Cotton Growth & Development in Southern Kansas & Northern Oklahoma (including the panhandle)

2020 Great Plains Cotton Conference

February 25-26 - Wichita, KS

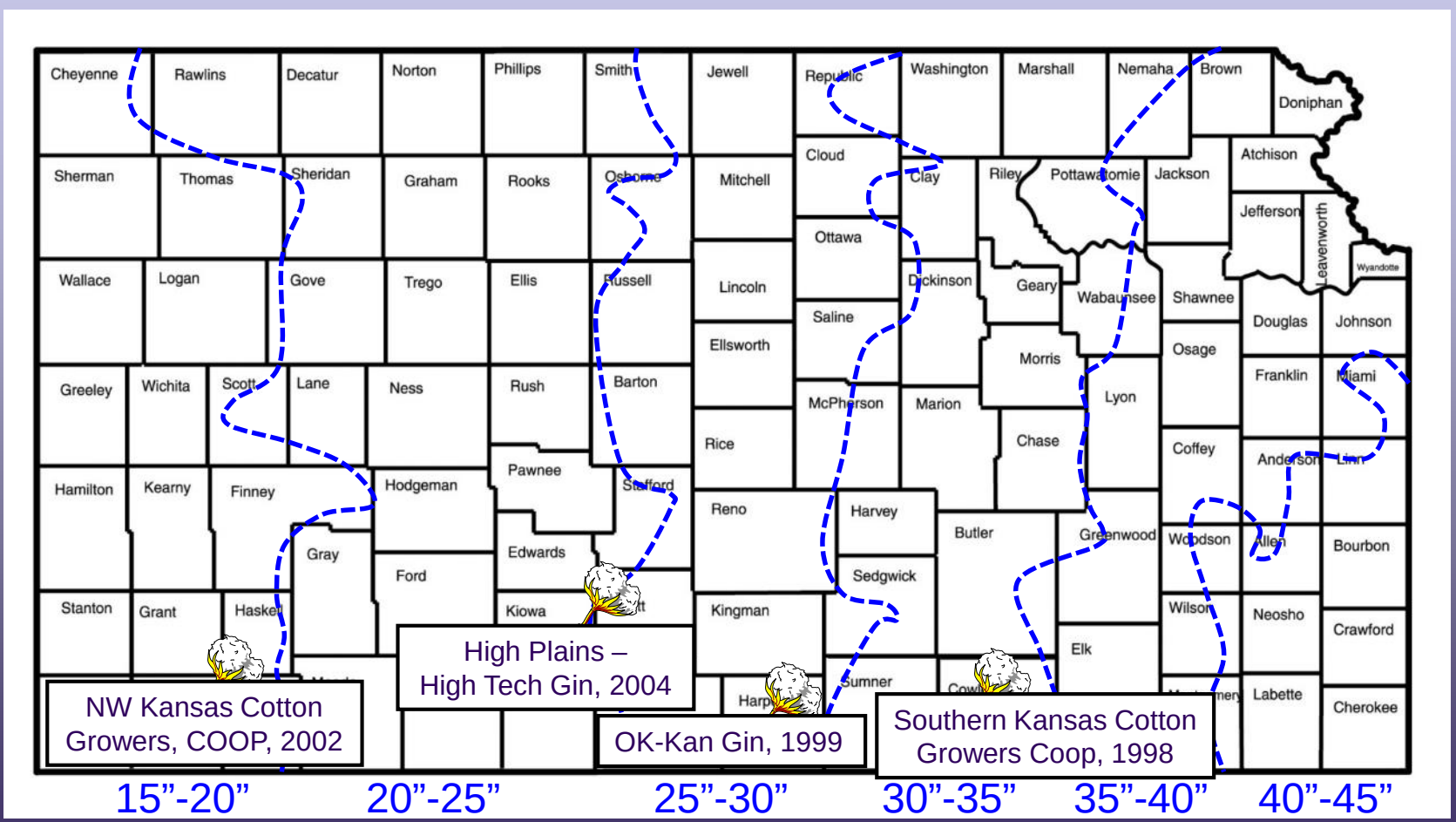
Stu Duncan, K-State Research & Extension

NE Region Extension Specialist, Crops & Soils

Cotton Culture

- Drought tolerant crop?
  - heat tolerant
  - perfect complete flower
  - effective flowering period is rather short
  - excess flower production
  - flowers inside canopy
  - taproot system
- Excellent rotation crop
  - herbicide rotation
  - dicot

Kansas Cotton Gins



Cotton in Kansas

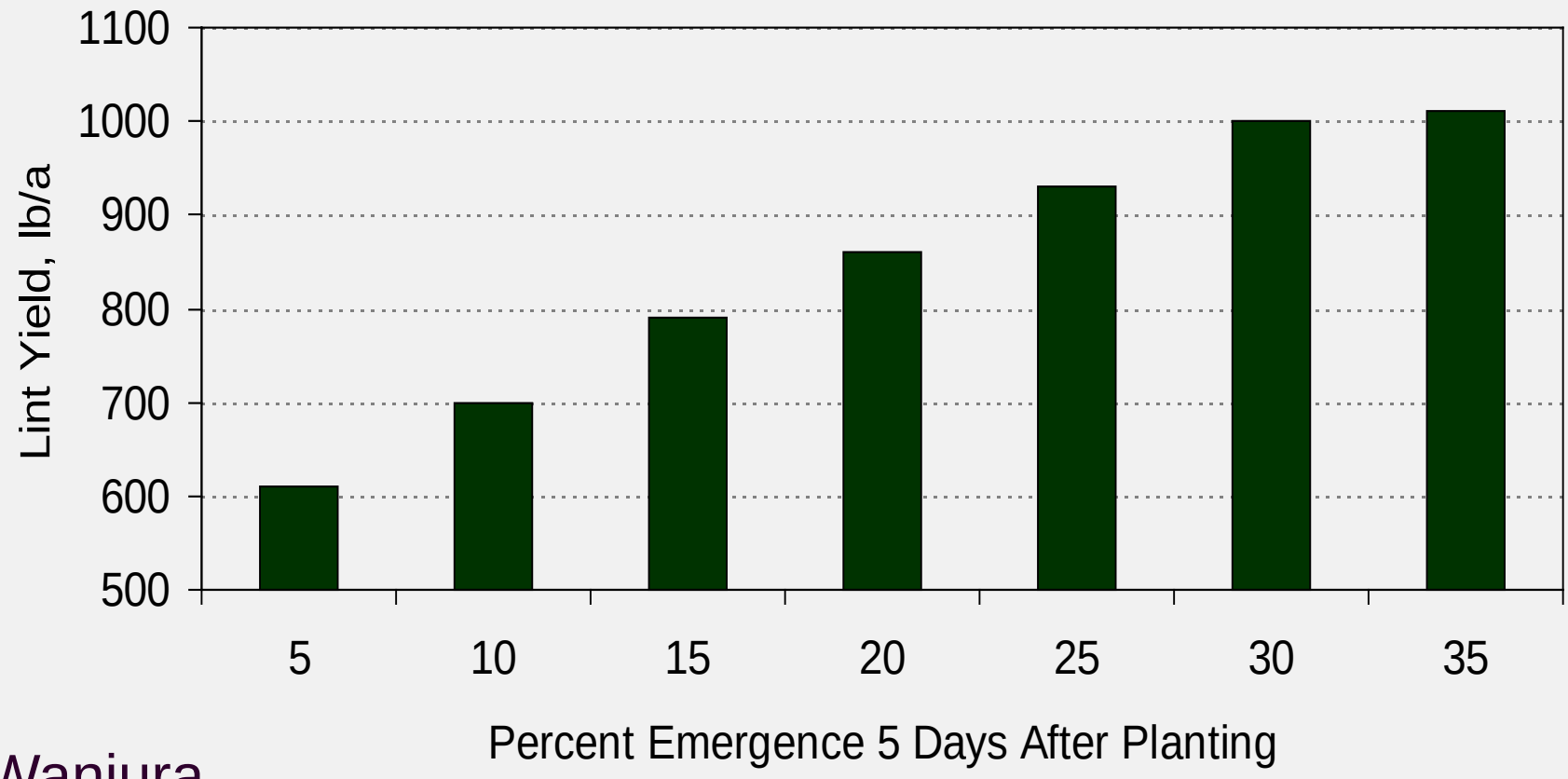
Year	Planted	Harvested	Yield	Production
	acres (1,000)		lb/a	bales (1,000)
1996	4.5	4.0	492	4.1
2000	40.0	37.0	288	22.2
2002	80.0	68.0	539	76.3
2006	115.0	110.0	511	117.0
2007	47.0	43.0	639	57.2
2011	80.0	65.0	510	69.0
2012	57.0	52.0	415	45.0
2015	15.0	16.0	1050	35.0
2016	32.0	31.0	852	55.0
2017	93.0	91.0	1051	185.0
2018	156.0	152.0	1177	335.0
2019†	175.0	153.0	910	290.0

† Predicted, January 10, 2020 *Crop Production Report* news release.

Planting Conditions for Rapid Germination and Emergence

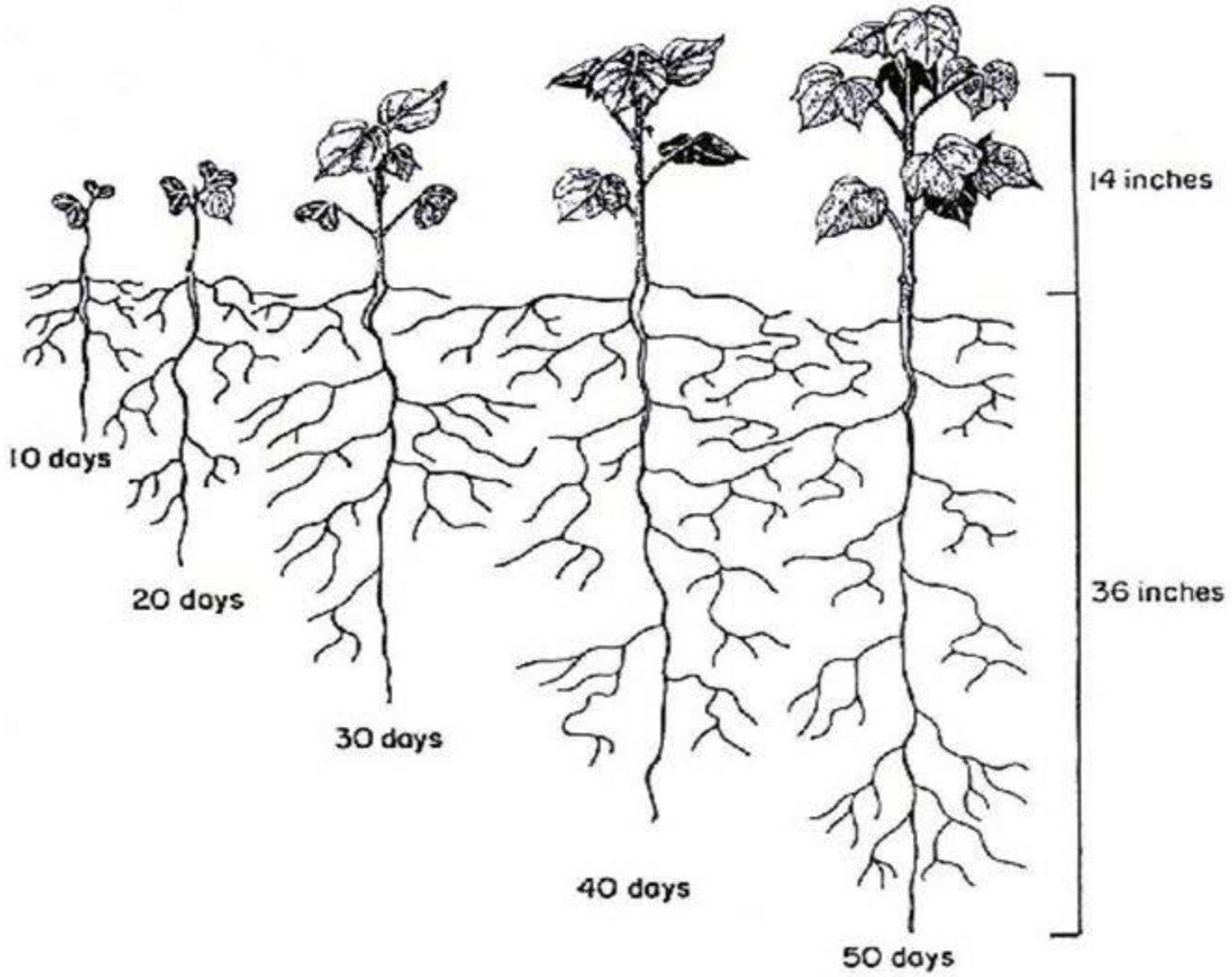
- Minimum soil temperature 60-62 degrees
- Favorable 5 day forecast
  - minimum temperature 50 degrees
  - maximum temperature > 75 degrees
- Plant in a firm moist seedbed
- Proper and uniform seeding rate (30” rows)
  - 3-4 seeds per foot irrigated
  - 2.5-3.5 seeds per foot dryland/fallow
- Seed should have a Warm Germ test of 80+ and a Cool Germ test of 60+

Relationship Between Emergence and Yield



Wanjura

Early Season Root Development of the Cotton Plant



Source: Oosterhuis, 1990

Phenological Development of Cotton

Growth Stage	Days	Heat Units – DD60s
Planting to Emergence	4 to 9	50 to 60
Emergence to First Square	27 to 38	425 to 475
Square to Flower	25 to 30	300 to 350
Planting to First Flower	60 to 70	775 to 850

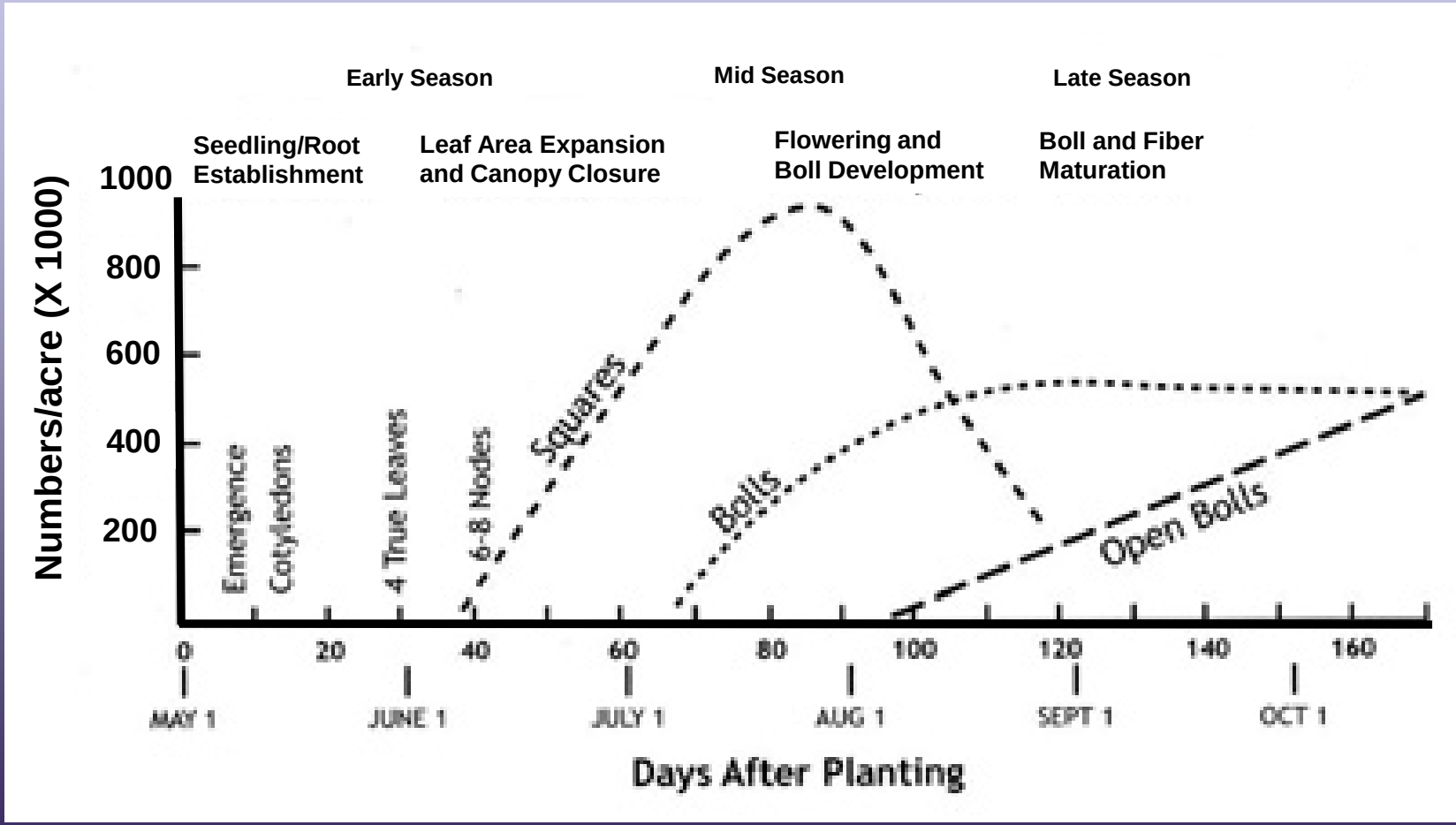
Modified from Oosterhuis, 1992

$$\frac{\text{Max Temp} + \text{Min Temp}}{2} - 60$$

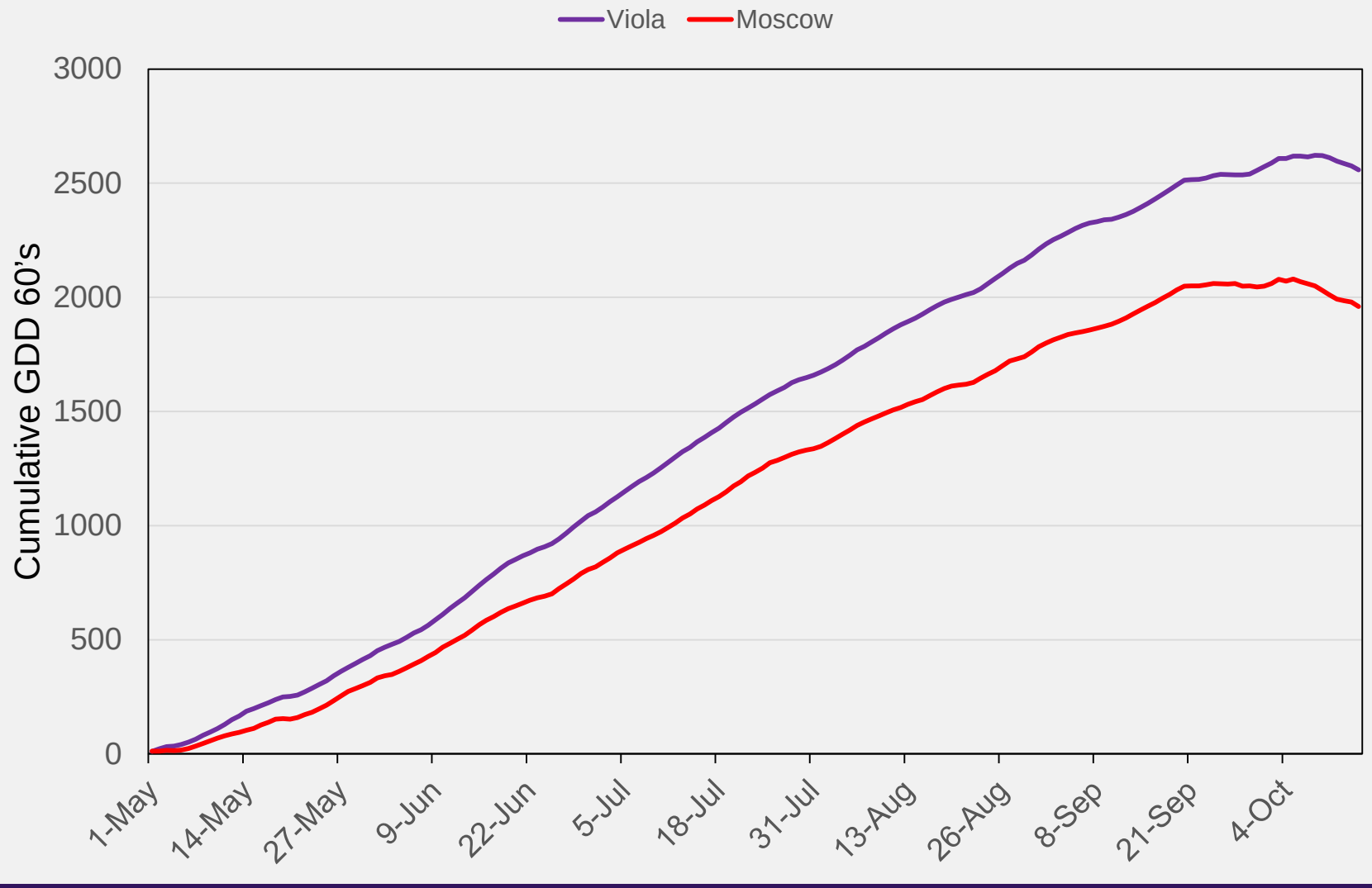
Heat Units for Growth

❖ Planting	10/day before planting
❖ Emergence	75-100
❖ Each new node/leaf	55
❖ Match head Square	550
❖ First Flower	1000
❖ First Open Boll	1800
• Flower – Open boll	≈ 650
• One bale crop	1800
• Two bale crop	2300 +

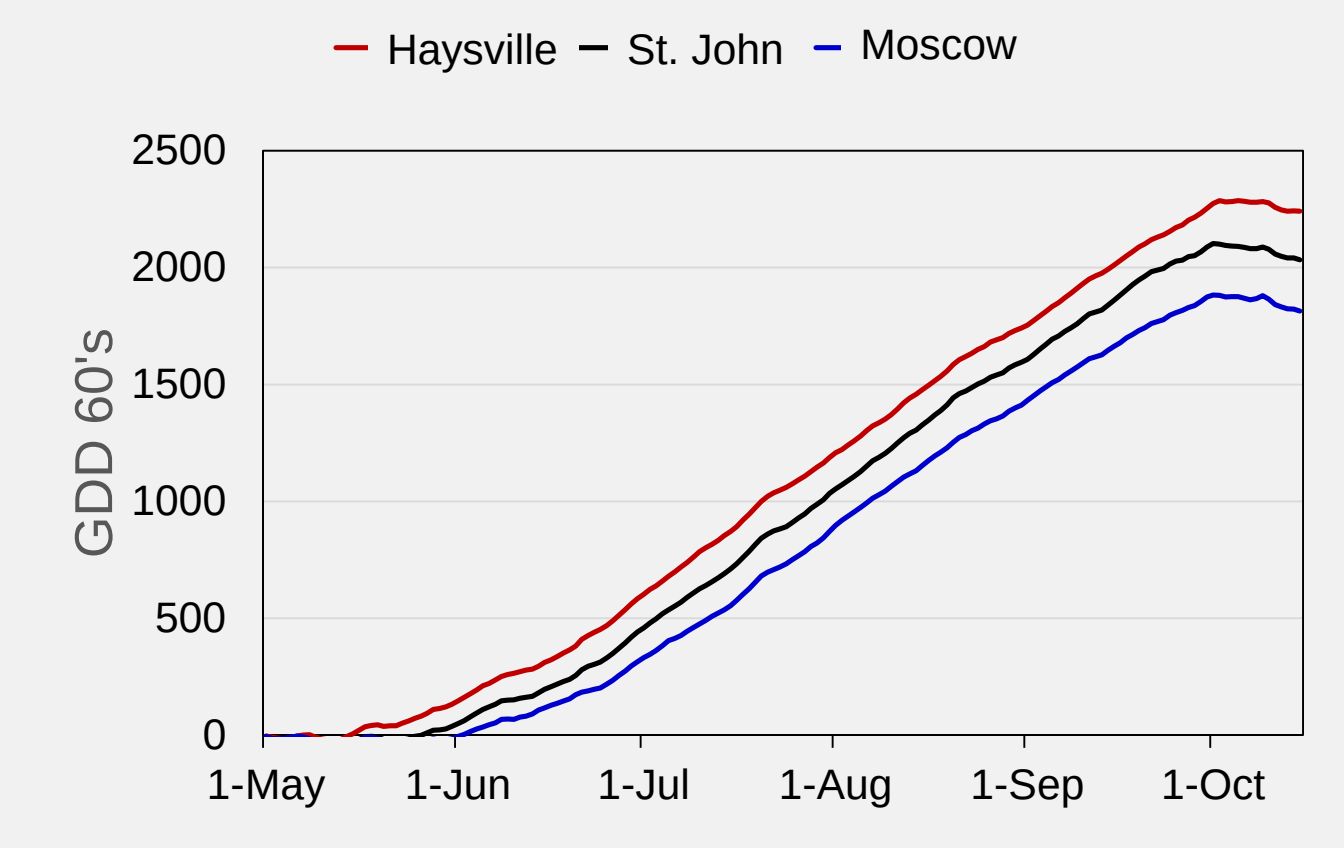
Developmental Stages of a Cotton Crop Overlap



2018 Growing Season GDD60's



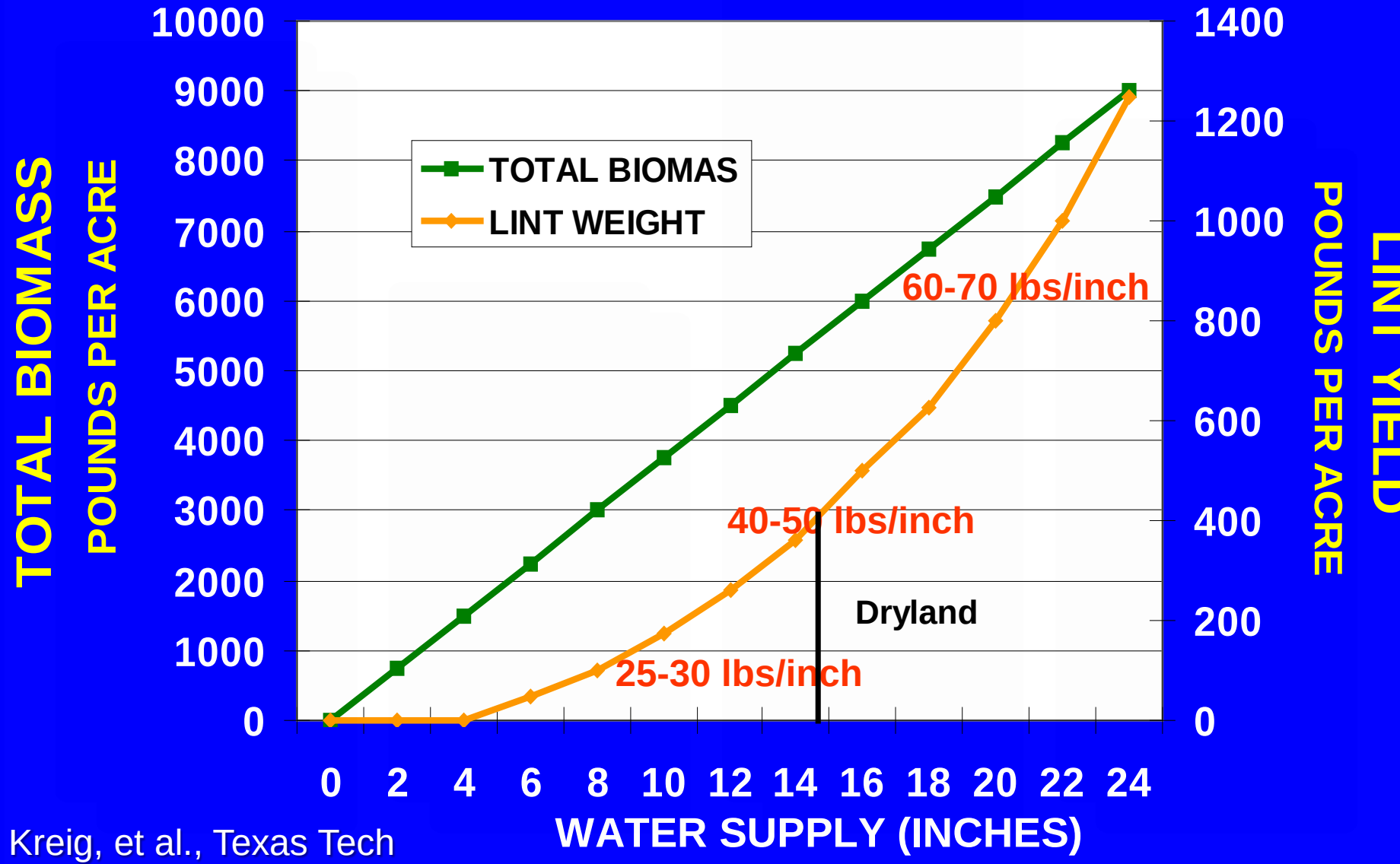
2019 Growing Season GDD60's



How Fast is a Cotton Crop Set

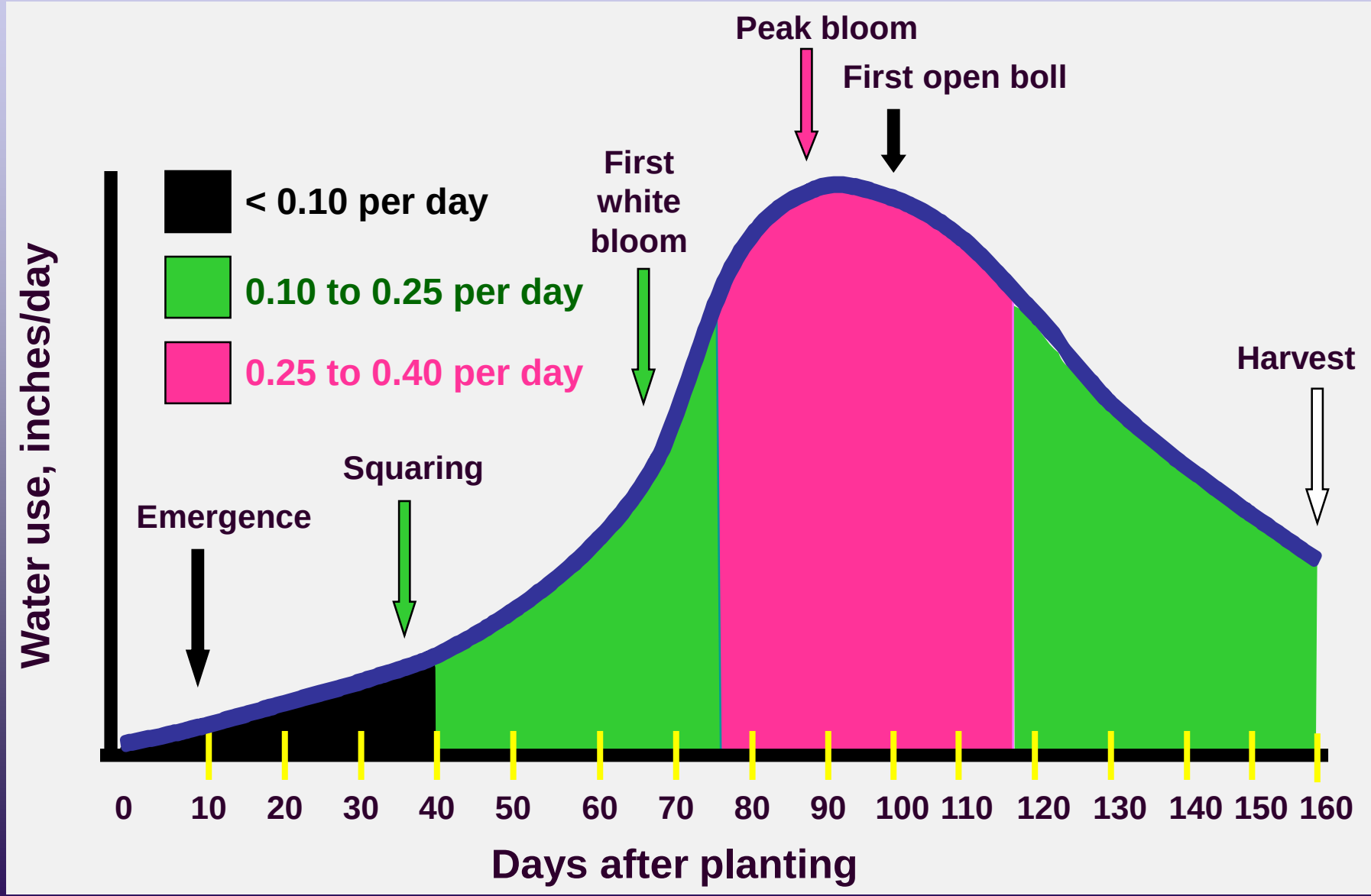
- Assume 8 days to establish a stand
  - 7 nodes x 3 days per node + 8 days (emergence) = 29
- 29 Days to first square
  - at first visible square the plant has formed approximately 4 other squares (microscopically) in its terminal
- Assume May 20 as the planting date
- 23 percent of the fruiting potential has been set by June 18
- 55 percent of the fruiting potential has been set by July 13

WATER USE EFFICIENCY
COTTON



Kreig, et al., Texas Tech

Rate of Water Use
As Related To Cotton Development



Ideal Cotton Plant

- Pre-square: AIL† = 1”; 8 nodes
- Square stage: AIL = 1.5 - 1.75”; 8-9 nodes above white flower and 15 total nodes; 90% square set
- Bloom period - 8 fruiting branches; boll set ≈ 60%??
- Harvest - 15 nodes; 30” tall; AIL = 2”

†AIL=Average Internode Length

Use of Plant Growth Regulators – PGR's

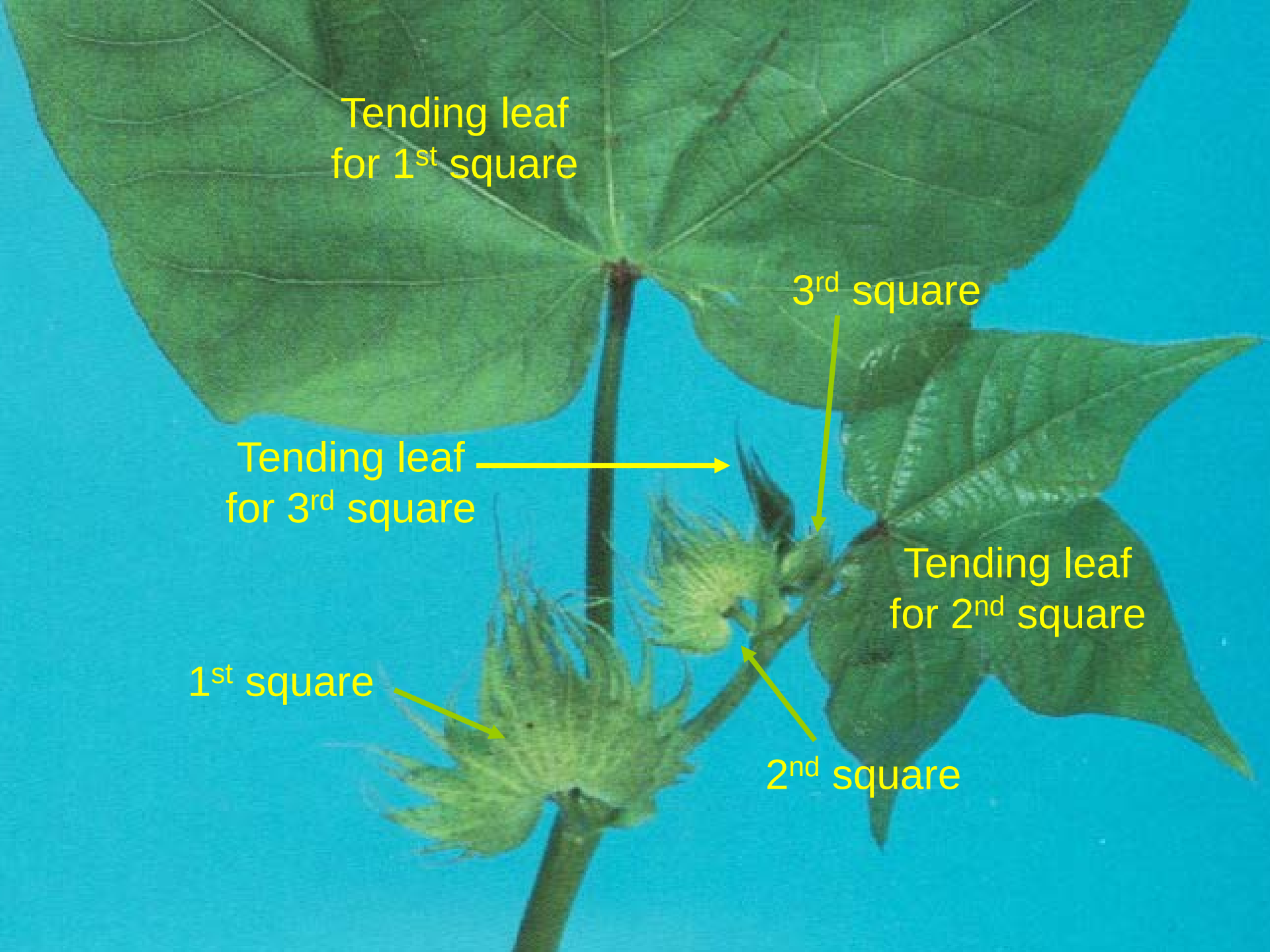
The length of the fourth internode from the terminal or the combined length of the top five internodes can be used to gauge vigor. Plants in which the third internode exceeds 3 to 4 inches or the top five internodes exceed 7 to 9 inches may be experiencing excessive vegetative growth and should be evaluated for using a growth inhibiting PGR.

Growth & Development to Flowering

Days Before Flower	Size of Bud	Comments
40	Microscopic	Square initiation can occur as early as 2nd true leaf expansion. Hot weather induces 4-bract squares, cool weather delays square initiation.
32	Microscopic	Lock numbers determined. Carbohydrate stress decreases number from 5 to 4.
23	2 mm PHS†	Ovule number determined. Carfbohydrate stress decreases potential seed number.
22	2 mm PHS	Pollen cells divide.
19	3 mm MHS‡	Pollen viability reduced by high nighttime temperatures.
5	13 mm	Squares start expanding rapidly
3	17 mm	Fibers begin to form
0	Flower opens	Pollen sheds and fibers start to elongate. Extremes of humididty or water disrupts pollen function.
+1	Flower	Fertilized ovules are now referred to as seeds.

Modified from Stewart, 1986


Bracts


Tending leaf
for 1st square
3rd square
Tending leaf
for 3rd square
Tending leaf
for 2nd square
1st square
2nd square

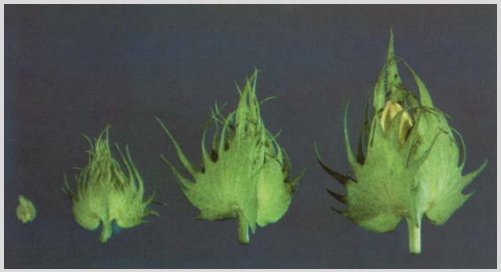
Fiber Development Timeline

Pre-bloom

20d 10d

4^{th} to 5^{th} leaf
Locks/boll
Pinhead Square
Ovules set

Matchhead Square
Pollen viability determined



PHS 7 d 14 d 21 d

Bloom

0

Fibers begin to form
Bloom opens
Ovule fertilized, now a seed

Post Bloom

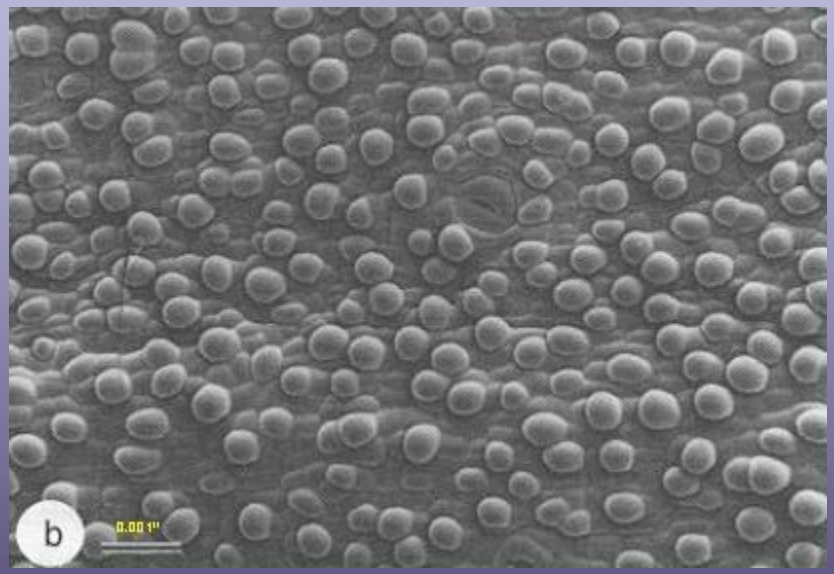
10d 20d 30d 40d 50d

Fiber lengthens for 15-16 days

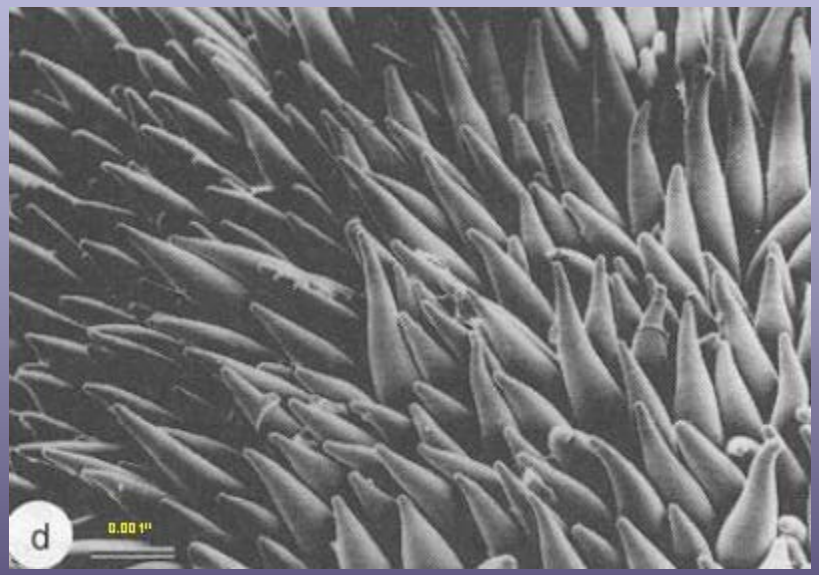
Micronaire develops from 16-18d after bloom until 40-45d post bloom

Each day one layer is laid down on inside of fiber tube

Fibers Originate from the Seed



Fibers at Anthesis



Fibers at 1 day after anthesis

C Bendnarz

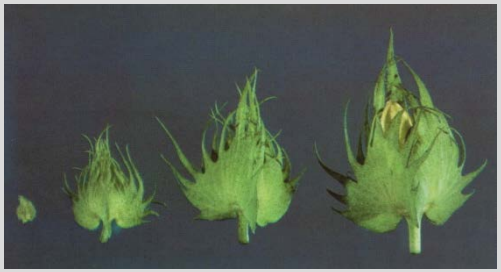
Fiber Development Timeline

Pre-bloom

20d 10d

4^{th} to 5^{th} leaf
Locks/boll
Pinhead Square
Ovules set

Matchhead Square
Pollen viability determined



PHS 7 d 14 d 21 d

Bloom

0

Fibers begin to form
Bloom opens
Ovule fertilized, now a seed

Post Bloom

10d 20d 30d 40d 50d

Fiber lengthens for 15-16 days

Micronaire develops from 16-18d after bloom until 40-45d post bloom

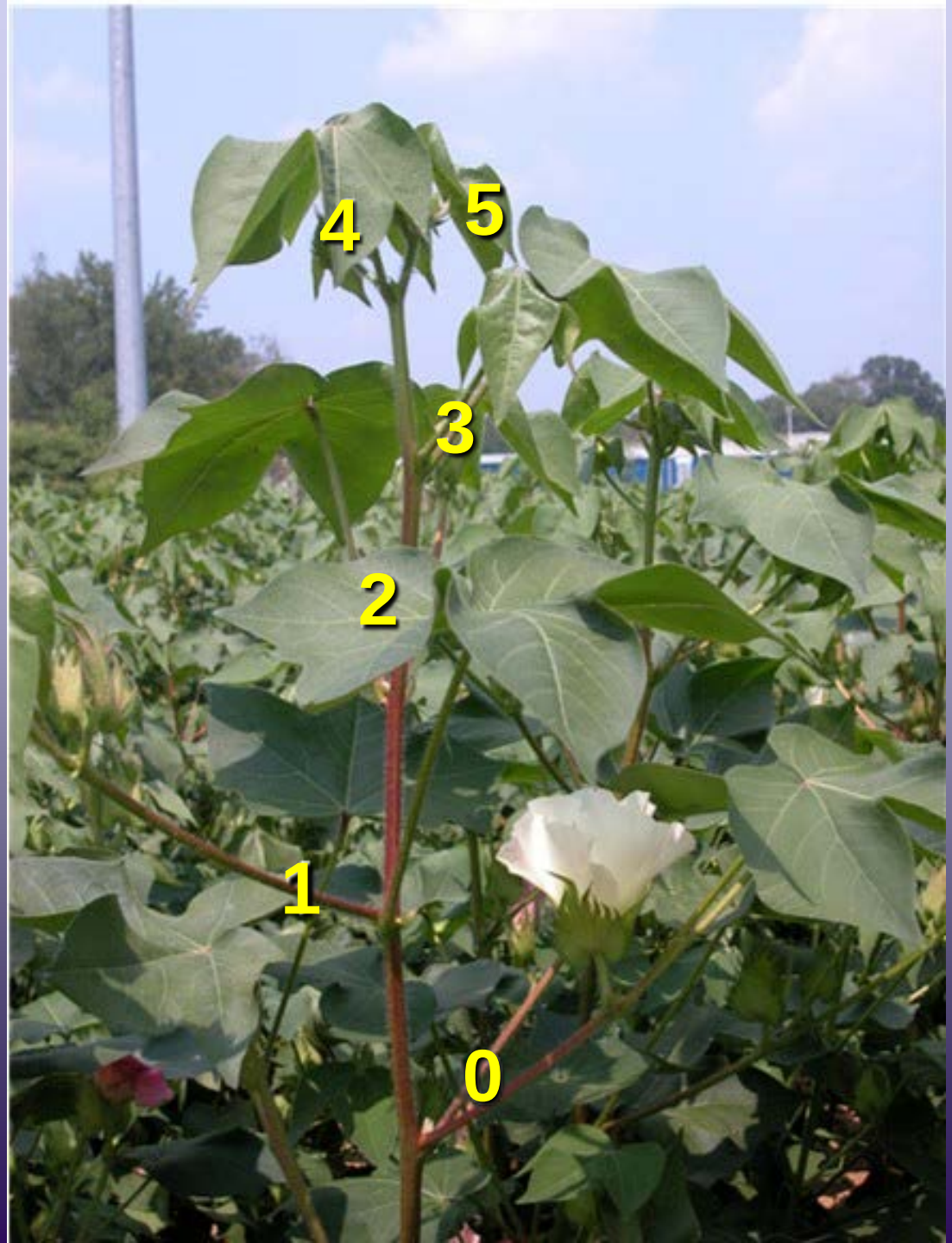
Each day one layer is laid down on inside of fiber tube

Nodes Above White Flower - NAWF

- Growth of the mainstem terminal relative to the progression of flowering toward the terminal
- Number of fully developed nodes above the highest 1st fruiting branch with a white flower
- At 1st flower (beginning bloom) KS cotton normally has 8-10 NAWF
- NAWF decreases as boll load increases or stress increases – boll load is faster than vegetative growth of the mainstem terminal

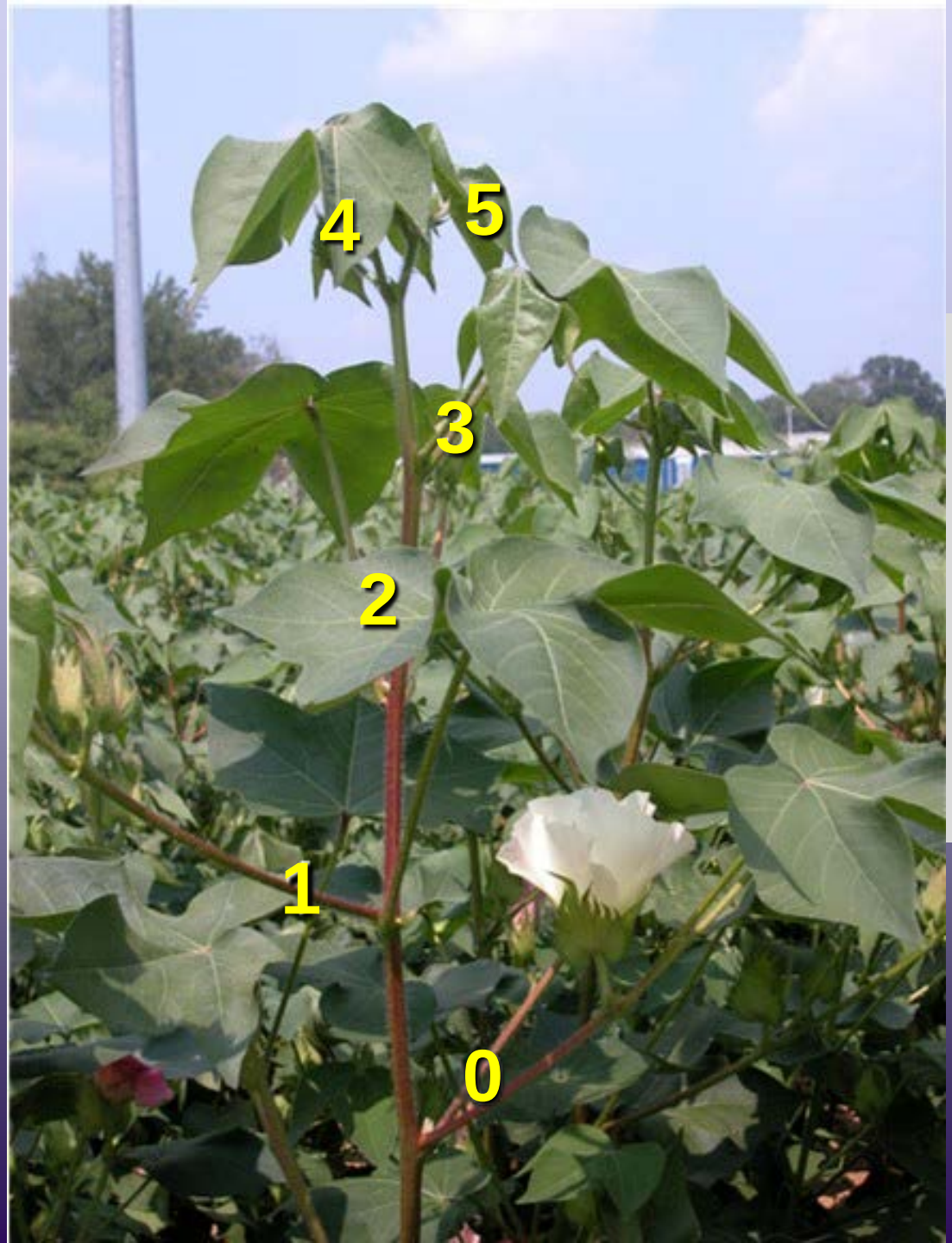
NAWF

Number of fully developed nodes above the highest 1st fruiting branch with a white flower.



Nodes Above White Flower NAWF

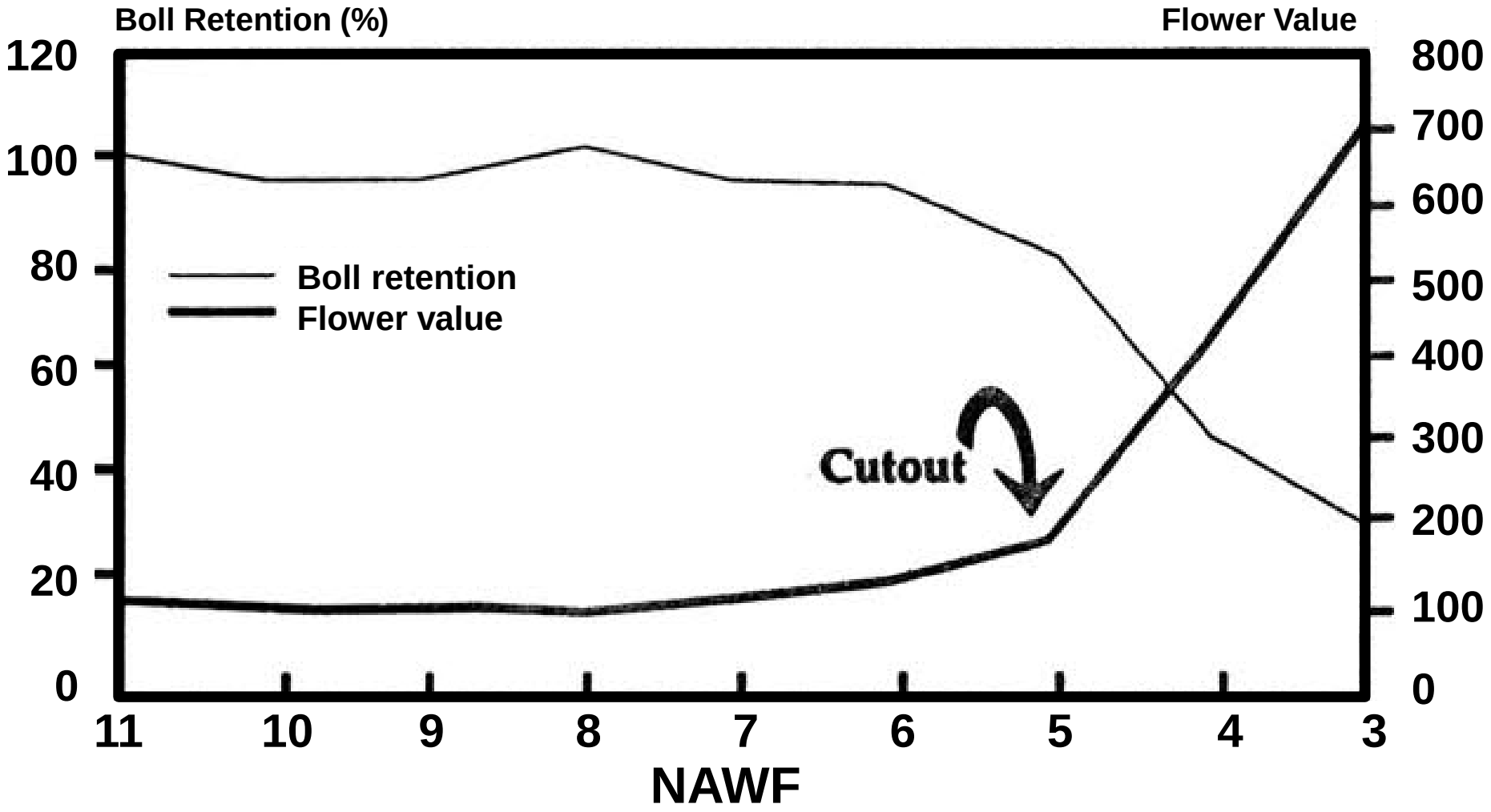
NAWF5 = Cutout



Cutout = Potential last boll that will ripen before killing frost

≈ 650-850 GDD_{60}

Flower Value and Boll Retention vs. Nodes Above White Flower (NAWF)



Note: Flower value = flowers required to produce a pound of seed cotton (Bourland, 1992)

Escambia County Extension, Univ. of Florida, 2012

- Early boll matures ≈ 45 days after bloom
- A new node develops ≈ every 3 days
- Number of nodes to mature a boll is 15
  (45 days/3 days/node = 15 nodes)
- 100% growth/node = 100%/15=6.67%
- 1st position boll 2 nodes up is 13% less mature!

- How is this useful?

- Fields can be **safely defoliated** when the **topmost** 1st position harvestable boll is only 4 nodes above the 1st position cracked boll.

# Nodes	Weight loss if defoliated prematurely for a 1st position boll above cracked node
2	0.0 %
3	1.3 %
4	8.0 %
5	14.6 %
6	21.3 %
7	28.0 %
8	34.7 %

Questions?

Email: sduncan@ksu.edu