Genotypic and Growing Year Differences in Yarn Qualities from Cotton Grown in Large-Plot, On-Farm Trials

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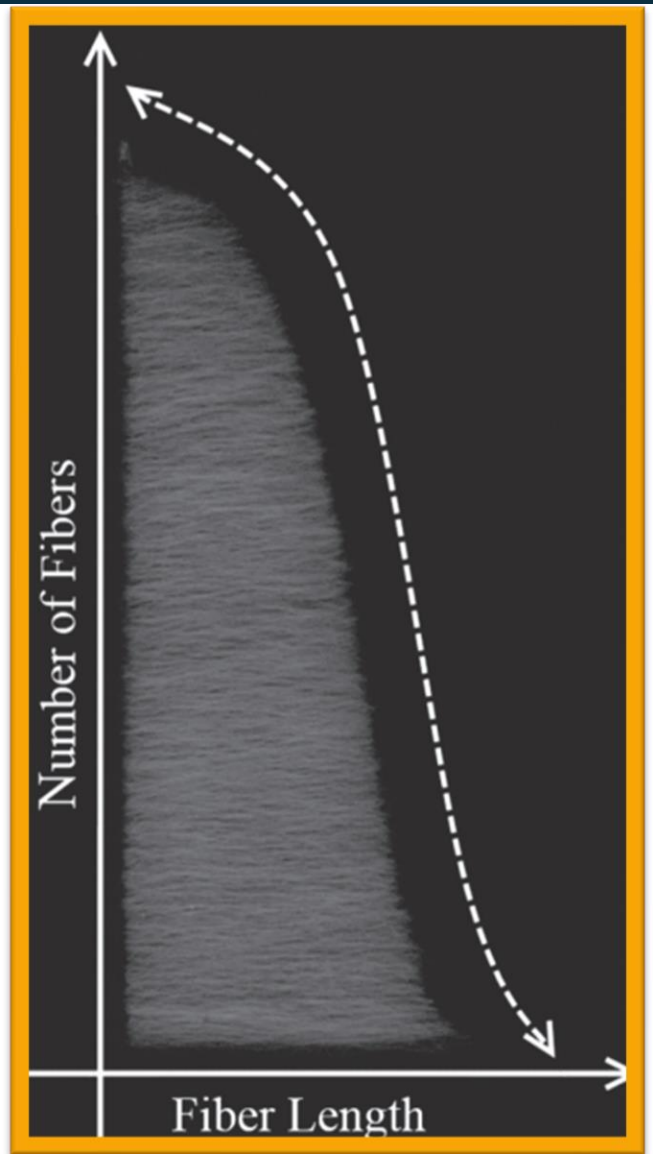
Introduction

- Fiber quality measurements are only able to capture a portion of variation in a sample
- Fiber quality is used to estimate yarn quality
- Spinning is mechanically intensive
- **Objective: Develop spinning protocols to improve the use of spinning trials in varietal evaluations**

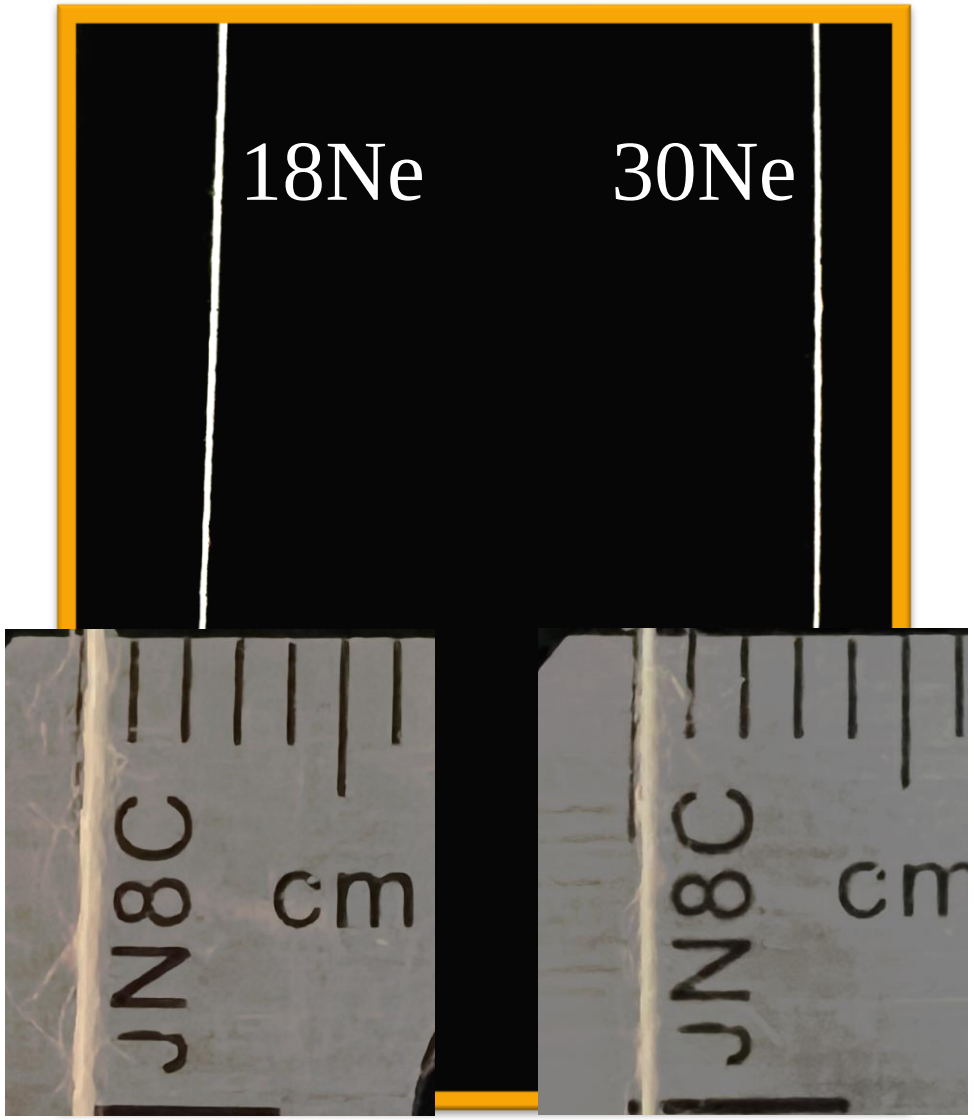


Introduction – Fiber Quality

- Fibers with a long length and high strength can endure faster manufacturing speeds
- Fibers that are immature and weak are prone to breakage during ring spinning
- Contaminants can lead to ends down

Materials & Methods – Yarn Spinning

- Two yarn counts were selected to represent regional markets
  - 18Ne is a coarser yarn that represents a traditional market for the area
  - 30Ne is a finer yarn and a more aspirational market where mills are willing to pay a premium for the fiber
- Two twist levels were selected
  - 3.64 - LOW
  - 4.00 - HIGH



Materials & Methods – Fiber & Yarn Quality

- Fiber quality from High Volume Instrument (HVI)
  - Length
  - Strength
  - Micronaire
  - Color
  - Trash
- Yarn quality from Statimat and Uster Tester 5
  - Tenacity (cM/Tex)
  - Work to Break (cNcm)
  - Elongation (%)
  - Imperfections per Inch

Materials & Methods -- Analysis

- ANOVA to determine differences in fiber and yarn quality of samples to assess variation and argue the need for a field check
  - Significant differences shown with Tukey's HSD
- Change (%) of yarn qualities between years for DP1820B3XF, NG3930B3XF, and ST4993B3XF.

Materials & Methods -- Samples

Location	Year	Total Samples	18Ne Low	18Ne High	30Ne Low	30Ne High
Floyd	2021	8	7	8	4	8
Hale TAMU	2021	10	10	10	6	10
Lubbock TAMU	2021	8	8	8	3	8
Lubbock Glover TAMU	2021	8	8	8	3	8
2021 Total	2021	34	33	34	16	34
Dawson TAMU	2022	8	8	8	6	8
Hale TAMU	2022	8	8	8	8	8
Lamb	2022	8	8	8	8	8
Lubbock TAMU	2022	8	3	8	0	4
2022 Total	2022	32	27	32	22	28
Hale	2023	9	9	9	9	9
Lubbock	2023	6	1	6	0	5
2023 Total	2023	15	10	15	9	14
TOTAL		81	70	81	47	76

Results – HVI Averages by Year

	2021		2022		2023	
Micronaire	3.4	C	3.9	B	4.9	A
Length (mm)	27.2	B	29.5	A	27.9	B
Uniformity (%)	78.6	B	80.9	A	80.8	A
Strength (gtex)	28.2	B	30.0	A	28.6	B
Reflectance	80.8	A	77.9	B	78.6	B
Yellowness	9.3	A	8.9	B	8.7	B

Premium Discount Base

Results – 18Ne

Low Twist

Yarn Quality	2021		2022		2023	
Tenacity (cN/Tex)	13.5	B	**14.5**	A	13.3	AB
Work to Break (cNcm)	695.9	B	**781.4**	A	694.7	AB
Elongation (%)	5.6	A	**6.0**	A	5.9	A
Imperfections per In	**135.6**	A	123.2	A	102.4	A

High Twist

Yarn Quality	2021		2022		2023	
Tenacity (cN/Tex)	**15.5**	A	15.4	A	14.7	A
Work to Break (cNcm)	873.1	A	859.7	A	**786.0**	A
Elongation (%)	**6.3**	A	**6.3**	A	6.1	A
Imperfections per In	**352.0**	A	394.1	A	385.4	A

Tenacity: Strength adjusted for amount of material
Work to break: How much force is needed to break the yarn
Elongation: How far can the yarn stretch and still return to its original shape
Imperfections per Inch: Thin places, thick places, and other defects in the yarn

Results – 30Ne

Low Twist

Yarn Quality	2021		2022		2023	
Tenacity (cN/Tex)	12.8	B	**14.1**	A	12.7	B
Work to Break (cNcm)	379.7	B	**431.9**	A	369.5	B
Elongation (%)	5.3	A	**5.6**	A	5.3	A
Imperfections per In	315.8	A	276.8	A	**214.0**	B

High Twist

Yarn Quality	2021		2022		2023	
Tenacity (cN/Tex)	14.4	AB	**15.0**	A	13.9	B
Work to Break (cNcm)	453.2	AB	**473.0**	A	419.7	B
Elongation (%)	5.8	B	**5.9**	B	7.5	A
Imperfections per In	2429.9	A	2141.1	AB	**1839.9**	B

Tenacity: Strength adjusted for amount of material
Work to break: How much force is needed to break the yarn
Elongation: How far can the yarn stretch and still return to its original shape
Imperfections per Inch: Thin places, thick places, and other defects in the yarn

Results – DP 1820 B3XF

			Tenacity (cM/Tex)				Elongation (%)				Imperfections per Inch			
Year	County	Irri?	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High
2021	**Hale**	**Irri**	15.4	17.1	14.0	16.0	5.6	6.0	5.0	**5.6**	**61.5**	81.5	81.5	580.3
2022	**Hale**	**Irri**	**16.7**	**18.1**	**16.0**	**16.8**	**5.8**	**6.4**	**5.4**	**5.6**	88.1	**72.8**	**72.8**	574.5
2023	**Hale**	**Irri**	14.0	16.1	13.3	15.9	5.7	5.2	5.0	6.1	86.4	85.0	479.6	**540.0**
2023	**Lubb.**	**Irri**												

Premium Discount Base Did Not Spin

Results – DP 1820 B3XF

			Tenacity (cM/Tex)				Elongation (%)				Imperfections per Inch			
Year	County	Irri?	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High
2021	**Hale**	**Irri**	15.4	17.1	14.0	16.0	5.6	6.0	5.0	5.6	61.5	81.5	81.5	580.3
2022	**Hale**	**Irri**	16.7	18.1	16.0	16.8	5.8	6.4	5.4	5.6	88.1	72.8	72.8	574.5
2023	**Hale**	**Irri**	14.0	16.1	13.3	15.9	5.7	5.2	5.0	6.1	86.4	85.0	479.6	540.0
2023	**Lubb.**	**Irri**												

Uniformity Discount, MIC and Length Base, Strength Premium

Premium Discount Base Did Not Spin

Results – DP 1820 B3XF
Change (%) Between Years

		Tenacity (cM/Tex)				Elongation (%)				Imperfections per Inch			
	Years	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High
Change %	2021&2022	8.4	5.8	14.3	5.0	**3.6**	6.7	**8.0**	0.0	**43.3**	10.7	10.7	1.0
	2021&2023	9.1	5.8	5.0	0.6	1.8	13.3	0.0	**8.9**	40.5	4.3	488.5	**6.9**
	2022&2023	**16.2**	**11.0**	**16.9**	**5.4**	1.7	**18.8**	7.4	**8.9**	1.9	**16.8**	**558.8**	6.0

Results – NG 3930 B3XF

			Tenacity (cM/Tex)				Elongation (%)				Imperfections per Inch			
Year	County	Irri?	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High
2021	**Floyd**	**Dry**	12.7	14.1	11.4	13.5	5.7	6.0	5.1	5.6	139.3	158.3	994.5	1091.3
2021	**Hale**	**Irri**	13.3	**15.7**		14.0	5.9	6.6		5.8	116.3	124.5		919.0
2021	**Lubb.**	**Dry**	13.6	15.1	12.5	14.1	5.8	6.4	5.2	5.9	152.8	135.0	942.0	964.8
2021	**Lubb.**	**Dry**	13.2	15.5	12.6	14.1	5.7	6.5	5.6	6.0	159.5	143.8	899.0	1056.8
2022	**Daw.**	**Dry**	12.6	14.4	12.1	13.5	5.5	6.2	5.2	5.5	115.4	106.1	632.9	837.6
2022	**Hale**	**Irri**	14.0	**15.7**	**13.5**	14.2	6.0	6.7	5.7	5.9	108.2	95.0	788.2	906.1
2022	**Lamb**	**Dry**	**14.1**	15.5	13.3	**14.5**	**6.5**	**6.9**	**5.8**	6.2	123.2	131.3	877.9	964.7
2022	**Lubb.**	**Dry**	10.1	11.7			4.8	5.2			309.4	286.2		
2023	**Hale**	**Irri**	13.1	15.07	12.8	13.98	5.4	6.1	5.1	**6.6**	**70.7**	**76.0**	**538.2**	**499.0**
2023	**Lubb.**	**Irri**												

Premium Discount Base Did Not Spin

Brooks NG 2930 B3XF

MIC and Uniformity Discount, Length Premium, Strength Base

			Tenacity (cM/Tex)				Elongation (%)				Imperfections per Inch			
Year	County	Irri?	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High
2021	Floyd	Dry	12.7	14.1	11.4	13.5	5.7	6.0	5.1	5.6	139.3	158.3	994.5	1091.3
2021	Hale	Irri	13.3	15.7		14.0	5.9	6.56		5.8	116.3	124.5		919.0
2021	Lubb.	Dry	13.6	15.1	12.5	14.1	5.8	6.4	5.2	5.9	152.8	135.0	942.0	964.8
2021	Lubb.	Dry								6.0	159.5	143.8	899.0	1056.8
2022	Daw.	Dry								5.5	115.4	106.1	632.9	837.6
2022	Hale	Irri	14.0	15.7	13.5	14.2	6.0	6.7	5.7	5.9	108.2	95.0	788.2	906.1
2022	Lamb	Dry	14.1	15.5	13.3	14.5	6.5	6.9	5.8	6.2	123.2	131.3	877.9	964.7
2022	Lubb.	Dry	10.1	11.7			4.8	5.2			309.4	286.2		
2023	Hale	Irri	13.1	15.07	12.8	13.98	5.4	6.10	5.1	6.61	70.7	76	538.2	499
2023	Lubb.	Irri												

Mic Premium, Uniformity Discount, Length and Strength Base

Premium Discount Base Did Not Spin

Results – NG 3930 B3XF
Change (%) Between Years

		Tenacity (cM/Tex)				Elongation (%)				Imperfections per Inch			
	Years	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High
Change %	2021&2022	**3.8**	5.1	**6.6**	**1.0**	1.3	2.0	5.0	0.7	15.5	10.1	18.9	10.4
	2021&2023	0.8	0.2	5.2	0.4	**6.5**	**4.3**	3.8	**13.3**	50.2	45.9	**43.1**	**50.5**
	2022&2023	3.1	**5.2**	1.3	0.6	5.3	2.4	**8.4**	12.5	**56.9**	**50.9**	29.8	44.7

Results – ST 4993 B3XF

			Tenacity (cM/Tex)				Elongation (%)				Imperfections per Inch			
Year	County	Irri?	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High
2021	Hale	Irri	13.17	15.37	12.62	14.40	6.04	6.93	5.92	6.38	93.75	91.5	591.25	685.75
2022	Daw.	Dry	12.78	14.68		13.75	6.06	6.72		6.11	78.8	78.0		585.0
2022	Hale	Irri	14.17	15.66	13.07	14.49	6.51	7.03	5.91	6.24	106.6	101.8	853.6	763.4
2022	Lamb	Dry	14.60	16.31	13.62	15.03	6.83	7.59	6.27	6.84	74	69.9	556.9	479.1
2022	Lubb.	Dry		11.92		12.92		5.59		5.34		255.8		1484
2023	Hale	Irri	12.33	14.24	11.89	13.21	5.58	5.87	5.78	7.50	76.5	76.0	527.9	581.0
2023	Lubb.	Irri												

Tenacity: Strength adjusted for amount of material

Elongation: How far can the yarn stretch and still return to its original shape

Imperfections per Inch: Thin places, thick places, and other defects in the yarn

Premium

Discount

Base

Did Not Spin

Results – ST 4993 B3XF

			Tenacity (cM/Tex)				Elongation (%)				Imperfections per Inch			
Year	County	Irri	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High
2021	Hale	Irri	13.17	15.37	12.62	14.40	6.04	6.93	5.92	6.38	93.75	91.5	591.25	685.75
2022	Daw.	Dry	12.78	14.68		13.75	6.06	6.72		6.11	78.8	78.0		585.0
2022	Hale	Irri											853.6	763.4
2022	Lamb	Dry											556.9	479.1
2022	Lubb.	Dry		11.92		12.92		5.59		5.34		255.8		1484
2023	Hale	Irri	12.33	14.24	11.89	13.21	5.58	5.87	5.78	7.50	76.5	76.0	527.9	581.0
2023	Lubb.	Irri												

ALL Premium

MIC Premium, Uniformity Discount, Length and Strength Base

Tenacity: Strength adjusted for amount of material

Elongation: How far can the yarn stretch and still return to its original shape

Imperfections per Inch: Thin places, thick places, and other defects in the yarn

Premium

Discount

Base

Did Not Spin

Results – ST 4993 B3XF
Change (%) Between Years

		Tenacity (cM/Tex)				Elongation (%)				Imperfections per Inch			
	Years	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High	18Ne Low	18Ne High	30Ne Low	30Ne High
Change %	2021&2022	5.2	4.7	5.7	2.4	7.1	2.8	2.9	3.9	7.8	38.1	19.3	20.7
	2021&2023	6.4	**7.4**	5.8	**8.3**	7.6	**15.3**	2.4	17.6	**18.4**	16.9	10.7	15.3
	2022&2023	**11.0**	2.7	**10.9**	6.0	**13.7**	12.8	5.1	**22.3**	11.5	**39.9**	**25.1**	**29.8**

Conclusions

- Changes in year have significant impacts on fiber quality parameters the HVI as well as different sizes and twists of ring spun yarn
- There are differences in yarn quality of varieties between years
- This study provides the opportunity to determine what is missing from fiber quality measurements to more reliably predict yarn quality

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