Tracking Cotton Growth and Development

Randy Norton, Ph.D.
Extension Agronomist
The University of Arizona
Safford, AZ

College of Agriculture and Life Sciences
Cooperative Extension
Arizona

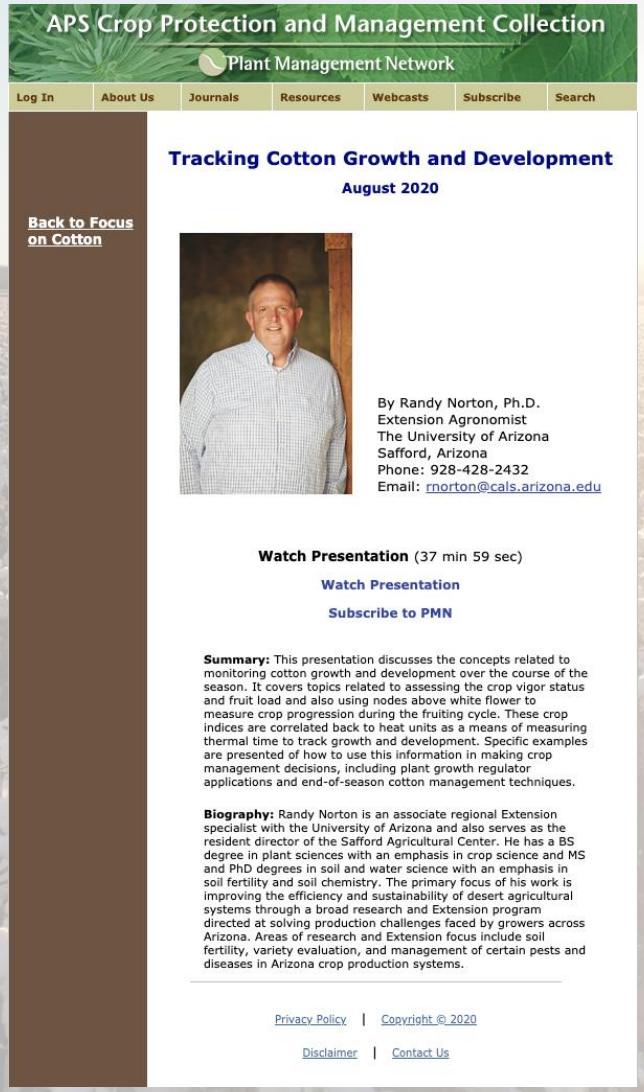
Outline

- Cotton phenology and development
- Review cotton developmental stages, timelines, and indices
- Review of 2020 crop status – heat stress implications
  - End of season management
    - Irrigation termination

2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

Recent PMN Presentation

http://www.plantmanagementnetwork.org/edcenter/seminars/cotton/GrowthDevelopment/



APS Crop Protection and Management Collection

Plant Management Network

Log In | About Us | Journals | Resources | Webcasts | Subscribe | Search

Back to Focus on Cotton

Tracking Cotton Growth and Development

August 2020

By Randy Norton, Ph.D.
Extension Agronomist
The University of Arizona
Safford, Arizona
Phone: 928-428-2432
Email: rnorton@cals.arizona.edu

Watch Presentation (37 min 59 sec)

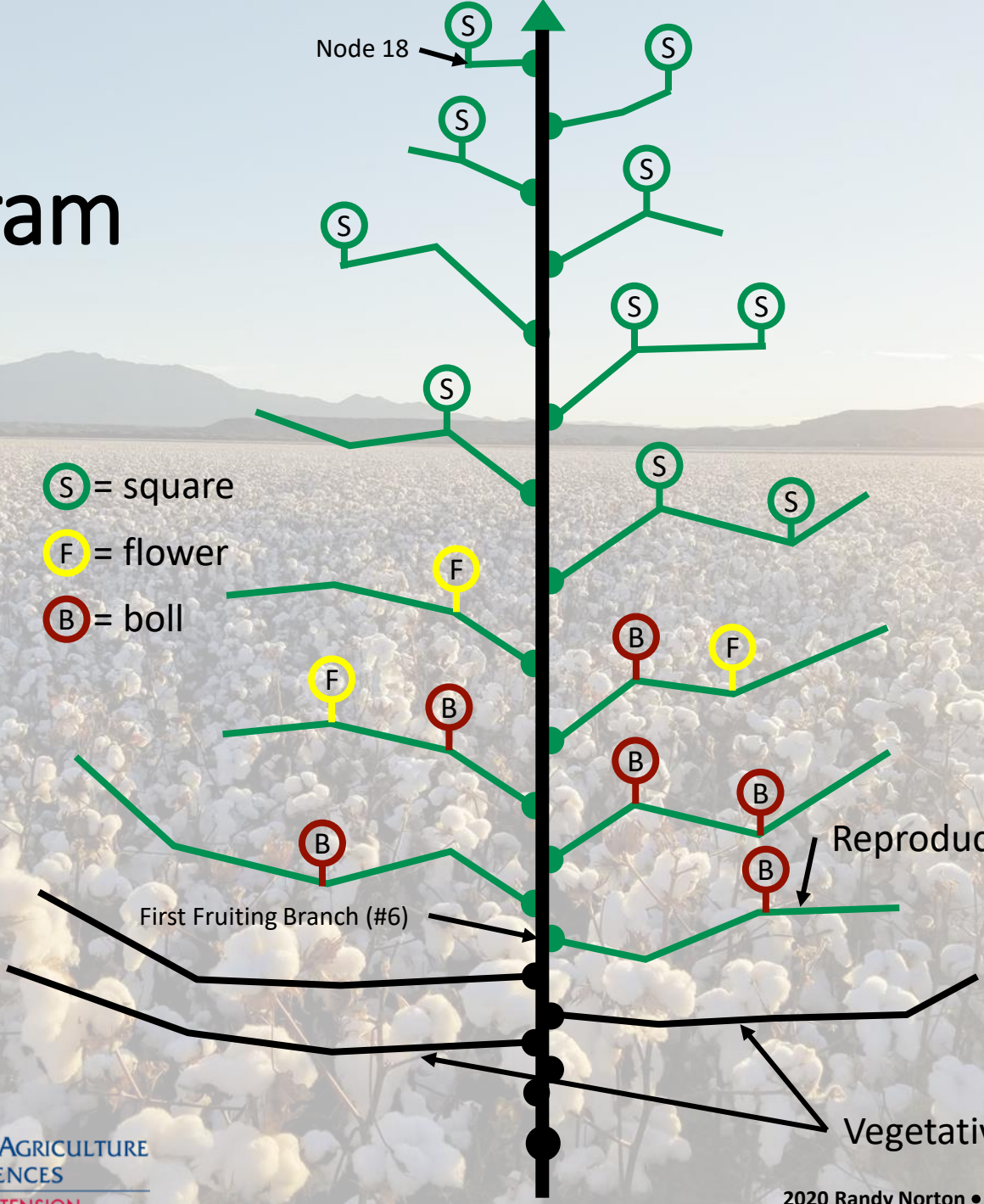
Watch Presentation

Subscribe to PMN

Summary: This presentation discusses the concepts related to monitoring cotton growth and development over the course of the season. It covers topics related to assessing the crop vigor status and fruit load and also using nodes above white flower to measure crop progression during the fruiting cycle. These crop indices are correlated back to heat units as a means of measuring thermal time to track growth and development. Specific examples are presented of how to use this information in making crop management decisions, including plant growth regulator applications and end-of-season cotton management techniques.

Biography: Randy Norton is an associate regional Extension specialist with the University of Arizona and also serves as the resident director of the Safford Agricultural Center. He has a BS degree in plant sciences with an emphasis in crop science and MS and PhD degrees in soil and water science with an emphasis in soil fertility and soil chemistry. The primary focus of his work is improving the efficiency and sustainability of desert agricultural systems through a broad research and Extension program directed at solving production challenges faced by growers across Arizona. Areas of research and Extension focus include soil fertility, variety evaluation, and management of certain pests and diseases in Arizona crop production systems.

Plant Diagram



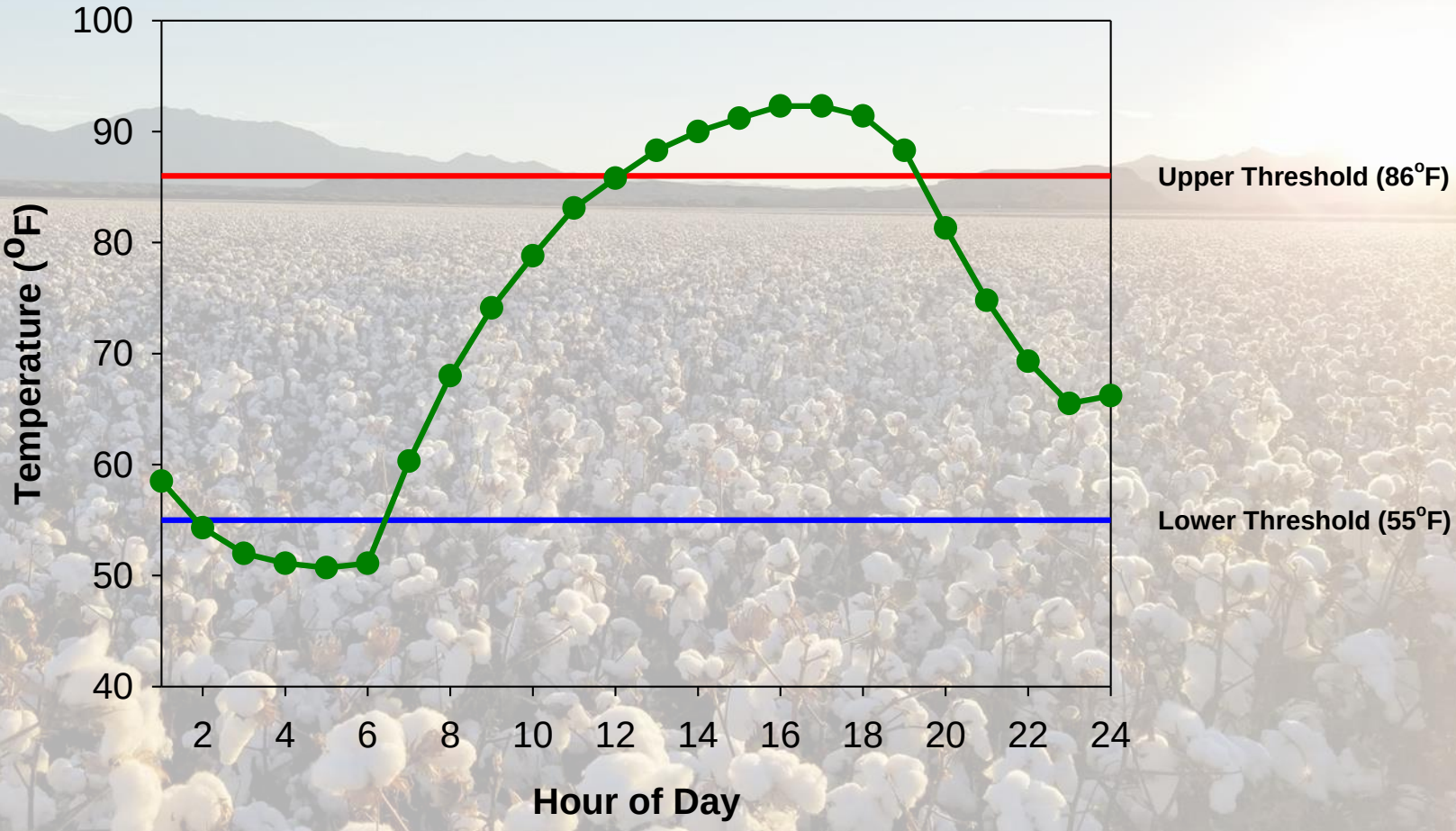
College of Agriculture and Life Sciences
Arizona Cooperative Extension

Tracking Cotton Crop Development

- **Biological systems**
  - **Respond to heat (thermally sensitive)**
  - **Drives development**
  - **DOY insensitive – to a certain extent**
- **Thermal units**
  - **Degree Days (DD60s)**
  - **Heat Units (HU)**
  - **Various definitions and calculations**

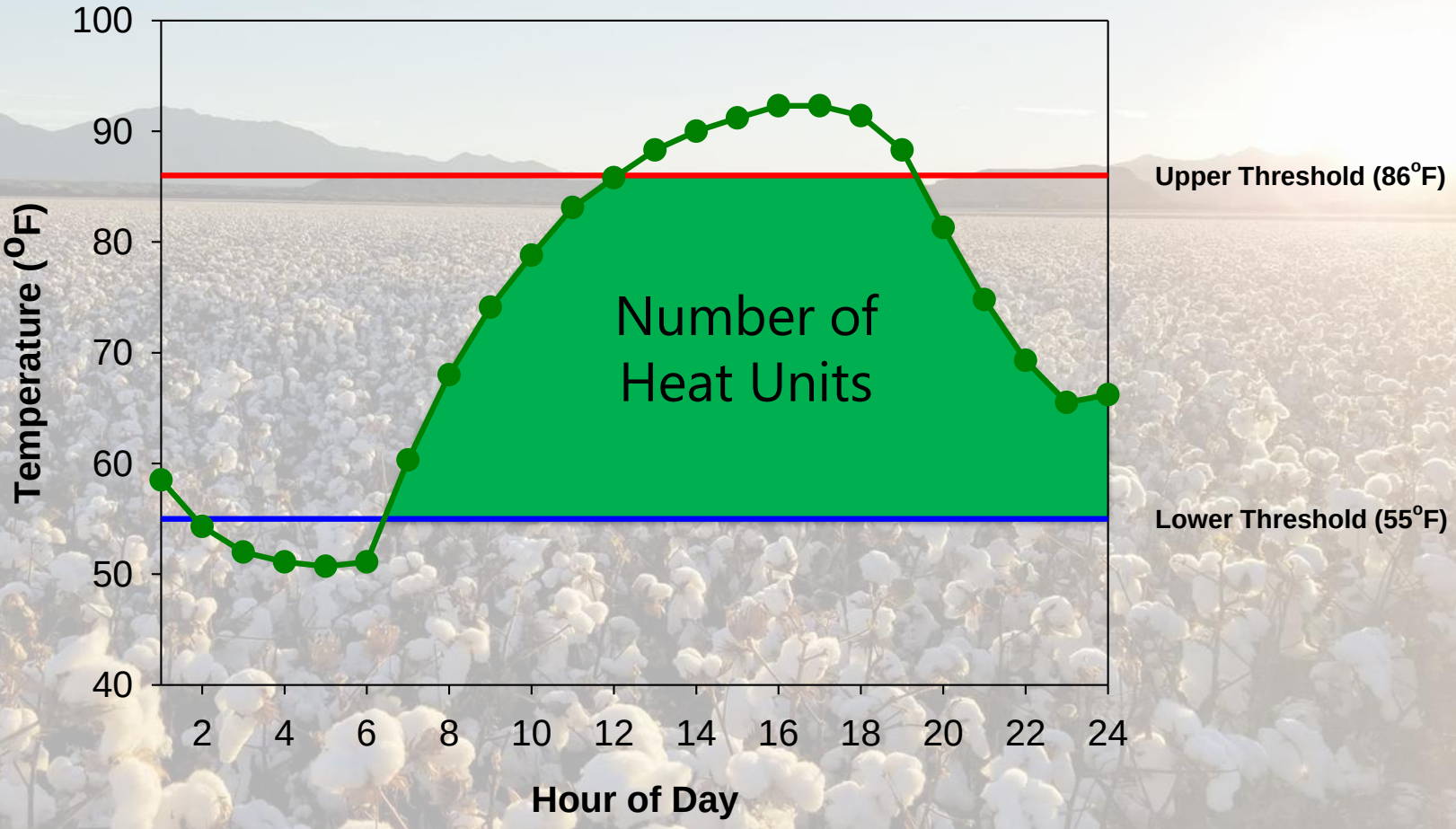
2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

HU Concept



2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

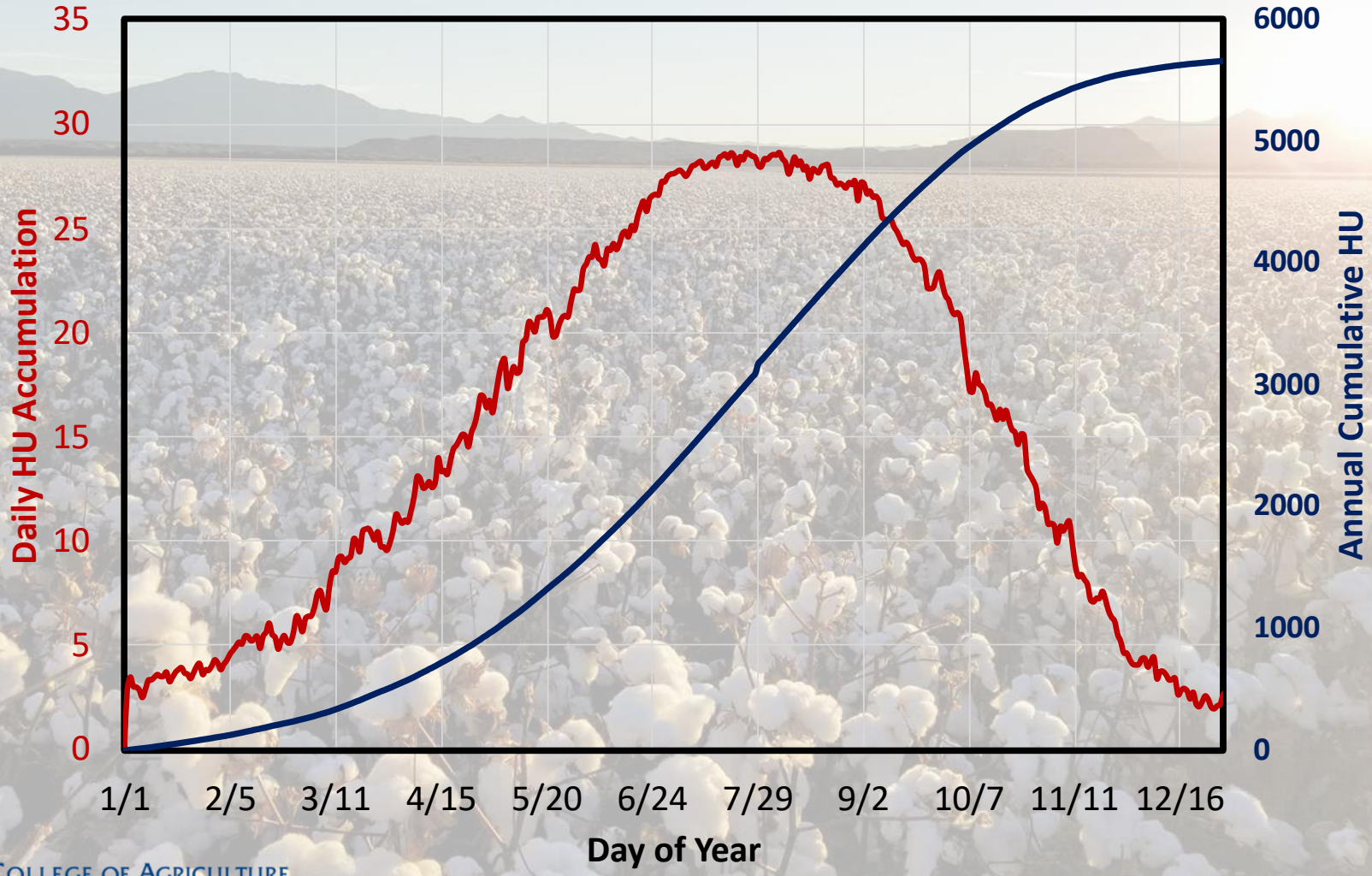
HU Concept



Sine curve used to model daily temperature then perform mathematical integration to determine area under curve bound by upper and lower thresholds

College of Agriculture and Life Sciences
Arizona Cooperative Extension

Annual HU Profile – Maricopa, AZ



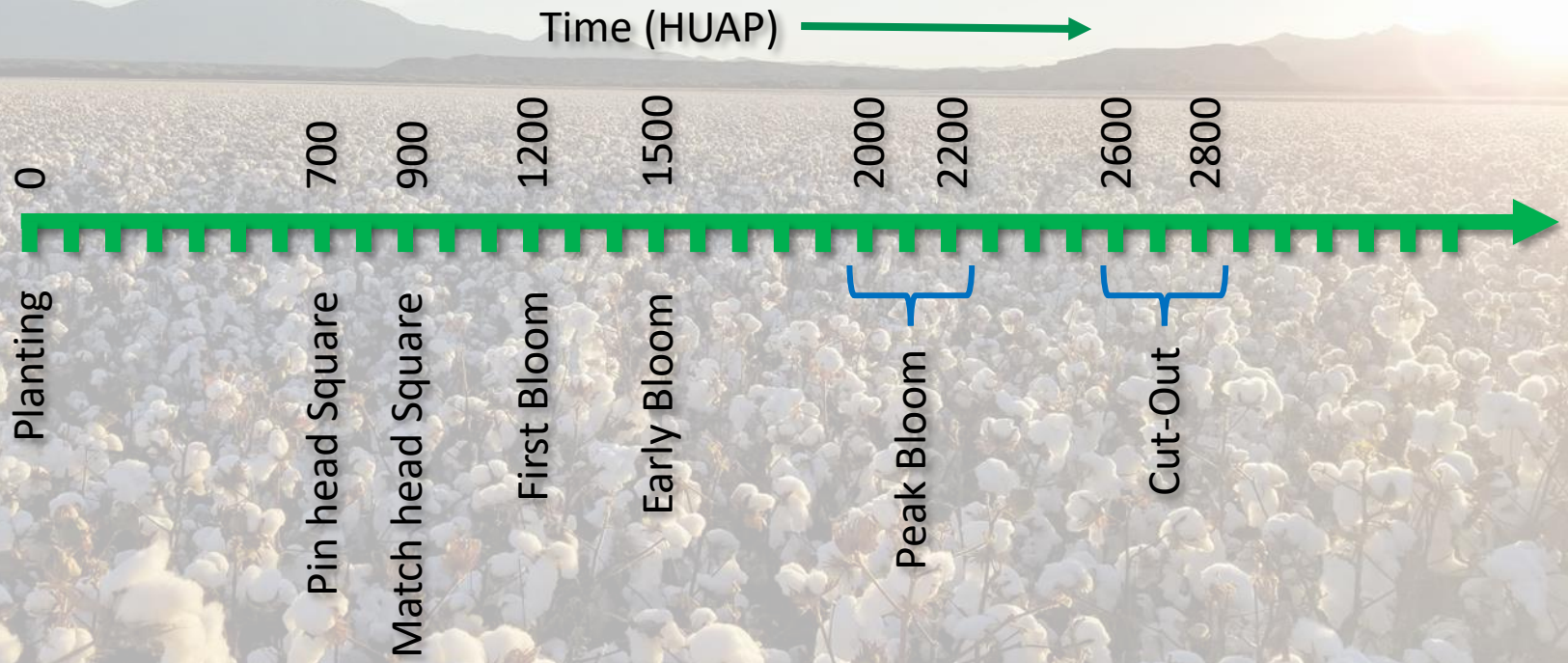
ARIZONA | COLLEGE OF AGRICULTURE AND LIFE SCIENCES
COOPERATIVE EXTENSION

Plant Growth and Development

- **Extensive database began in the late 80's though the late 90's**
  - **JC Silvertooth**
    - **Growth timelines (mileposts of development)**
    - **Crop status (vegetative/reproductive)**
- **Continued to refine in the present**
  - **Norton**
- **Developing average (normal) baselines**
- **Well over 10,000 observations under arid and semi-arid, non-stressed conditions**

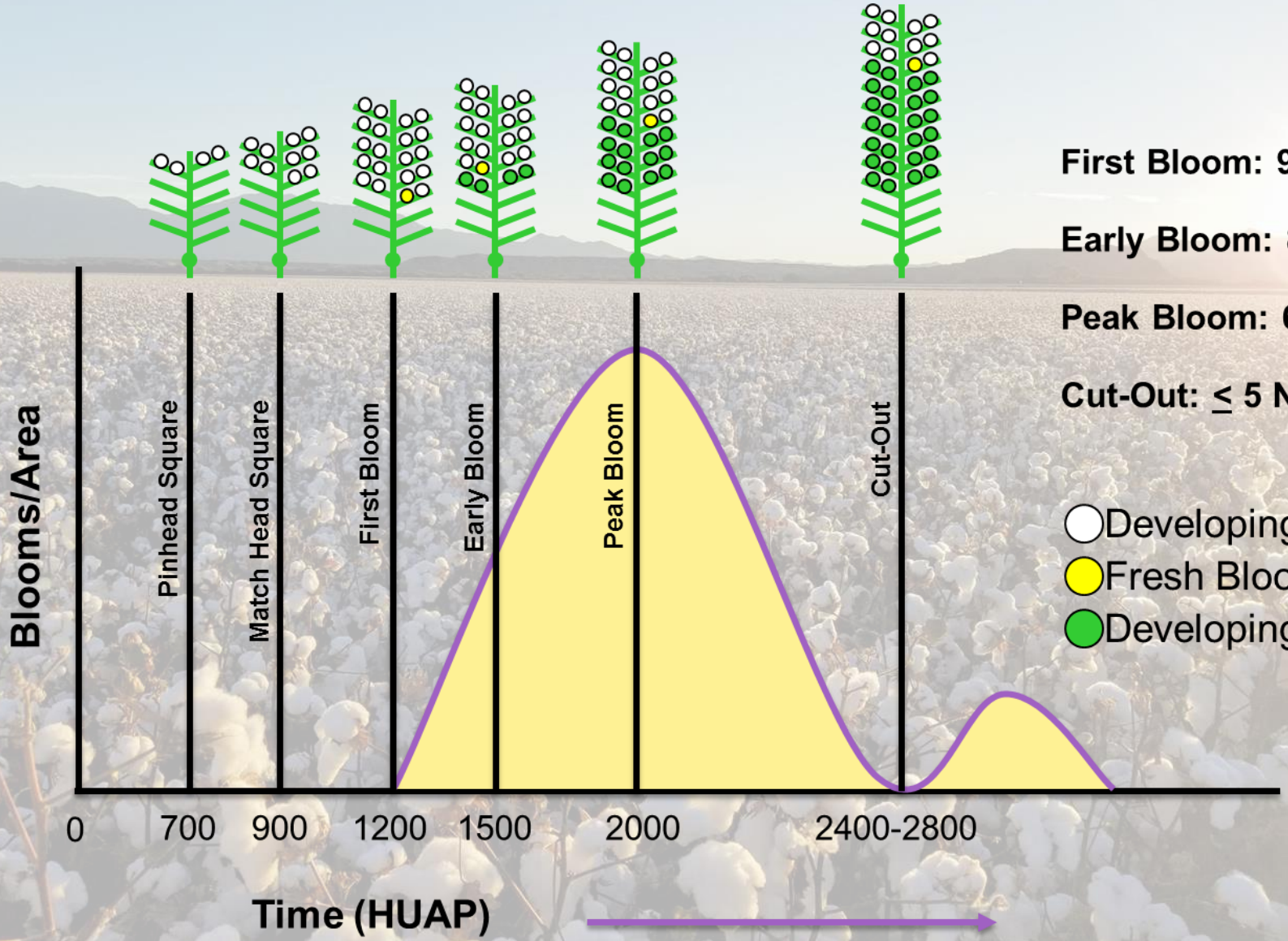
2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

Crop Developmental Mileposts



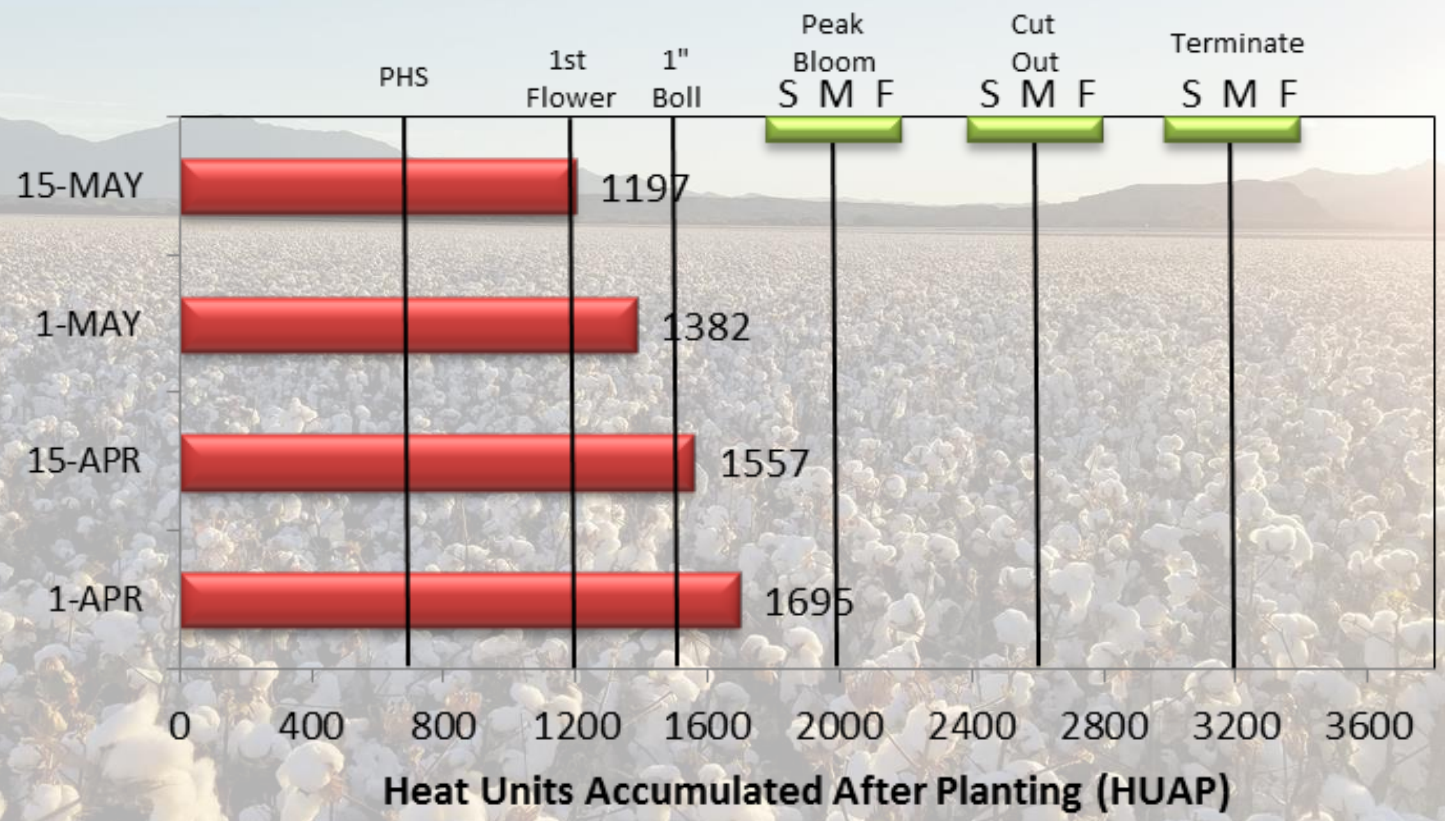
College of Agriculture and Life Sciences
Arizona Cooperative Extension

Crop Development - NAWF



College of Agriculture and Life Sciences
Arizona Cooperative Extension

Cotton Advisory



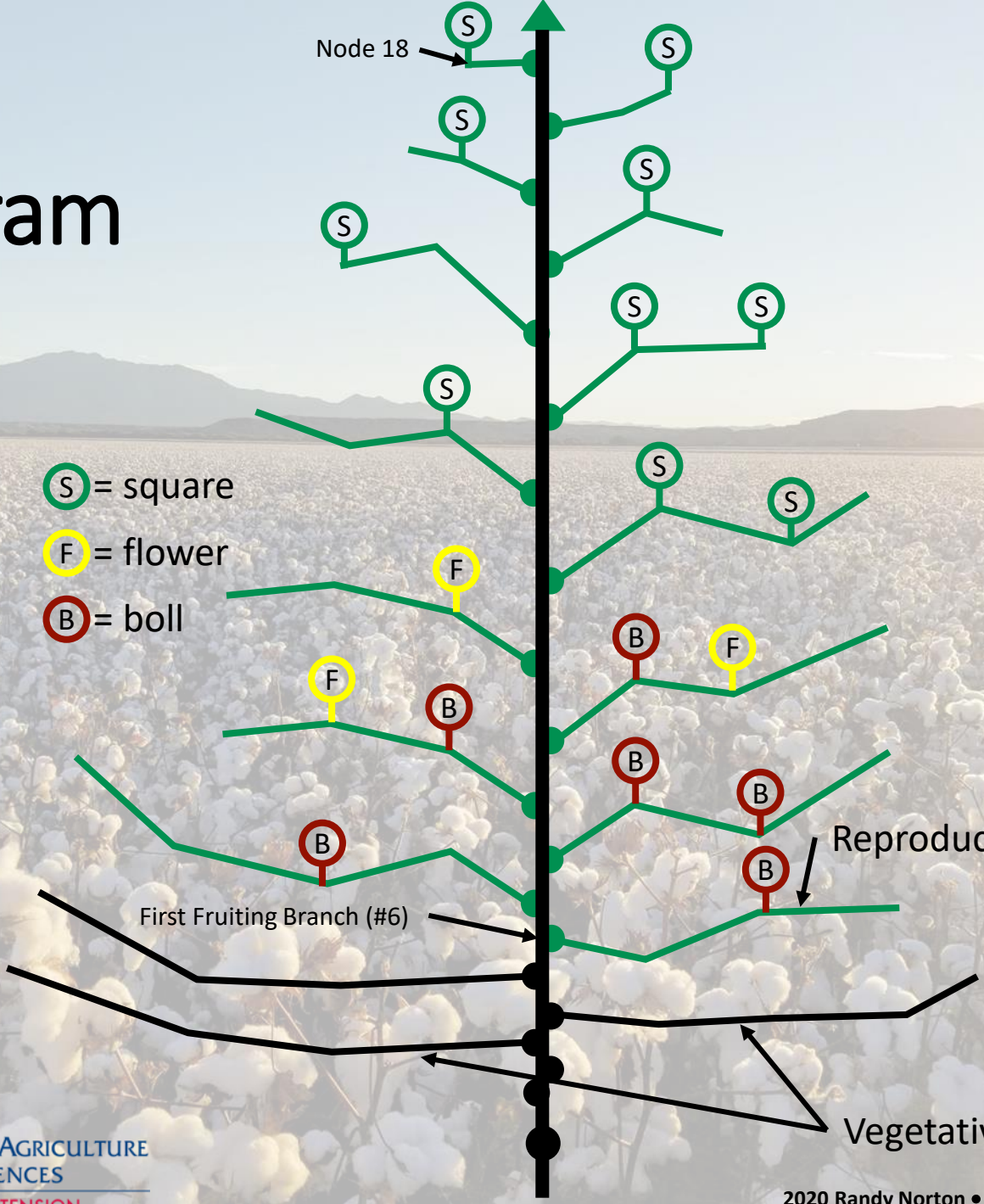
College of Agriculture and Life Sciences
Arizona Cooperative Extension

Crop Monitoring

- **Crop monitoring tools used to monitor crop status**
  - **Finer detail for decision making**
- **Height to node ratios (HNR)**
  - **Crop Vigor**
- **Fruit retention (FR)**
  - **Fruit load (carbohydrate sink)**
- **Nodes above white flower (NAWF)**
  - **Progression through fruiting cycle**

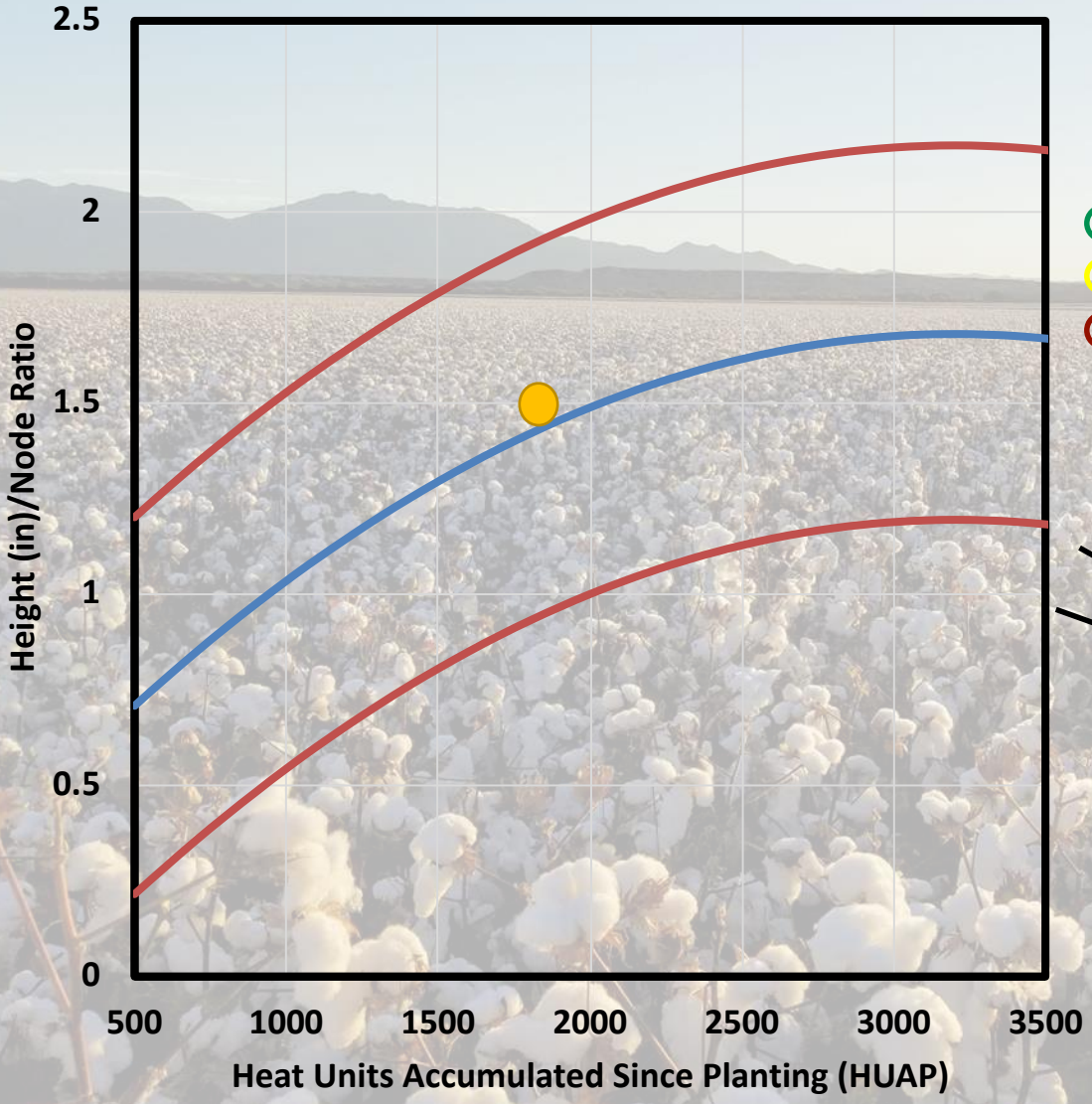
2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

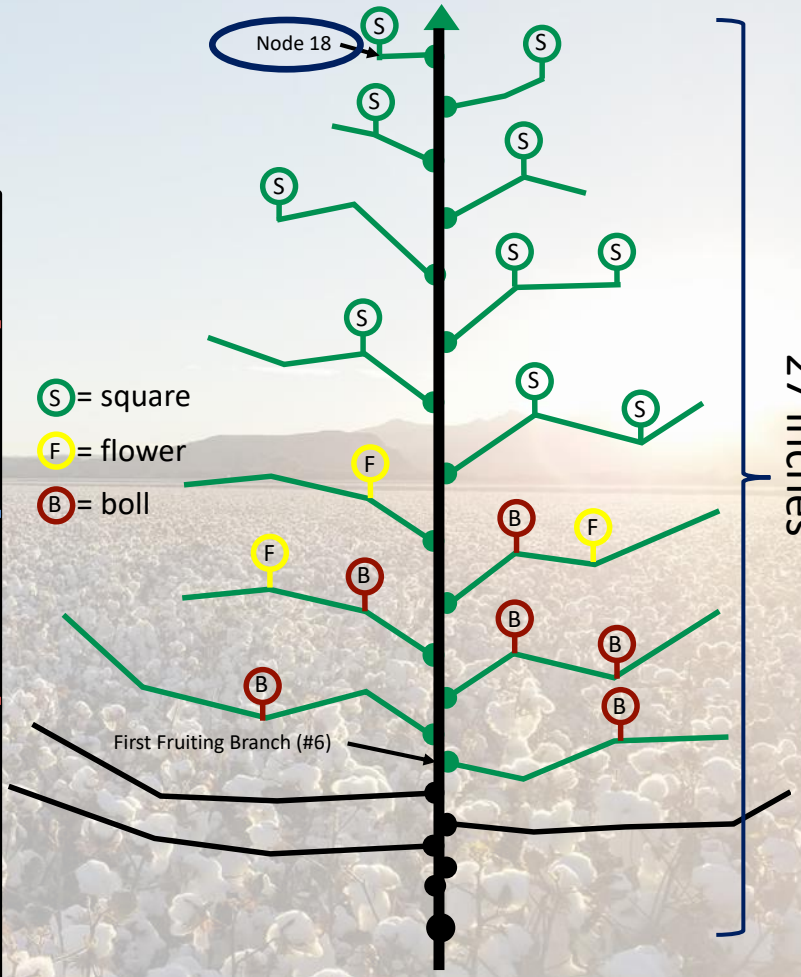
Plant Diagram



College of Agriculture and Life Sciences
Arizona Cooperative Extension

Height to Node Ratio





Ratio of plant height (inches – cotyledons to terminal) to total nodes – cotyledon = 0

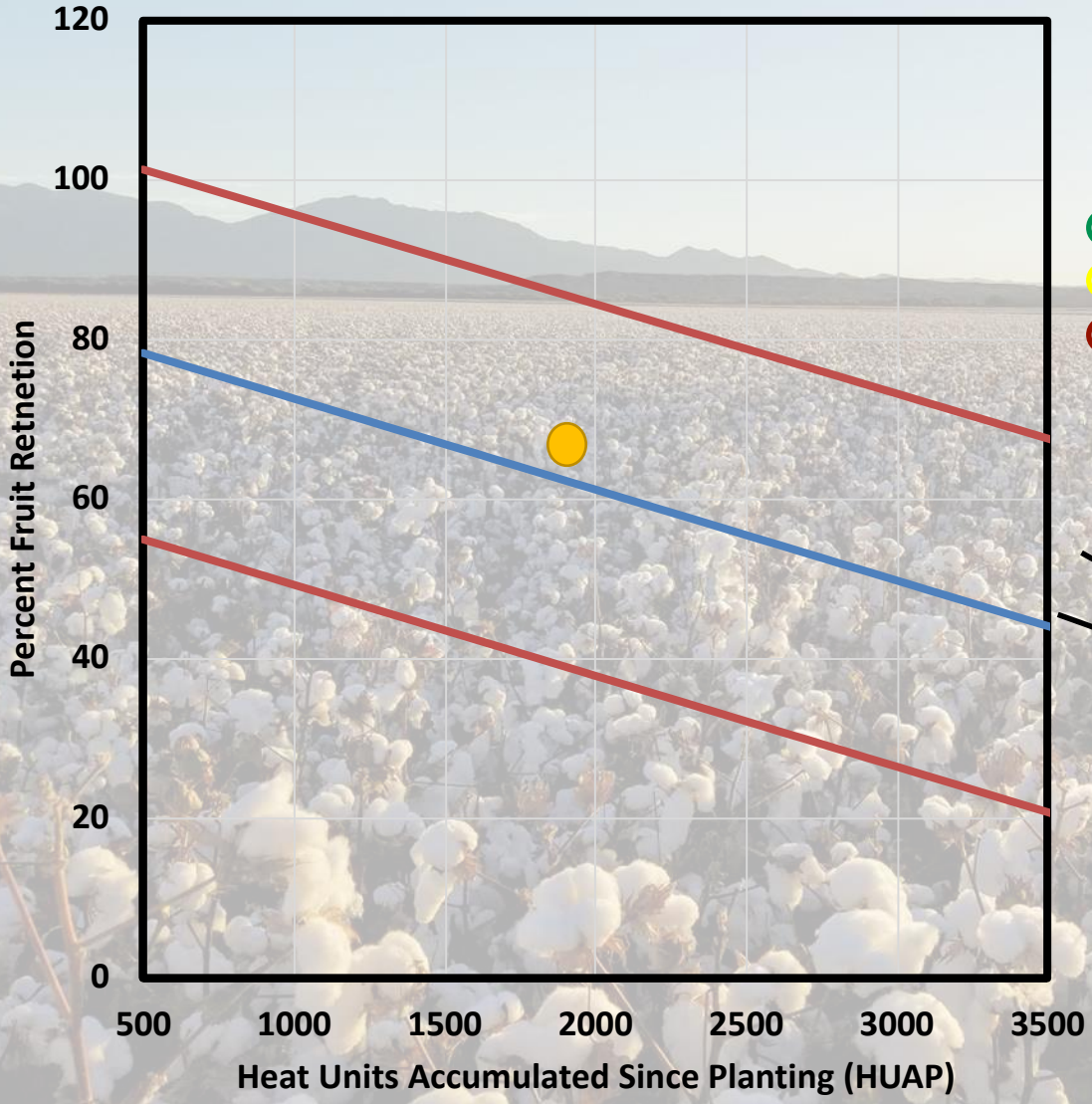
Example 18 nodes and 27 inches

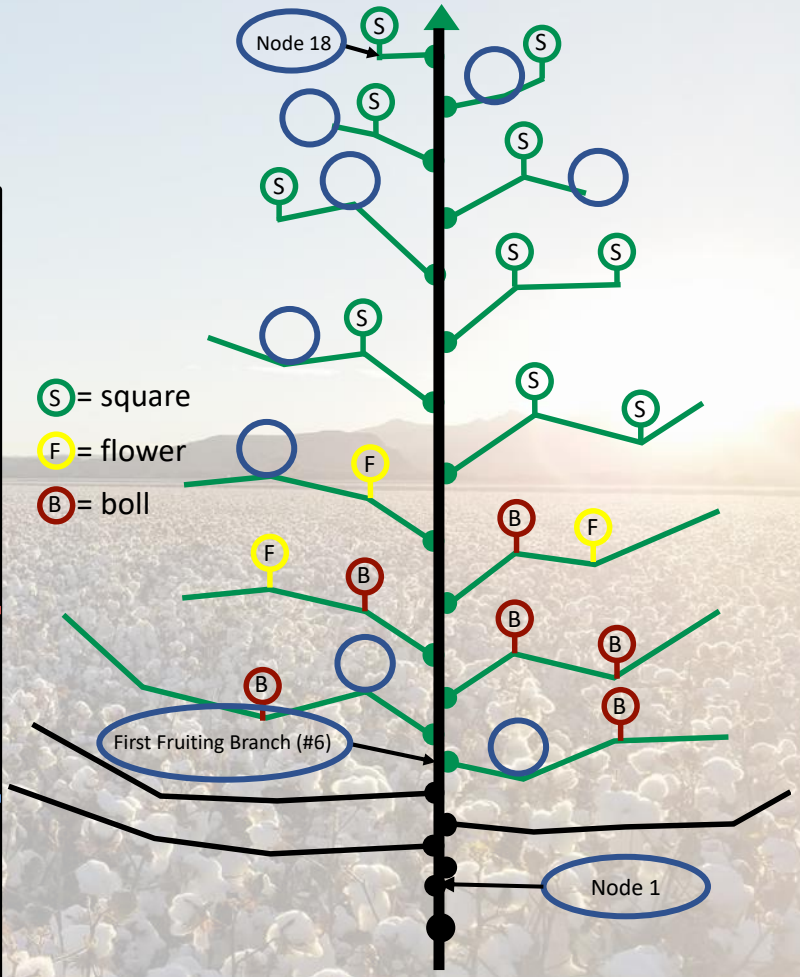
27/18 = 1.5

College of Agriculture and Life Sciences
Arizona Cooperative Extension

2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

Fruit Retention

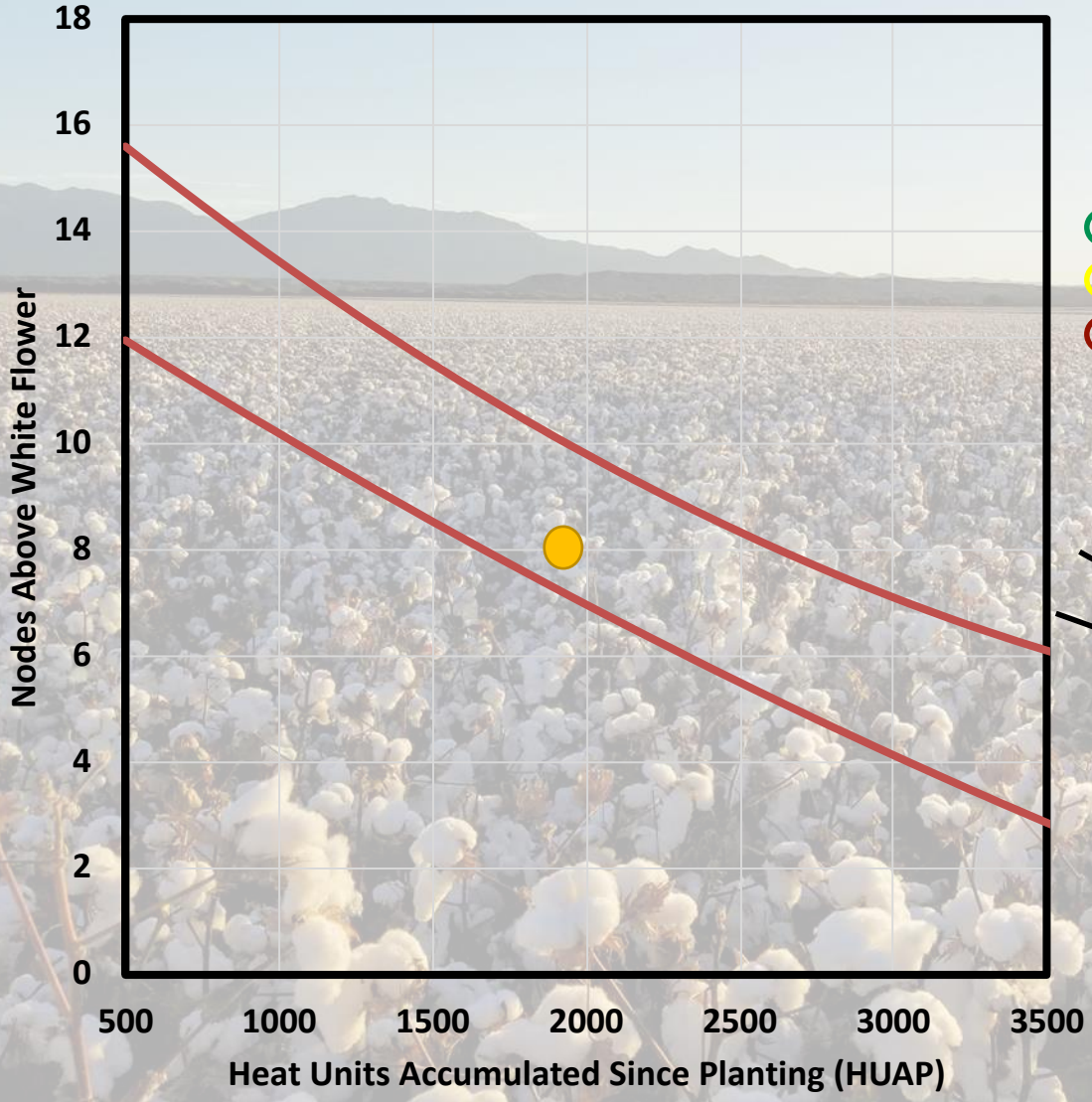


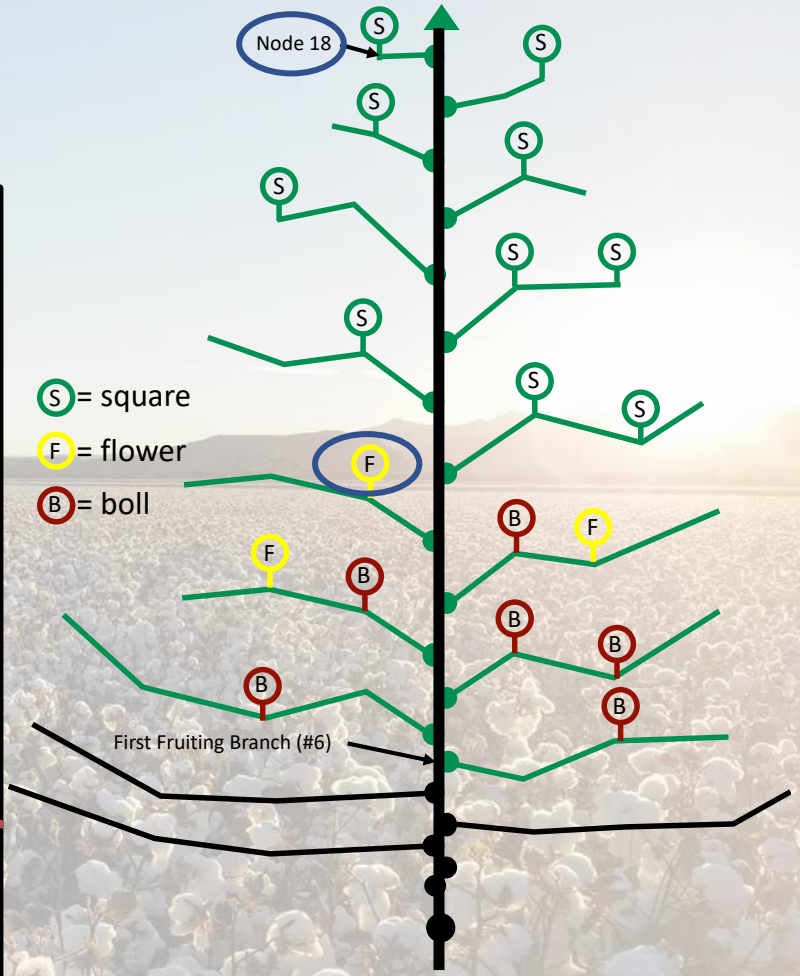


Total MSN (18) subtract FFB (6) and add 1
Multiply by 2 (2 positions on each FB)
Total potential sites = 26
Count AMS = 8 total
Percent of retained over total
18/26*100 = 69.2

ARIZONA | COLLEGE OF AGRICULTURE AND LIFE SCIENCES
COOPERATIVE EXTENSION

Nodes Above White Flower





Identify upper-most *1st position* fresh bloom

Count total number of nodes above to terminal

NAWF = 8

College of Agriculture and Life Sciences
Arizona Cooperative Extension

Using Growth and Development Data

- **Fertilizer Applications**
  - **Timing according to fruit load and vigor between PHS and PB**
- **Irrigation scheduling**
  - **NAWF as an indicator of crop stress**
- **PGR Applications**
  - **Feedback approach based upon crop conditions of fruit load and vigor**
- **Assessing the effects of heat stress on fruit load**

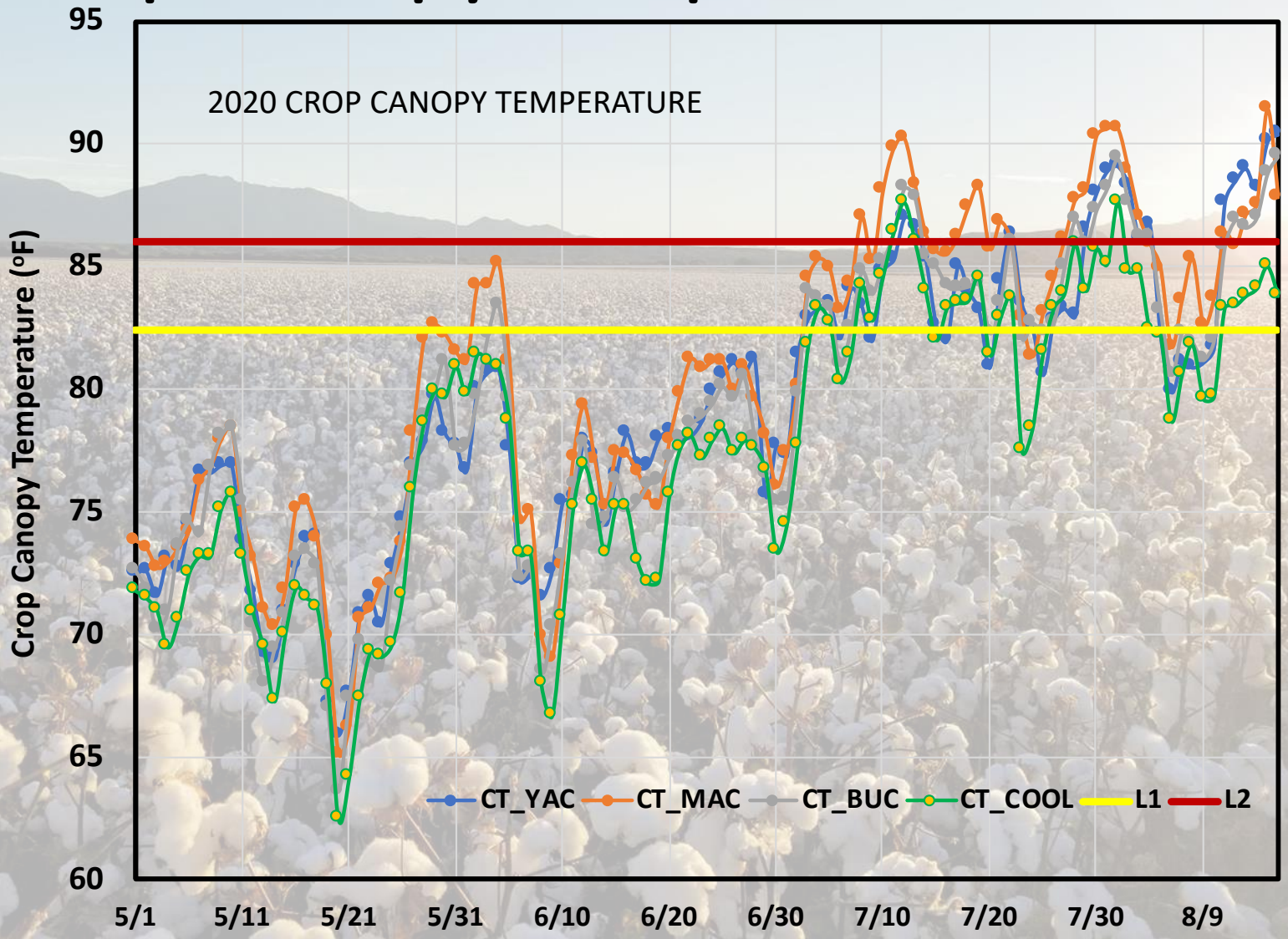
2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

2020 Heat Stress

- **Characterized by crop canopy temperature (CCT)**
  - **P.W. Brown – calculated value based on**
    - **Air temperature**
    - **Relative humidity**
    - **Vapor pressure deficit**
  - **L1 vs. L2**
    - **L1 – CCT > 82.4 < 86 ^{o}F**
    - **L2 – CCT > 86 ^{o}F**

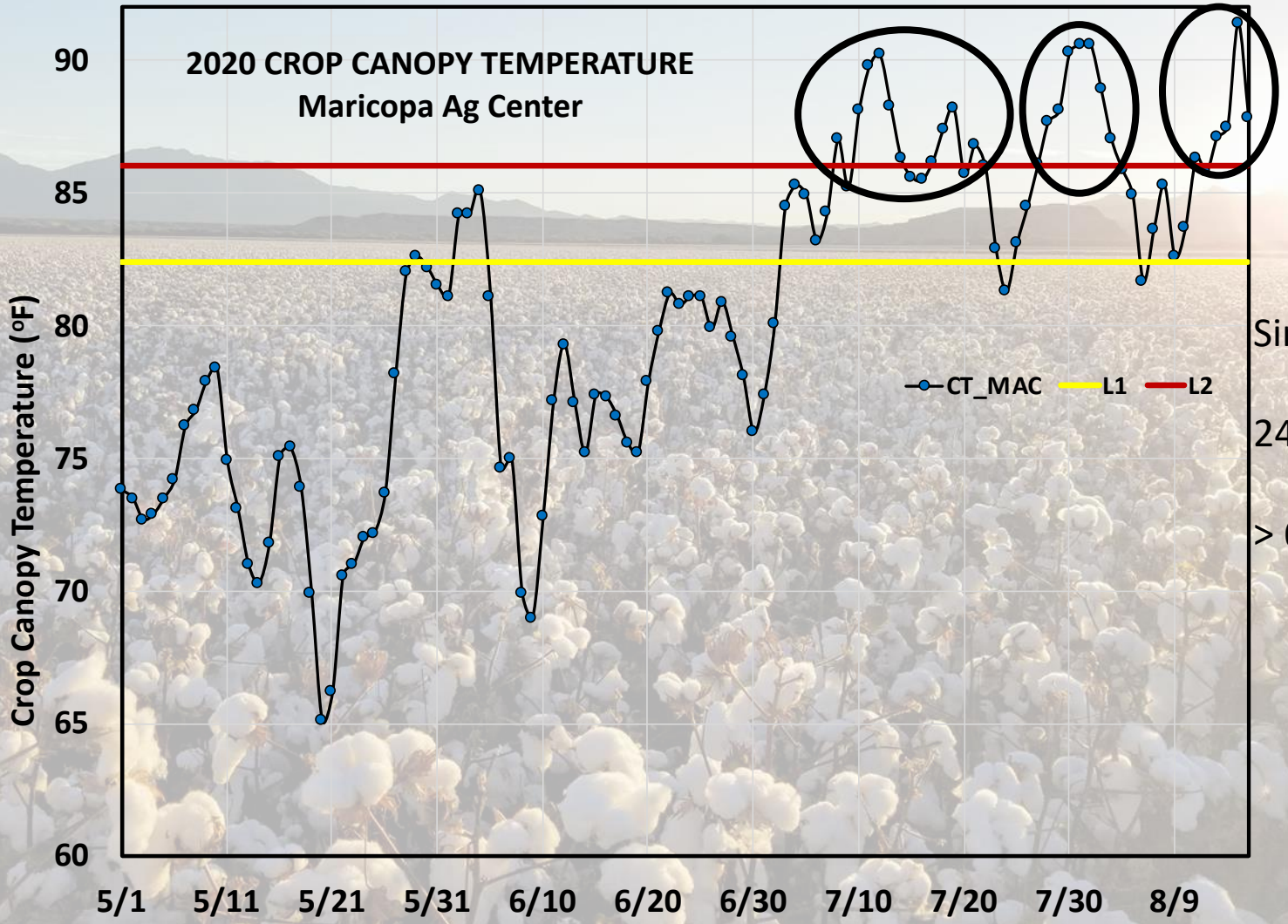
2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

Crop Canopy Temperature



College of Agriculture and Life Sciences
Cooperative Extension

2020 Crop Canopy Temperatures



Since 8 July:

24 Days L2

> 60%

College of Agriculture and Life Sciences
Cooperative Extension
ARIZONA

Heat Stress Observations

- **Flowers tagged (312) on 15 July – Evaluated 29 July**
  - **Approximately 80% retained**
- **Flowers tagged (312) on 29 July – Evaluated 12 August**
  - **Approximately 3% retained**
  - **Mainly abnormal bolls**

2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

In-Field Observations

College of Agriculture and Life Sciences
Cooperative Extension
Arizona

2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

Implications of Heat Stress

- **Crop had excellent fruit set prior most fields better than 60%**
- **Top third of plant many aborted and cavitated sites**
- **Evaluate extent of loss – plant mapping**
- **Cautious about late season growth spurt – may result in buggy whips**
  - **Possible PGR application to arrest growth**
  - **More difficult defoliation***

2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

End of Season Monitoring

- **Use of HU to predict boll maturation**
- **Assist in timing of defoliation**
- **Assist in determining final irrigation**

2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

Crop Monitoring - Irrigation Termination

- **Identify last fruit intended for harvest**
  - **point of diminishing returns**
  - **occurrence of cut-out**
    - **consider variety type**
- **Consider…**
  - **Insect populations / pressure**
  - **Additional irrigation events**
  - **Additional fertilization events**
  - **More difficult to defoliate as temps decrease**
  - **Reduce fruit retention late season**

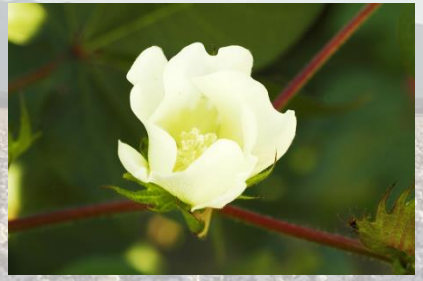
2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

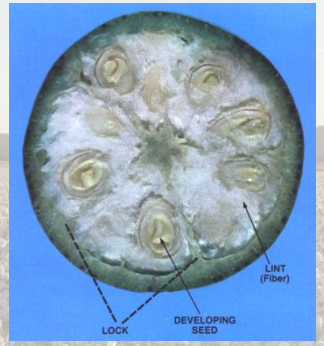
Irrigation Termination Decision

- **Identify last flower to be taken to harvest**
- **Determine the amount of time for that flower to mature into a harvestable boll**
- **Must provide sufficient soil water through fiber elongation phase (~600 HU ~21 days / Aug. and Sep.)**

2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

Boll Development and Maturation





600 HU

400 HU

Fresh Bloom

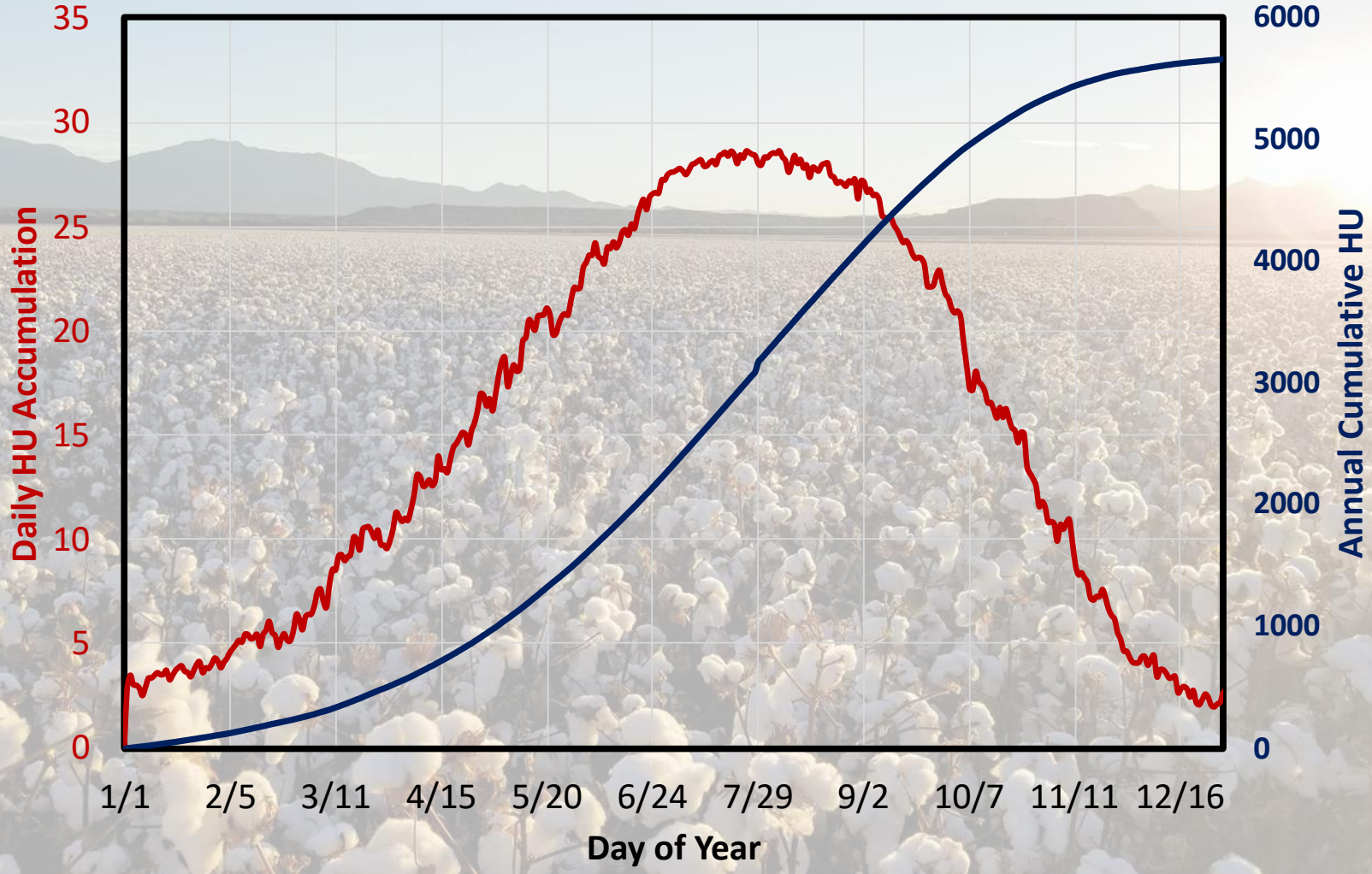
Full sized Hard Green Boll

Open Boll

ARIZONA | COLLEGE OF AGRICULTURE AND LIFE SCIENCES
COOPERATIVE EXTENSION

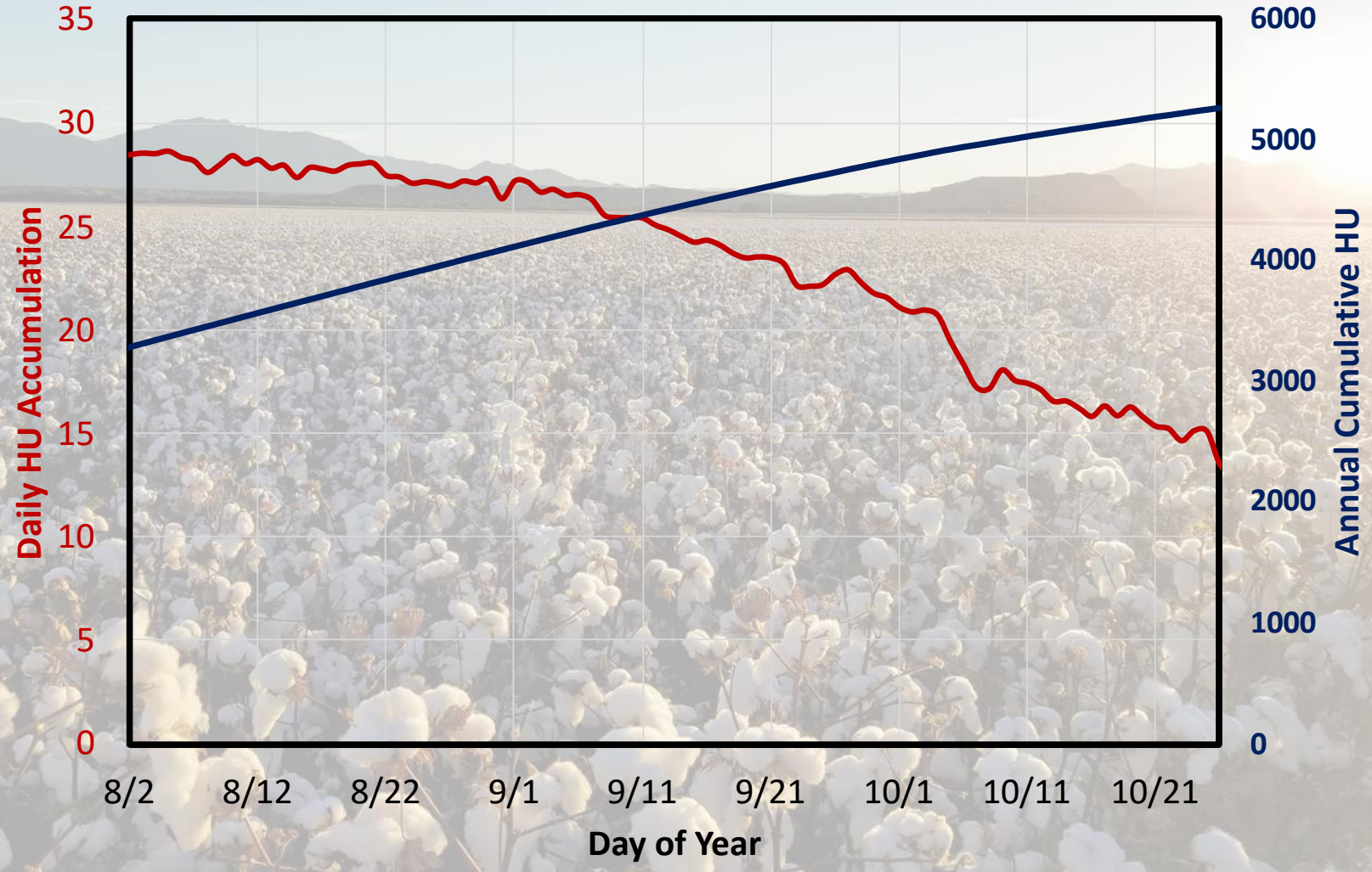
2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

Normal HU Accumulations



College of Agriculture and Life Sciences
Cooperative Extension

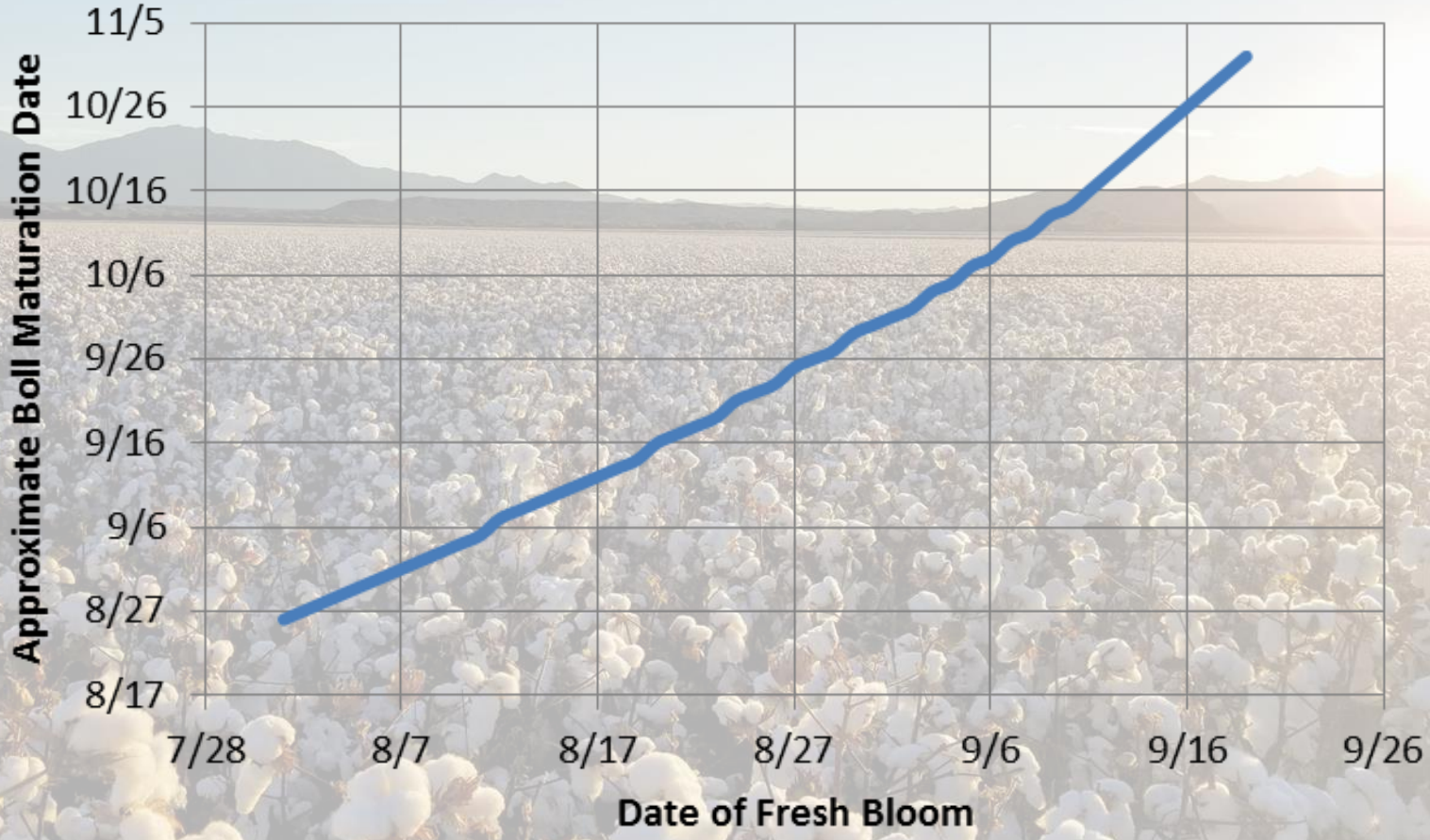
Late Season Heat Units



ARIZONA | COLLEGE OF AGRICULTURE AND LIFE SCIENCES
COOPERATIVE EXTENSION

2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

Boll Maturation Data



College of Agriculture and Life Sciences
Arizona Cooperative Extension

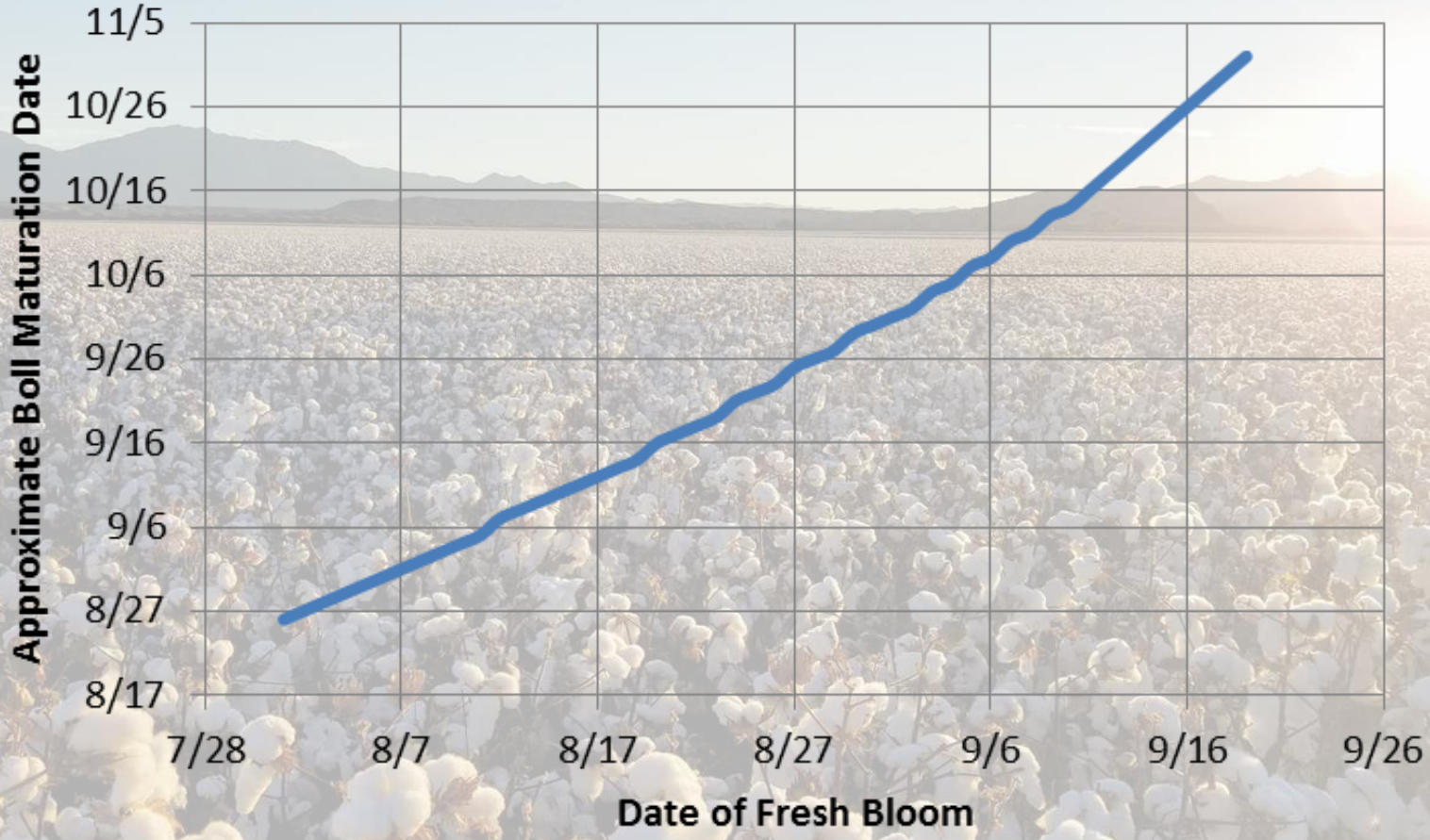
2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

Irrigation Termination

- **Scenario**
  - **Crop planted on 4/20**
  - **Last flower identified for harvest on 8/27**
  - **On average should mature on 9/25**

2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

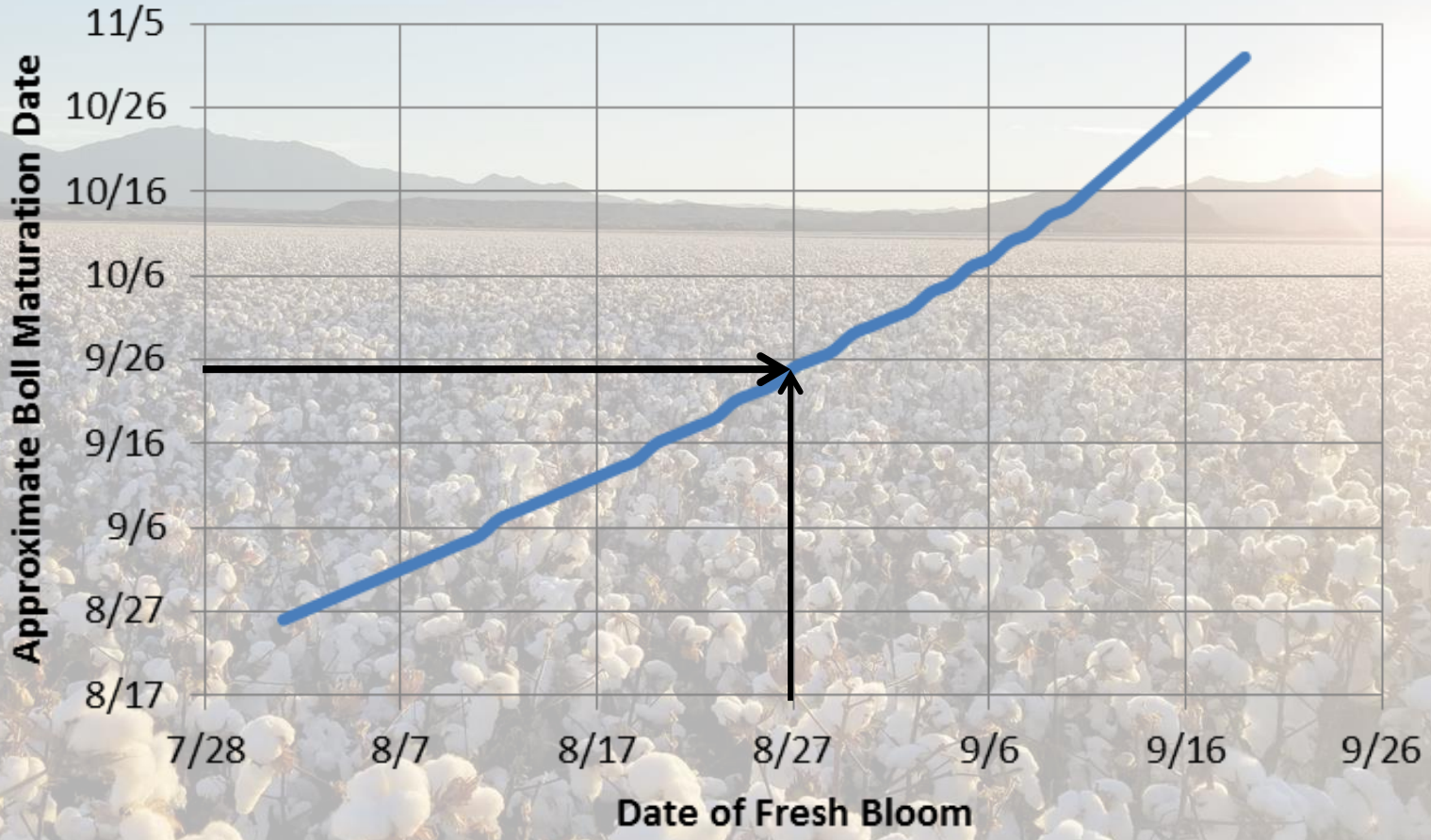
Boll Maturation Data



College of Agriculture and Life Sciences
Arizona Cooperative Extension

2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

Boll Maturation Data



2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

Scenario – cont.

- **Irrigation occurred on day of final flower identification – 8/27**
- **Water use for that period 8/27-9/25…**
  - **6.05” water**
  - **Average soil will hold 2” plant available water (PAW) per foot**
  - **x 3 foot effective rooting depth**
  - **= 6 inches of water holding capacity**
  - **Irrigate @ 50% PAW or 3” depleted**
  - **Average water use would deplete 3” in 12 days**
    - **Final Irrigation on 9/7**

2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu

Cotton Growth and Development

- **Tracking allows for more accurate estimation of crop status**
- **Improves efficiency of inputs**
  - **Using a crop feedback approach**
  - **Better informed management decisions**
- **Improve economic efficiency of operation**

2020 Randy Norton • 928.651.0420 • rnorton@arizona.edu