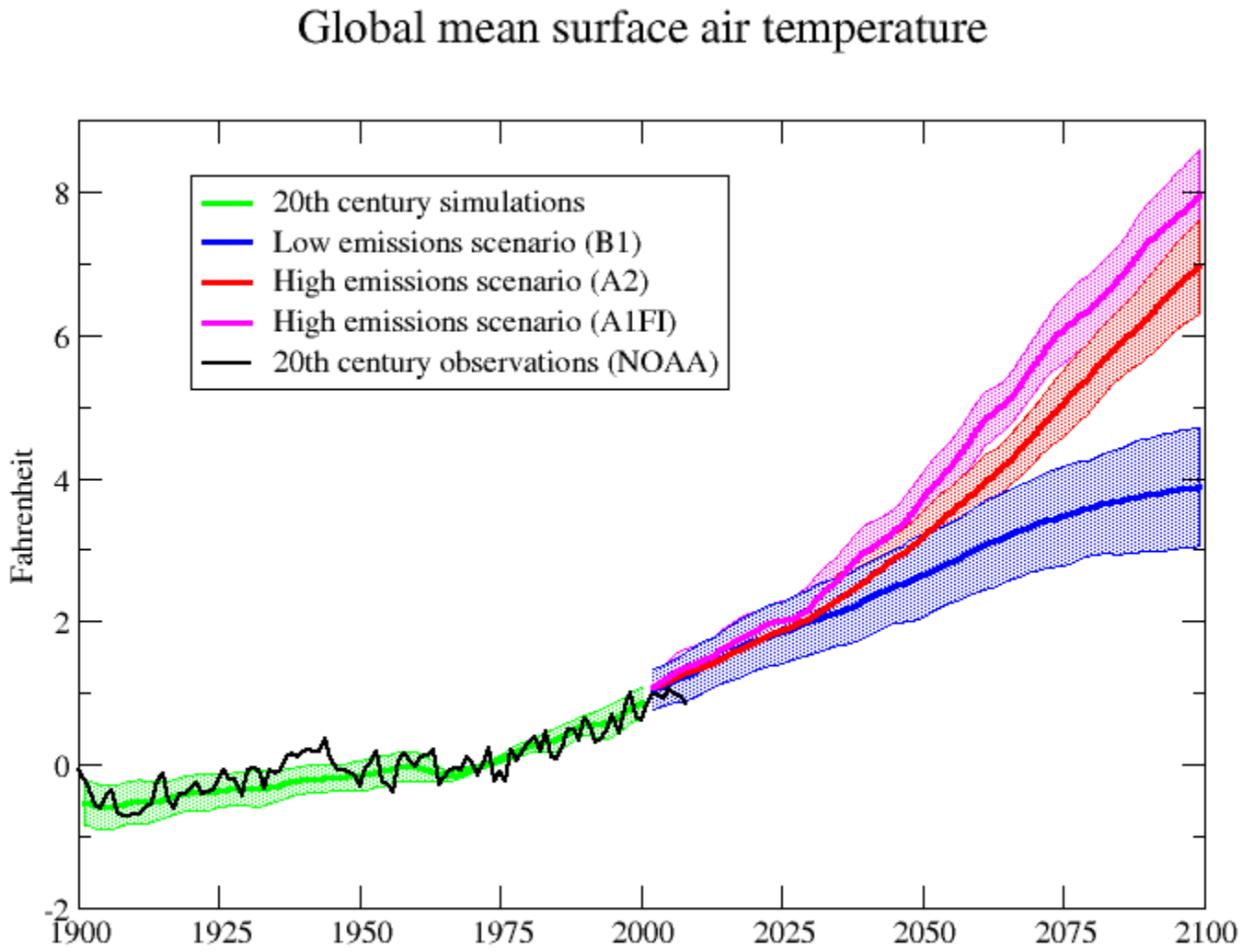
Elizabeth Waring and Nick Smith

Texas Tech University

@LizzWaring

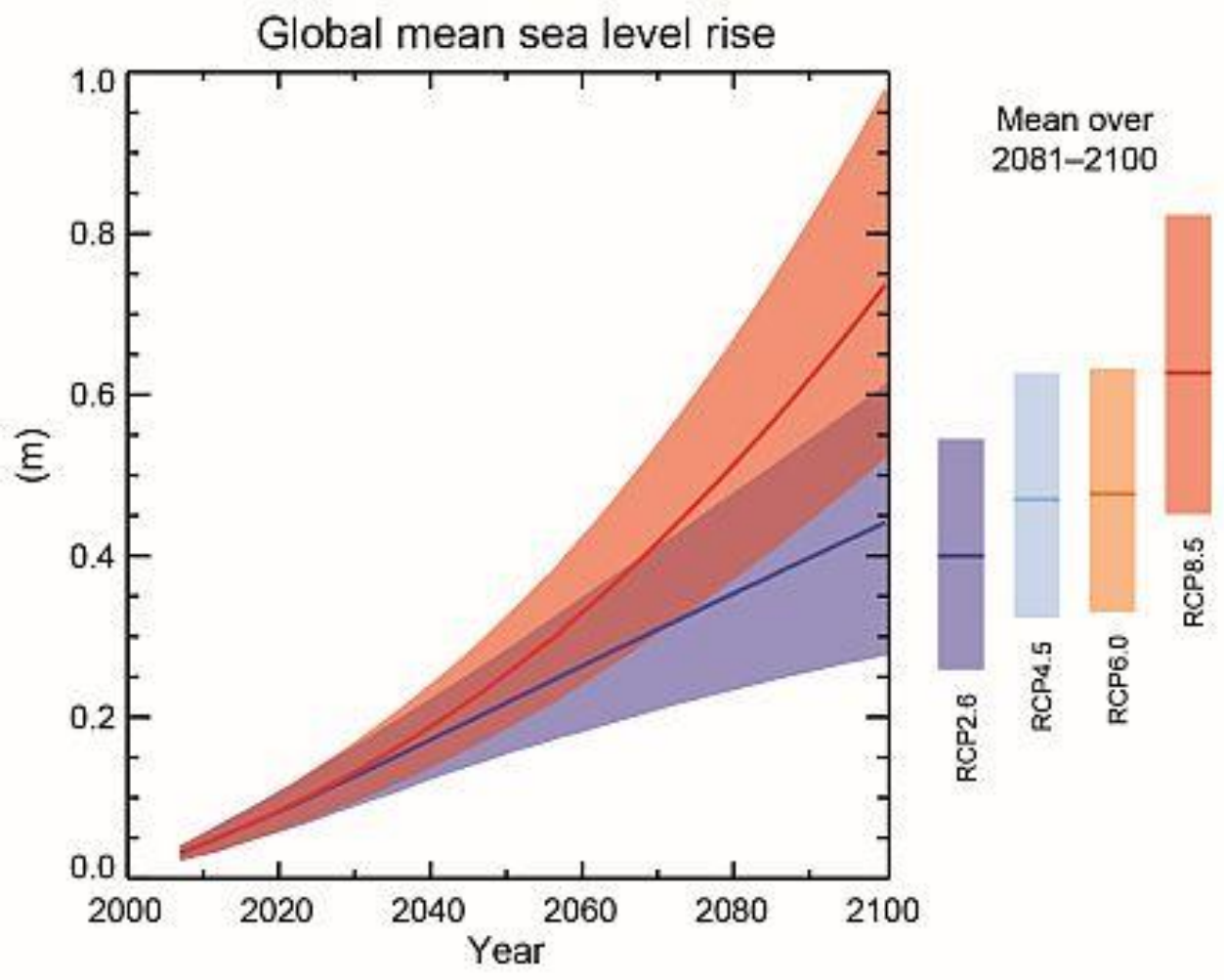
Global Change

- Increased Temperatures



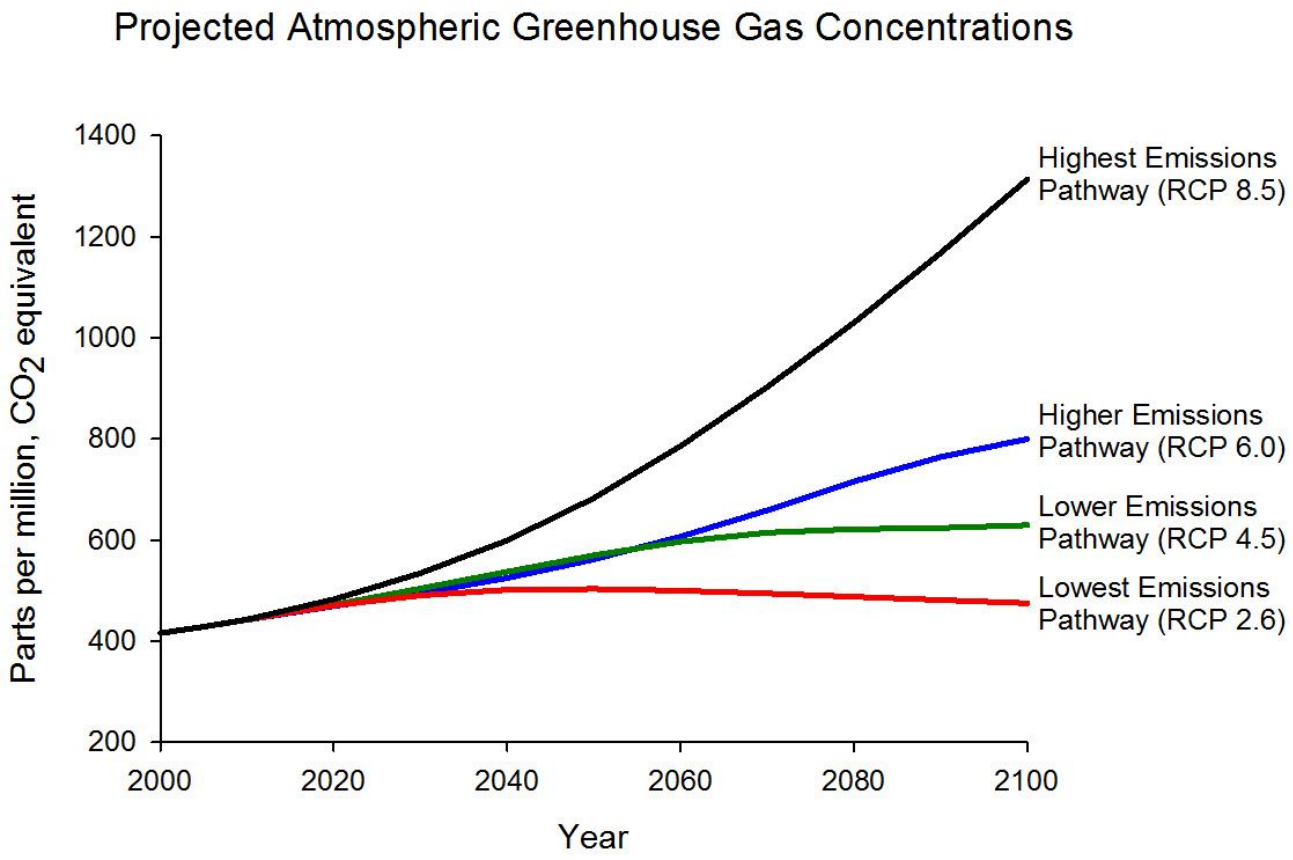
Global Change

- Increased Temperatures
- Sea Level Rise



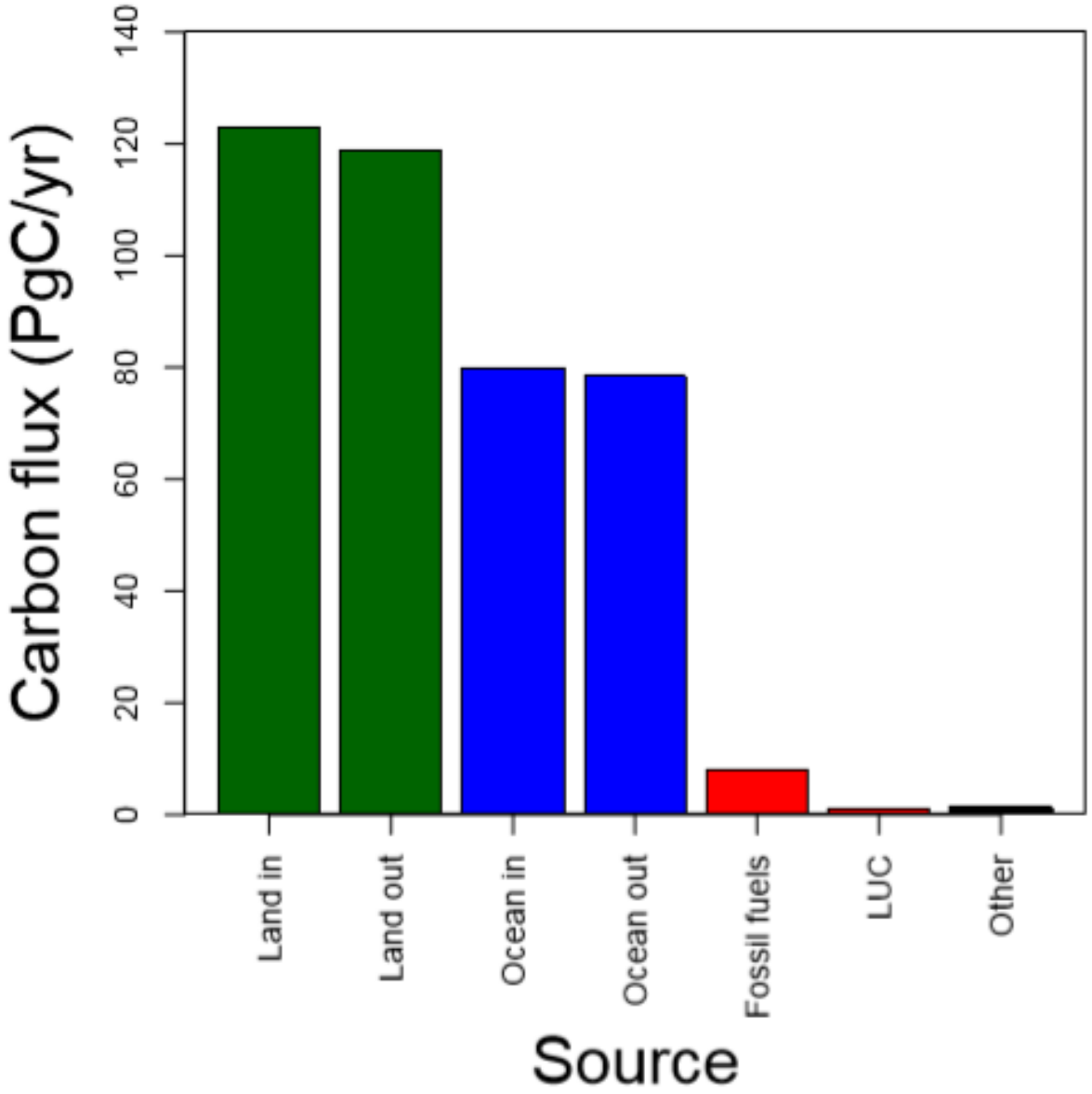
Global Change

- Caused by increased CO_2

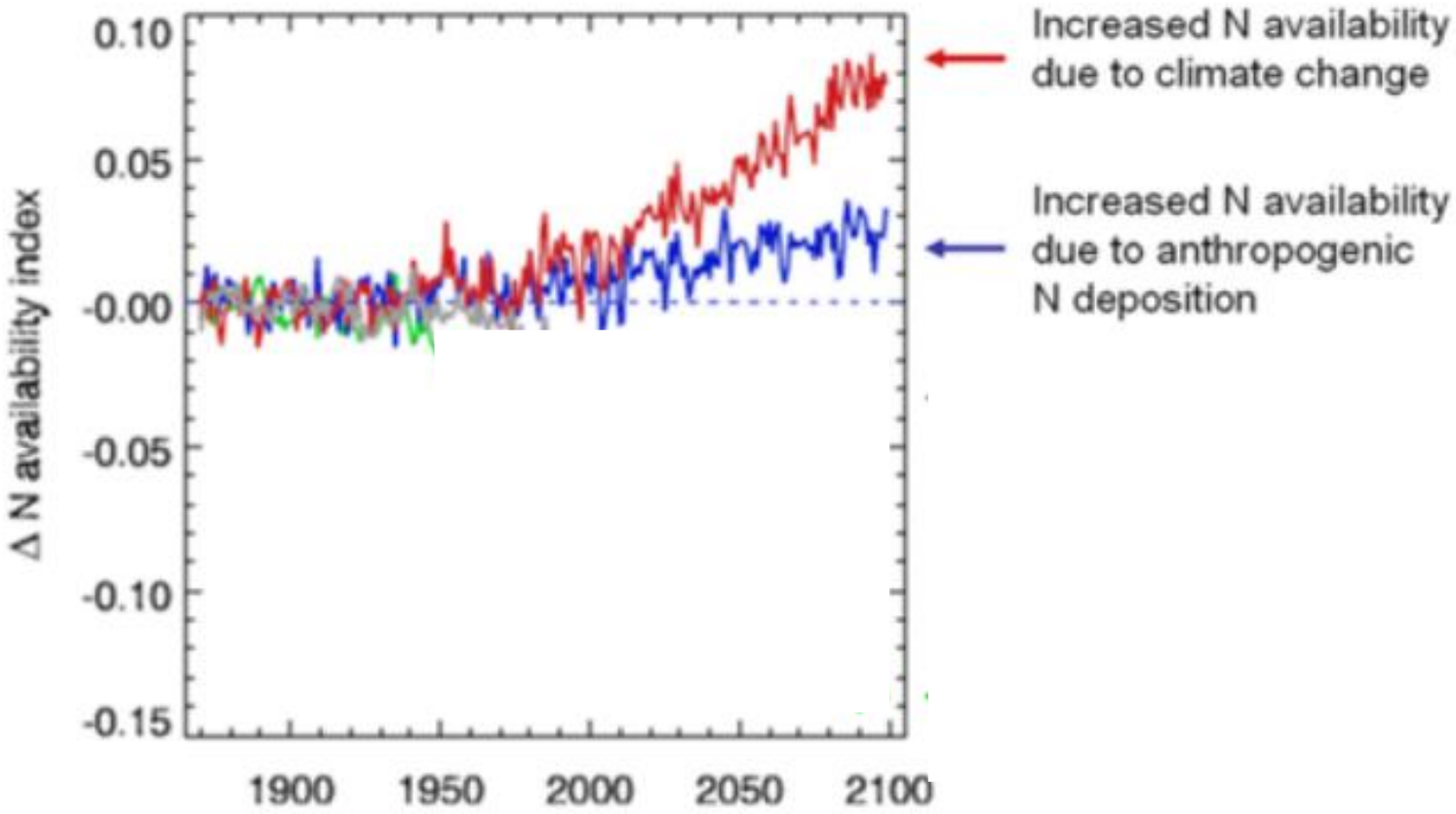


Global Change

- Plants only way to decrease global CO_2

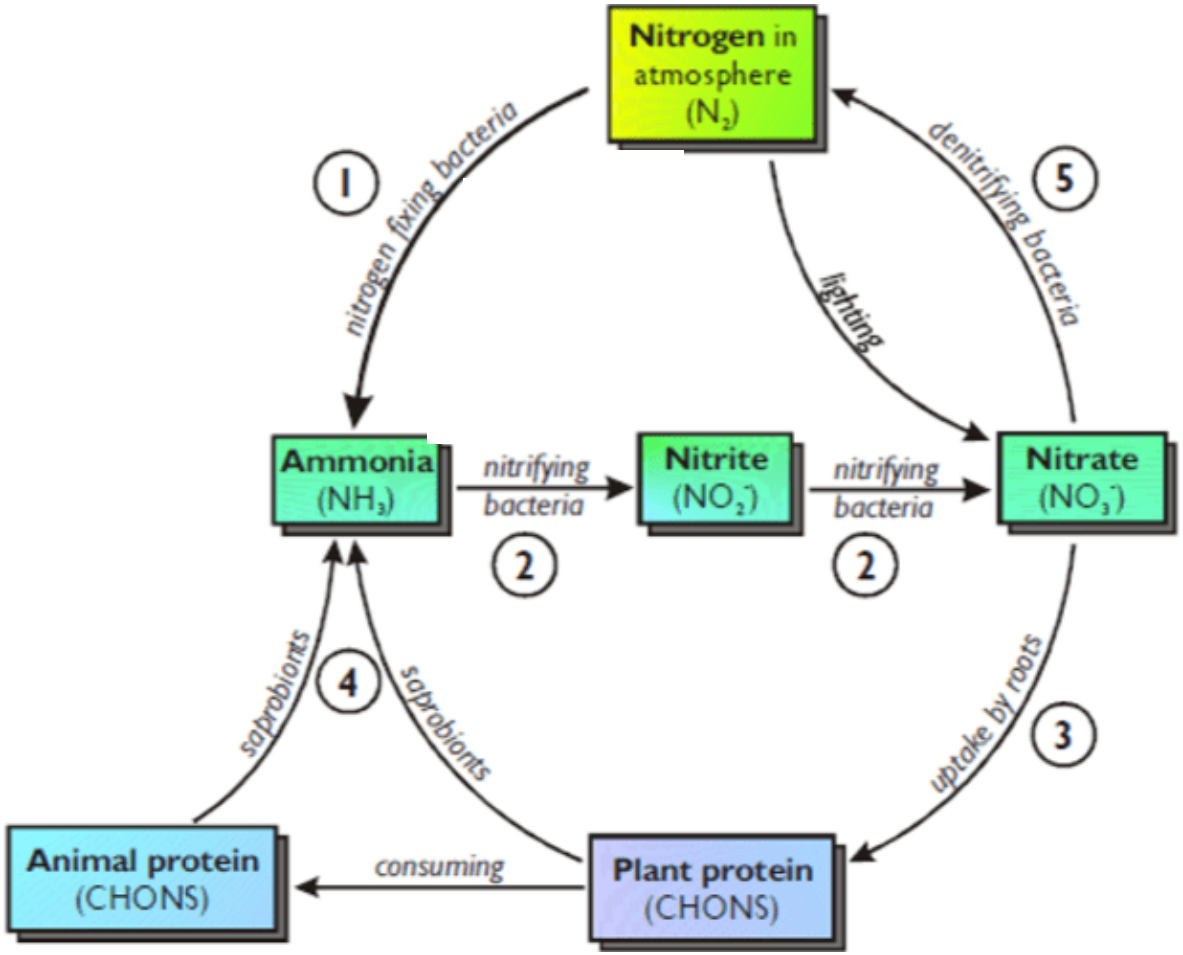


Global Change

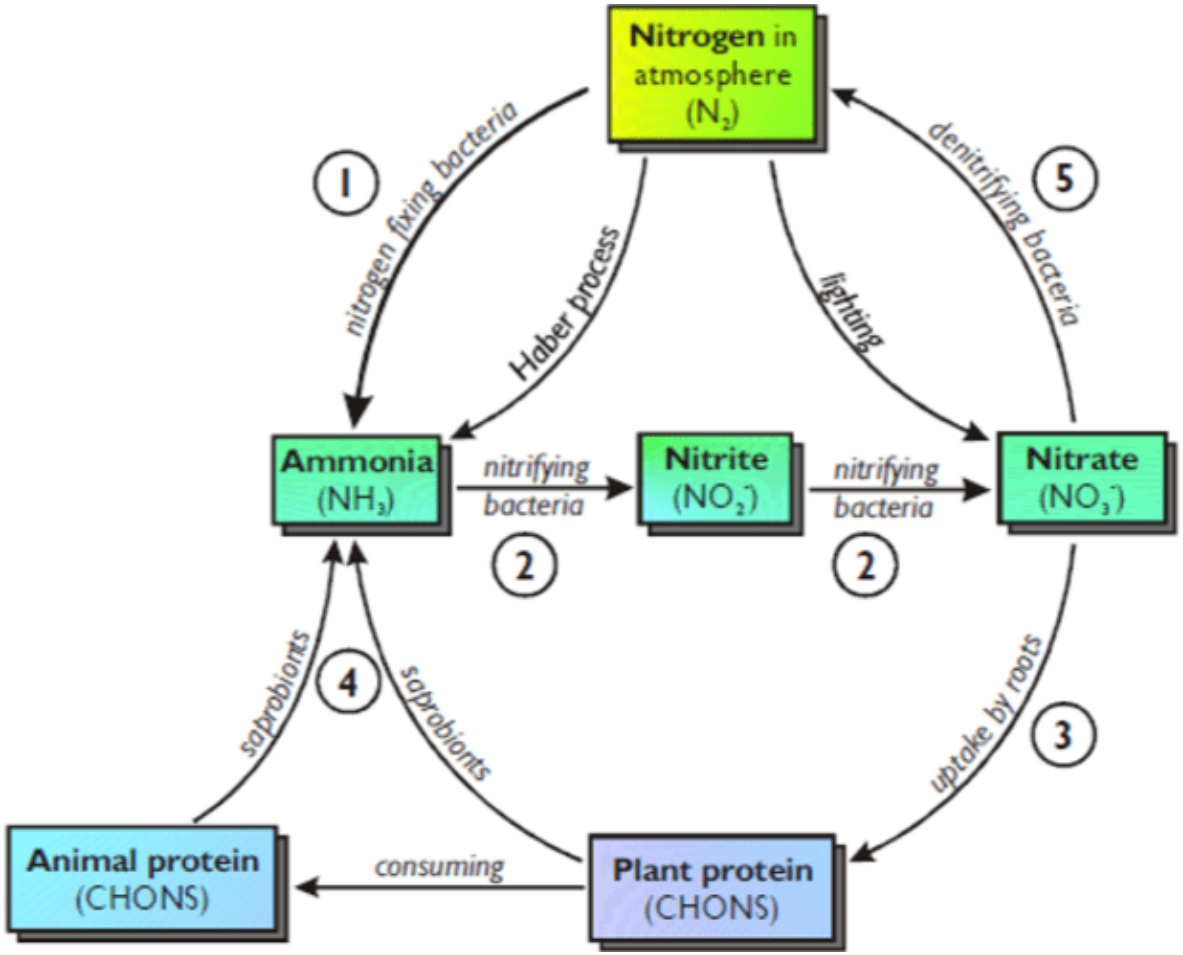


Courtesy of NCAR

Terrestrial N inputs increasing

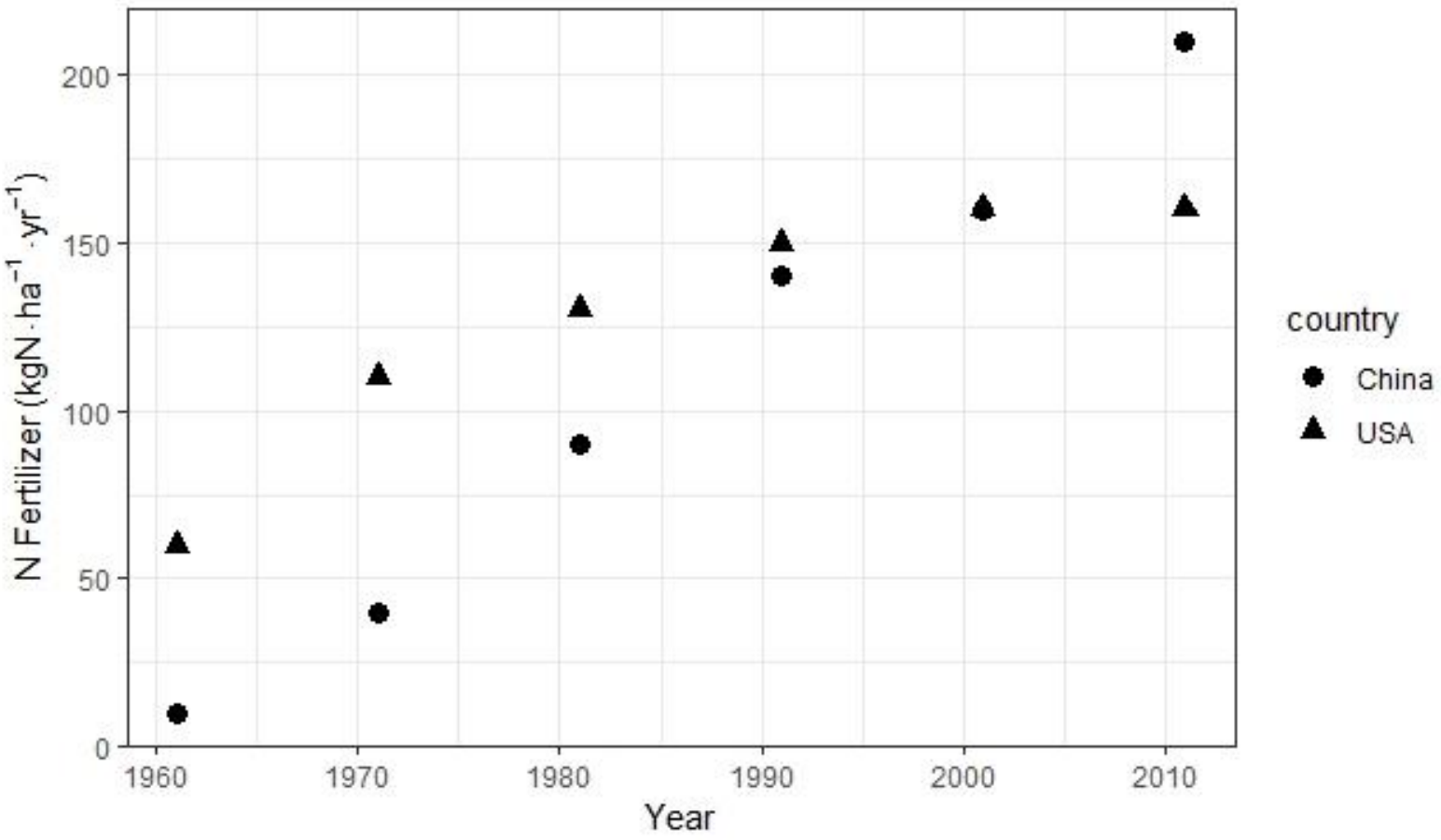


Terrestrial N inputs increasing



Terrestrial N inputs increasing

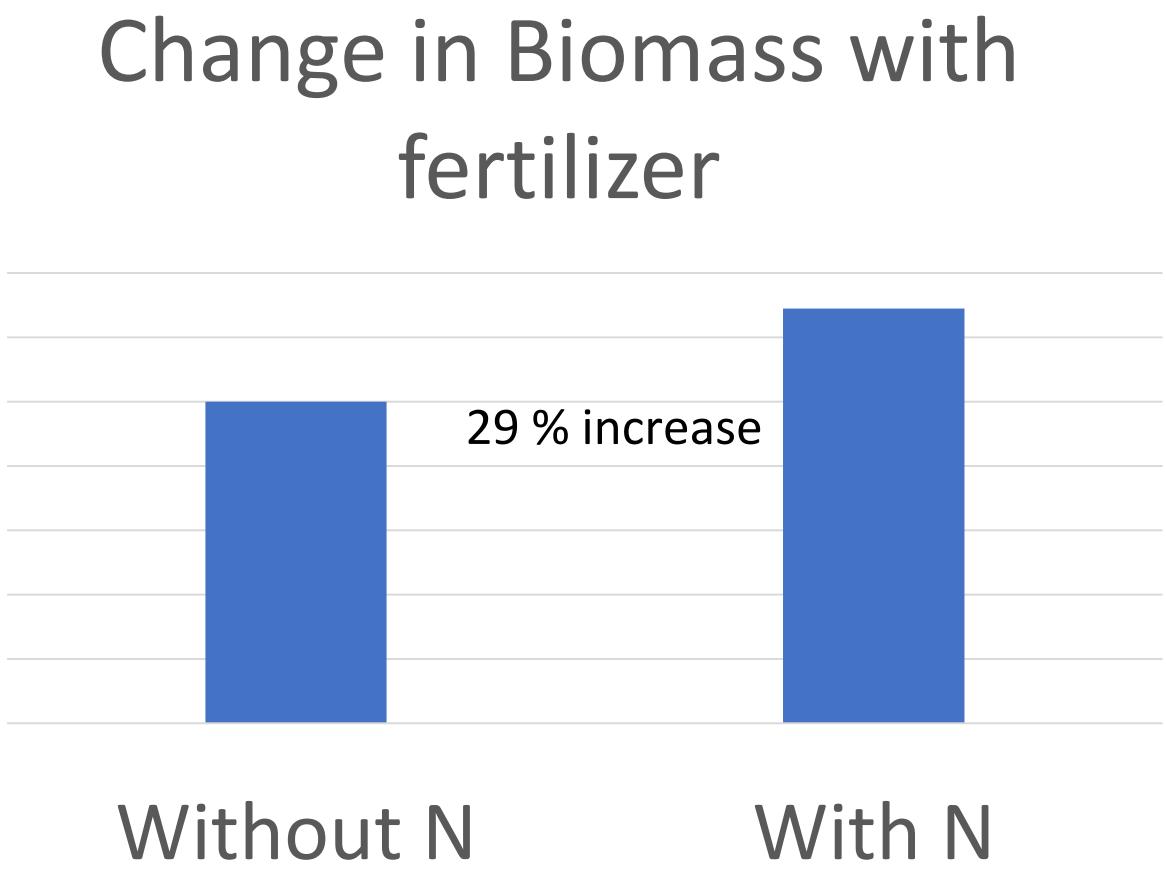
- Example: China and USA



Modified from X Zhang *et al.* (2015)

Biomass increases due to fertilization

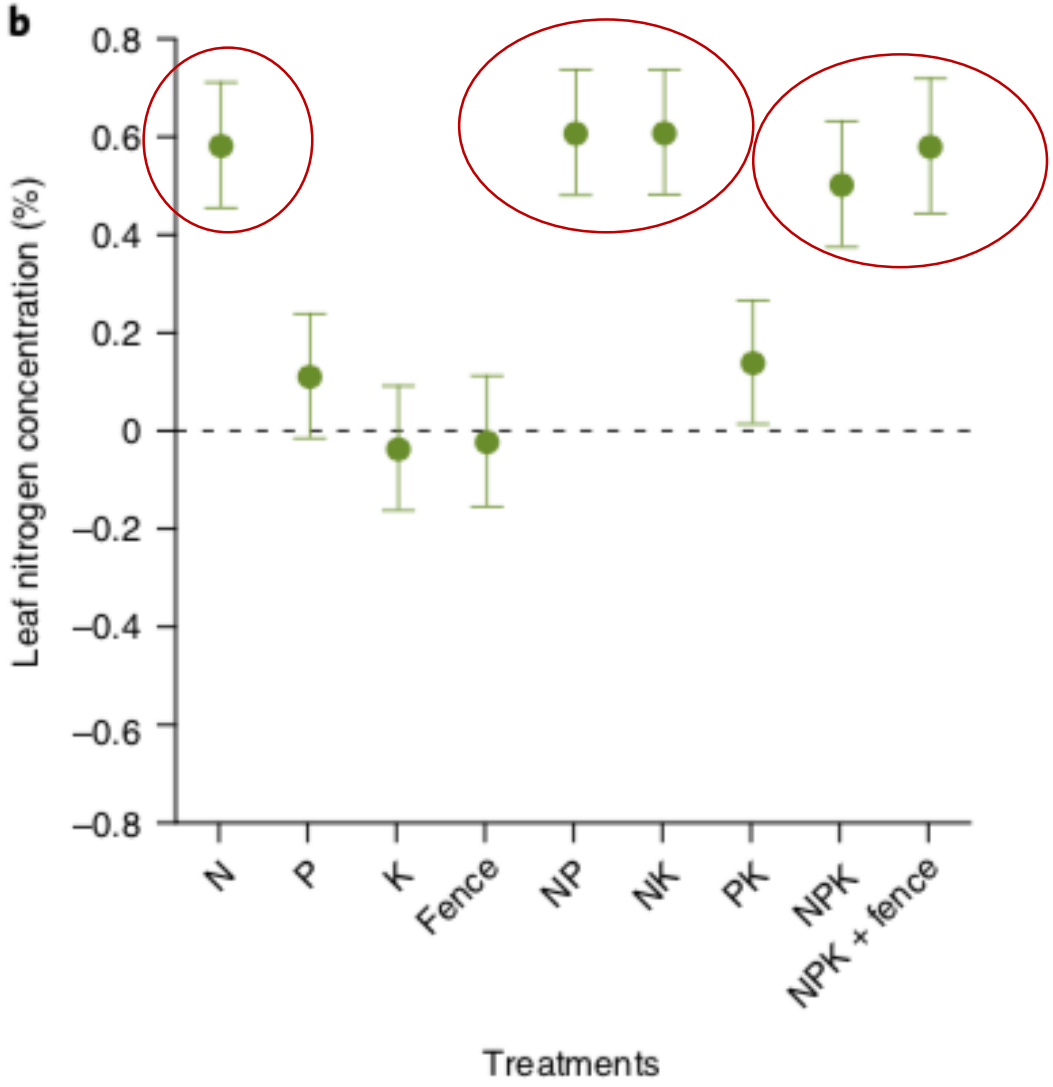
- From LeBauer and Treseder (2008)
- Metanalysis of 126 studies



Modifiied from LeBauer and Treseder. *Ecology* (2008) Table 1

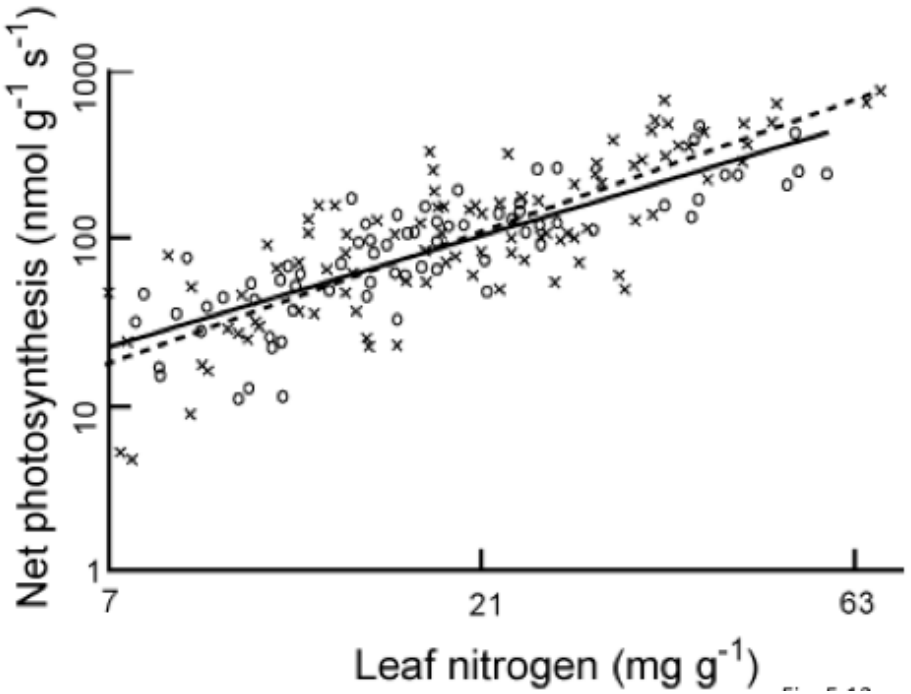
Leaf N increases with soil N

- Firn et al (2019)
- Global set of 27 sites



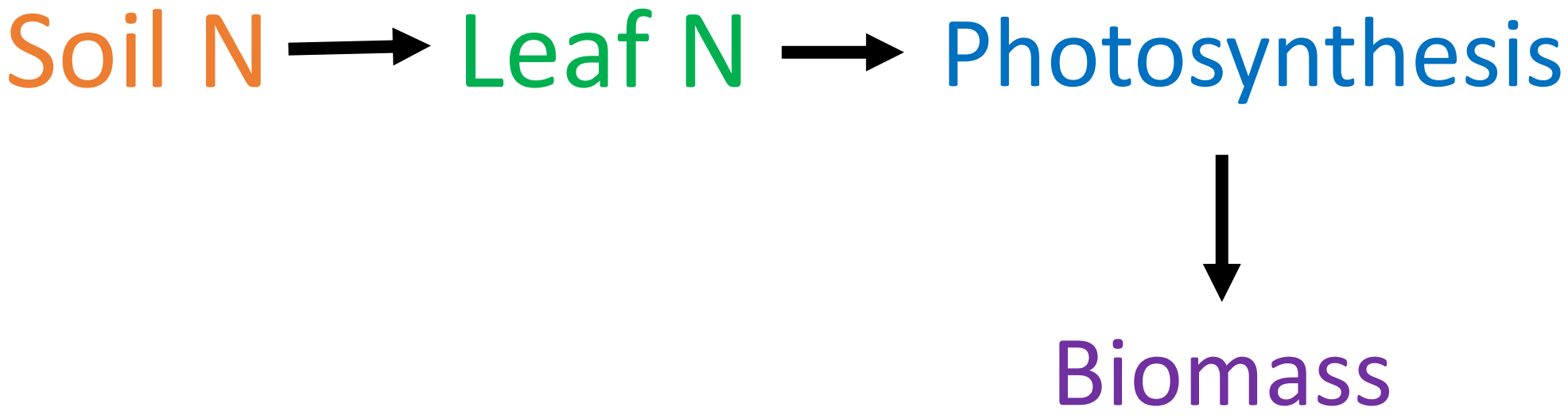
Nitrogen and Carbon Assimilation

- First step of Calvin-Benson Cycle catalyzed by Rubisco
- Strong relationship
- Link carbon and nitrogen metabolism



Redrawn from Reich et al. (1997) in Chapin 2011

Soil N supply paradigm



Not so sure about that….

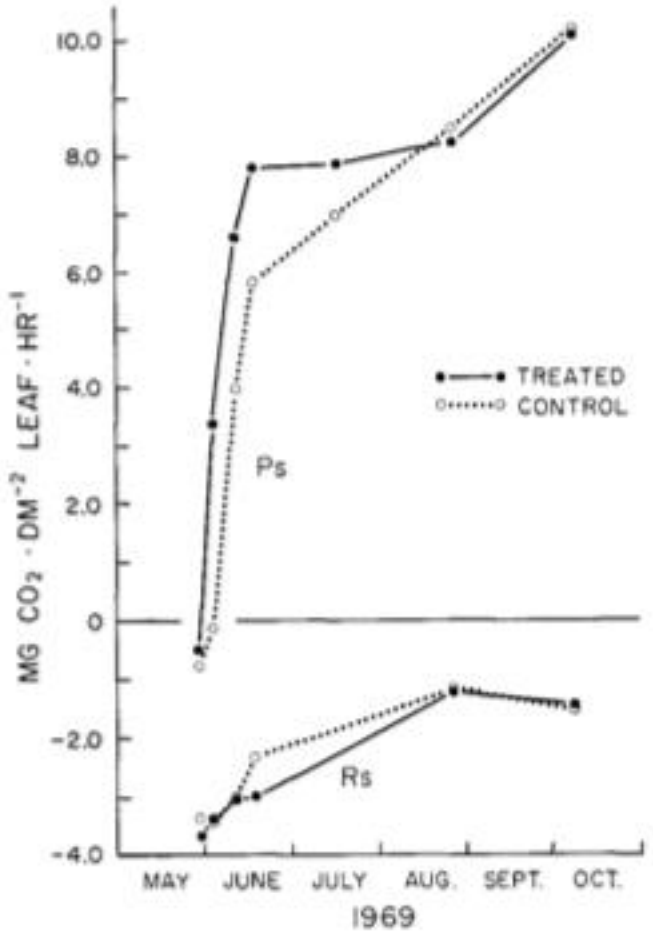
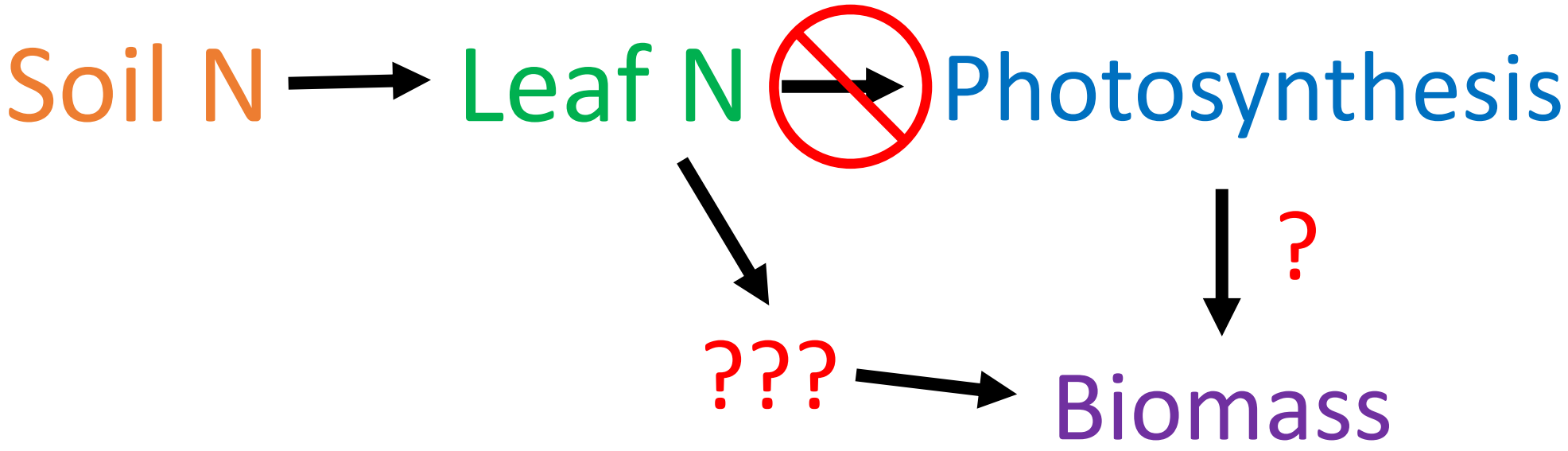


FIGURE 3. *Net photosynthesis (Ps) and dark respiration (Rs) in 1969 for current shoots of Douglas-fir trees treated April 1968.*

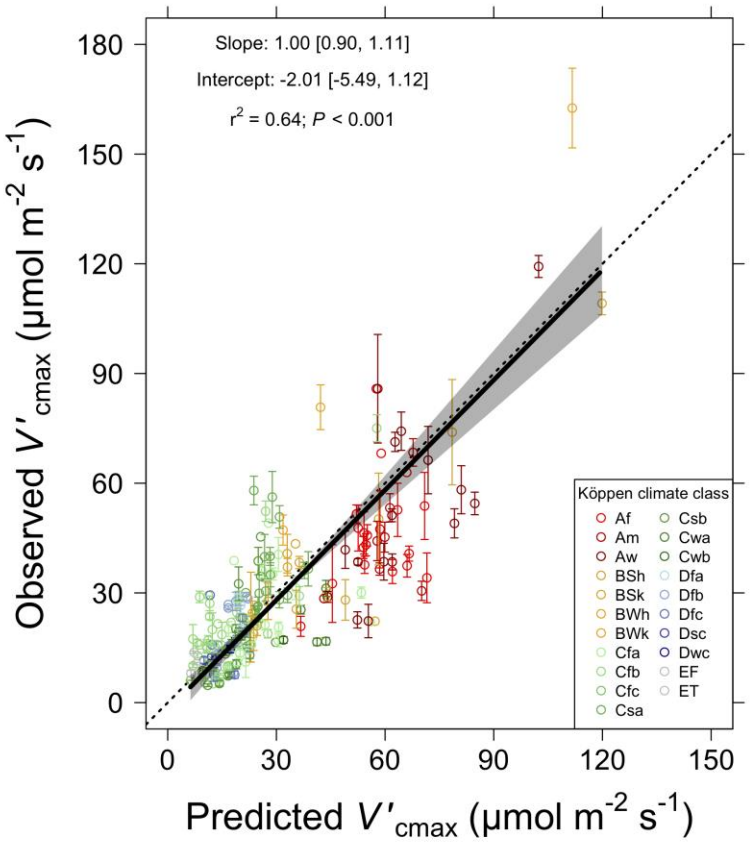
Not necessarily doing more photosynthesis though

Brix (1971)

Hypothesis



- Smith et al 2019
- Photosynthesis optimized by environment not nitrogen
- Predictions for photosynthesis without N



How I am approaching N availability issue

whole plant research

Greenhouse

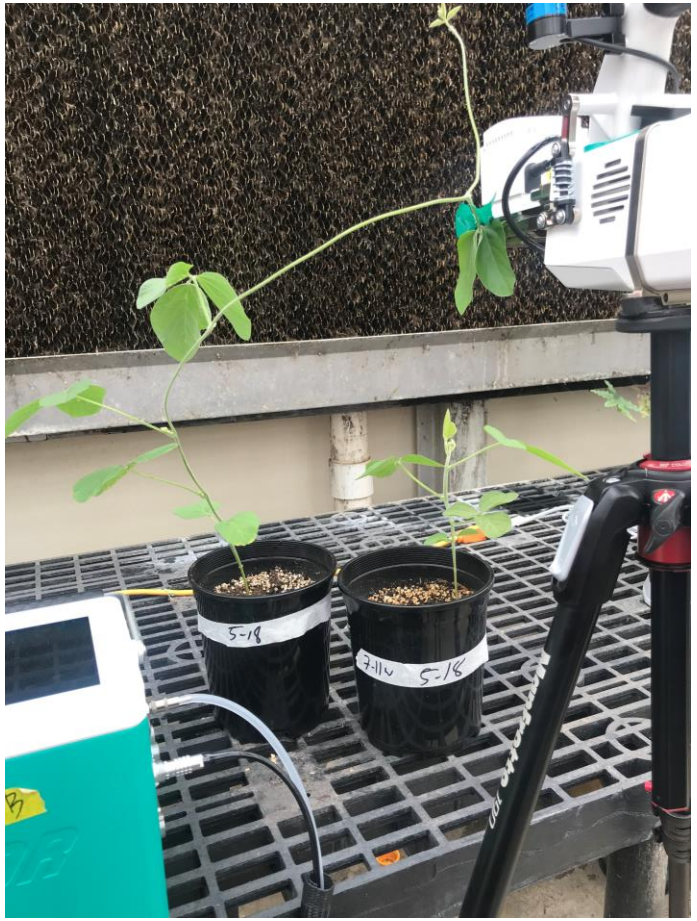
- Four light treatments
- Four N fertilization treatments
- Two species
  - Cotton
  - Soybean

Greenhouse

- ~~Four light treatments~~
- Four N fertilization treatments
- Two species
  - Cotton
  - Soybean

Greenhouse

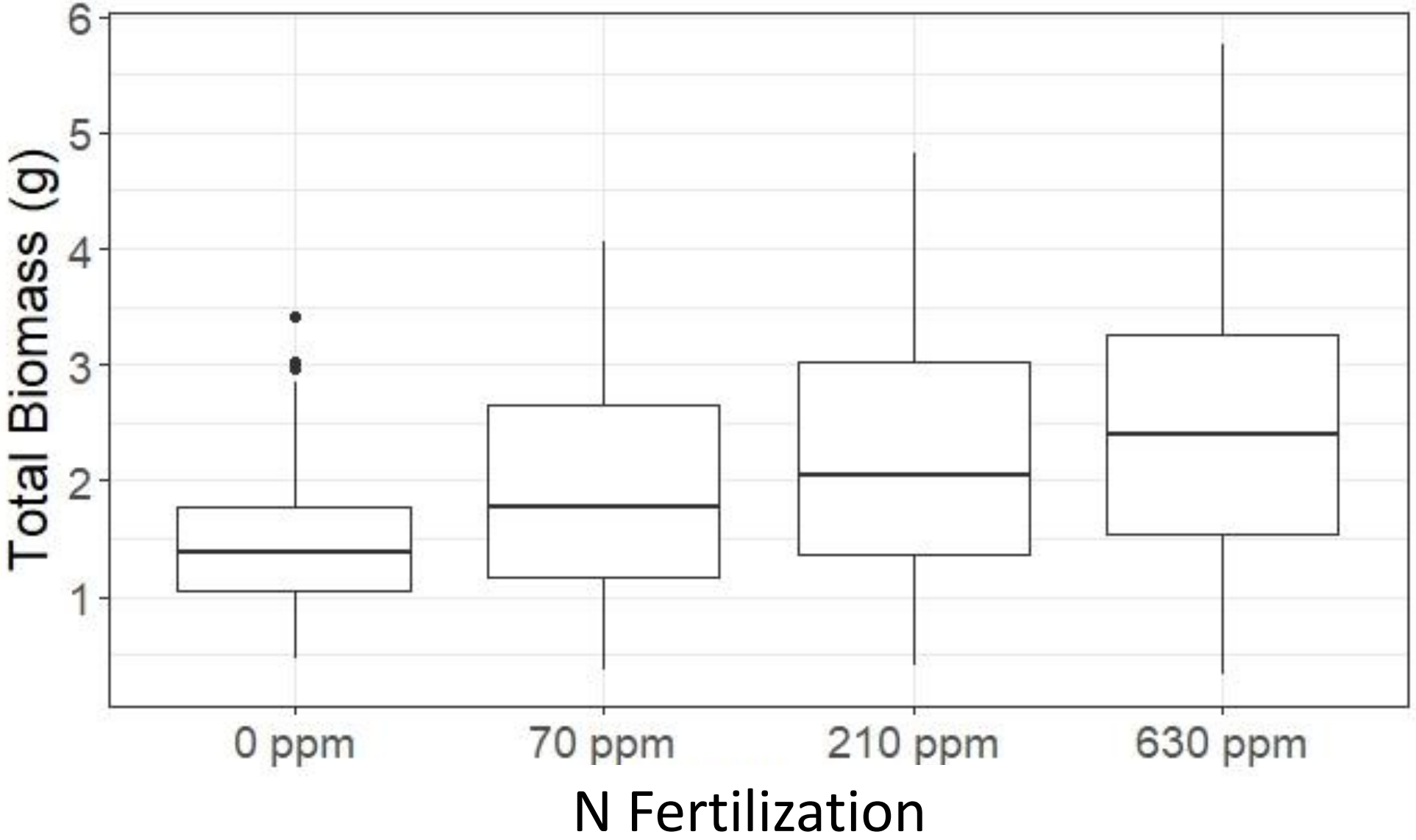
- Li6800
- Biomass
- Area
- Elemental analysis



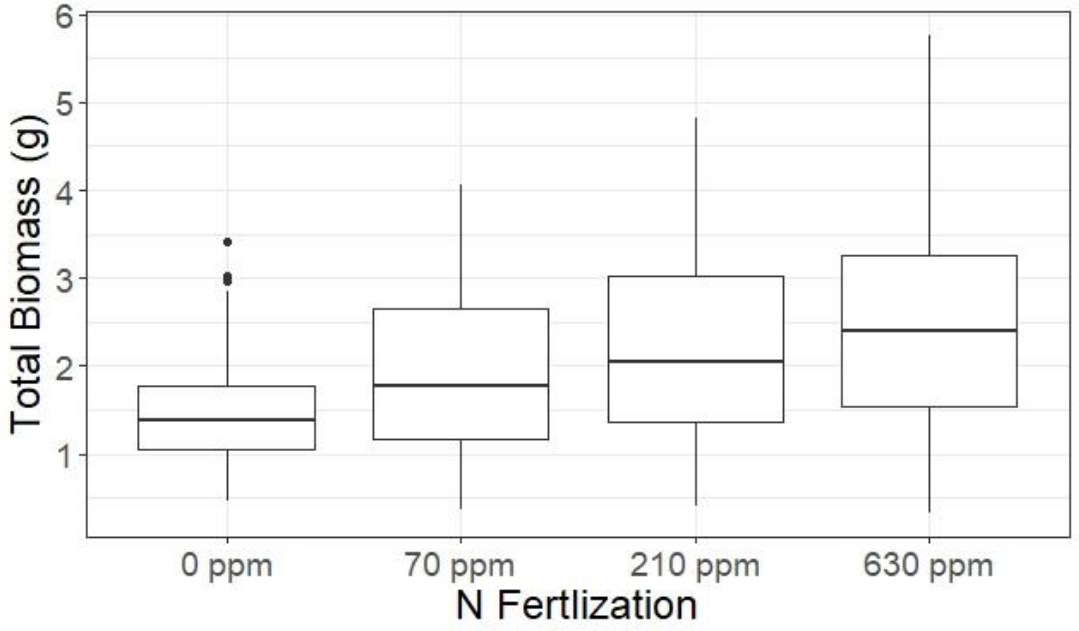
Soil N → Biomass

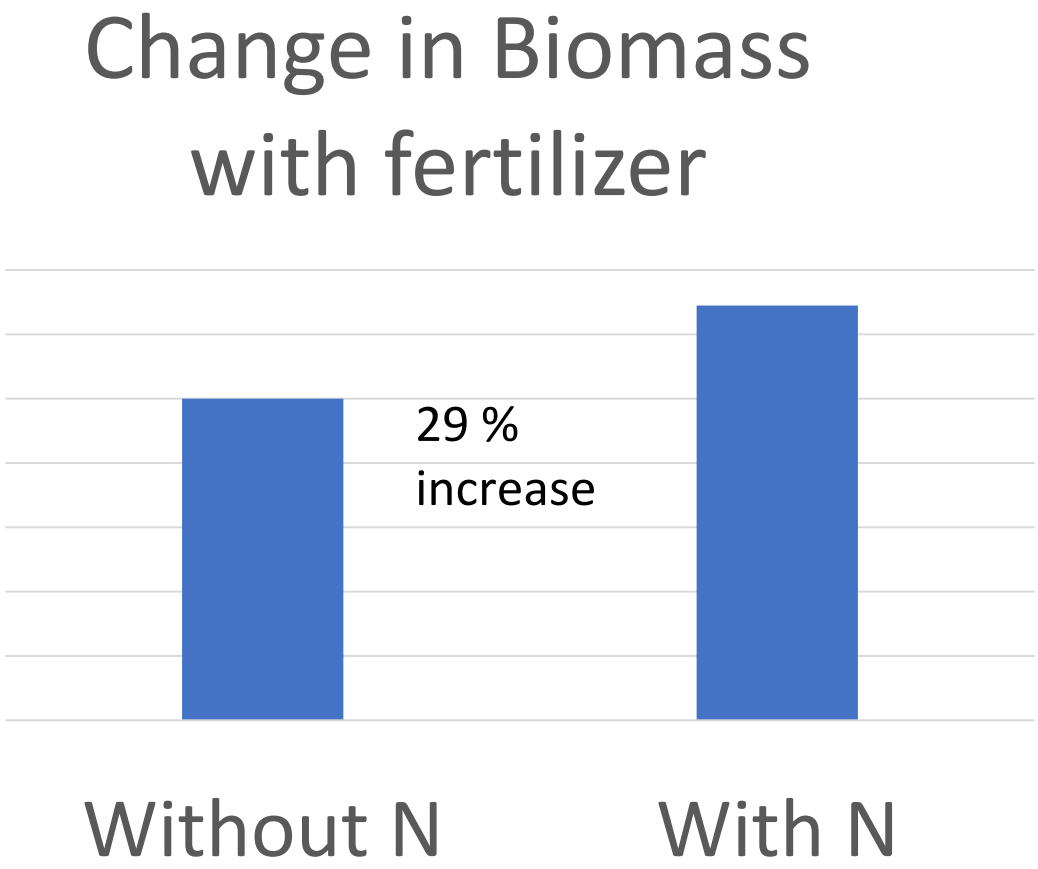
70% increase

P=0.0213



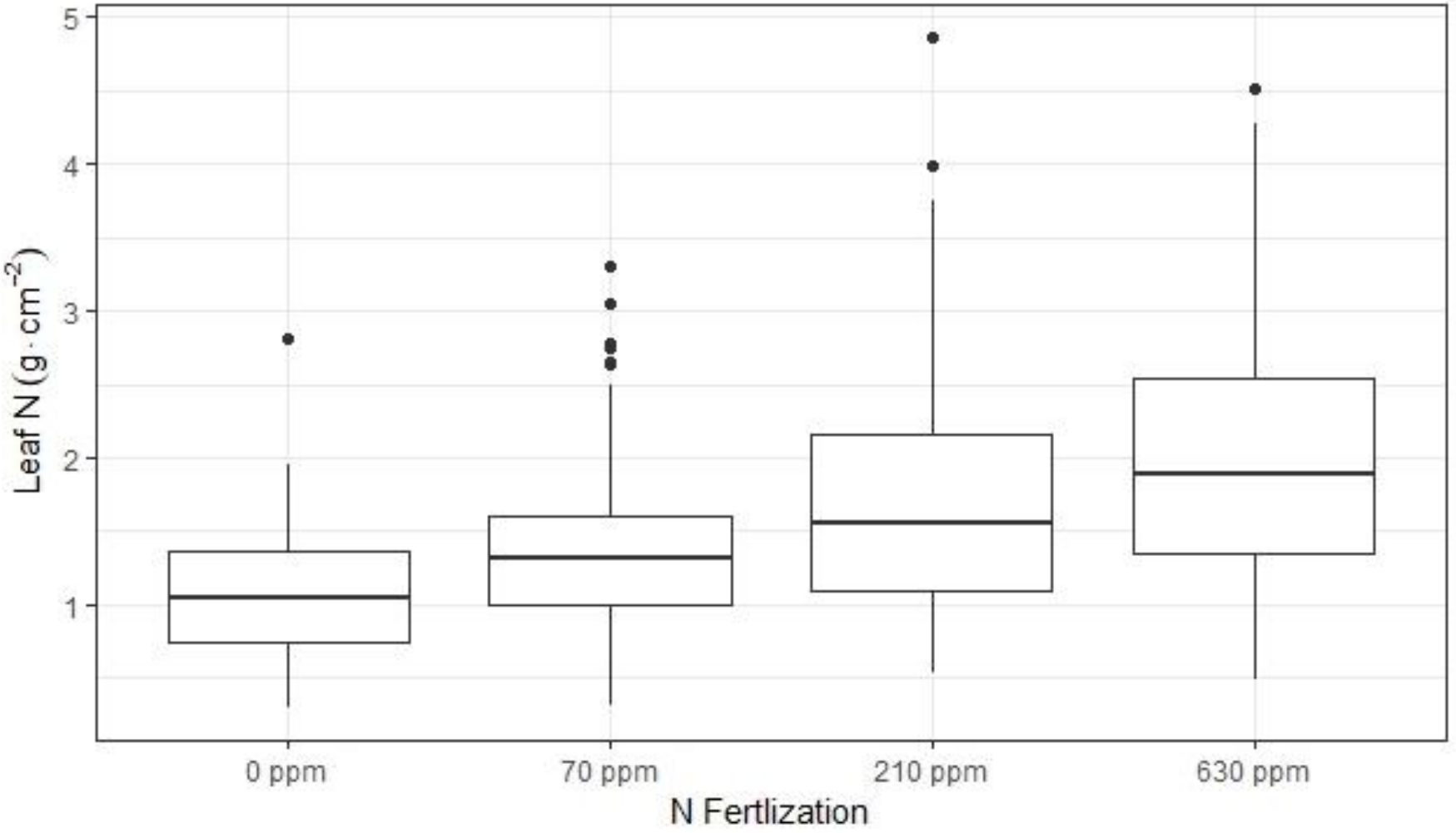
Soil N → Biomass



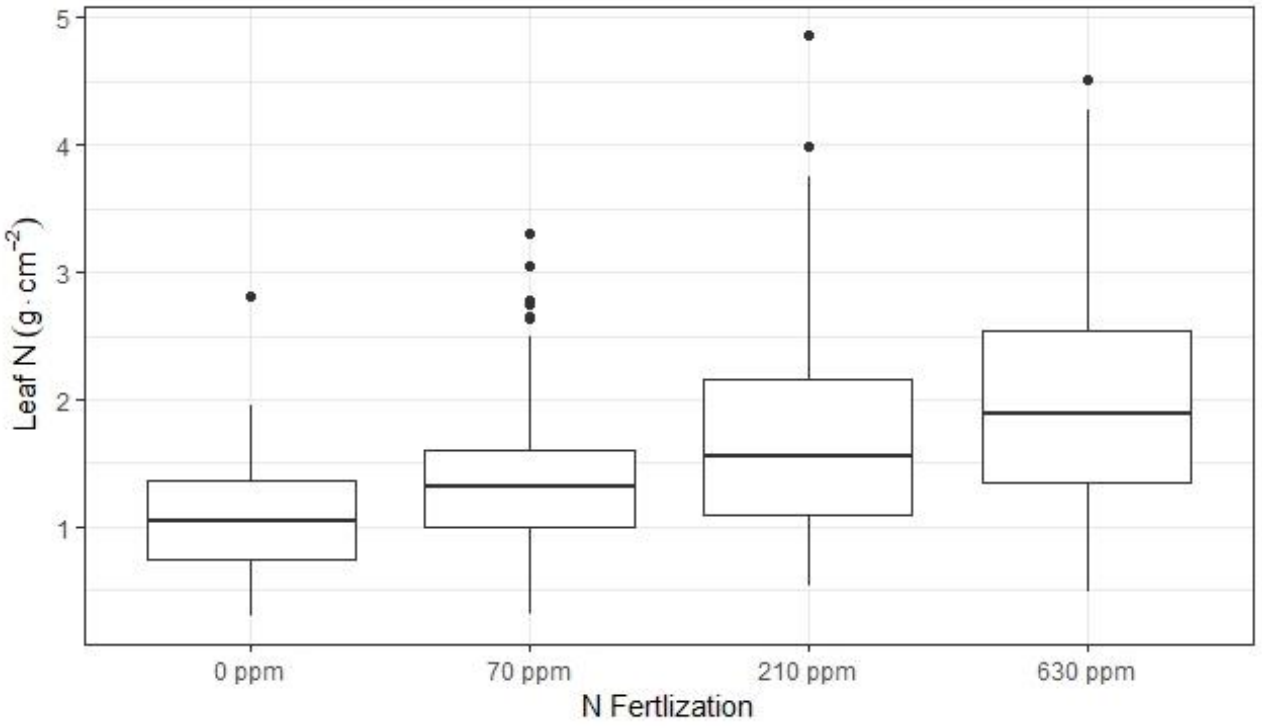


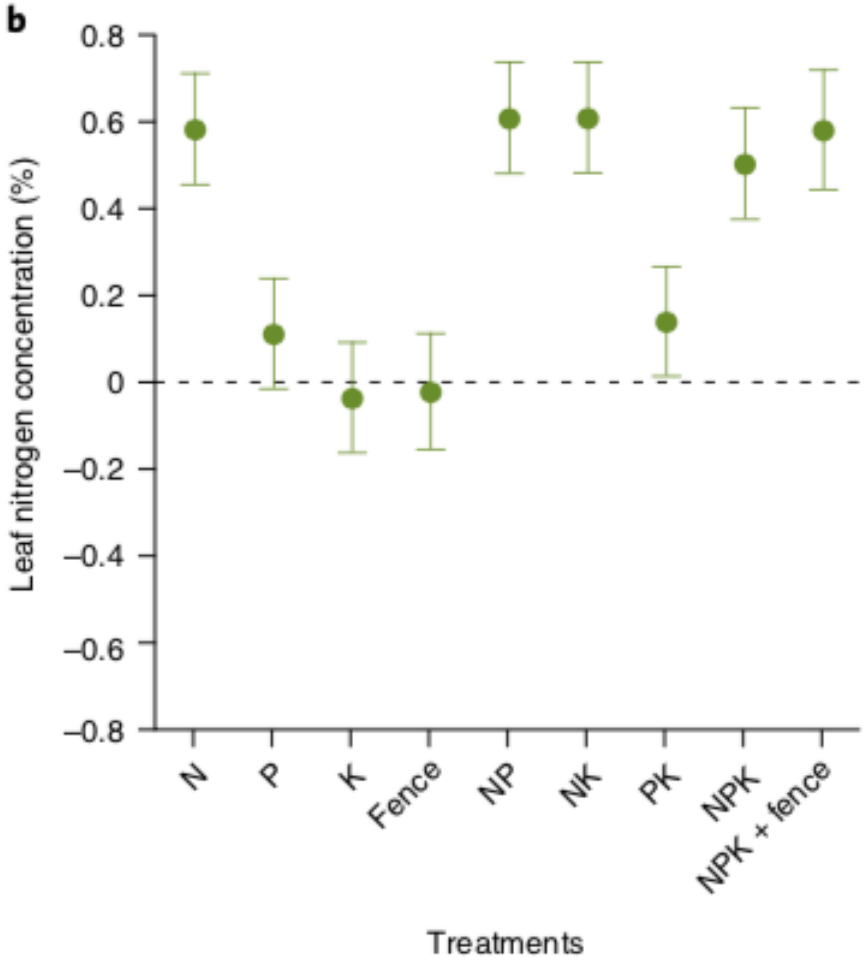
Soil N → Leaf N

100% increase

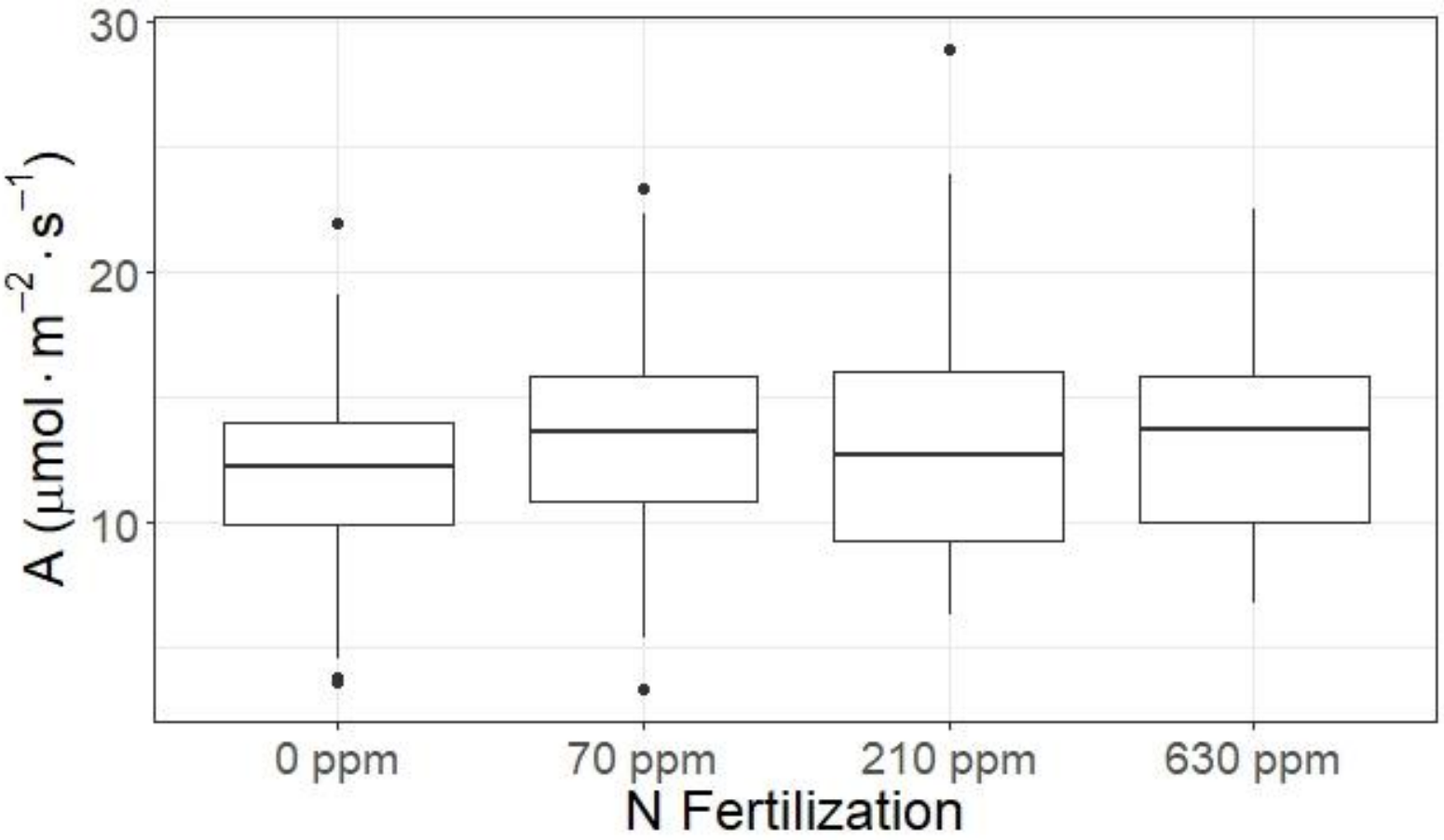


Soil N → Leaf N

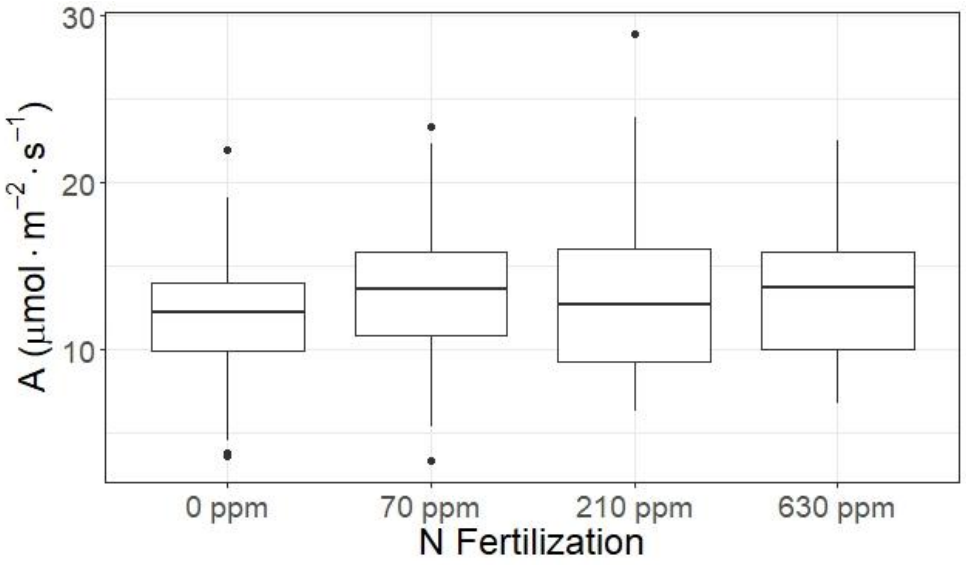

Leaf N (g · cm^{-2})
5
4
3
2
1
0 ppm
70 ppm
210 ppm
630 ppm
N Fertlization

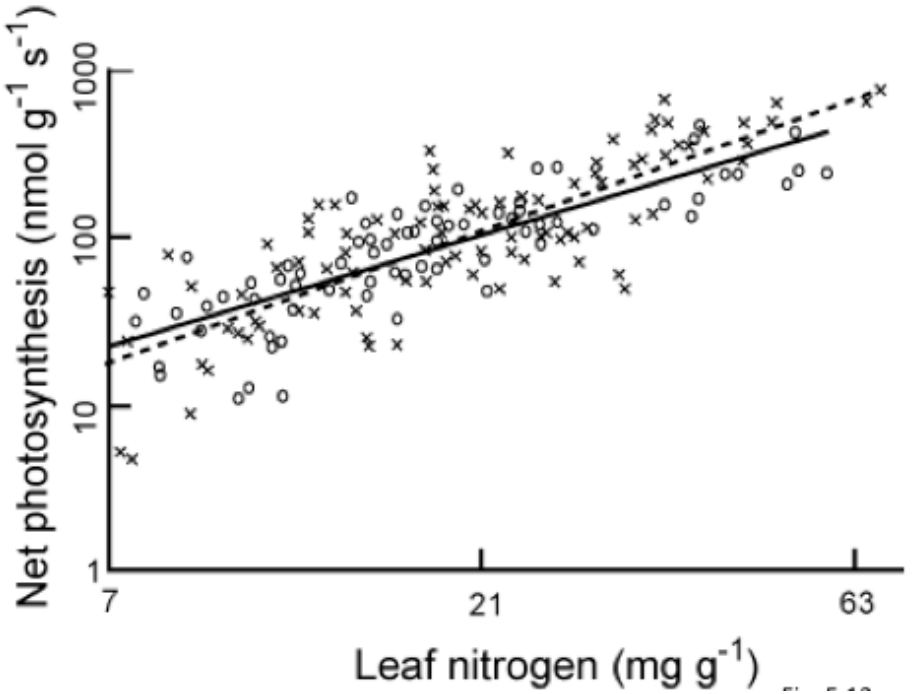

b
Leaf nitrogen concentration (%)
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
N
P
K
Fence
NP
NK
PK
NPK
NPK + fence
Treatments

Soil N → Leaf N ⊘→ Photosynthetic capacity

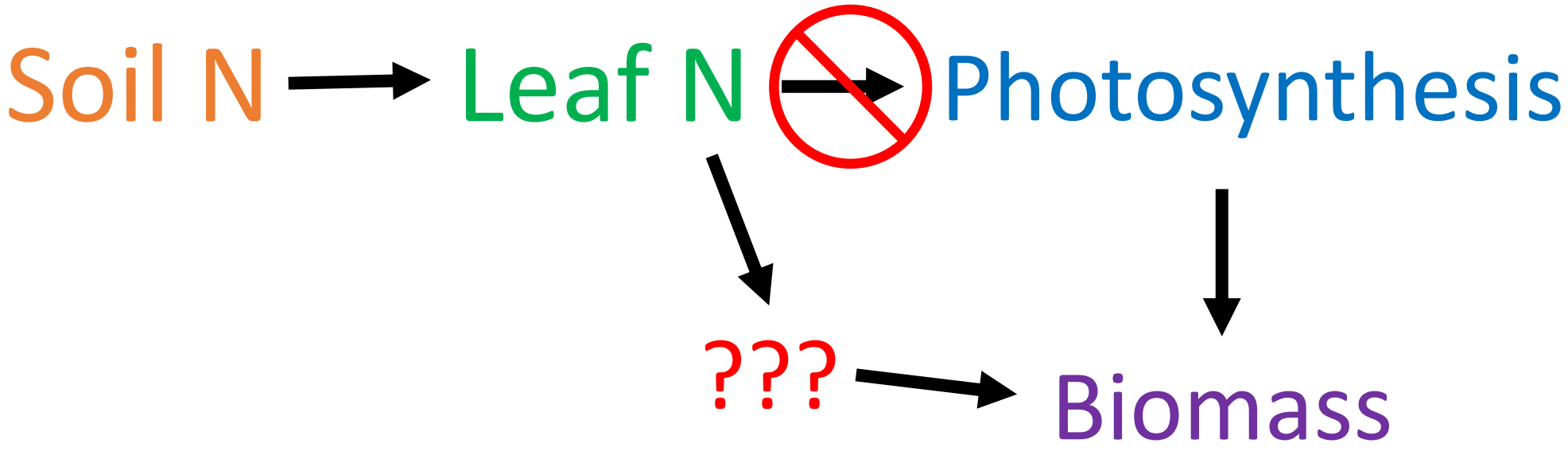


Soil N → Leaf N ⊘→ Photosynthetic capacity



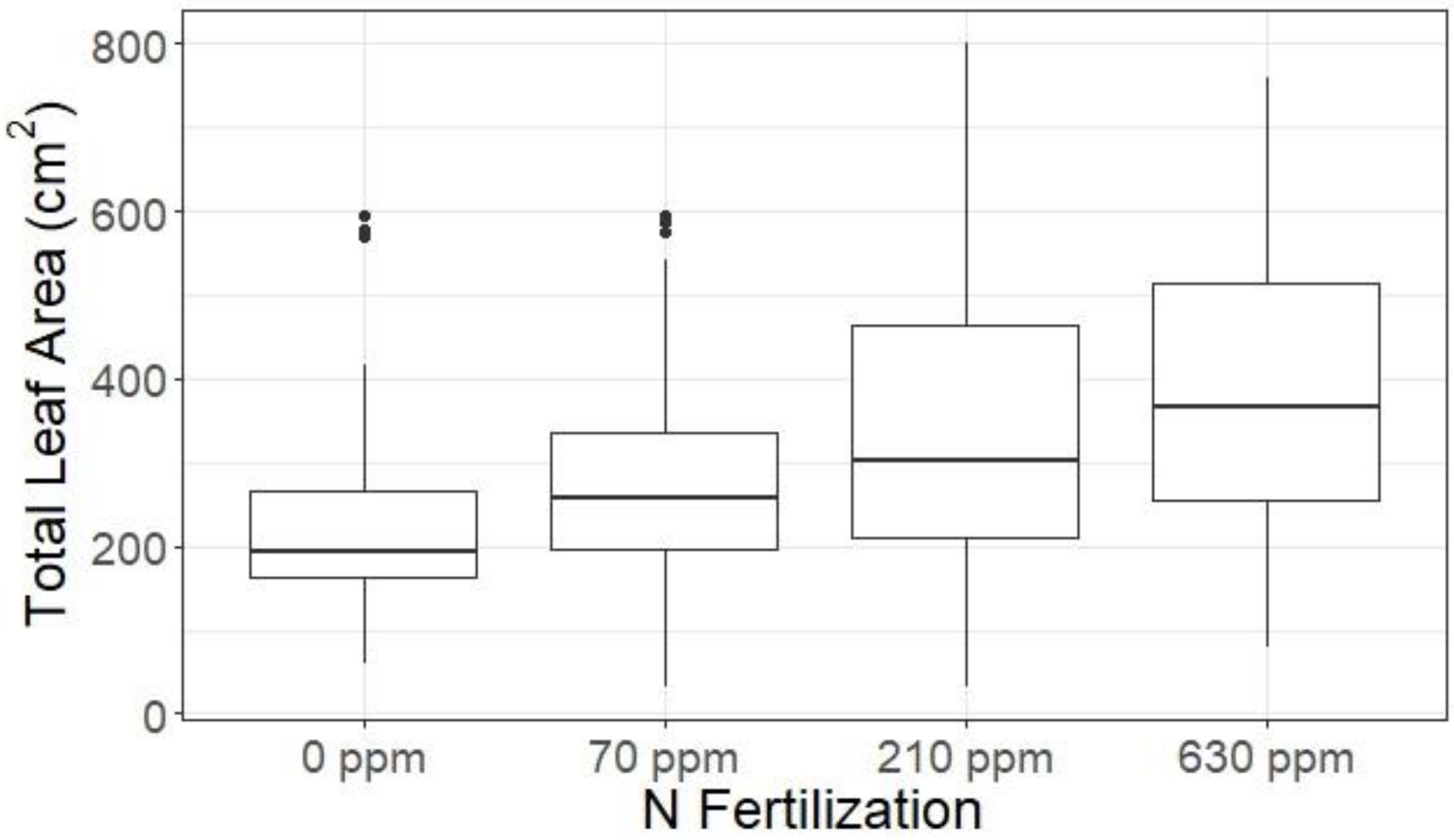


Hypothesis

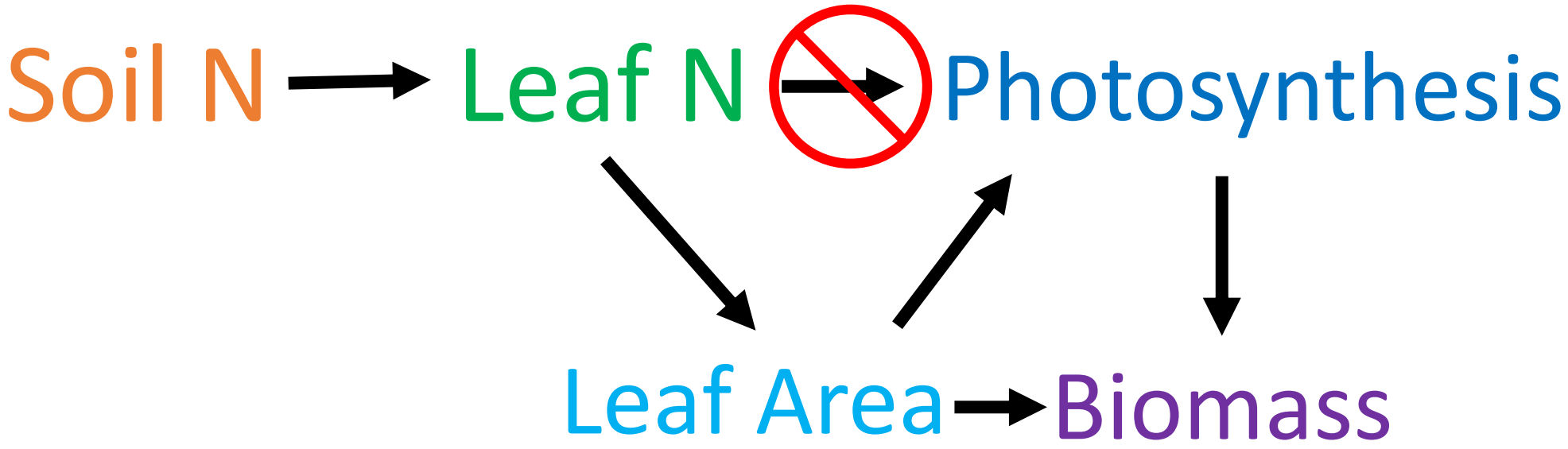


Soil N → Leaf Area

90% increase



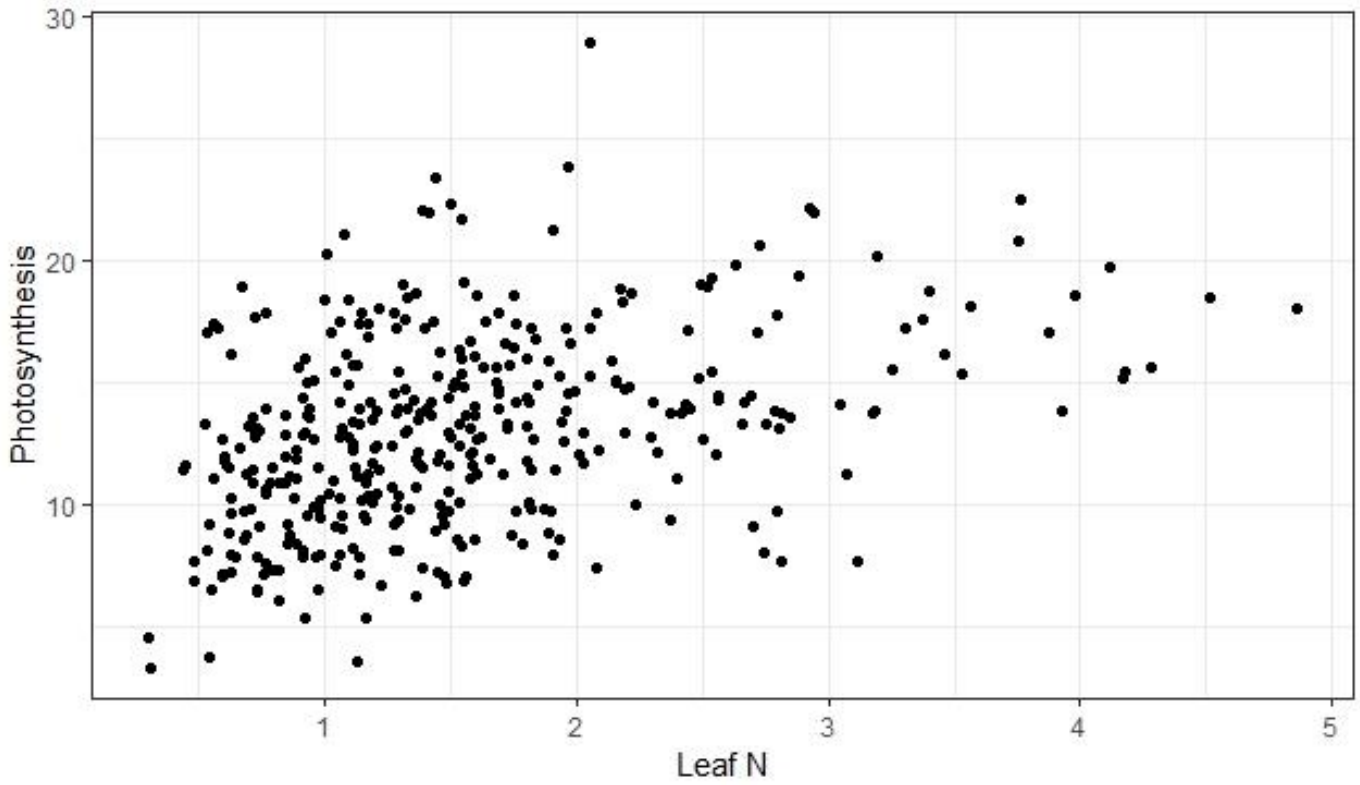
Conclusion



Summary

- Soil N effect –
  - Increase in leaf N
  - Increase in leaf area
  - No change in photosynthetic capacity
    - **FERTILIZATION DOES NOT INCREASE LEAF-LEVEL PHOTOSYNTHESIS**

- N fertilization increase Leaf N
- Light increase photosynthesis
- Photosynthesis drives N demand, not other way around



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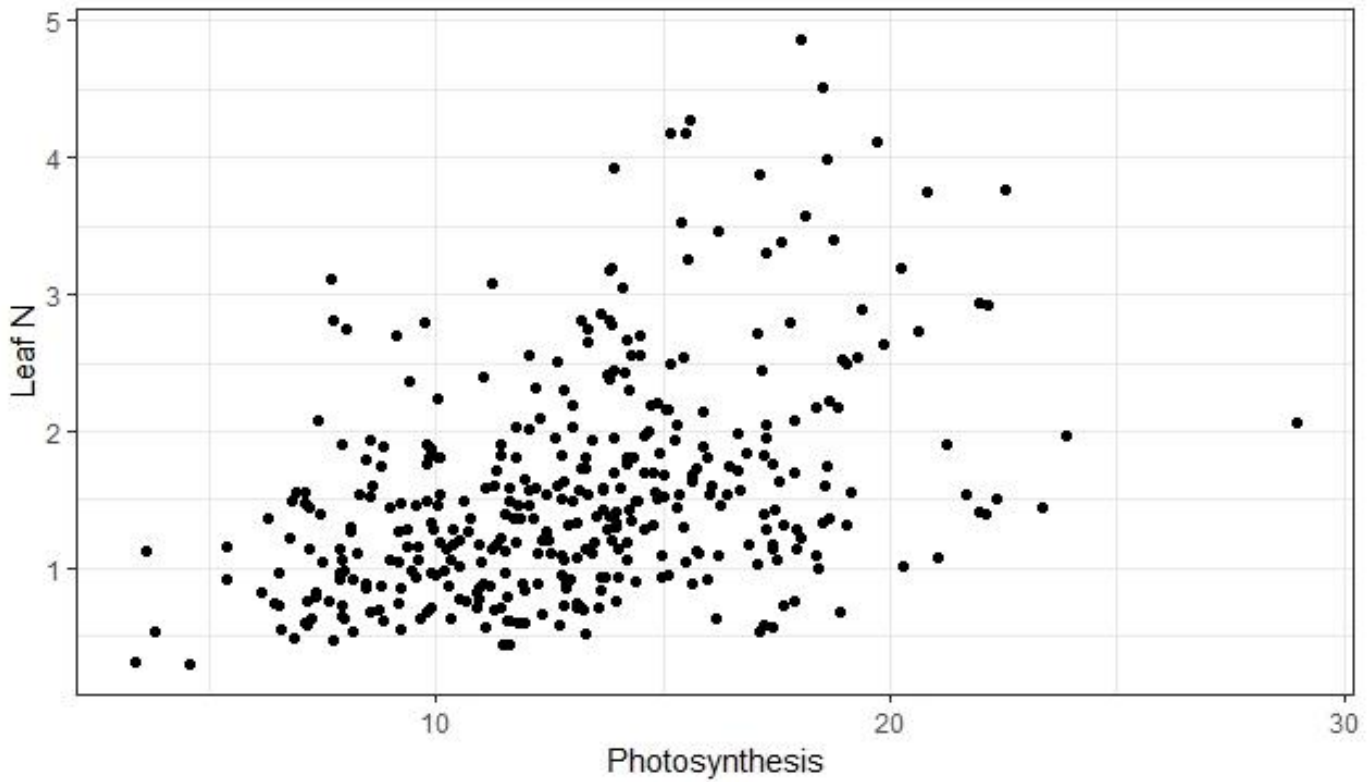

Undergraduate involvement

- **Undergraduate Researchers:**
- Josh Gutierrez
- Jorge Ochea
- Austin Cooper
- Mahum Haque
- Angel Barron
- Leah Ortiz
- Kobe Young
- Dave Baychoo
- Zachary Bailey