THE POSITIVE EFFECT OF HIGH MICRONAIRE ON SPINNINGPERFORMANCE OF TWO CALIFORNIA ACALA VARIETIES

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Abstract

Phytogen 33 and El Dorado are two Acala varieties that have been developed for the San Joaquin Valley of California. Data are presented that show these two varieties to have relatively higher micronaire than the SJV fiber quality standard (Maxxa) resulting from a higher fiber maturity. The data also show Phytogen 33 and El Dorado to have smaller fiber perimeters and lower or equal linear densities (fineness) than Maxxa even when the micronaire is 0.4 - 0.5 higher. Spinning into carded and combed Ne50's count yarn shows that these two varieties produce yarns that have equal or better strength characteristics and lower levels of imperfections. It is concluded that high micronaire in these two varieties does not predict coarseness and poor spinning performance. It is also shown that an excellent quality Ne50's count yarn can be spun from Phytogen 33 or El Dorado fiber with a 4.9 or 4.7 micronaire, respectively.

Introduction

Over the last several years we have been analyzing the fiber and yarn characteristics of several varieties with high micronaire (Pellow et. al., 1993; Pellow et. al., 1994; Palmer et. al., 1996; Cooper et. al., 1996; Pellow et. al., 1996). At the 1996 Beltwide Cotton Conferences we presented information on the San Joaquin Valley variety El Dorado Acala (Palmer et. al., 1996; Cooper et. al., 1996; Pellow et. al., 1996). This variety has the unusual characteristics of a relatively high micronaire resulting from a high fiber maturity and thick cell wall along with a smaller perimeter and linear density. Therefore, the spinning performance is not compromised by the high micronaire while the yarn uniformity and defect levels are much reduced. This type of fiber with high maturity and low fineness resulting in a more cylindrical fiber rather than a ribbon-type fiber, was also found by Cooper, (Cooper et. al., 1988). We are reporting here on another Acala variety, Phytogen 33 Acala, with similar characteristics. One of the major problems with the commercialization of this type of fiber is the long held belief that high micronaire is a sign of coarseness and poor spinning performance. In the instances of these two varieties, this is not true. In this study we compare the three year averages for fiber and spinning qualities of Acala Maxxa, the San Joaquin Valley fiber quality standard, to Phytogen 33 and El Dorado Acalas which have relatively higher micronaire values. Also, we compare the fiber and spinning qualities of selected high micronaire bales of Phytogen 33 and El Dorado to that of Acala Maxxa having a micronaire in the middle of the premium range.

Methods and Materials

Acala Maxxa is used in this study for comparison because it is the fiber quality standard set by the San Joaquin Valley Cotton Board. All potential new varieties must be compared to the fiber quality standard for three years prior to being eligible for commercial release. Acala Maxxa was planted on approximately 70-80% of the cotton acreage in the San Joaquin Valley in 1996. Therefore, a comparison to Acala Maxxa is essentially a comparison to the majority of the San Joaquin Valley fiber.

Seed cotton samples were taken from a total of nine test plot locations in the San Joaquin Valley over three years. The tests were grown in a randomized complete block design with four replications. The plots were machine picked and the samples were ginned on a 40 saw commercial-type gin with three stages of precleaning, an air jet lint cleaner, and two saw-type lint cleaners. Lint subsamples from each of the four replications were taken for fiber testing at the H. B. Cooper Cotton Research Center (J. G. Boswell Company) and for arealometer testing at Starlab in Knoxville, TN. For spinning and yarn testing, additional lint subsamples were combined from two replications within each test thus resulting in two replications per test location. These subsamples were spun into carded and combed Ne50's count yarn at the International Textile Center in Lubbock, TX. The data from the fiber and yarn tests are presented in Tables 1 through 7 and represent average values obtained under many environmental and production regimes and also from multiple locations and years in the San Joaquin Valley.

The 1996 season in the San Joaquin Valley had a high heat unit accumulation which raised the average micronaire of the crop. For Phytogen 33 and El Dorado, a significant number of bales reached the top of the premium range and above. For the data in Tables 8 through 14, lint samples were taken from the J. G. Boswell Company 1996 bales. The bales were selected to have high micronaire values for Phytogen 33 and El Dorado and an average micronaire for Maxxa. The field locations from which the cotton was grown were in close proximity to each other on uniform Tulare Clay soil. Lint subsamples were tested using individual instruments at the H. B. Cooper Cotton Research Center, the arealometer at Starlab in Knoxville, TN, and spun into carded and combed Ne50's at The International Textile Center in Lubbock, TX.

Results

The average fiber properties obtained over three years of testing for Phytogen 33 and El Dorado are compared to Maxxa in Table 1. Phytogen 33 and El Dorado have

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significantly higher uniformity ratio, elongation, and micronaire. Phytogen 33 also has a significantly higher 2.5% span length than Maxxa while El Dorado has a higher tenacity. Both Phytogen 33 and El Dorado have a lower short fiber index than Maxxa. The basis for the high micronaire of Phytogen 33 and El Dorado was investigated by using the arealometer (Table 2). These data show that Phytogen 33 and El Dorado when compared to Maxxa have a significantly higher percent maturity and cell wall thickness and significantly lower perimeter or intrinsic fineness. The combination of these properties result in a linear density (weight-fineness, fineness) that is equivalent between Phytogen 33 and Maxxa and significantly lower for El Dorado. It is important to note that even though the micronaire of Phytogen 33 and El Dorado is higher than Maxxa, the fineness is equal to or lower than Maxxa.

Lint subsamples having the fiber properties described above were ring spun into carded and combed Ne50's count yarns. The data in Table 3 show that Phytogen 33 and El Dorado have significantly lower combing and total manufacturing waste than Maxxa. Table 4 shows that Phytogen 33 has a lower carded 50's single yarn tenacity and mean strength and a higher yarn elongation than Maxxa but has an equivalent skein strength. El Dorado Acala has a significantly higher tenacity, mean strength, elongation and skein strength. The comparison of the combed Ne50's yarn strength properties is similar to the carded Ne50's except that the skein strength of Maxxa is significantly higher than Phytogen 33 (Table 5). Defects in the carded and combed 50's yarns are compared in Tables 6 and 7 respectively. The trends among the three varieties are similar in both yarn types. The absolute differences among the varieties are greater and there are more significant differences in the carded yarns than in the combed yarns. Phytogen 33 and El Dorado have lower nonuniformity, thick and thin places than Maxxa. Nep levels are significantly lower for El Dorado than for Phytogen 33 and Maxxa in the carded yarns. There are no significant differences in nep levels in the combed yarns. When all quality factors are considered, Phytogen 33 produces a yarn that is intermediate in quality between the higher quality of El Dorado and that of Maxxa.

The same series of tests as described above was conducted for lint samples from bales harvested in 1996. The Phytogen 33 and El Dorado bales were selected to have relatively high micronaires (4.91 and 4.72 respectively) while the Maxxa bale was selected to have a micronaire closer to the middle of the premium range (4.42). The fiber properties as measured by individual instruments are listed in Table 8. The Phytogen 33 as compared to Maxxa had significantly greater 2.5% span length and micronaire. The uniformity ratio, tenacity and elongation were also higher for Phytogen 33 but the differences were not statistically significant. El Dorado, when compared to Maxxa, had a longer 2.5% span length, higher uniformity ratio, tenacity, elongation, and micronaire. All of these differences were statistically significant. The basis for the high micronaire of Phytogen 33 and El Dorado was investigated again with these samples by using the arealometer (Table 9). The results of testing the high micronaire bales were similar to the results in the three year average data. Phytogen 33 and El Dorado had significantly higher fiber maturity and cell wall thickness along with significantly smaller fiber perimeter and fineness (linear density) than Maxxa. As with the three year average data, the high micronaire of these selected bales was a result of high maturity and not coarseness. Differences in manufacturing waste among the varieties for the high micronaire bales was consistent with the over-years average data and showed that Phytogen 33 and El Dorado had significantly less combing waste than Maxxa (Table 10). Carded and combed 50's yarn strength data for the high micronaire bales are presented in Tables 11 and 12 respectively. There were no significant differences between Phytogen 33 and Maxxa for the carded yarns and only the yarn elongation was significantly higher for Phytogen 33 in the combed yarns. The comparison between El Dorado and Maxxa shows higher single yarn tenacity and mean strength for El Dorado with the differences for the carded yarn being significant. The yarn elongation and skein strength are significantly higher for El Dorado in both carded and combed yarns.

Differences among varieties for yarn defects in carded and combed Ne50's yarns are shown in Tables 13 and 14, respectively. Comparing Phytogen 33 and Maxxa, Phytogen 33 is lower in all measurements (nonuniformity CV%, thin and thick places, neps) however, the differences are not significant. In the combed yarns, Phytogen 33 is significantly lower in yarn defects in all measurements except neps. El Dorado also has lower yarn defect values than Maxxa in all measurements with the differences in thick places and neps being significant. As was seen with Phytogen 33, El Dorado has significantly lower combed yarn defects except for neps. Once again the data show that Phytogen 33 produces a yarn quality that is intermediate between the higher quality of El Dorado and that of Maxxa.

Discussion

El Dorado and Phytogen 33 are two Acala varieties released for production in the San Joaquin Valley in 1995 and 1996 respectively. These varieties have relatively higher micronaire values than Acala Maxxa which is the San Joaquin Valley fiber quality standard. Two similar sets of data have been presented comparing Phytogen 33 and El Dorado to Maxxa in an effort to determine the basis for the higher micronaire values and to investigate the effect on spinning quality. The first set of data is from averages of nine replicated test plots over three years. The second set of data is from 1996 bales where those of Phytogen 33 and El Dorado were selected for high micronaire and the Maxxa was selected to have a micronaire in the middle of the premium range. The arealometer data indicate that the high micronaire of Phytogen 33 and El Dorado results from high fiber maturity and a thick cell wall. This data also shows

that these two varieties have a smaller perimeter and a lower fineness (linear density) value. These relationships hold true even when comparing very high micronaire bales of these two varieties to the Maxxa bale with average micronaire. Therefore, the high micronaire of Phytogen 33 and El Dorado is not the result of coarseness and should not be used to predict poor spinning performance. This statement is substantiated by the spinning performance and yarn testing of Ne50's carded and combed yarns. Carded yarn strength factors are higher for Phytogen 33 than for Maxxa however, Maxxa produces a combed Ne50's yarn that is equal to or slightly stronger than Phytogen 33. It should be noted that Acala Maxxa has much more combing waste (short fiber) than Phytogen 33. Once this is removed, the yarn quality of Maxxa is greatly improved. This evokes the hypothesis that high fiber maturity, which produces a more cylindrical fiber as opposed to a more flattened fiber, is less susceptible to fiber damage in mechanical operations like picking, ginning, opening, carding, etc. More research on this topic could result in economic savings to the spinning mills. El Dorado produces a stronger combed yarn than either Phytogen 33 or Maxxa in part due to its higher fiber strength, elongation and length uniformity.

In addition to the yarn strength not being compromised by the high micronaire in these two varieties, the yarn quality is improved. Phytogen 33 and El Dorado have equal or improved nonuniformity, thin places, thick places, and neps. Many of these differences when compared to the San Joaquin Valley fiber quality standard are statistically significant improvements. Additionally, knitted samples from the high micronaire bales when dyed showed better dye uptake by Phytogen 33 and El Dorado (data not presented, samples available). Also, in a previous study, El Dorado had a lower frequency of white specks than Maxxa (Pellow et. al., 1996.).

The effects of high micronaire as shown here for Phytogen 33 Acala and El Dorado Acala may not be the same for all varieties. We show here that the high micronaire of Phytogen 33 and El Dorado is a consequence of high fiber maturity and that the fineness is still in the range of the high quality Acalas. Evaluations of fiber maturity, cell wall thickness and fineness are necessary to help predict the effects of the high micronaire of other varieties on spinning performance. As a result of our evaluations we have shown that it is possible to spin fiber from Phytogen 33 with a 4.9 micronaire or El Dorado with a 4.7 micronaire into a Ne50's carded or combed yarn and have the performance and quality equal to or better than the San Joaquin Valley Acala fiber quality standard having a premium range micronaire.

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Table 1. Fiber Properties: Three year average - 9 locations.

	Phytogen 33	Maxxa	El Dorado	LSD
2.5% Span Length	1.17 a	1.14 b	1.14 b	0.01
Uniformity Ratio	50.0 a	48.1 b	49.9 a	0.4
Short Fiber Index	1.3 a	2.7 a	0.8 a	2.9
Tenacity (Stelometer)	23.9 b	23.7 b	24.9 a	0.5
Elongation (Stelometer)	6.7 b	6.5 c	6.9 a	0.1
Micronaire	4.32 a	3.95 c	4.18 b	0.05

Table 2. Arealometer Properties: Two year average - 7 locations.

	Phytogen 33	Maxxa	El Dorado	LSD
Micronaire	4.18 a	3.79 c	4.02 b	0.08
Percent Maturity	88 a	80 b	90 a	2
Cell Wall Thickness	2.71 a	2.43 c	2.66 b	0.04
Perimeter	44.25 b	47.19 a	42.08 c	1.25
Weight-Fineness	3.73 a	3.71 a	3.44 b	0.11
Fineness(millitex)	147 a	146 a	135 b	4

Table 3. Manufacturing Waste: Three year average - 9 locations

	Phytogen 33	Maxxa	El Dorado	LSD
Opening and Carding	3.6 b	3.9 a	3.8 ab	0.2
Combing	12.7 b	15.4 a	13.1 b	0.5
Total	15.9 b	18.7 a	16.4 b	0.6

Table 4. Carded 50's Yarn and Skein Strength: Three year average - 9 locations

	Phytogen 33	Maxxa	El Dorado	LSD
Tenacity	16.82 c	17.23 b	18.20 a	0.25
Mean Strength	201 c	205 b	216 a	3
CV of Strength	11.3 b	12.3 a	11.5 b	0.5
Elongation	4.66 b	4.46 b	5.02 a	0.21
CV of Elongation	9.9 b	10.9 a	9.8 b	0.7
Skein Break Factor	2527 b	2526 b	2709 a	58

Table 5. Combed 50's Yarn and Skein Strength: Three year average - 9 locations

	Phtogen 33	Maxxa	El Dorado	LSD
Tenacity	18.18 c	19.03 b	19.61 a	0.57
Mean Strength	217 b	226 ab	233 a	15
CV of Strength	10.4 a	10.4 a	10.3 a	2.5
Elongation	4.75 b	4.65 b	5.13 a	0.20
CV of Elongation	9.3 a	8.9 a	8.5 a	2.8
Skein Break Factor	2742 c	2833 b	2986 a	61

Table 6. Carded 50's Yarn Defects: Three year average - 9 locations

	Phytogen 33	Maxxa	El Dorado	LSD
Nonuniformity (CV%)	22.07 b	22.99 a	21.60 b	0.50
Thins	535 b	780 a	487 b	64
Thicks	1401 b	1632 a	1251 c	105
Neps	1359 a	1465 a	1064 b	193

Table 7. Combed 50's Yarn Defects: Three year average - 9 locations

	Phytogen 33	Maxxa	El Dorado	LSD
Nonuniformity (CV%)	17.42 ab	17.75 a	17.11 b	0.36
Thins	131 b	179 a	118 b	18
Thicks	316 ab	337 a	272 b	56
Neps	268 a	234 a	231 a	39

Table 8. Fiber Properties: 1996 Bales

	Phytogen 33	Maxxa	El Dorado	LSD
2.5% Span Length	1.16 a	1.13 b	1.16 a	0.02
Uniformity Ratio	47.9 b	47.4 b	50.4 a	1.1
Short Fiber Index	5.1 ab	6.1 a	4.5 b	1.3
Tenacity (Stelometer)	24.5 ab	23.5 b	25.8 a	1.4
Elongation (Stelometer)	5.8 ab	5.2 b	6.3 a	0.9
Micronaire	4.91 a	4.42 c	4.72 b	0.04

Table 9. Arealometer Properties: 1996 Bales

	Phytogen 33	Maxxa	El Dorado	LSD
Micronaire	4.91 a	4.42 c	4.72 b	0.04
Percent Maturity	95 a	85 b	97 a	4
Cell Wall Thickness	3.07 a	2.76 b	3.05 a	0.09
Perimeter	43.56 b	48.7 a	41.04 b	2.77
Weight-Fineness	4.02 b	4.26 a	3.70 c	0.23
Fineness(millitex)	158 b	168 a	146 c	9

Table 10. Manufacturing Waste: 1996 Bales

	Phytogen 33	Maxxa	El Dorado	LSD
Opening and Carding	5.4 a	5.3 a	5.7 a	3.1
Combing	15.3 b	18.6 a	15.3 b	0.6
Total	19.8 a	22.9 a	20.0 a	3.2

Table 11. Carded 50's Yarn and Skein Strength: 1996 Bales

	Phytogen 33	Maxxa	El Dorado	LSD
Tenacity	15.16 b	15.14 b	16.46 a	0.36
Mean Strength	187 b	186 b	204 a	7
CV of Strength	13.0 b	15.2 a	12.4 b	1.6
Elongation	4.59 b	4.30 b	5.09 a	0.36
CV of Elongation	10.1 a	11.0 a	9.6 a	2.5
Skein Break Factor	2396 b	2308 b	2556 a	98

Table 12. Combed 50's Yarn and Skein Strength: 1996 Bales

	Phytogen 33	Maxxa	El Dorado	LSD
Tenacity	17.05 b	17.85 ab	18.50 a	0.99
Mean Strength	209 b	219 ab	228 a	13
CV of Strength	13.2 a	12.9 a	10.8 b	1.1
Elongation	4.79 b	4.64 c	5.22 a	0.14
CV of Elongation	9.6 a	9.8 a	8.5 a	5.7
Skein Break Factor	2689 b	2791 b	2914 a	160

Table 13. Carded 50's Yarn Defects: 1996 Bales

	Phytogen 33	Maxxa	El Dorado	LSD
Nonuniformity (CV%)	23.80 a	25.21 a	23.10 a	2.19
Thins	754 a	1155 a	741 a	726
Thicks	1761 ab	2129 a	1506 b	488
Neps	1372 a	1541 a	1065 b	235

Table 14. Combed 50's Yarn Defects: 1996 Bales

	Phytogen 33	Maxxa	El Dorado	LSD
Nonuniformity (CV%)	17.60 b	18.02 a	17.20 c	0.34
Thins	123 b	189 a	110 b	18
Thicks	292 b	342 a	272 b	32
Neps	191 a	183 a	208 a	48