Tracking Cotton Growth and Development

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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
Recent PMN Presentation

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

Node 18

First Fruiting Branch (#6)

Reproductive Nodes (sympodial)

Vegetative Nodes (monopodial)

S = square
F = flower
B = boll

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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
HU Concept

![Graph showing temperature fluctuations over the day with upper and lower thresholds.]
HU Concept

Sine curve used to model daily temperature then perform mathematical integration to determine area under curve bound by upper and lower thresholds.
Annual HU Profile – Maricopa, AZ

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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
Crop Developmental Mileposts

<table>
<thead>
<tr>
<th>Time (HUAP)</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Planting</td>
</tr>
<tr>
<td>700</td>
<td>Pin head Square</td>
</tr>
<tr>
<td>900</td>
<td>Match head Square</td>
</tr>
<tr>
<td>1200</td>
<td>First Bloom</td>
</tr>
<tr>
<td>1500</td>
<td>Early Bloom</td>
</tr>
<tr>
<td>2000 - 2200</td>
<td>Peak Bloom</td>
</tr>
<tr>
<td>2600</td>
<td>Cut-Out</td>
</tr>
<tr>
<td>2800</td>
<td>Cut-Out</td>
</tr>
</tbody>
</table>
Crop Development - NAWF

- First Bloom: 9-11 NAWB
- Early Bloom: 8-9 NAWB
- Peak Bloom: 6-8 NAWB
- Cut-Out: ≤ 5 NAWB

<table>
<thead>
<tr>
<th>Blooms/Area</th>
<th>Pinhead Square</th>
<th>Match Head Square</th>
<th>First Bloom</th>
<th>Early Bloom</th>
<th>Peak Bloom</th>
<th>Cut-Out</th>
</tr>
</thead>
</table>

Time (HUAP)

0 700 900 1200 1500 2000 2400-2800

- Developing Square
- Fresh Bloom
- Developing Boll
Cotton Advisory

Heat Units Accumulated After Planting (HUAP)

- 15-MAY: 1197
- 1-MAY: 1382
- 15-APR: 1557
- 1-APR: 1695
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
Plant Diagram

S = square
F = flower
B = boll

First Fruiting Branch (#6)

Reproductive Nodes (sympodial)

Vegetative Nodes (monopodial)
**Height to Node Ratio**

The chart illustrates the relationship between height (inches) and node ratio for a plant, with the x-axis representing Heat Units Accumulated Since Planting (HUAP) and the y-axis representing Height (in)/Node Ratio.

- **S** = square
- **F** = flower
- **B** = boll

**First Fruiting Branch (#6)**

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

Example 18 nodes and 27 inches

\[ \frac{27}{18} = 1.5 \]
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
Identify upper-most 1st position fresh bloom
Count total number of nodes above to terminal
NAWF = 8
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 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 °F
    • L2 – CCT > 86 °F
2020 Crop Canopy Temperatures

Since 8 July:
24 Days L2
> 60%

Crop Canopy Temperature (°F)

2020 Crop Canopy Temperatures

2020 CROP CANOPY TEMPERATURE
Maricopa Ag Center

Since 8 July:
24 Days L2
> 60%
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
In-Field Observations
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*
End of Season Monitoring

• Use of HU to predict boll maturation
• Assist in timing of defoliation
• Assist in determining final irrigation
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
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.)
Boll Development and Maturation

- Fresh Bloom
- 600 HU
- Full sized Hard Green Boll
- 400 HU
- Open Boll
Normal HU Accumulations

Annual Cumulative HU
Daily HU Accumulation
Day of Year

1/1 2/5 3/11 4/15 5/20 6/24 7/29 9/2 10/7 11/11 12/16
Late Season Heat Units

![Graph showing daily heat unit accumulation and annual cumulative heat units over the course of the season. The graph includes data points for August 2, August 12, August 22, September 1, September 11, September 21, October 1, October 11, and October 21, with a steady decrease in daily accumulation and an increase in annual cumulative heat units.]
Boll Maturation Data

Approximate Boll Maturation Date

Date of Fresh Bloom

7/28 8/7 8/17 8/27 9/6 9/16 9/26

Boll maturation data is shown graphically, with dates of fresh bloom on the x-axis and approximate boll maturation dates on the y-axis. The graph indicates a trend where boll maturation dates increase as the date of fresh bloom advances.
Irrigation Termination

• Scenario
  • Crop planted on 4/20
  • Last flower identified for harvest on 8/27
  • On average should mature on 9/25
Boll Maturation Data
Boll Maturation Data

Approximate Boll Maturation Date

Date of Fresh Bloom

8/17  8/27  9/6  9/16  9/26

7/28  8/7  8/17  8/27

11/5  10/26  10/16  10/6  9/26  9/16  9/6
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
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