Impacts of Thermo-limited Environments on Cotton Productivity

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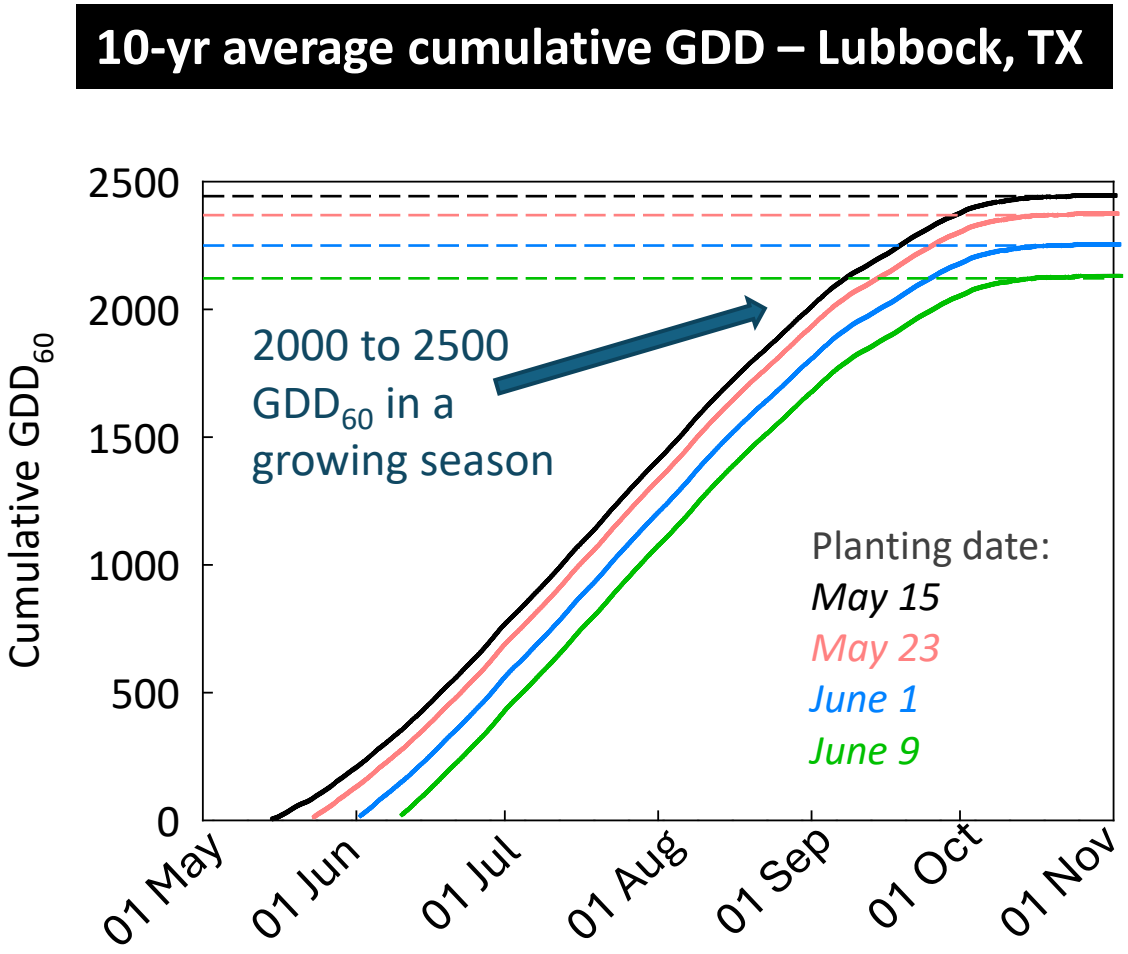
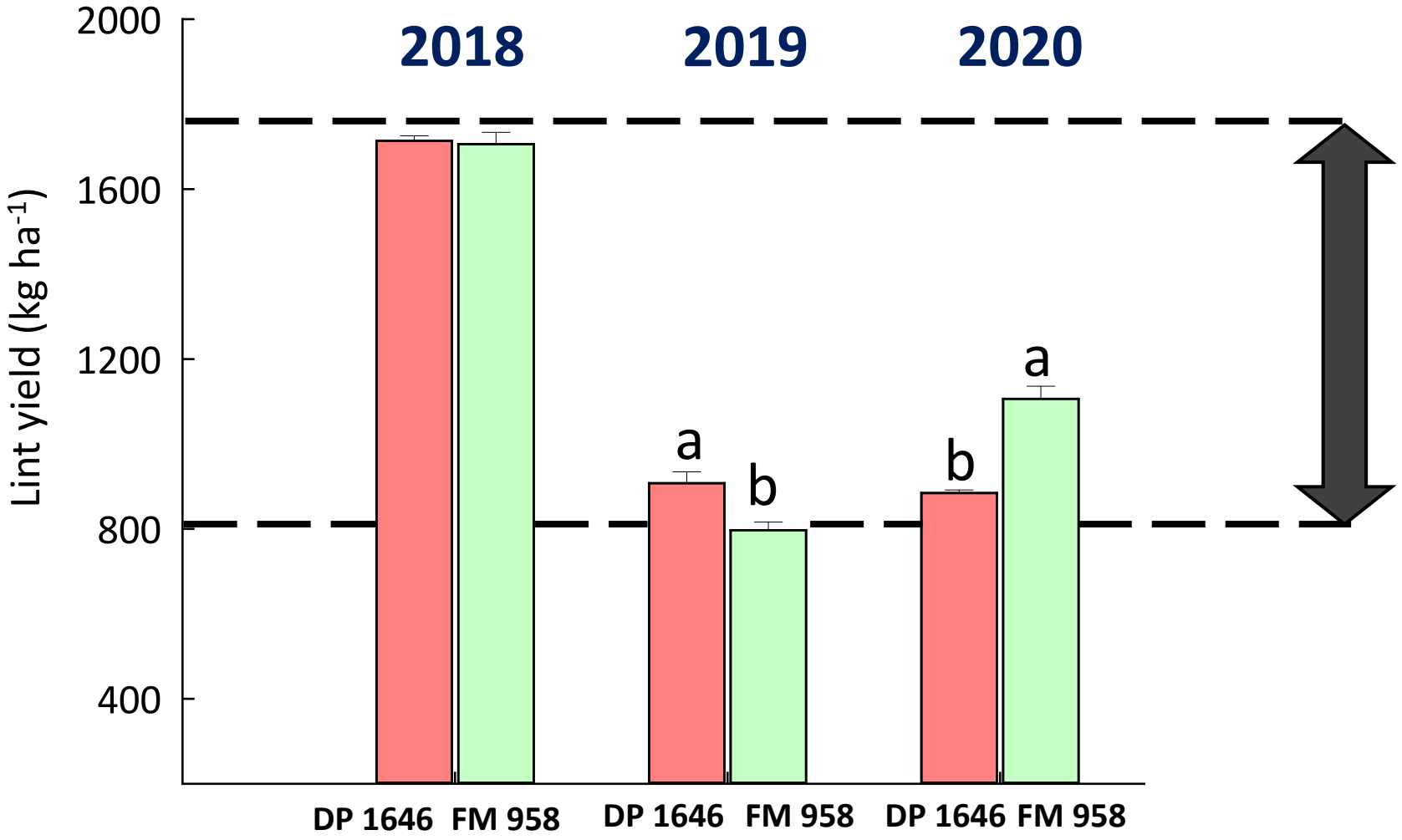
Introduction

- Cotton properties
  - Hot weather C3 crop
  - Taproot system
  - Indeterminate growth habit
  - Water-limited ⟷ temperature-limited
- High-yielding cotton
  - *~2250 HU + for maturity*
  - *~ 18 in of rain per year*
  - *60% irrigated acreage*
  - *3 bale cotton requires 18 in water*



Recent studies - Yield loss despite optimal input



~50% yield loss

- ✓Optimal N rate
- ✓Adequate water supply
- ✓No disease/pest infestation
- ✗Weather conditions
  Primarily temperature

Adapted from Pabuayon et al. (2020). Dry matter and nutrient partitioning changes for the past 30 years of cotton production. Agronomy Journal.

Objectives

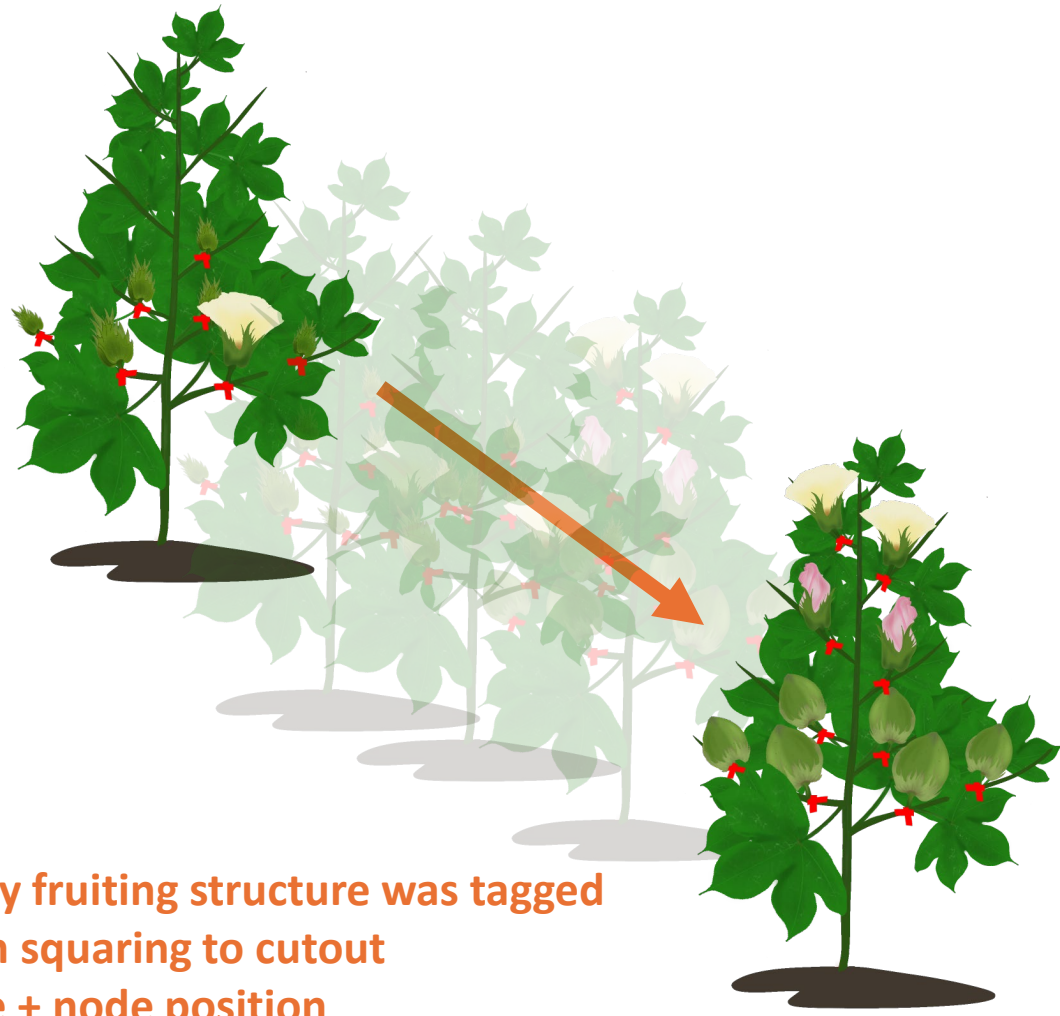
1. Evaluate planting date and temperature effects on cotton emergence by cultivar.
2. Track plant development using temperature data, alongside research in Canyon, Texas.
3. Determine thermo-limited effects on cotton growth patterns and yield.

Experiment details

- 2024, Texas Tech Research Farm
- Irrigation rates
  - *Low (7.0 in), high (14.0 in)*
- Sub-surface drip irrigation system
- Five varieties
  - *DP 1820 (early-mid, medium tall)*
  - *DP 2115 (early, compact)*
  - *FM 2398 (mid, medium tall/vigorous)*
  - *FM 765AX (early-mid, short compact)*
  - *PHY 205 (very early, short compact)*
- Soil temperature monitoring using HOBO sensors

Data collection and analysis

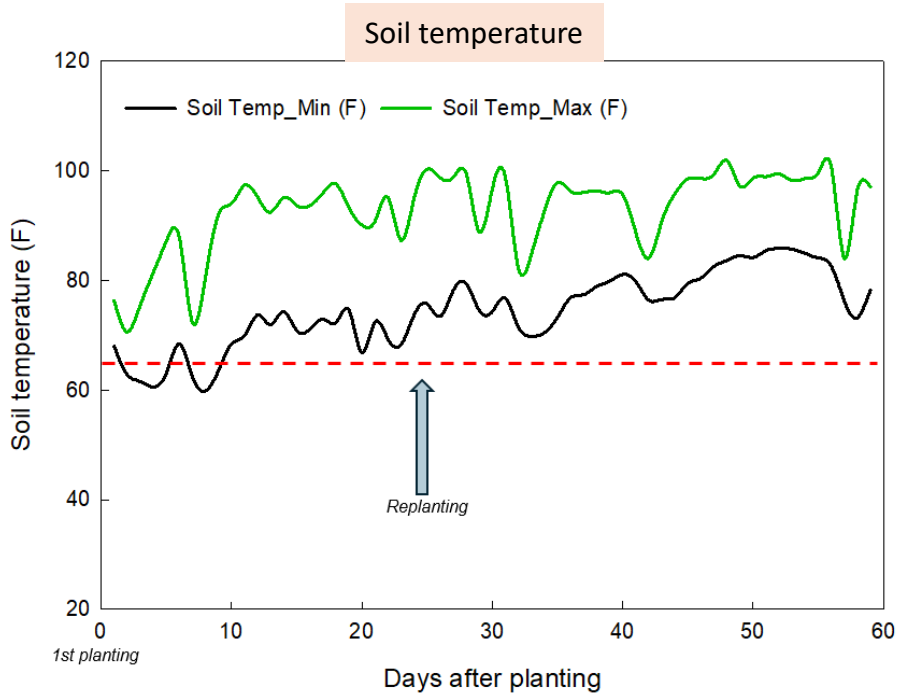
- Emergence rates
- Weekly in-season plant mapping until cutout
  - plant height
  - node of/above first square
  - node of/above white flower
  - total nodes
- Lint yield

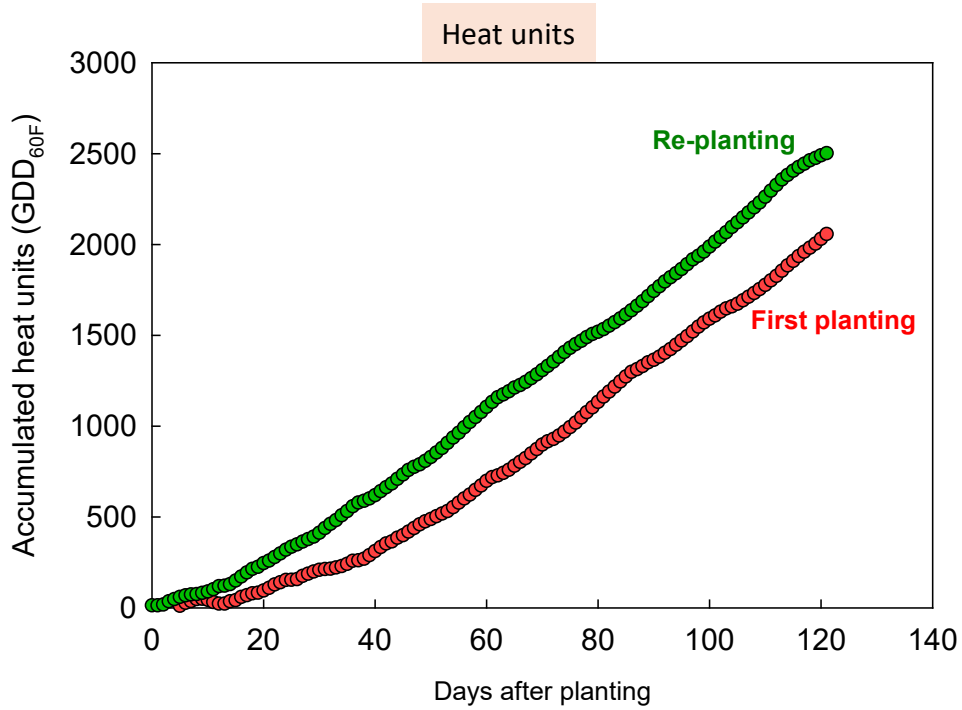


Every fruiting structure was tagged from squaring to cutout
Date + node position

Weather affected emergence rates

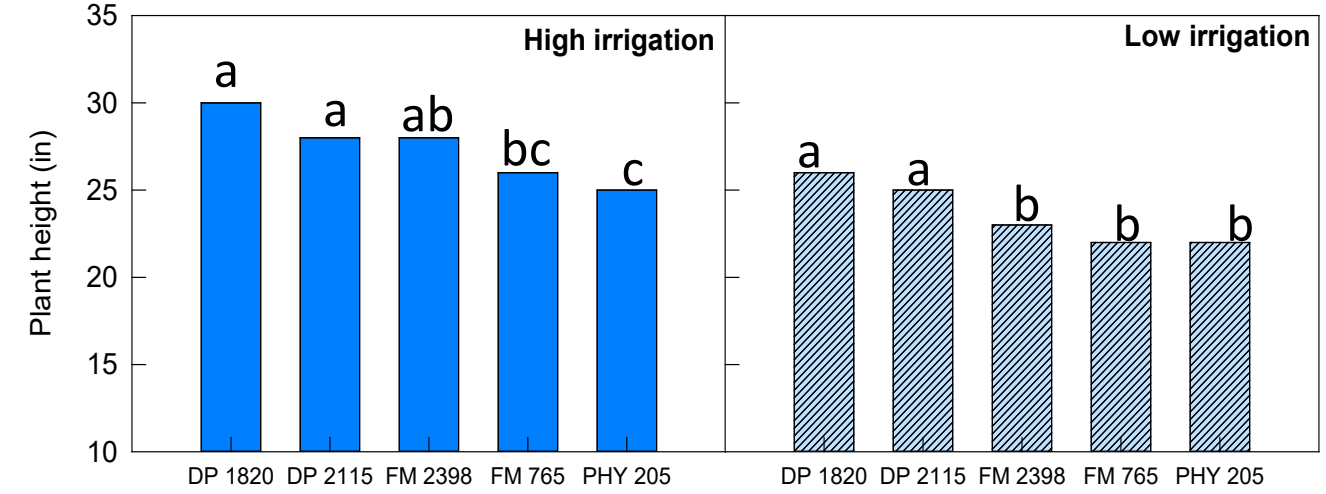
- May 9 planting emergence rates were very low (<2 plants per foot)
- Heavy rainfall, low soil temperatures
  - created challenging conditions for crop establishment
  - replanting on June 3 → resulted in acceptable emergence rates (3-4 plants per foot)

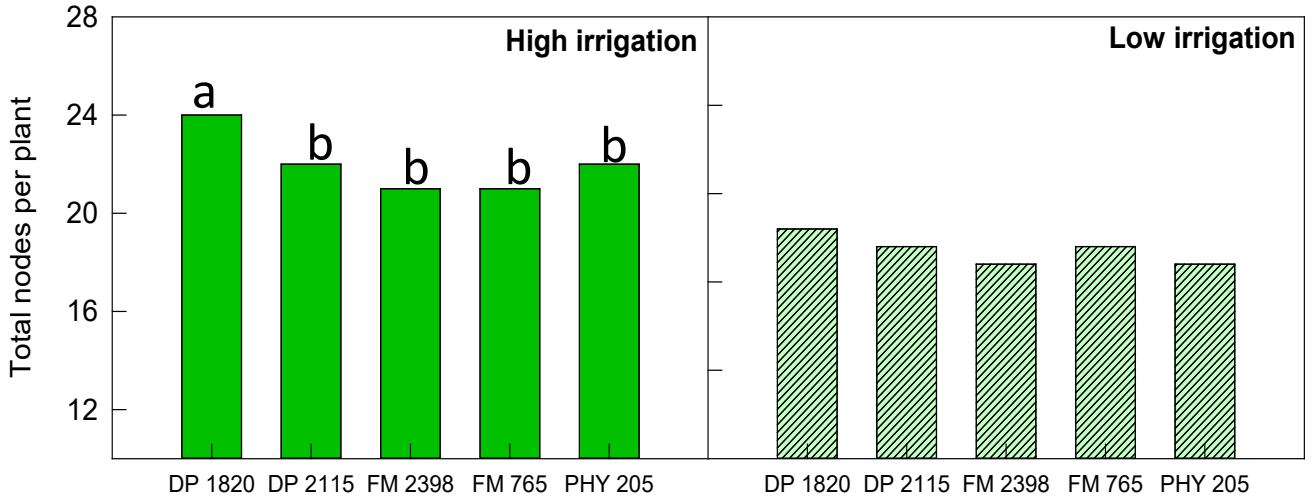




Plant height and node development

- PHY 205, FM 2398, FM 765
  - compact stature
  - more determinate growth habit
  - reduced responsiveness to irrigation
- DP 1820, DP 2115
  - tallest under both irrigation levels
  - better structural development
  - greater potential for fruiting positions?
  - depends on assimilate distribution





Node production rate

Early season

- Node production averaged 2.6-2.9 days/node across all cultivars
- FM 765 had the slowest node production
- DP 1820, DP 2115, and FM 2398
  - maintained consistent node production rates regardless of irrigation level

Average number of days for node development in cotton varieties grown at TTU Research Farm in 2024.

	Early-season		*Mid-season*	
	Low	High	Low	High
DP 1820	2.6	2.7	2.3 c†	2.2 b
DP 2115	2.6	2.7	2.4 bc	2.3 ab
FM 2398	2.6	2.7	2.8 a	2.5 a
FM 765	2.7	2.9	2.5 ab	2.5 a
PHY 205	2.7	2.7	2.7 a	2.5 a

†Means with similar letters are not significant at α = .05.

Node production rate

Mid-season

- FM 2398, PHY 205 had the slowest node production
- DP 1820 – fastest rate, particularly under high irrigation
- Increased irrigation resulted in faster node development
- FM 765 and PHY 205
  - remained relatively stable across treatments

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Taller plants did not translate to higher yield

- Yield efficiency is driven by factors beyond plant size
- **High irrigation**
  1. FM 765 – balances moderate height with maximum yield
  2. DP 1820 – tallest but less efficient in lint production
- **Low irrigation**
  1. FM 2398 – high yield despite reduced height; strong drought resilience

Average lint yield of cotton varieties grown at TTU Research Farm in 2024.

	Lint yield (lb/a)	
	Low irrigation	*High irrigation*
DP 1820	688	1182 bc
DP 2115	562	1102 c
FM 2398	704	1244 b
FM 765	594	1418 a
PHY 205	650	1252 b

†Means with similar letters are not significant at α = .05.

Key Takeaways

High Irrigation Response

- FM 765: Best performer - optimal height-yield balance
- DP 1820/2115: Rapid node production, tall but lower lint efficiency

Low Irrigation Response

- FM 2398: Highest drought resilience, maintains yield
- PHY 205: Conservative growth, compact structure

Growth Strategies Trade-offs

- Rapid (DP 1820/2115): Best in optimal conditions
- Conservative (FM 2398/PHY 205): Better stress adaptation
- Balanced (FM 765): Delayed but stable growth

Key Takeaways

1. Aggressive growth doesn't always translate to higher yield efficiency
2. High irrigation favors moderate-sized FM 765 for high lint yield
3. Growth strategies in thermo-limited environments reveal trade-offs:
    - Rapid (DP 1820/2115): Best in optimal conditions
    - Conservative (FM 2398/PHY 205): Better stress adaptation
    - Balanced (FM 765): Delayed but stable growth

Acknowledgements

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Thank you!
Questions?