Managing Cotton in a Short Season Environment

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Overview of Cotton Growth and Development Requirements

- Heat unit accumulation or degree days with a base of 60°F

\[
\text{Max Temp} + \text{Min Temp} \div 2 - 60 = \text{Accumulated Heat Units/DD60s}
\]

- 20 – 25 per day June – August
- < 10 mid-September – end of season

- What two key factors are missing?
- High temp. max?

<table>
<thead>
<tr>
<th>Growth Stage</th>
<th>Days</th>
<th>Heat Units – DD60s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planting to Emergence</td>
<td>4 to 9</td>
<td>50 to 60</td>
</tr>
<tr>
<td>Emergence to First Square</td>
<td>28 to 45</td>
<td>425 to 475</td>
</tr>
<tr>
<td>Square to Flower</td>
<td>20 to 25</td>
<td>300 to 350</td>
</tr>
<tr>
<td>Planting to First Flower</td>
<td>60 to 70</td>
<td>775 to 850</td>
</tr>
<tr>
<td>Flower to Open Boll</td>
<td>45 to 65</td>
<td>850 to 950</td>
</tr>
<tr>
<td>Planting to Harvest Ready</td>
<td>130 to 160</td>
<td>2200 to 2600</td>
</tr>
</tbody>
</table>
Amarillo, TX Heat Unit Accumulation

- **2007 - 2019**
- **2019**
- **2016**

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>May</td>
<td>200</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Jun</td>
<td>500</td>
<td>400</td>
<td>600</td>
</tr>
<tr>
<td>Jul</td>
<td>500</td>
<td>600</td>
<td>700</td>
</tr>
<tr>
<td>Aug</td>
<td>500</td>
<td>600</td>
<td>500</td>
</tr>
<tr>
<td>Sep</td>
<td>300</td>
<td>400</td>
<td>300</td>
</tr>
<tr>
<td>Oct</td>
<td>100</td>
<td>50</td>
<td>200</td>
</tr>
</tbody>
</table>
Emergence: 50 to 60
First Square: 425 to 475
First Flower: 775 to 850
Flower to Open Boll: 850 to 950
Fruit Retention is Critical!
Defining “Short Season” Beyond Heat Units

• Early Frost? Cool Spring?

• Planting – Emergence – Squaring
  • Initiating reproductive growth

• Timeline for effective blooming
  • Amount of time crop spends during window of productive flowering; i.e. flowers that will produce harvestable bolls
Defining “Effective Blooming”

- “Flowering by the 4th of July”

- Function of heat units, environmental conditions, management, variety, stress, etc.

- Only can speed the process up so much, plant can only progress so much in a day

| Planting to First Flower | 55 to 70 | 775 to 850 |

![Bar chart showing Lint Yield with three bars: A, B, and C.]

![Bar chart showing Heat Unit Accumulation with three bars: 12-May, 31-May, 9-Jun.]

- DD60's Prior to Bloom
- DD60's Bloom to Harvest
Considerations for Flowering

- Takes on avg. 60 days from planting to first flower, then we can use a desired first flower date to target range of planting dates
  - Easier for irrigated cotton than dryland

- Also need to know last effective bloom date to determine flowering duration
  - If I want to productively flower for 5 weeks and my last effective bloom date is Aug. 15th, then I need to be planting ~May 5th – 15th

- Helps give us an idea of how our crop calendar should look and early season management needs to reach squaring “on time”.
Last Effective Bloom Date

• Last calendar day that we can expect a white flower to form a harvestable boll (not necessarily of the highest quality).

• Days needed to accumulate minimum heat units to go from white flower to open boll, prior to killing freeze (sub-30)

• Goodwell 2009 – 2019 average last effective bloom date:
  • **August 6**\(^{th}\)
  • Range:
  • **July 24**\(^{th}\) – **Aug. 15**\(^{th}\)

• Amarillo 2007 – 2019 average last effective bloom date:
  • **August 8**\(^{th}\)
  • Range:
  • **July 25**\(^{th}\) – **Aug. 15**\(^{th}\)
Managing for Earliness

• Fertility
Cotton Fertility in a Short Season Environment

• Meeting crop demand is key, must avoid deficiencies which result in stress, fruit shed, delayed maturity, and reduced yield

• **Timeliness** – regardless of nutrient must stay ahead of demand curve and understand crop nutrient uptake and use.

• If deficiency symptoms have not been observed, what is the need for N or P at peak bloom? Even if symptoms are observed, what’s the ROI for applications that late?
Cotton Fertility in a Short Season Environment

- Stay ahead of demand curve for efficient use of nutrients and $, and to avoid excess which can reduce yield and quality

- One of the only crops which can have a negative response to N

- Many nutrients are taken up early and reallocated when demand increases to developing fruit; large applications of any nutrient after first week of bloom should be avoided.

Figure 1. The growth and development of the cotton plant follows a typical sigmoid curve. This curve is representative of nutrient and water demands during the season (NCC, 1996).
Managing for Earliness

- Variety Selection
- Fertility
Variety Selection in a Short Season Environment

- Under the same conditions and management, large differences in growth and maturity are rare
  - Percent open, although exaggerated, critical parameter for short season production.

- To mitigate risk, typically stick with early-mid to early for irrigated, mid to mid-late for dryland
  - Differences in growth habit make later maturing varieties more suitable to handle stress than earlier maturities.
Variety Selection in a Short Season Environment

• Management can trump maturity class characteristics.

• Early season stress can delay fruiting/flowering, early maturing variety will likely have shorter window in which to respond

• Favorable conditions can allow late maturing variety to fruit up faster, although late season growth potential can lead to rank growth, fruit shed, and potential disease issues

• Match variety selection to management style, understand conditions when viewing variety trial data, and other components of variety
  • Seedling vigor, Bt and herbicide trait packages, etc.
Managing for Earliness

- Pest Control
- Variety Selection
- Fertility
Pest Control in a Short Season Environment

• Thrips – early season vegetative feeding insects, can stunt growth and delay maturity
  • Seed treatments/in-furrow applications/overspray
  • Ensure control up to 4 – 5 leaf

• Weed control – tillage and/or herbicide application
  • Yellows + incorporation (tillage or irrigation/rainfall)
  • Burndown and/or residuals at plant
  • Early season competition
  • Season-long control is critical
Managing for Earliness

- Harvest Aids
- Pest Control
- Variety Selection
- Fertility
Harvest Aids in a Short Season Environment

• Numerous studies currently on-going for harvest aid timing regarding growth stage and freeze

• Timeliness is key – if you’re going to invest in harvest aids then allow them to work for you

• Applying a boll opener (hormonal product) in cool conditions with little to no heat unit accumulation forecasted isn’t the best use of the product.
  • Heat unit accumulation impacts hormonal boll openers just like the plant itself.
Preliminary Findings

• Harvest aid applications at early than recommended growth stages successful in boll opening and defoliation

• Applying defoliant and boll opener in favorable weather 4 days prior to killing freeze (21°) resulted in successful boll opening and leaf drop
  • Daytime highs of 72°, 81°, 89°, and 64° preceding freeze event
## Contribution to Lint Value by Fruiting Position ($/ac)

### 2\textsuperscript{nd} Harvest Event

**100% Open Bolls**

**FM 9180 B2F**

<table>
<thead>
<tr>
<th>Boll Location</th>
<th>Lint Yield (lb/ac)</th>
<th>Lint Value ($/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1\textsuperscript{st} Position</td>
<td>1343 (81%)</td>
<td>$768.36 (81%)</td>
</tr>
<tr>
<td>2\textsuperscript{nd} Position</td>
<td>188 (12%)</td>
<td>$107.91 (12%)</td>
</tr>
<tr>
<td>Vegetative</td>
<td>121 (7%)</td>
<td>$69.84 (7%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1652</strong></td>
<td><strong>$946.11</strong></td>
</tr>
</tbody>
</table>

\[ \text{Cotyledonary Node} \]

\[ \text{Main Stem Node #s} \]

\[ \text{Vegetative Branch} \]

\[ \text{All Vegetative Bolls Combined} \]

\[ Boman \text{ and Wanjura, unpublished} \]
Managing for Earliness

- Irrigation
- Harvest Aids
- Pest Control
- Variety Selection
- Fertility
Irrigation Management in a Short Season Environment

• Timeliness of supplemental irrigation is key to provide adequate water supply while avoiding excess

• Deficiencies – reduced above and below ground growth, reduction in fruiting sites, fruit retention, and yield

• Primed acclimation – early season challenge to promote root development
  • Not stress, stress is always bad

• Excess - rank growth, fruit shed, favorable for pathogens, reduced fiber quality
Irrigation Management in a Short Season Environment

• Current irrigation research for short season cotton – OPREC in Goodwell, OK with Dr. Jason Warren

• Irrigation scheduling for optimal yield and fiber quality while maximizing water use efficiency ($ per inch)

• Attempted to manipulate existing OK mesonet estimated ET and irrigation planner
Cotton Response to Irrigation

• Ensure adequate irrigation was supplied, particularly at squaring to ensure optimal fruit retention, while avoiding excess

• Previous research from across the Cotton Belt has focused on growth stage specific response

• Squaring: most sensitive (deficient = loss)
  • Fruit retention

• Flowering: highest demand (largest requirement)
Current Irrigation Research

• Identified that ET was likely being overestimated
• Cotton planted May 15\textsuperscript{th}; irrigation initiated on July 10\textsuperscript{th} (mid-squaring), terminated Sept. 6th

• Schedules utilized in 2019:
  • 90\% of ET
  • 63\% of ET
  • 36\% of ET
  • 90\% of ET during squaring, 63\% during flowering
  • 36\% of ET during squaring, 63\% during flowering
  • Seasonal rainfall = 11.5”
2019 "Lint Yields" Goodwell, OK

<table>
<thead>
<tr>
<th>Treatment</th>
<th>90% ET</th>
<th>63% ET</th>
<th>36% ET</th>
<th>90% SQ - 63% FL</th>
<th>36% SQ - 63% FL</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB</td>
<td>11.7&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BC</td>
<td>8.4&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>4.9&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>9.8&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>6.9&quot;</td>
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</table>
Managing for Earliness

• Irrigation
• Harvest Aids
• Pest Control
• Variety Selection
• Fertility
• Other inputs?
Managing Cotton in a Short Season Environment

• Getting the basics – fertility, variety selection, pest control, harvest aids, and irrigation – right will get you > 95% of the way there (of what we can control....)

• Other inputs such as plant growth regulators (PGRs) can aid when weather presents excess of water or favorable growth conditions at the wrong time

• Understanding what PGRs do and when to use them will help them become an effective and efficient tool
PGR Evaluation, Goodwell, OK 2019

• Evaluated 3 PGR application strategies across 6 varieties
  
• Generic mepiquat chloride
  
• Applied at early, mid, and late bloom.

• Non-treated control
  • Low – 4 oz, 8 oz, and 16 oz (28 oz total)
  • High – 8 oz, 16 oz, and 24 oz (48 oz total)
  • Rescue – 0 oz, 16 oz, 16 oz (32 oz total)

• Data collected September 4th
<table>
<thead>
<tr>
<th>Variety</th>
<th>Height</th>
<th>Nodes</th>
<th>NAWF</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY 210 W3FE</td>
<td>23.3 c</td>
<td>17.9</td>
<td>2.7</td>
</tr>
<tr>
<td>PHY 250 W3FE</td>
<td>23.8 c</td>
<td>17.6</td>
<td>2.8</td>
</tr>
<tr>
<td>PHY 320 W3FE</td>
<td>27.5 a</td>
<td>18.5</td>
<td>2.9</td>
</tr>
<tr>
<td>PHY 350 W3FE</td>
<td>27.8 a</td>
<td>18.4</td>
<td>2.8</td>
</tr>
<tr>
<td>PX2C14</td>
<td>26.4 b</td>
<td>18.4</td>
<td>2.9</td>
</tr>
<tr>
<td>PX3B07</td>
<td>25.7 b</td>
<td>18.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Non-Treated</td>
<td>25.8 b</td>
<td>18.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Low (28 oz total)</td>
<td>25.3 b</td>
<td>18.1</td>
<td>2.8</td>
</tr>
<tr>
<td>High (48 oz total)</td>
<td>25.3 b</td>
<td>18.0</td>
<td>2.8</td>
</tr>
<tr>
<td>Rescue (32 oz total)</td>
<td>26.7 a</td>
<td>18.4</td>
<td>2.9</td>
</tr>
</tbody>
</table>
Factors to Consider

• Things we can control
  • Irrigation management – supplement rainfall and schedule based on crop need
  • Fertility – apply appropriate rates for realistic yield goal at appropriate timing
  • Variety selection – several varieties available that fit any environment
  • Variety placement – high fertility + high water availability vs. marginal fertility and water availability
  • Pests – weeds, insects, and pathogens/nematodes
  • Fiber Quality? Sound management and variety selection will address the fiber quality issues that we can control

• Things we can’t control
  • Environment – temperature, sunlight, and rain
Thank You

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