Fiber Quality and Defoliation

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University of Tennessee
Jackson, TN
Today’s objective
Concisely cover 1) fiber development, 2) fiber quality, 3) how properly defoliating can impact your price per pound.
Why is fiber quality important?
Table 4. Percentage sum of squares explained by genotype and environment for lint yield, lint percentage, micronaire, length, strength and uniformity. Sum of squares were calculated for each parameter by ANOVA of three cultivars across 85 site-years and three cultivars across 69 site-years.

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<th>Source</th>
<th>Lint yield</th>
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<th>Micronaire</th>
<th>Length</th>
<th>Strength</th>
<th>Uniformity</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>%</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Environment</td>
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<td>90.7</td>
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<td>47</td>
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<td>Genotype</td>
<td>1.3</td>
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<td>18</td>
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<td>DP 1522 B2XF, PHY 312 WRF, and ST 4946 GLB2 across 85 yield environments</td>
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<tr>
<td>Environment</td>
<td>85.8 (1.2)†</td>
<td>88.5 (2.2)</td>
<td>70.9 (-1.2)</td>
<td>70.5 (-0.8)</td>
<td>47.9 (-0.9)</td>
<td>70.4 (-0.3)</td>
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<tr>
<td>Genotype</td>
<td>1.9 (-0.6)</td>
<td>4 (-0.7)</td>
<td>16.8 (1.2)</td>
<td>12 (1.3)</td>
<td>22.5 (1.3)</td>
<td>2.6 (0.2)</td>
</tr>
</tbody>
</table>

† Numbers in parentheses represent the change of percentage sum of squares from the 85-environment dataset to the 69-environment dataset.
Where does the fiber originate?


Wendel Labs, Iowa State University: http://www.eeob.iastate.edu/faculty/WendelJ/comparativeevol.htm
Cotton Fiber is... 

- A seed hair
- Composed of a single, hyper-elongated cell  
  - Expands to over 25,000 times its original size
- Influenced by all environmental parameters during development
- 99% Cellulose
- One of 12,000-18,000 fibers on each seed coat

Cotton Incorporated:
How does the fiber form?

- Beginning at flowering, fibers begin to elongate.
- During this period, the primary wall must form very quickly.
- 15-20 days after flower, the secondary wall begins to form.
- Elongation continues until the secondary wall is formed at the fiber tip (typically 20-25 days after flower).
- Secondary wall formation continues until the seed reaches maturity and the boll opens.

How does the fiber form?

• After the boll opens, water evaporates from the lumen and causes the fiber to collapse on itself.

• The maturity of the fiber influences the ability of the fiber to fold and twist.

• These properties (the empty lumen, folds and twists) allow the fiber to take dye and influence its’ spinning properties.

http://www.swicofil.com/products/001cotton.html
What is ‘excellent’ fiber quality?

“as white as snow, as long as wool, as strong as steel, and as fine as silk”

Supima is extraordinarily rare and soft, making up less than 1% of the world's cotton. Extra long, fine fibers create a softer, smoother surface that holds vibrant colors for longer, ensuring premium quality and a surprisingly long lifespan with double the strength and durability of regular cotton.

TRUE LUXURY
Turn your bedroom into a tranquil oasis with exceptionally soft, 100% American-grown Supima® cotton.

HOTEL COLLECTION BEDDING
How is quality measured?

• USDA Classing Offices located throughout the cotton belt classify cotton.
• A sample from each bale is removed and sent to the classing office.
• The classing office processes the samples on an high volume instrument (HVI)

What parameters are measured?

- Length
- Length Uniformity Index
- Strength
- Micronaire
- Color
- Trash/Leaf

http://www.cottoninc.com/fiber/quality/Classification-Of-Cotton/Overview/
Length

• What is it?
  • Average length of the longer half of the fibers
  • OR Upper-half mean length
  • Reported in 100ths and 32nds of an inch

• What influences length?
  • Mainly cultivar, although extreme environmental stress can impact
  • Excessive cleaning and or drying at gin can shorten

• Why is length important?
  • Impacts yarn strength, evenness, fineness, and efficiency of spinning process

<table>
<thead>
<tr>
<th>Inches</th>
<th>32nds</th>
<th>Inches</th>
<th>32nds</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.79 &amp; shorter</td>
<td>24</td>
<td>1.11–1.13</td>
<td>36</td>
</tr>
<tr>
<td>0.80–0.85</td>
<td>26</td>
<td>1.14–1.17</td>
<td>37</td>
</tr>
<tr>
<td>0.86–0.89</td>
<td>28</td>
<td>1.18–1.20</td>
<td>38</td>
</tr>
<tr>
<td>0.90–0.92</td>
<td>29</td>
<td>1.21–1.23</td>
<td>39</td>
</tr>
<tr>
<td>0.93–0.95</td>
<td>30</td>
<td>1.24–1.26</td>
<td>40</td>
</tr>
<tr>
<td>0.96–0.98</td>
<td>31</td>
<td>1.27–1.29</td>
<td>41</td>
</tr>
<tr>
<td>0.99–1.01</td>
<td>32</td>
<td>1.30–1.32</td>
<td>42</td>
</tr>
<tr>
<td>1.02–1.04</td>
<td>33</td>
<td>1.33–1.35</td>
<td>43</td>
</tr>
<tr>
<td>1.05–1.07</td>
<td>34</td>
<td>1.36 &amp; longer</td>
<td>44 &amp; longer</td>
</tr>
<tr>
<td>1.08–1.10</td>
<td>35</td>
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Length Uniformity Index

• What is it?
  • Ratio between the mean length and upper half mean length of fibers as a percentage
  • If all fibers were exactly the same length, uniformity would = 100%

• What influences uniformity?
  • Mainly environment

• Why is uniformity important?
  • Affects yarn evenness, strength, and efficiency of spinning.
  • Indication of short fiber content- if low uniformity, good chance there is a high percentage of short fibers.

<table>
<thead>
<tr>
<th>Description of degree of uniformity</th>
<th>Length uniformity index (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high</td>
<td>above 85</td>
</tr>
<tr>
<td>High</td>
<td>83–85</td>
</tr>
<tr>
<td>Intermediate</td>
<td>80–82</td>
</tr>
<tr>
<td>Low</td>
<td>77–79</td>
</tr>
<tr>
<td>Very Low</td>
<td>below 77</td>
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</table>
Strength

• What is it?
  • Grams per tex
    • Tex=weight in grams of 1,000 meters of fiber

• What influences strength?
  • Mainly cultivar, although extreme environmental stress can impact

• Why is strength important?
  • Closely correlated to yarn strength, more likely to withstand breakage during manufacturing processes

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<td>Very Strong</td>
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<td>Strong</td>
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<td>Weak</td>
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Measurement of Length, Uniformity and Strength
Micronaire

• What is it?
  • Measure of fiber fineness AND maturity
  • Determined by measuring air permeability of a constant mass of fibers compressed to a fixed volume

• What influences micronaire?
  • Almost an even split between cultivar and environment
  • Fruiting gaps or periods of heat/drought stress can cause high mic
  • Low mic typically caused by short-season

• Why is micronaire important?
  • Fine, mature fibers result in stronger yarns
  • Thick, over-mature fibers do not dye or process well
  • Immature fibers require slower processing speeds to prevent damage to fibers
Measurement of Micronaire
Color

• What is it?
  • Degree of reflectance (Rd) and yellowness (+b) determined by HVI
    • Reflectance measures brightness or dullness
    • Yellowness measures degree of pigmentation

• What influences color?
  • Rainfall, freezes, insects, fungi, staining (leaf, soil, grass), excessive moisture while in module or bale

• Why is color important?
  • Bright, white fibers can be manipulated downstream very easily.
  • Dull, yellow fibers do not hold dyes or finishes well
Trash/Leaf/Extraneous

• What is it?
  • Measure of leaf and other material in the fiber
  • Trash percent area and particle count
    Leaf from HVI

• What influences these materials in cotton?
  • Variety, harvest procedures, ginning, preparation

• Why is trash important?
  • It must be removed before the manufacturing process
  • Very small particles often remain in the fiber if present after the ginning process and can detract from the quality of the finished product
Measurement of Color and Trash
How does poor defoliation impact:

• **Length**
  • Decreased if excessive lint cleaning is required (excessive trash)

• **Length Uniformity Index**
  • Decreased if excessive lint cleaning is required (excessive trash)

• **Strength**
  • Decreased if defoliation improperly timed (immature fibers)

• **Micronaire**
  • Can be in discount (high or low) if defoliation improperly timed

• **Color**
  • Decrease if allowed to weather
  • Decrease if green leaves are not removed
  • Decreased if picked when too wet

• **Trash/Leaf**
  • Obvious- decrease if leaves desiccated on plant or not removed (left green) and are pulled into module/basket
Putting it together

• Properly time on plant and picker
  • Plant: hit premium micronaire by stopping secondary wall development in fiber
  • Picker: minimize weathering of lint/potential for regrowth; protect color and reduce potential for stringout/fallout

• Select proper rates and products based on plant and forecast
  • Only aggressive enough to make abscission layer form
  • Reduce leaf, trash; protect length, uniformity and turnout
Table 4. Percentage sum of squares explained by genotype and environment for lint yield, lint percentage, micronaire, length, strength and uniformity. Sum of squares were calculated for each parameter by ANOVA of three cultivars across 85 site-years and three cultivars across 69 site-years.

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Table 5. Percentage sum of squares explained by genotype and environment for lint yield, lint percentage, micronaire, length, strength, and uniformity. Sum of squares were calculated for each parameter by ANOVA of four cultivars across 69 site-years and every combination of three cultivars across 69 site-years.

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<td>47.5</td>
<td>39.1</td>
<td>46.6</td>
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<tr>
<td>Genotype</td>
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Take Home

• Fiber quality is simple; we want white, uniform, long, strong, properly matured fibers

• Variety selection and environmental conditions play very important roles in realized fiber quality

• Proper defoliation can significantly increase returns through impacts on fiber quality
Additional reading

• The Classification of Cotton. Cotton Incorporated.  
  http://www.cottoninc.com/fiber/quality/Classification-Of-
  Cotton/Classing-booklet.pdf

• Quality of Cotton Classed by Classing Office. USDA-Agricultural 
  Marketing Service.  
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