2025 Southwest Cotton Physiology Conference

Adaptive Carbon Use in Cotton Leaves Under Deficit Irrigation

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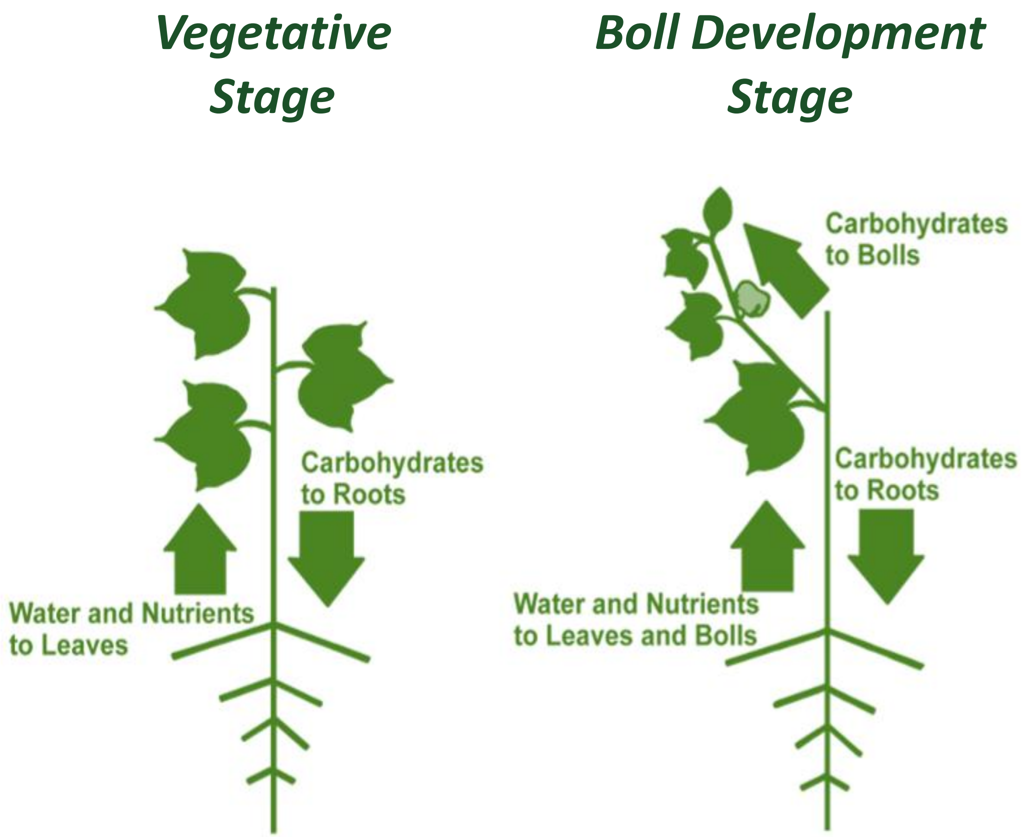
Partitioning of photosynthate carbon

- Cotton
  - indeterminate growth habit
  - vegetative and reproductive growth overlap
- Carbon resource competition:
  1. Between fruits (1° sink) – node, position
  2. Between fruits and developing leaves (2° sink)
- Carbon contribution of **leaves** drives growth and development

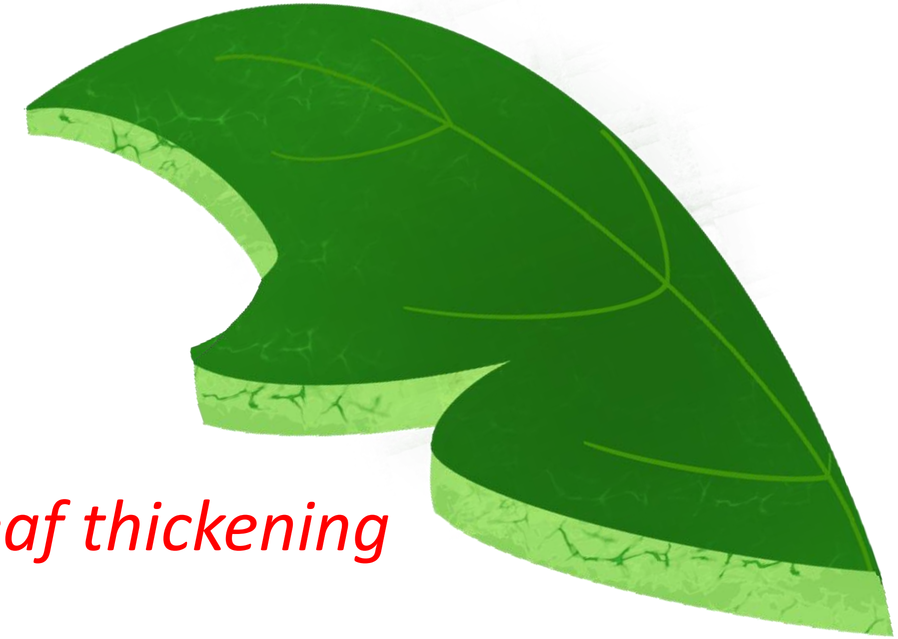


Carbon demand at two growth stages of cotton.
Ritchie, G. L., Bednarz, C. W., Jost, P. H., & Brown, S. M. (2007). Cotton growth and development.

Why focus on individual leaves?

- Well-distributed leaf mass, better light capture, improves photosynthesis
- Leaf mass increase: area growth versus thickening
- Trade-off?

Leaf area expansion



Leaf thickening

Objective

Determine the adjustments in leaf carbon partitioning of cotton grown under two levels of irrigation based on:

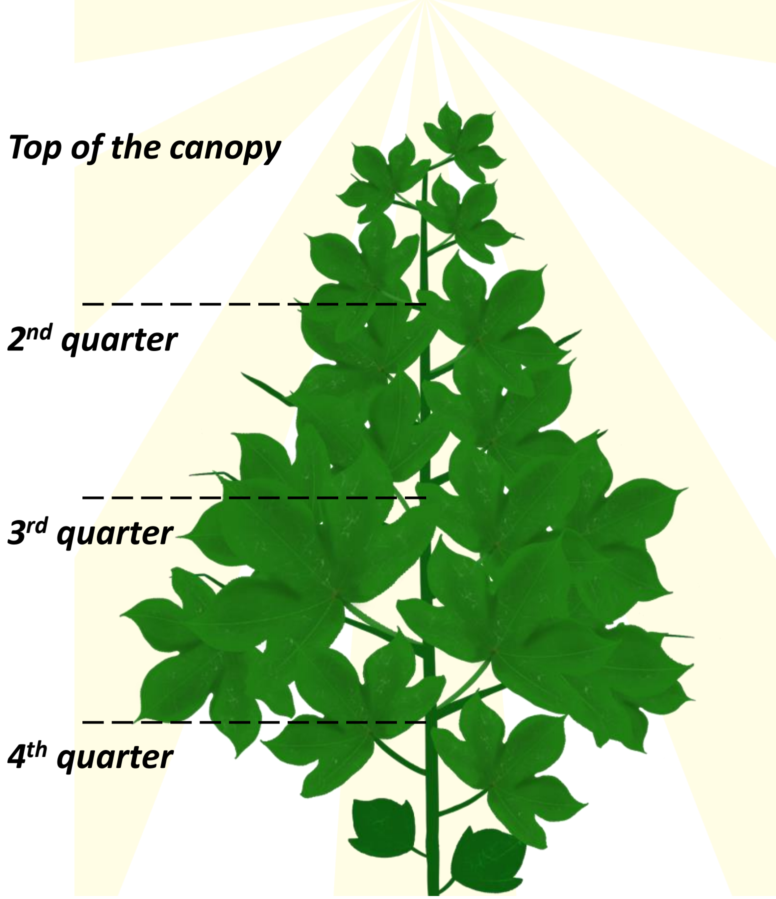
- *Leaf mass, leaf area, and specific leaf weight*
- *Radiation interception*
- *Carbon accumulation relative to plant size*
- *Relationship between leaf C production and fruit C demand*

Experiment details

- 2-yr study, TTU Research Farm, Lubbock, TX
- Varieties:
  - PhytoGen (PHY) 350 (early-mid)
  - Stoneville (ST) 5707 (mid-full)
- Irrigation:
  - low (7.0 in), high (14.0 in)
  - subsurface drip irrigation system

Measurements

- Specific leaf weight per node (mainstem leaf)
  = leaf mass (g)/leaf area (cm^2)
- Radiation interception (Apogee quantum sensors)



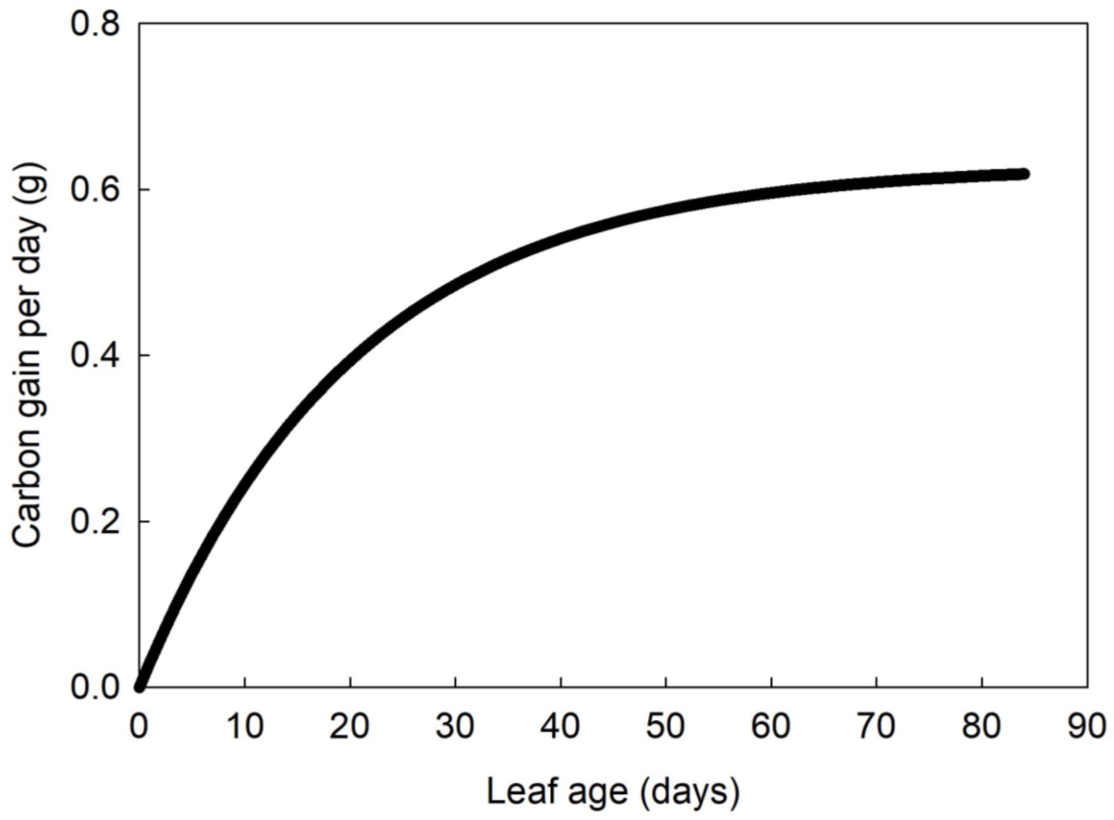
Sections for radiation capture measurements.

Experiment details

- Total leaf C accumulation by node

$$Y=a*(1-e^{-bX})$$

Y = *daily carbon gain among all leaves on the plant at a given node*
X = *leaf age in days after initiation*
a and **b** = *values based on a best-fit equation*

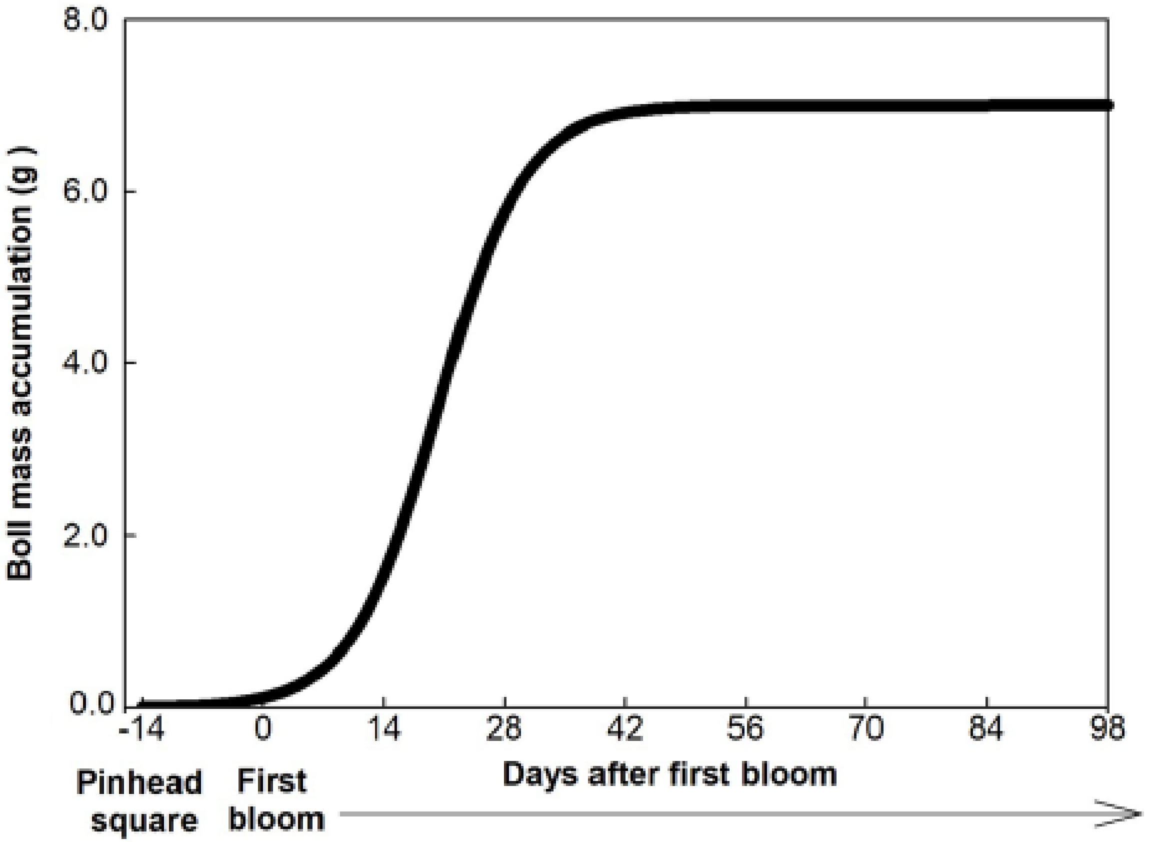


Pabuayon, I. L. B., Bicaldo, J. J. B., & Ritchie, G. L. (2025). Within-canopy carbon partitioning to cotton leaves in response to irrigation. Crop Science, 65(1), e21405.

Experiment details

- Fruit mass accumulation by node based on a 3-parameter sigmoid fit equation

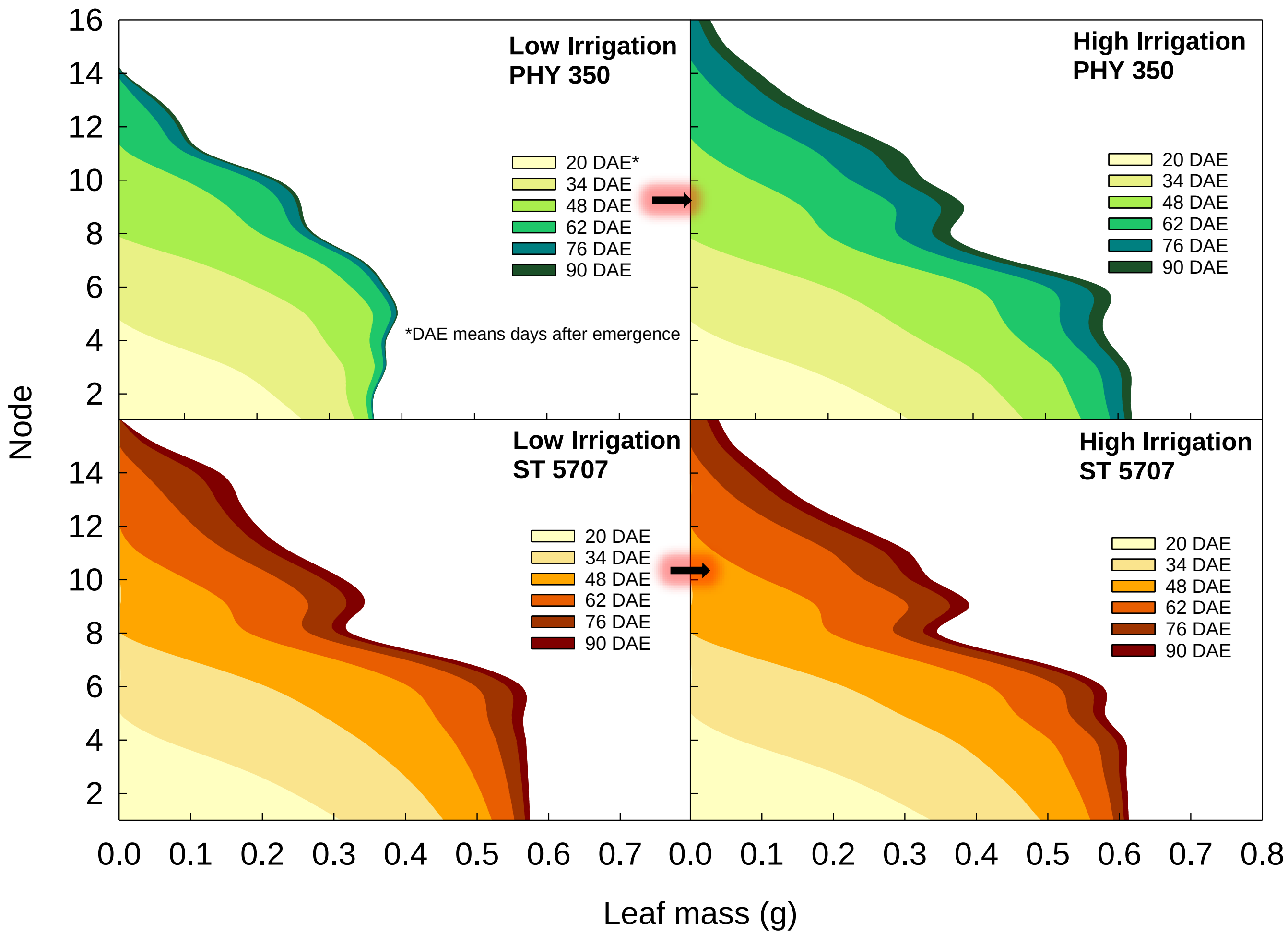
$$Y = \left(\frac{A}{1+\exp^{[-(X-X0)/B]}} \right)$$



Pabuayon, I. L. B., Bordovsky, J. P., Lewis, K. L., & Ritchie, G. L. (2023). Fruiting patterns impact carbon accumulation dynamics in cotton. *Field Crops Research*, 295, 108892.

Leaf carbon accumulation by node

- Bottom of canopy
  - higher rates of C accumulation
- Higher on the plant
  - water deficit reduces leaf production and growth
- What is driving the variations in leaf mass?
  - leaf thickening
  - leaf area expansion



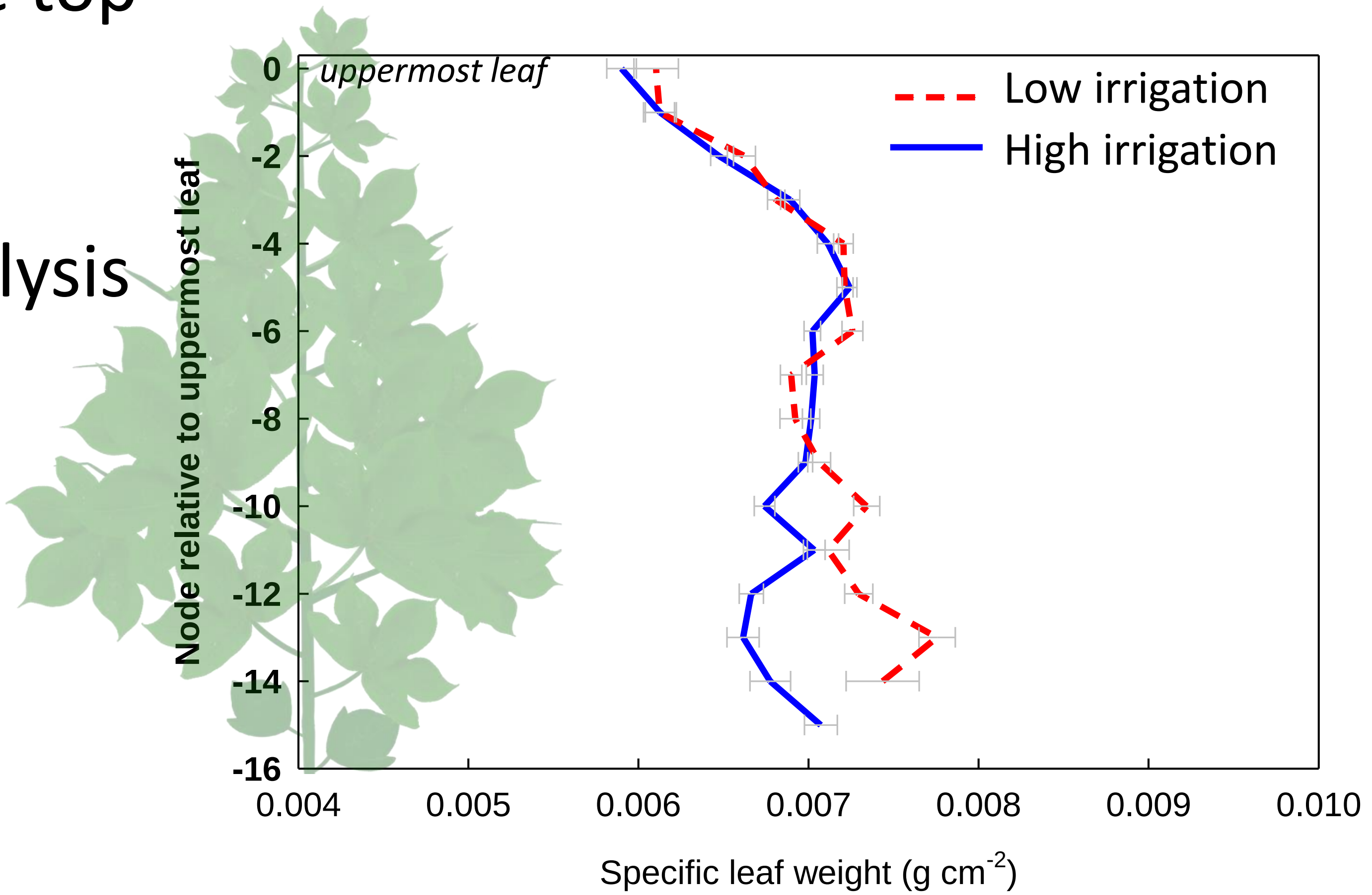
Carbon partitioning for leaf thickening

Later developed leaves:

- 4th/5th mainstem leaves from the top
  - heaviest leaves
  - maximum resources
  - best indicator samples for analysis

Early developed leaves:

- Water-limited
  - partitions C for leaf thickening
  - maximizes the capacity for area-based photosynthesis



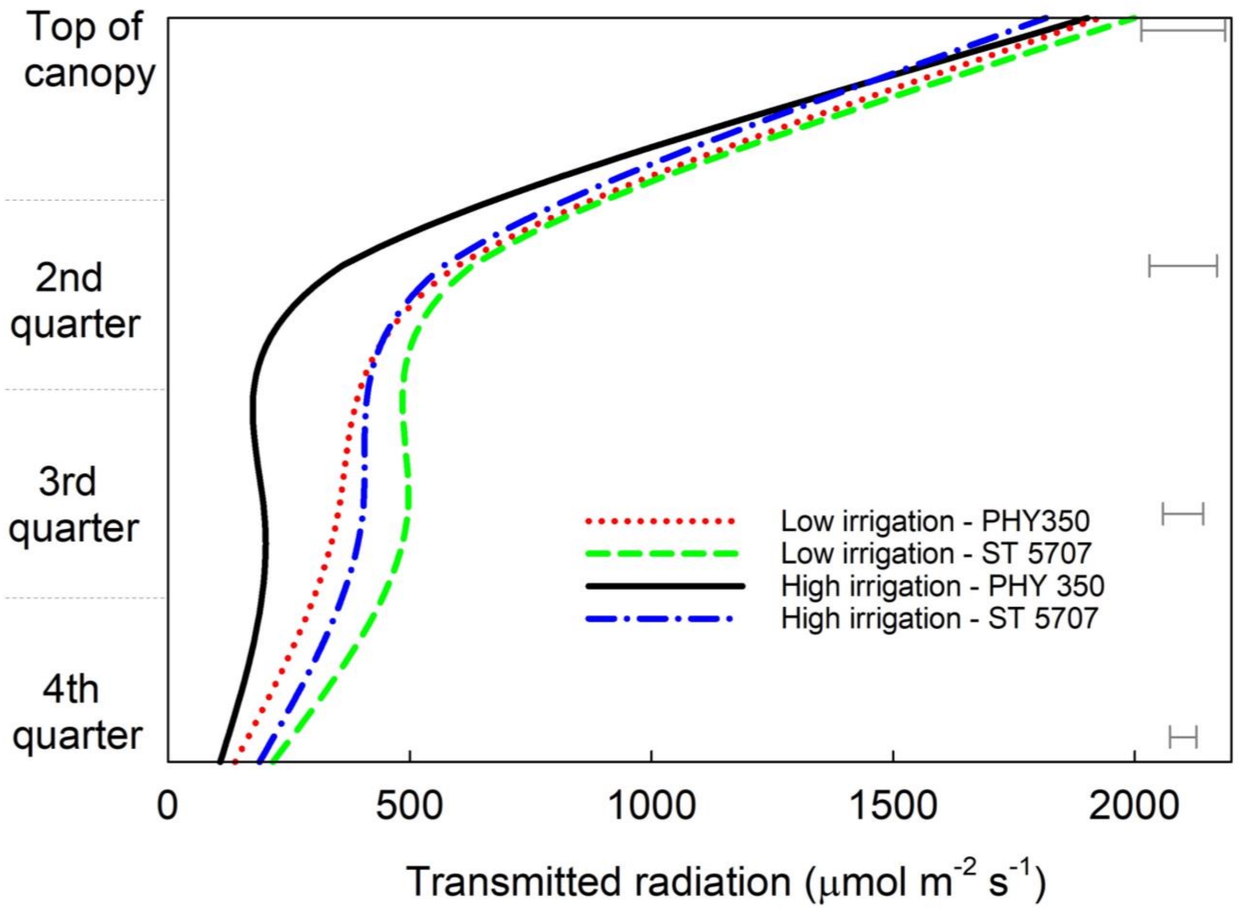
Radiation interception

Non-water limiting conditions

- Larger effective leaf area
- Increased light capture
- Higher net assimilation rate

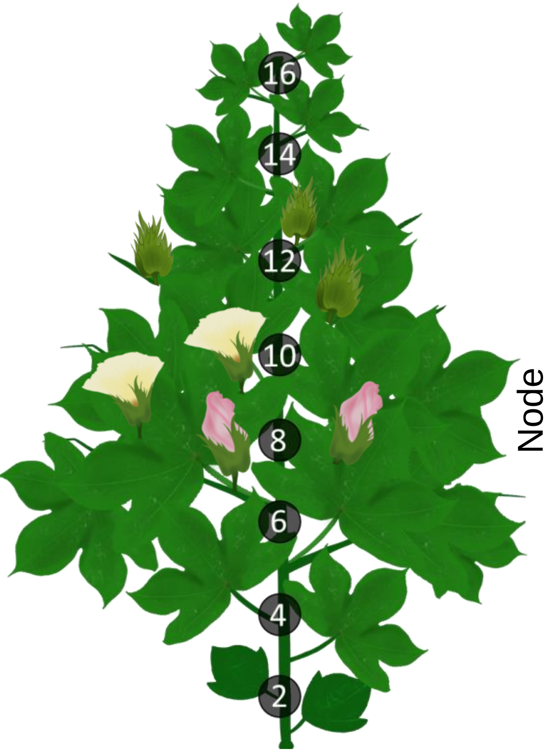
More shading at the bottom

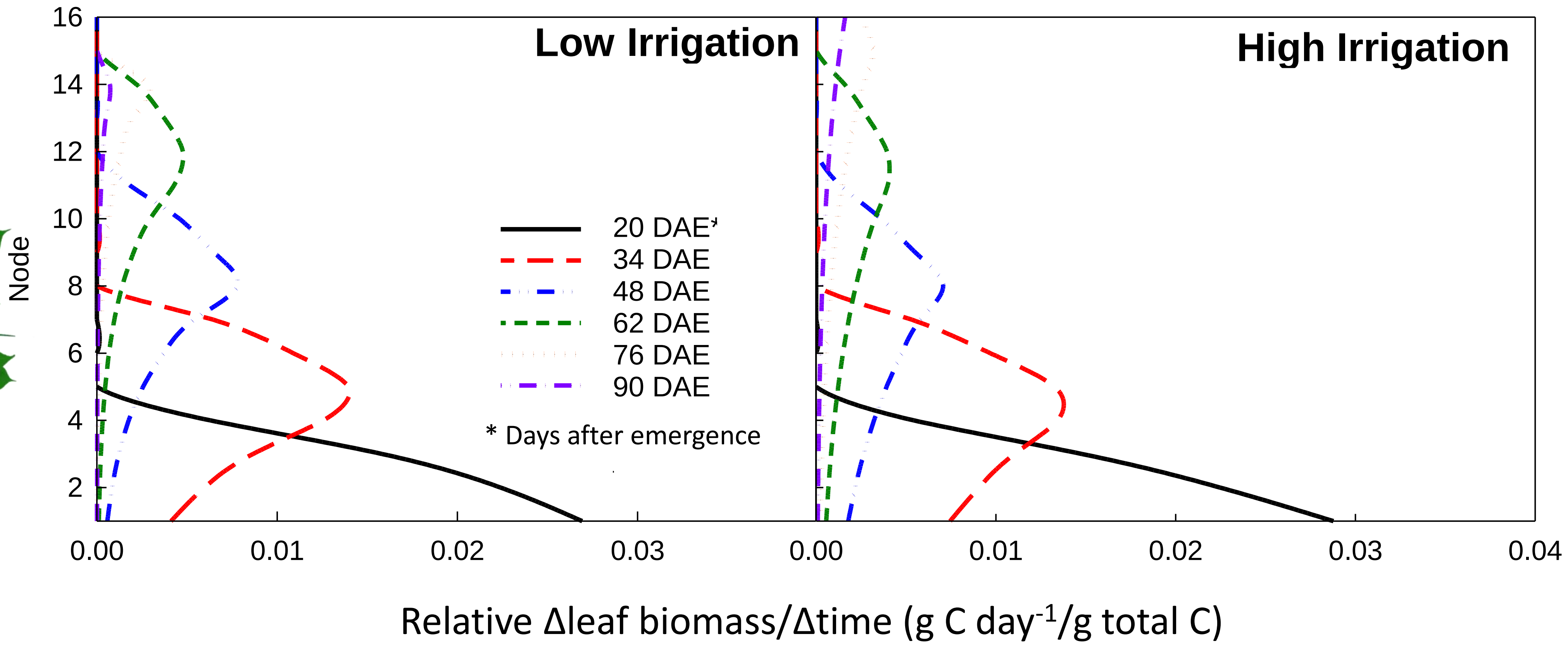
- thicker leaves not beneficial
- diverts C resources from area growth
- increases cost of
  - maintenance respiration
  - adding new thicker leaves



Leaf carbon accumulation relative to plant size

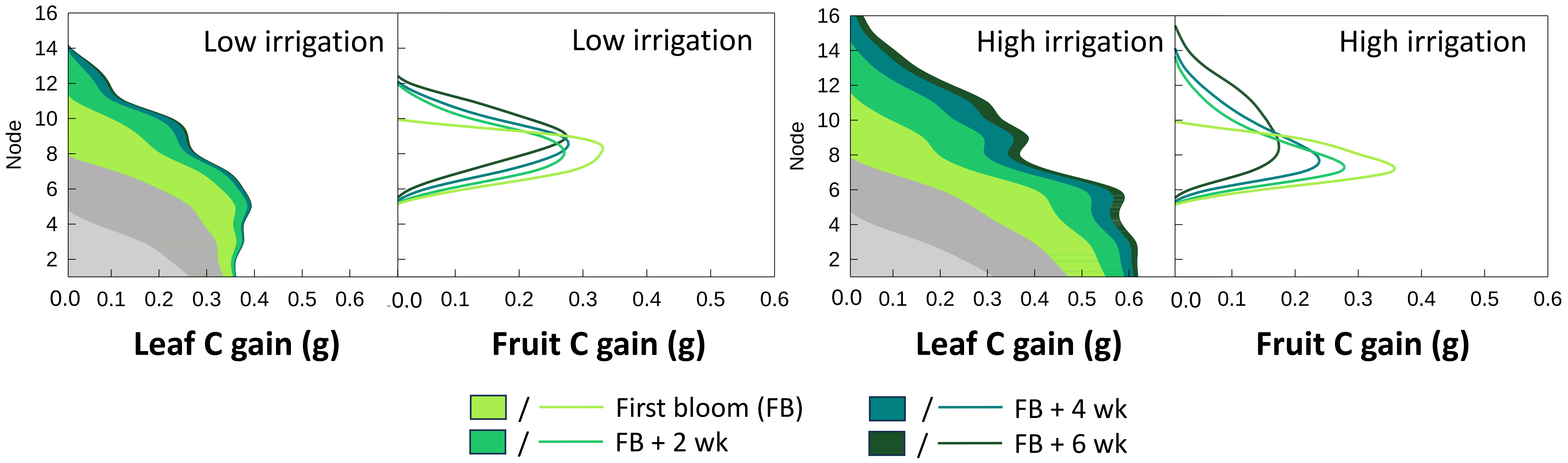
- Rate of leaf C accumulation declines as C resources are partitioned towards fruit development





Carbon production and demand synchronicity

- Leaf C production and fruit C demand are **synchronous**
- Low irrigation - more compact, C partitioning to *increase fruit retention*
- High irrigation - C diluted higher on the plant, *reduced fruit retention*



Conclusions and Future Directions

1. Water-limited conditions
    - thicker leaves compensate for large gains in leaf area
2. Irrigation encourages less-determinate growth habit
    - prioritizes leaf area expansion
3. Early maturing cultivar - synchronous leaf C production and fruit C demand
4. Expand research - other management strategies

e.g. planting density – ***Dr. Ken Legé (TAMU)***

soil microbiome/cover crop systems – ***Dr. Lindsey Slaughter (TTU)***

Crop Science

ORIGINAL ARTICLE

Crop Physiology & Metabolism

Within-canopy carbon partitioning to cotton leaves in response to irrigation

Irish Lorraine B. Pabuayon | Jessica Joy B. Bicaldo | Glen L. Ritchie

Acknowledgements

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- Dr. Ken Lege and Dr. Cory Mills for providing the cotton seeds

PhytoGen COTTONSEED

BASF We create chemistry

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TEXAS TECH Davis College

Thank you!
Questions?

Acknowledgements

- Crop Physiology Research Group – PSS Texas Tech
  - *Dr. Glen Ritchie*
  - *Jessica Bicald*
  - *Zelalem Alem*
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