Cotton Growth and Development in Oklahoma

SW Cotton Physiology Conference 2025

Overview

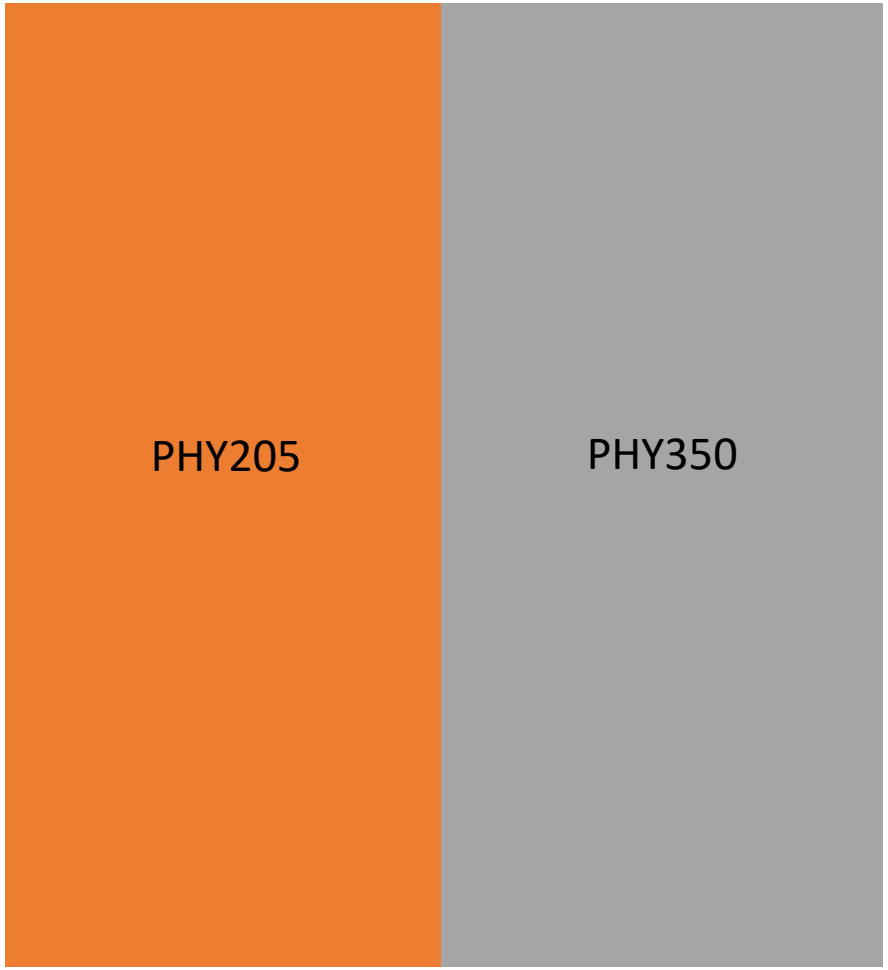
- Introduction/Background
- Previous Research
- Project Overview
- Boll Distribution
- Profitability by Position
- Preliminary Conclusions
- Future Directions

Introduction

- Deficit Irrigated Cotton in the Panhandle of Oklahoma
  - Decline in the Ogallala Aquifer has influenced the shift to crops with a lower water demand like cotton (Guru & Horne, 2001).
  - Producing cotton in non-traditional growing regions, like Oklahoma, prove difficult, therefore adaptations to variety and management practices must be adopted (Oosterhuis, 1994; Esparza et al., 2007; Johnson et al., 2002).

Background

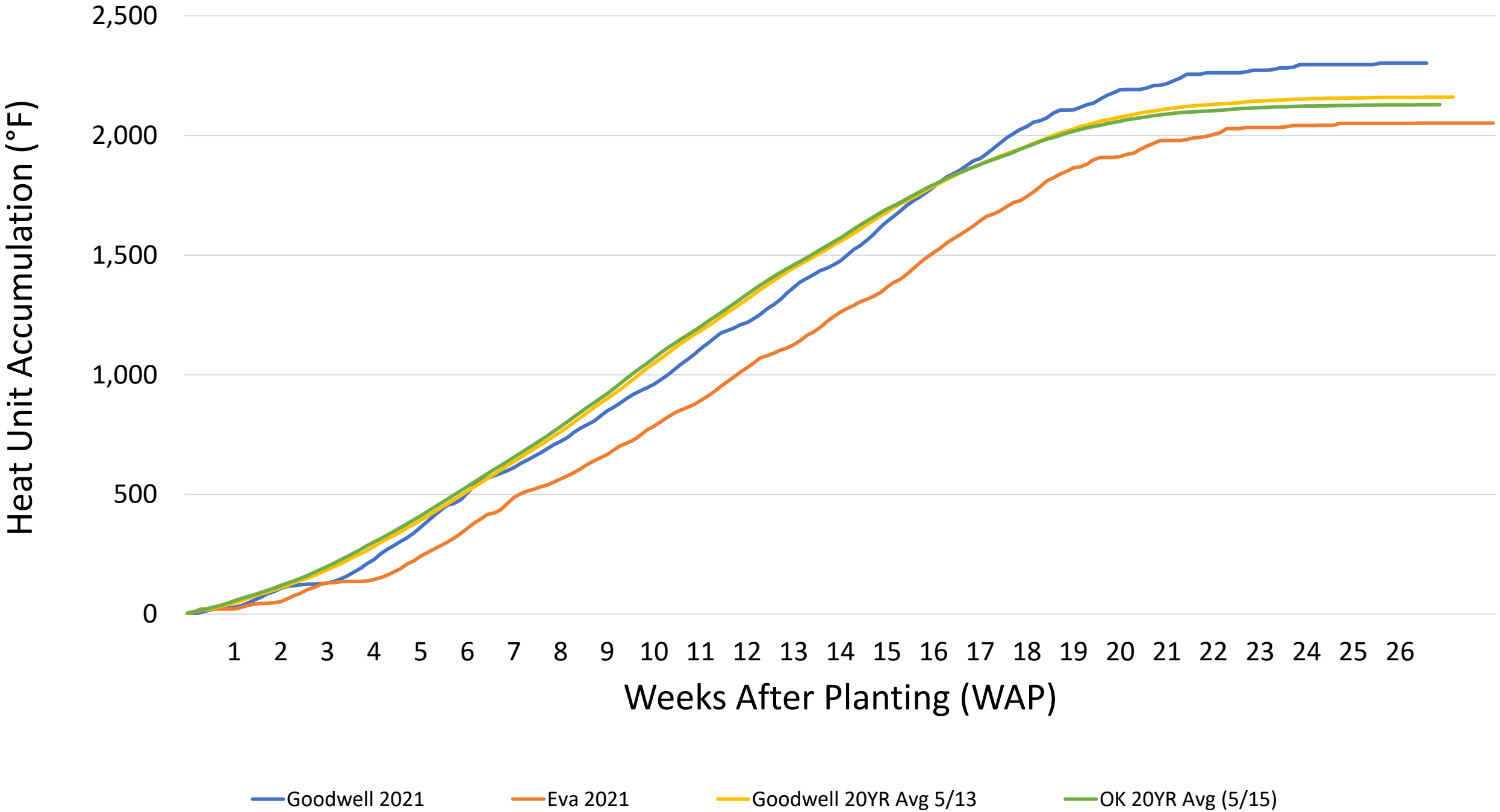
Irrigation Treatment	Irrigation Received (in)
Check	1.38
Full Irrigation	12.32
70% of Full	9.09
40% of Full	5.83
Square= Full + Bloom= 70% of Full	10.71
Square= Full + Bloom= 40% of Full	9.06
Square= Full + Bloom= 0% of Full	6.85
Square=70% + Bloom= 40% of Full	7.48
Square=70% + Bloom= 0% of Full	5.28
Square= 40% + Bloom= Full	9.17
Square= 40% + Bloom= 70%	7.52
Low Pre-water + Square= 70% + Bloom= 70%	7.95
Low Pre-water + Square= 70% + Bloom= 40%	6.30



Background

	Phytogen 205	Phytogen 350
Maturity	Very Early	Early-Mid
Plant Height	Short	Medium-Tall
NFFB	7.5	6.4
Micronaire	4.4	4.2
Staple Length (mm)	27.94	29.21
Strength (g tex^{-1})	30.1	30.0

- Irrigation at the beginning of the season (squaring) impacted plant growth (height).
- More irrigation generally delayed maturity in both varieties.
- PHY 205 lint yield more responsive to increasing irrigation than PHY 350.
- PHY 205 tended to out yield PHY 350.


2,500
2,000
1,500
1,000
500
0
Heat Unit Accumulation (°F)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Weeks After Planting (WAP)
Goodwell 2021
Eva 2021
Goodwell 20YR Avg 5/13
OK 20YR Avg (5/15)

Introduction

	Goodwell 2021	Eva 2021
	Yield lbs ac^{-1}	
90% Replacement of ET	1,394	1,968
90% at Sq/70% at Bloom	1,206	1,844
70% Replacement of ET	1,258	1,512
40% Replacement of ET	1,138	1,219

- Higher yields with 300 less HU
- Cotton lint yield has been shown to be correlated to heat unit accumulation in an environment with reduced stressors.

Introduction

Growth Stage	Heat Units (GDD_{60})	Heat Units (GDD_{60})
Planting to Emergence	50-60	
Emergence to First Square	425-475	
Square to Flower	300-350	
Planting to First Flower	775-850	
Flower to Open Boll	850-950	
Planting to Harvest Ready	2,200-2,600	~1,800

Figure 1. Growing degree days (GDD) accumulation chart proposed by Oosterhuis (1990), the reduced base threshold.

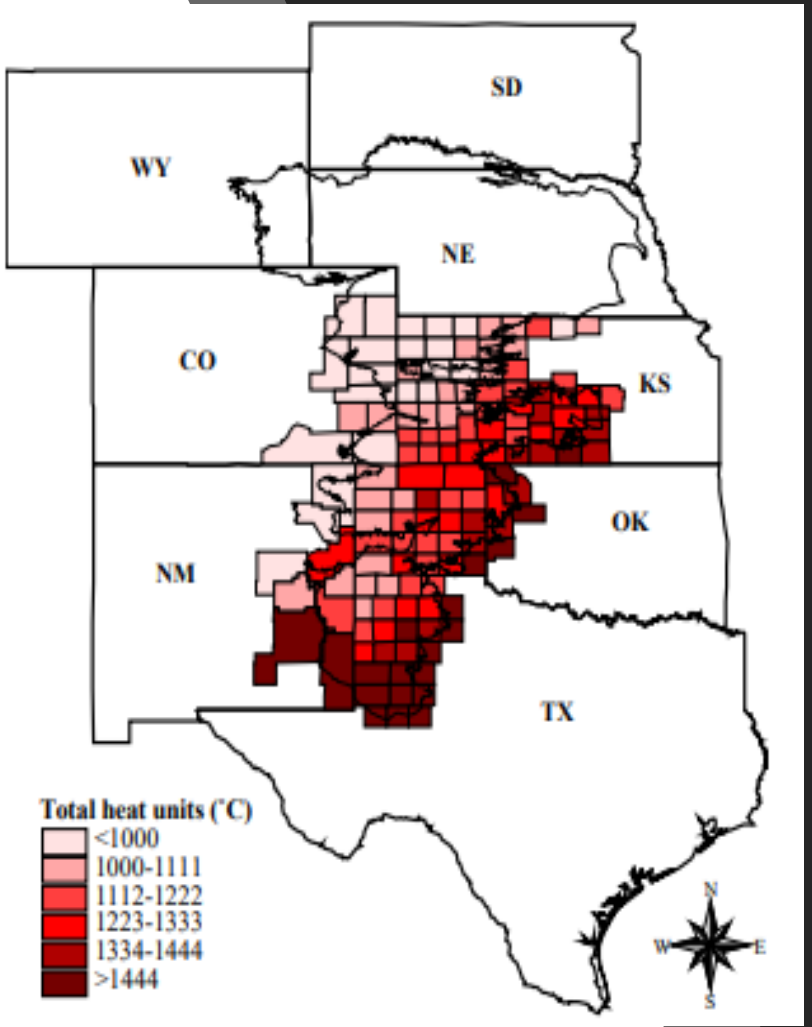
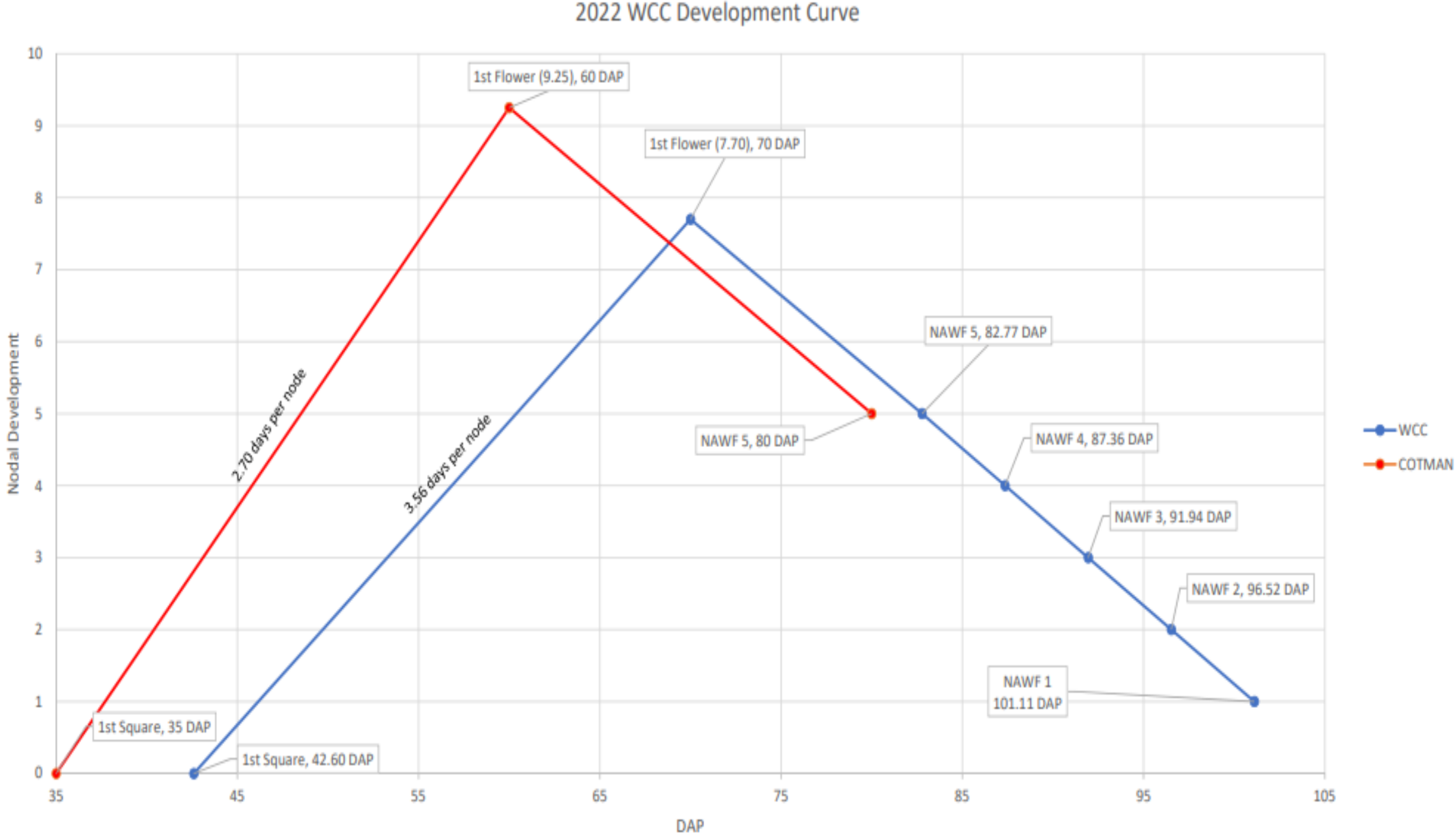


Figure 1. *Long term averages of the 131 counties in the study depicting sufficient heat unit accumulation to grow cotton in the Ogallala Aquifer region (Esparza et al., 2007).*

Short Seasoned Environment

- Studies have indicated a potential to decrease the heat units (2,600 °F) by one third (1,800 °F) and still have cost effective cotton growth in short seasoned environments like the Oklahoma and Texas Panhandle (Waddle, 1984).
- Raper et al., (2023) reevaluated the base threshold (60 °F) and found no indication for adjustment
  - Also, in a thermo-limited cotton production region


2022 WCC Development Curve
Nodal Development
DAP
1st Flower (9.25), 60 DAP
1st Flower (7.70), 70 DAP
NAWF 5, 82.77 DAP
NAWF 5, 80 DAP
NAWF 4, 87.36 DAP
NAWF 3, 91.94 DAP
NAWF 2, 96.52 DAP
NAWF 1
101.11 DAP
2.70 days per node
3.56 days per node
1st Square, 35 DAP
1st Square, 42.60 DAP
WCC
COTMAN

Related Research

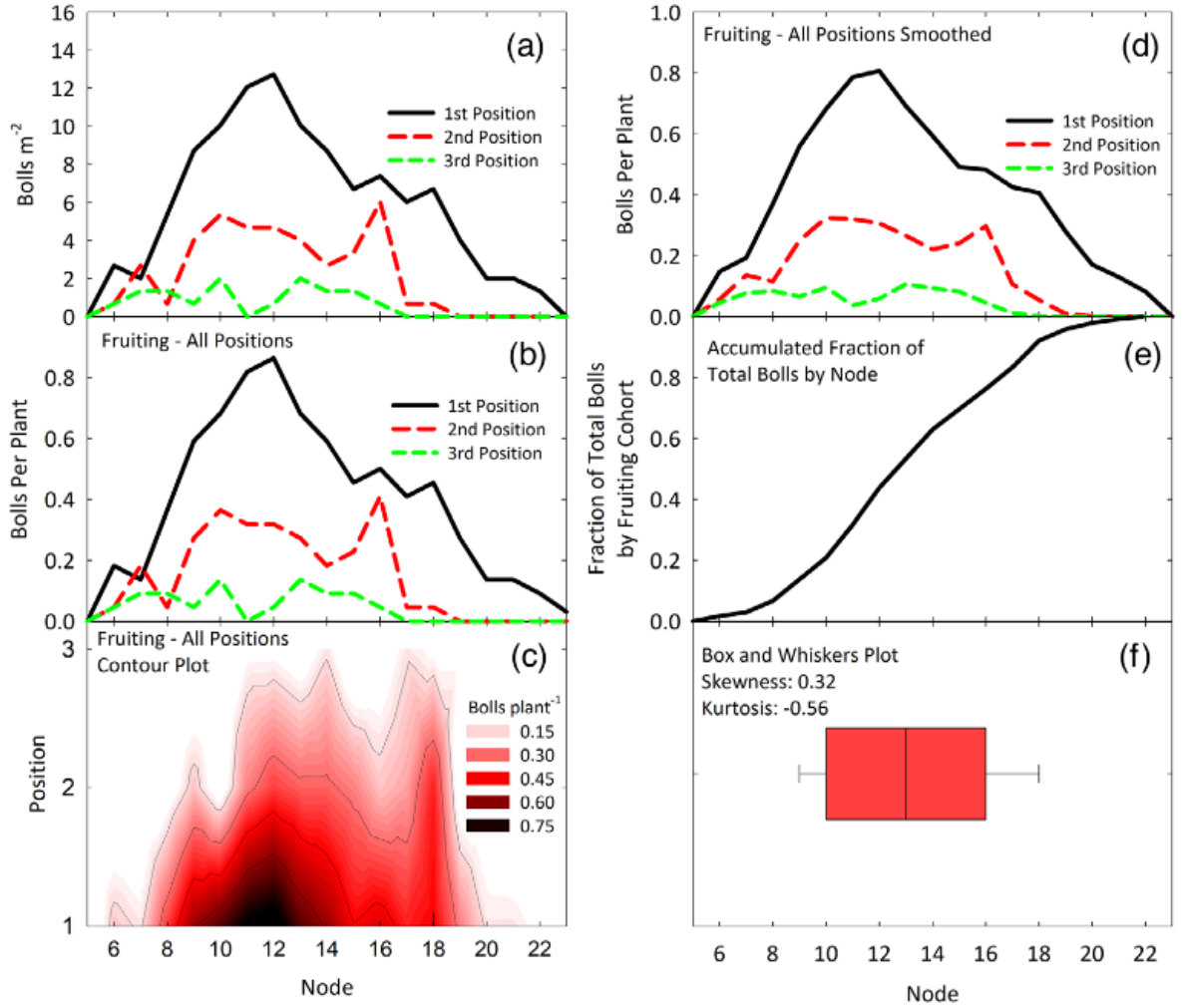
	WCC	TDC	Δ
First Square (DAP)	42-45 DAP	35 DAP	7-10 d
Vertical Fruiting Interval (days per node)	3.5-4.5 days/node	2.7 days/node	0.8-1.8 days/node
First Flower	70-78 DAP	60 DAP	10-18 d
Node	7.2-7.7	9.25	1.55-2.05
Cutout	TBD	NAWF 5	TBD

(Brorman et al., 2023)

Previous Research

Cotton Yield Distribution

- Yield is typically set on 8-10 fruiting branches
  - 80% of yield is from 1st and 2nd position bolls
  - Vegetative bolls contribute less than 20% to yield as this value also includes bolls outside the major fruiting positions (1st and 2nd position).



(Pabuayon et al., 2021)

Observed Growth Differences

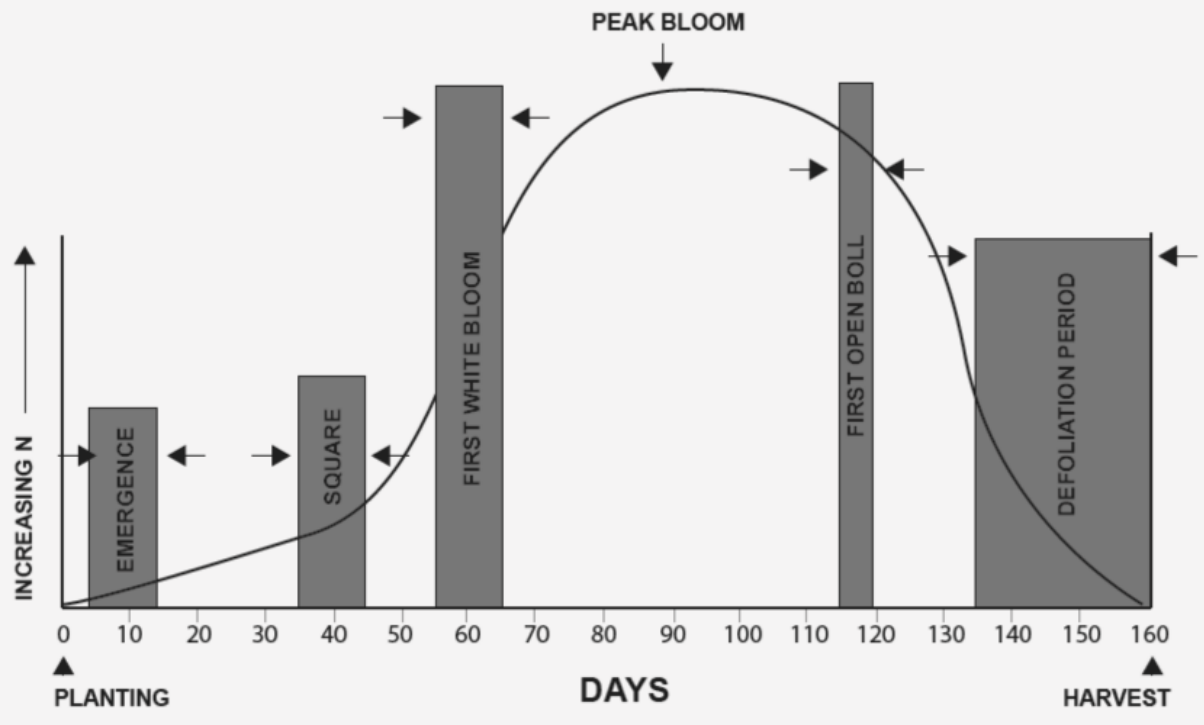


Figure 2. *The growth and development curve of a cotton plant following a sigmoidal curve (NCC, 1996).*

- Emergence can take ~2 weeks
- Prolonged squaring period?
- 4-5 weeks of flowering
  - Typically, ~6 weeks
- 850-950 HUs required from flowering to open boll
- Fiber quality differences are base/premium

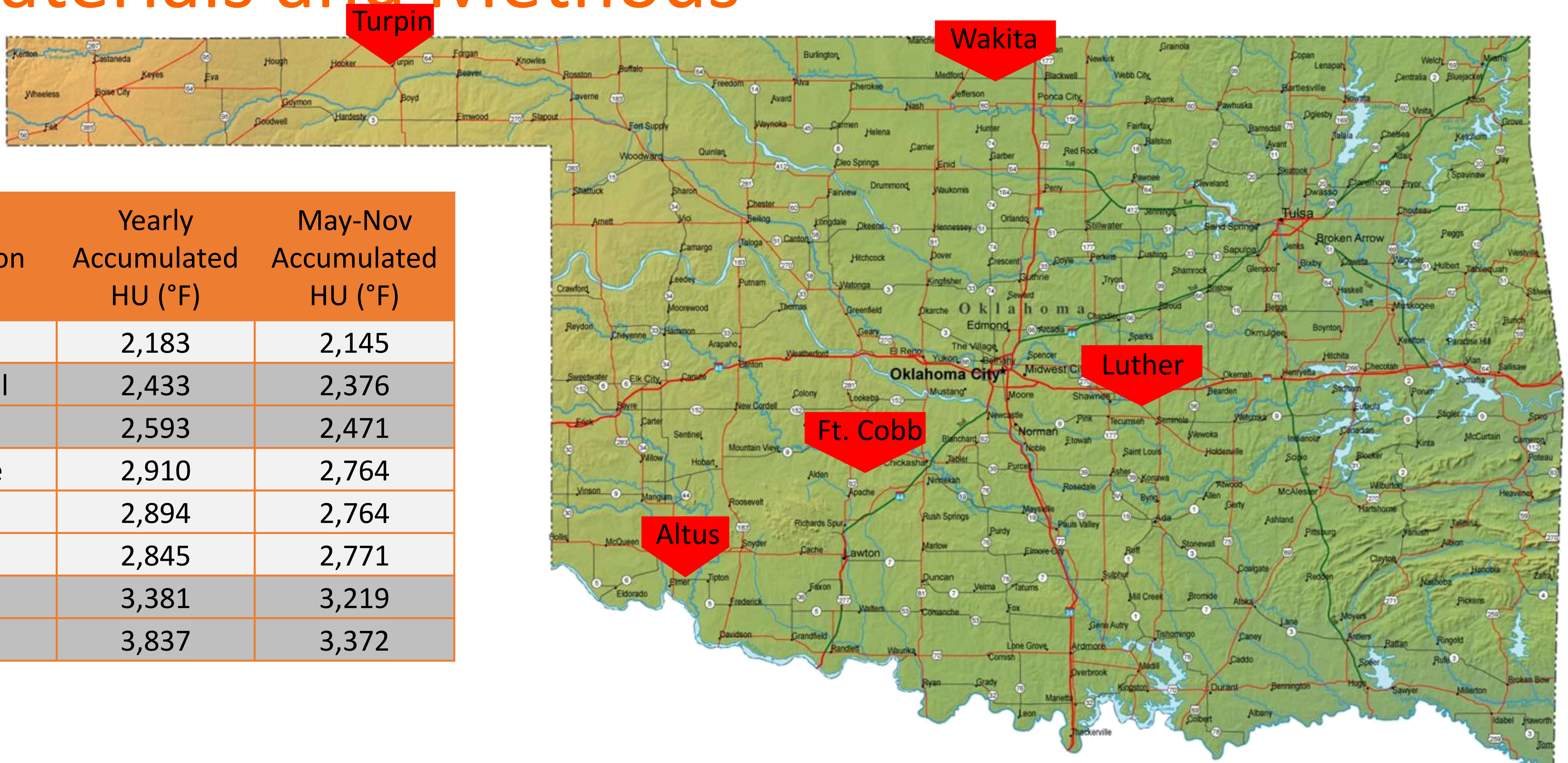
PhD Research

Objectives

- Gain a better understanding of cotton growth and development in Oklahoma with respect to the heat units received within the short growing season.
- Equate growth and development patterns across the state to create a more accurate estimate of growth stage with a region-specific growth and development chart.

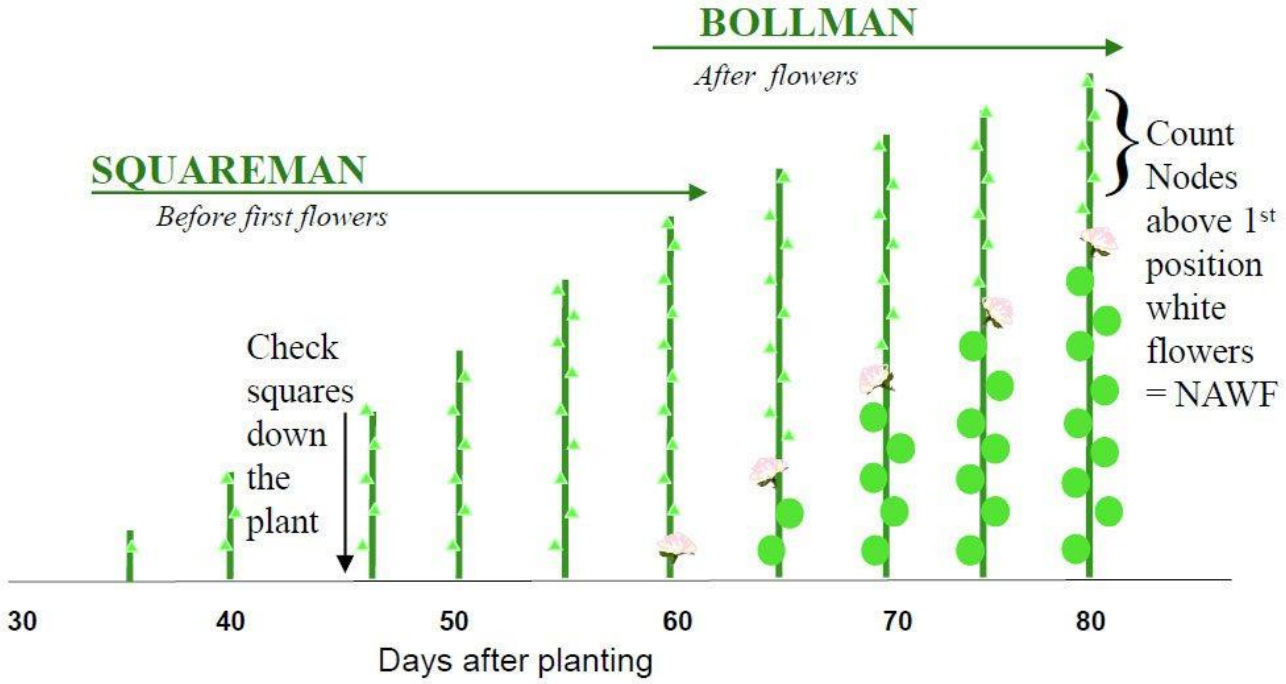
Materials and Methods

Location	Yearly Accumulated HU (°F)	May-Nov Accumulated HU (°F)
Eva	2,183	2,145
Goodwell	2,433	2,376
Ft Cobb	2,593	2,471
Shawnee	2,910	2,764
Bixby	2,894	2,764
Wakita	2,845	2,771
Altus	3,381	3,219
Georgia	3,837	3,372



Data Collection

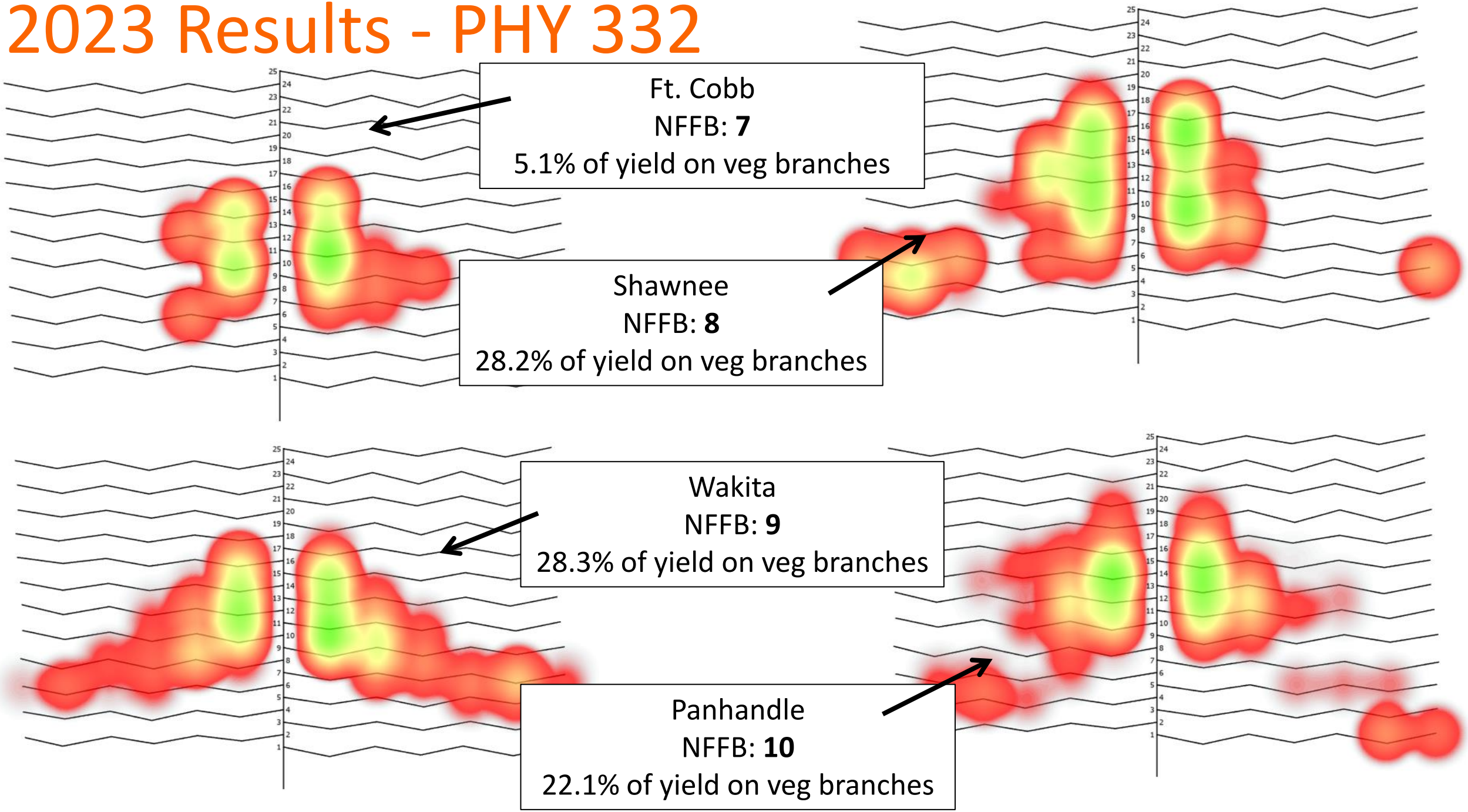
- Stand Count
- Plant Height
- First Fruiting Branch
- Plant Mapping (1-2 weeks)
  - 60% of the field is squaring
  - 10 plants per plot
- Node above white flower (NAWF)
- Total Nodes



Genetic Characteristics

	Phytogen 205 W3FE	Phytogen 332 W3FE	Phytogen 350 W3FE	Phytogen 400 W3FE	Phytogen 411 W3FE
Maturity	Very Early	Early-Mid	Early-Mid	Mid	Mid
Micronaire	4.4	4.1	4.2	4.6	4.4
Staple Length	1.10	1.20	1.15	1.13	1.10
Plant Height	Short	Medium-Tall	Medium-Tall	Medium	Medium-Tall
Strength	30.1	32.8	30.0	31.0	30.8
NFFB	7.5	6.3	6.4	6.4	7.4

2023 Results - PHY 332



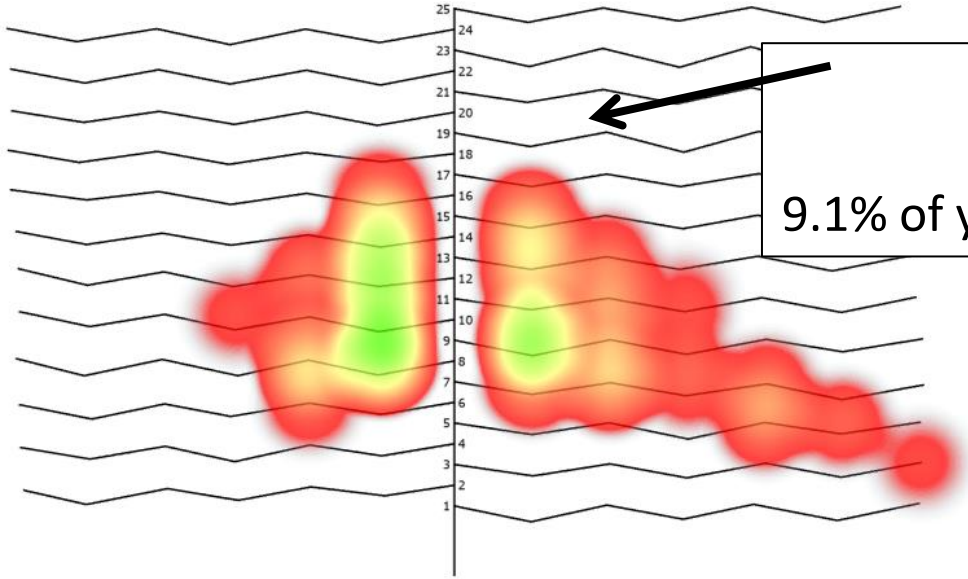
Ft. Cobb
NFFB: **7**
5.1% of yield on veg branches

Shawnee
NFFB: **8**
28.2% of yield on veg branches

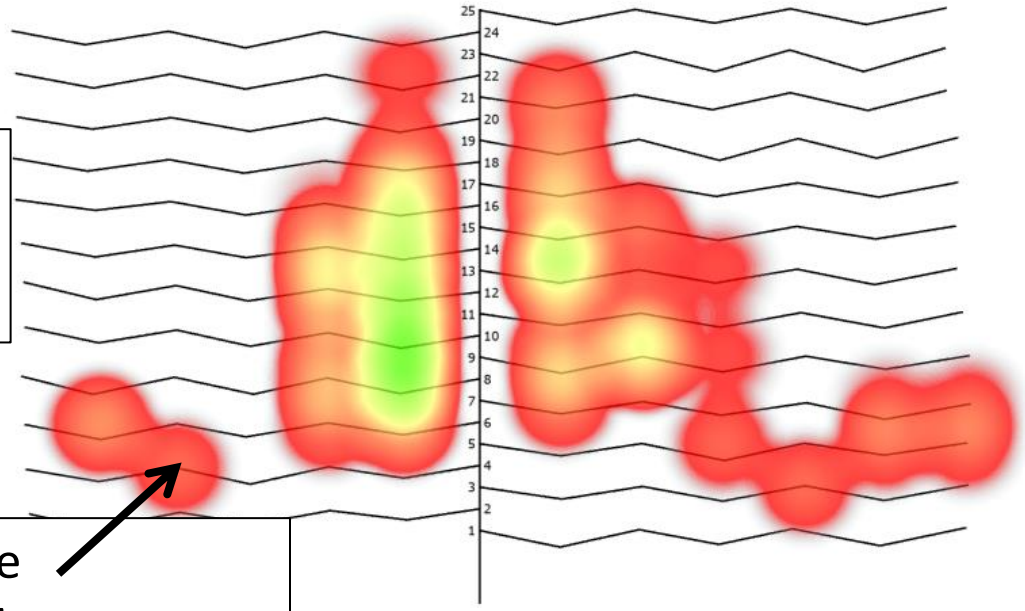
Wakita
NFFB: **9**
28.3% of yield on veg branches

Panhandle
NFFB: **10**
22.1% of yield on veg branches

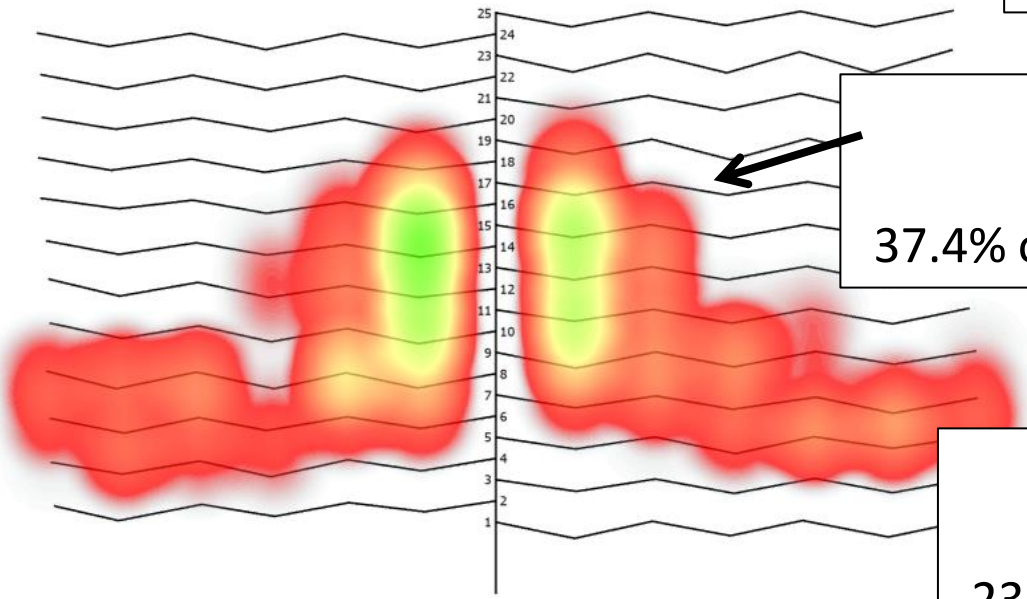
2023 Results - PHY 400



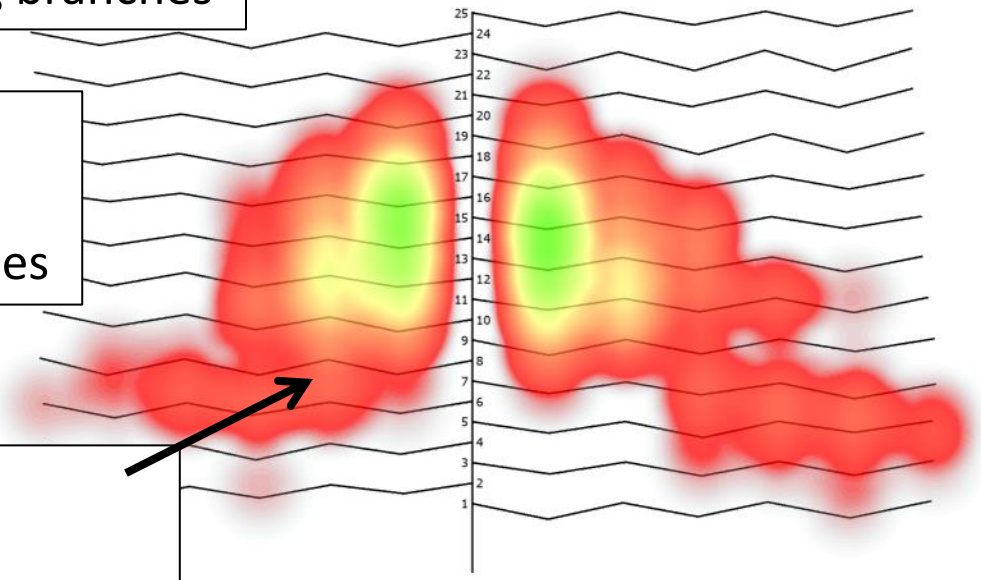
Ft. Cobb
NFFB: **7**
9.1% of yield on veg branches



Shawnee
NFFB: **7**
18.6% of yield on veg branches



Wakita
NFFB: **9**
37.4% of yield on veg branches



Panhandle
NFFB: **10**
23.4% of yield on veg branches

Profitability

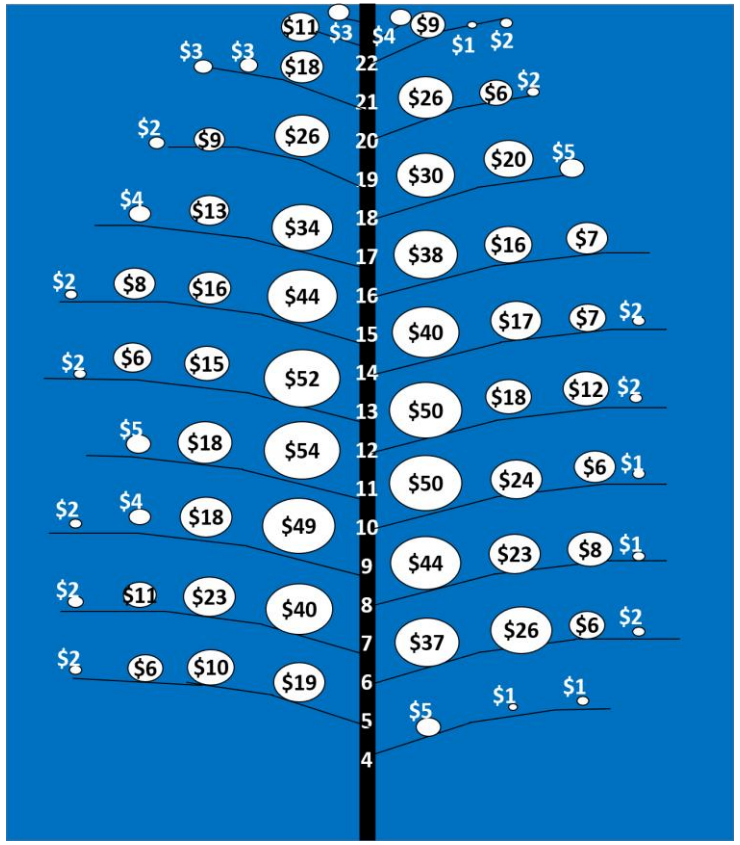


Figure 1. Money tree schematic created using field data from Georgia in 2020 at $0.75/lbs (UGA Cooperative Extension, 2022).
Plant total = $1,083

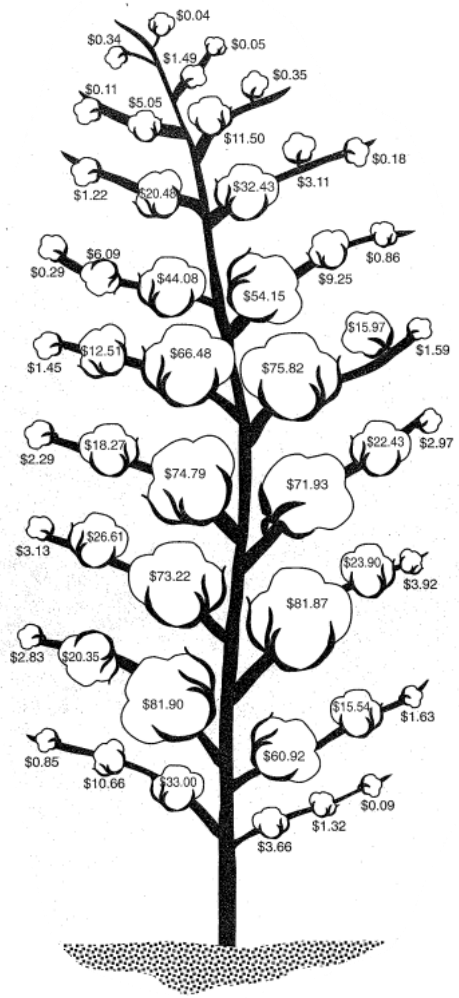


Figure 2. Money tree schematic created using field data from Mississippi in 1990-1991 at $0.70/lbs (Mississippi State University Cooperative Extension, 1995).
Plant total = $1,079

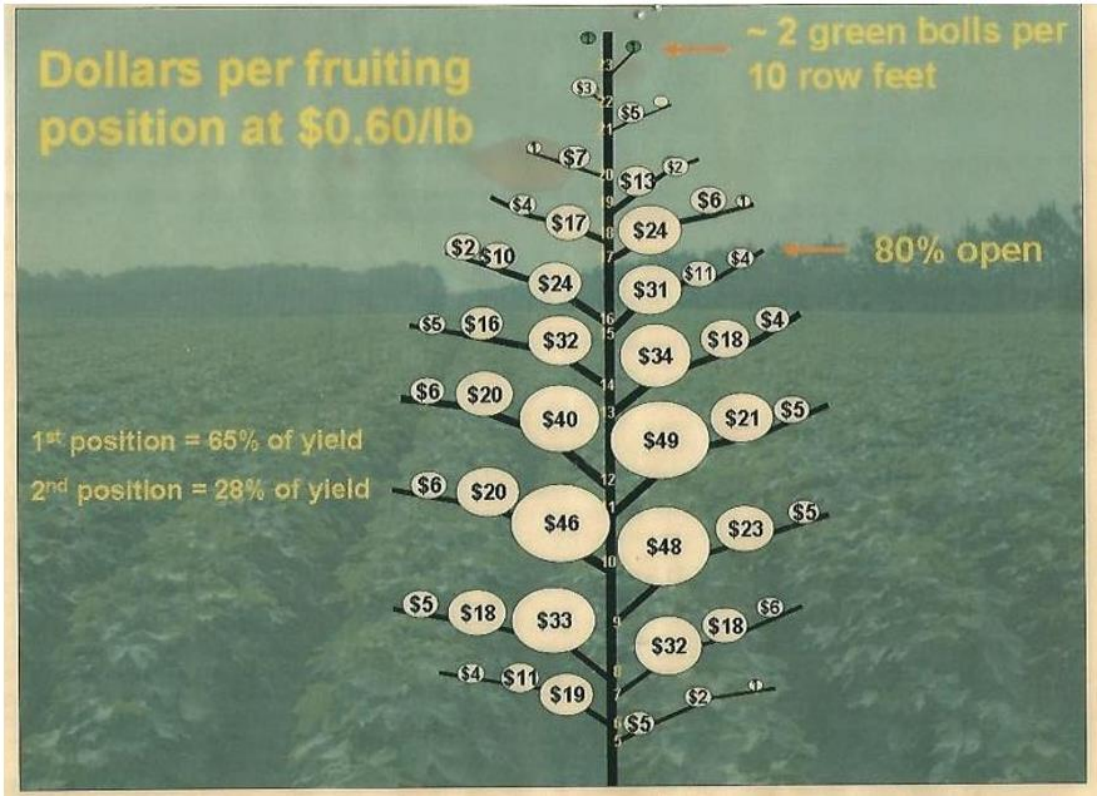
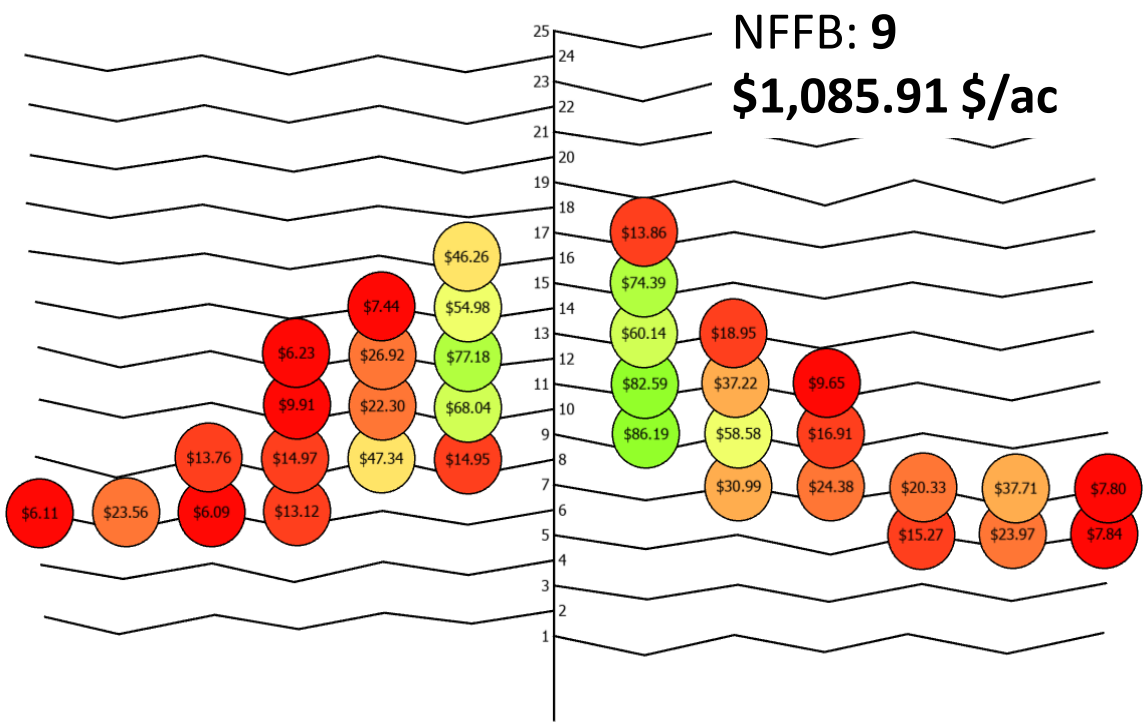


Figure 3. Money tree schematic from UGA publication from 2003 (UGA Cooperative Extension, 2022).
Plant total = $719

Wakita

PHY 332



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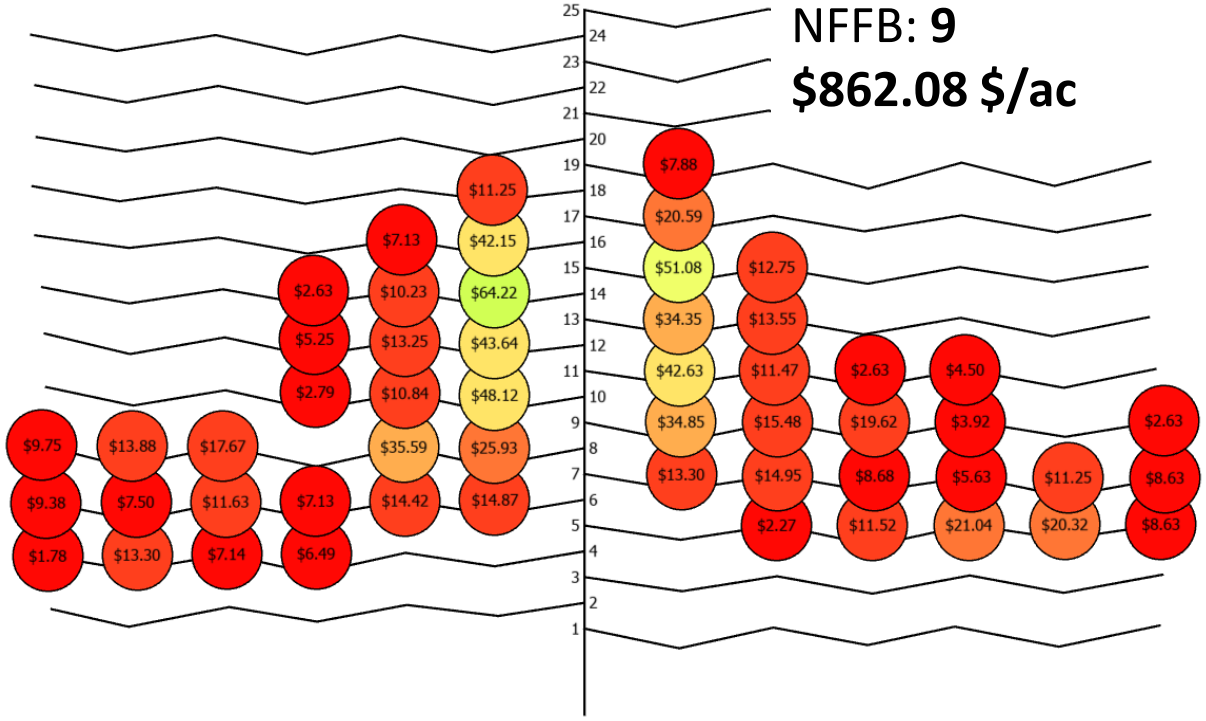
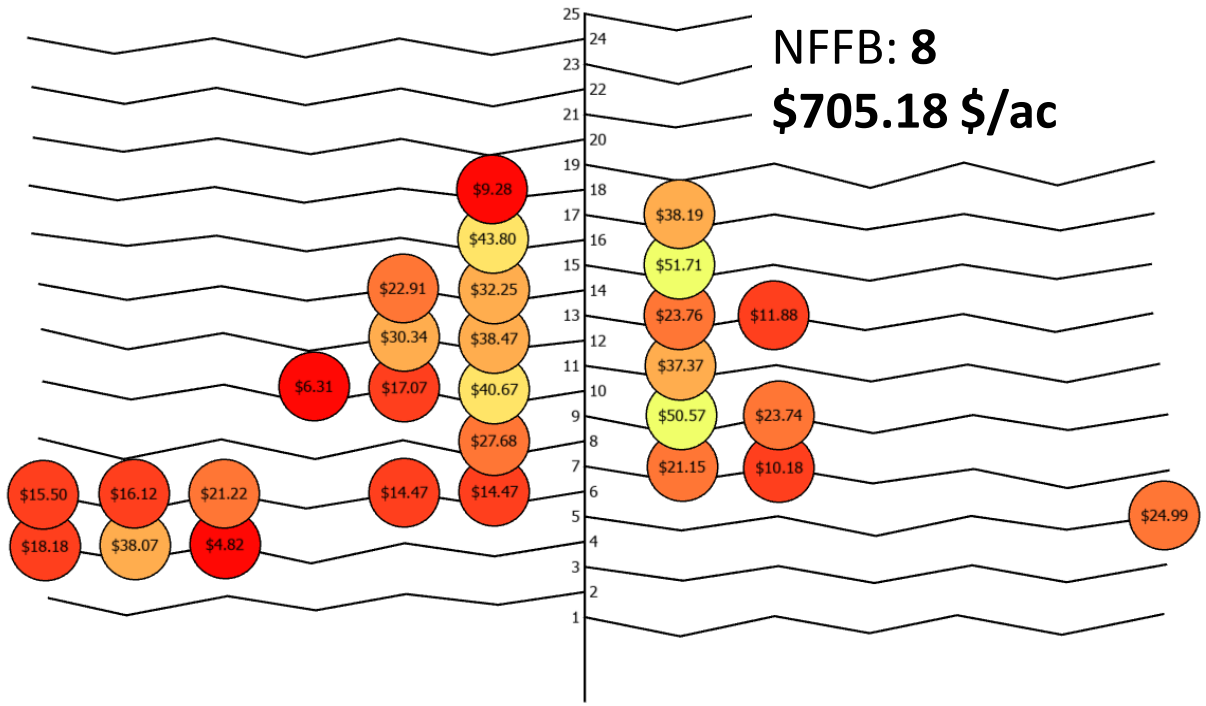
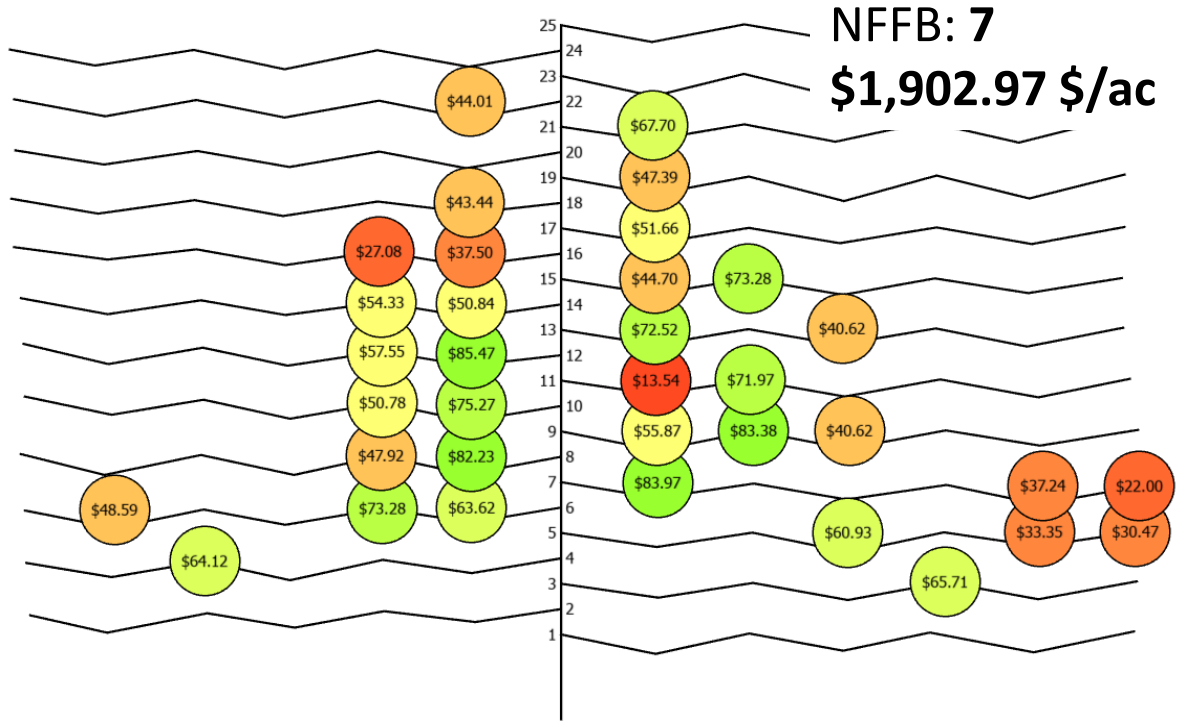


Luther

PHY 332

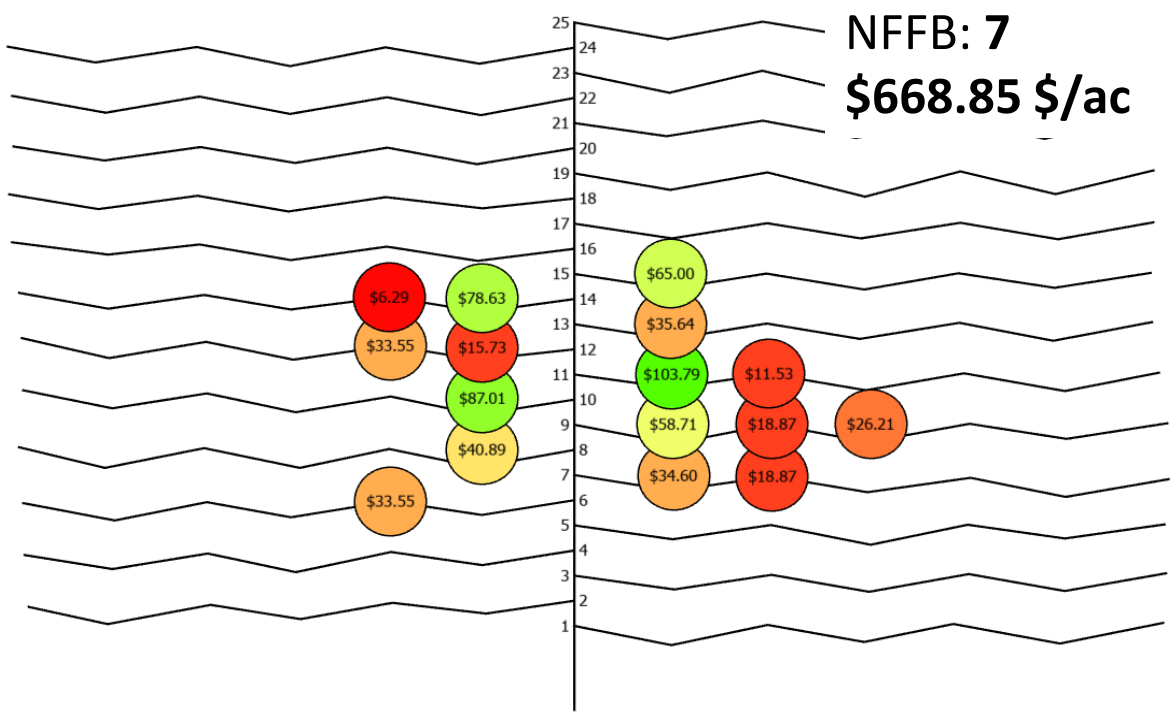


PHY 400



Ft. Cobb

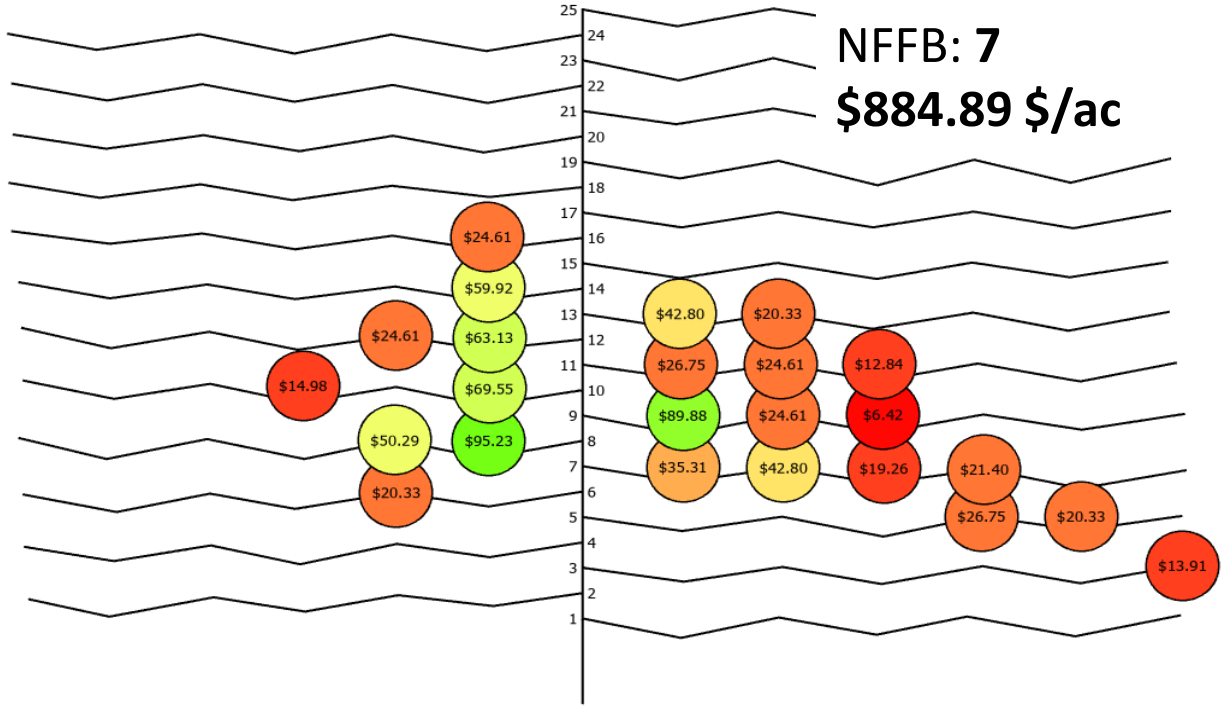
PHY 332



NFFB: **7**

$668.85 $/ac

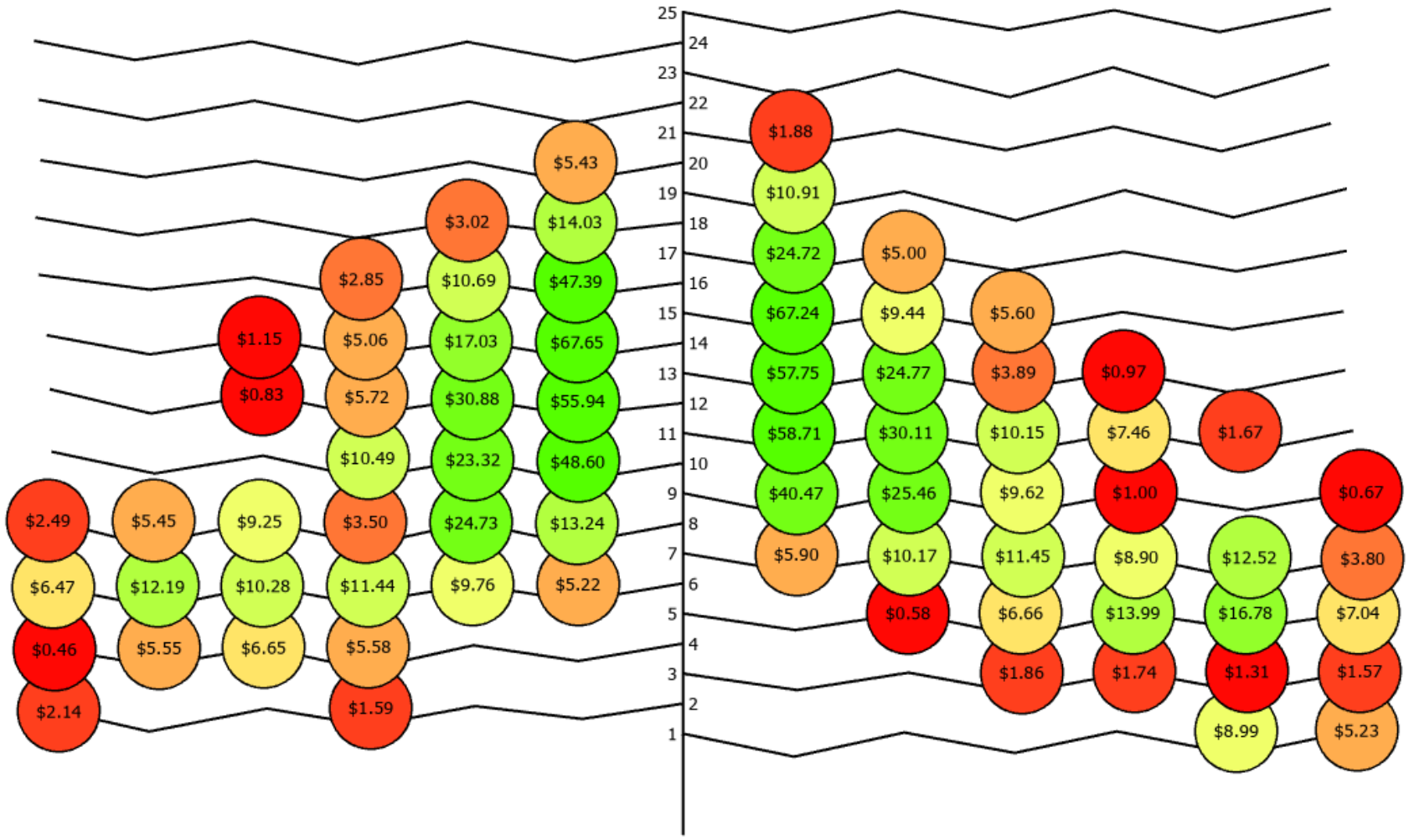
PHY 400



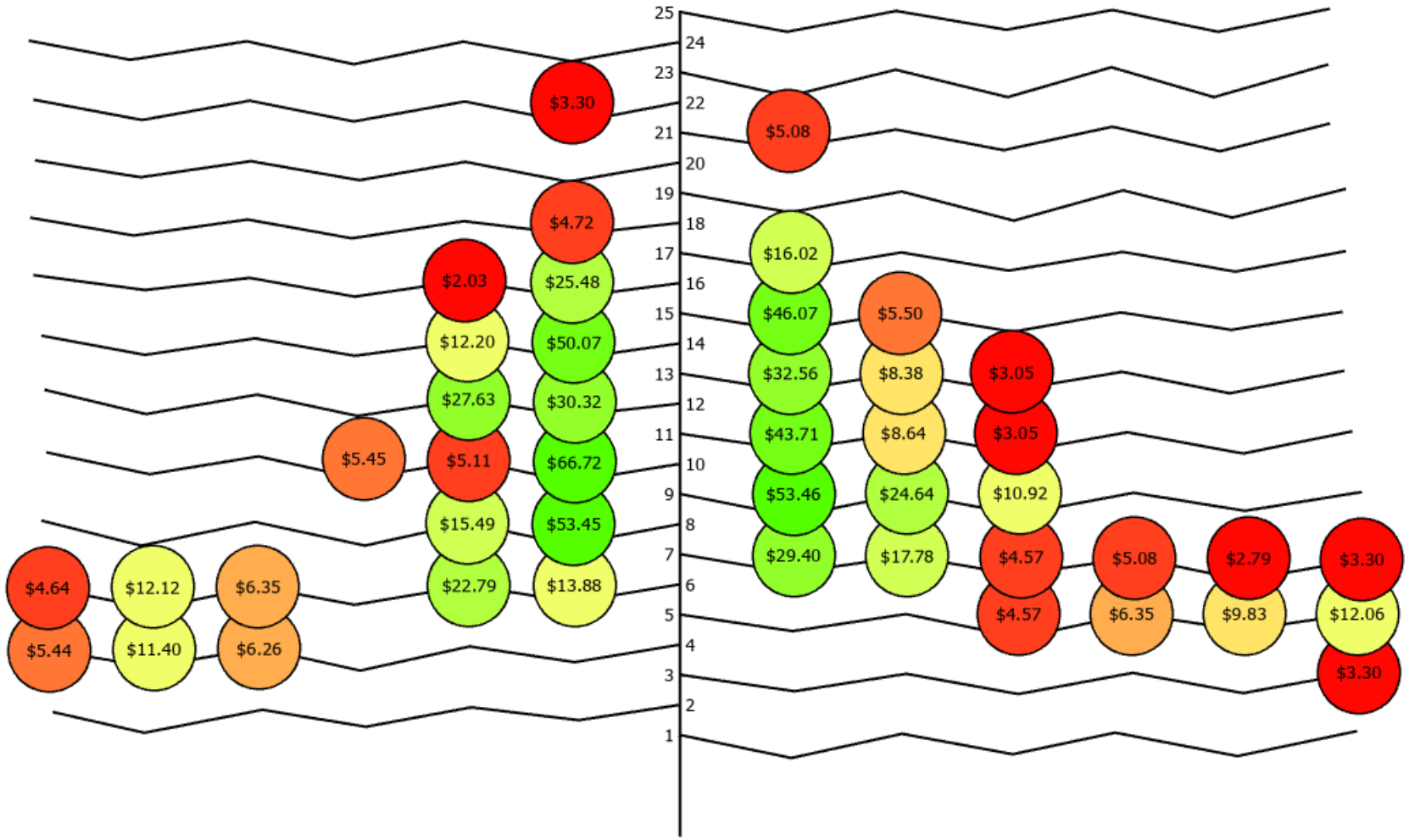
NFFB: **7**

$884.89 $/ac

Northern Oklahoma



Southern Oklahoma



Boll Distribution by Position

	1990 Mississippi State	Georgia Publication Mean	Northern Oklahoma	Southern Oklahoma
Position 1	74%	64%	50%	62%
Position 2	18%	23%	18%	17%
Position 3	2%	6%	5%	4%
Position 4	—	—	1%	1%
Position 5	—	—	<1%	<1%
Monopodial Bolls (Vegetative Bolls)	7%	11%	25%	19%

Boll Distribution by Nodes

	1990 Mississippi State	Georgia Publication Mean	Northern Oklahoma	Southern Oklahoma
Node ≤ 10	41%	47%	41%	56%
Node 11-15	40%	36%	46%	36%
Node ≥ 16	12%	17%	13%	8%

Preliminary Results

- Greater percentage of bolls on vegetative branches, especially evident in the northern region of Oklahoma.
- >50% of yield from below node 11 in the southern portion of the state.
- Southern locations have a more compact boll load that shows similarities to the Cotton Belt.
- Bottom 2/3 of the plant has the largest contribution to yield and profitability.

Conclusions & Future Directions

- 2024 data and 2025 data will be added to build a more concrete foundation of boll distribution in Oklahoma.

- Having a better understanding of cotton growth and development can allow for us to begin to alter management practices to optimize production.

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