FIBER QUALITY TRENDS ACROSS YEARS AND VARIETIES

David W. Albers, Thomas A. Kerby and Ken Lege
Delta and Pine Land Company
Lubbock, TX; Scott, MS; and Centre, AL

Abstract

Trends in fiber properties of the U.S. Cotton crop are impacted by numerous factors, including both the varieties planted and environmental stresses encountered each year. In this paper, two statistical methods were utilized to determine the impact of year and variety on fiber quality parameters: trend line analysis and partitioning the variation from different sources by analysis of variance. The analysis of variance approach determined that the contribution of year to year variation to staple length and micronaire was greater than the variation due to variety planted. Fiber strength was much more dependent on the variety planted, than on yearly variation. The trend line analysis of USDA-Smith Doxey data from 1994 to 2000 had a very similar trend line to a single variety, NuCOTN 33 B, for micronaire and fiber strength, indicating that the year to year variation is a stronger source of variation than variety. The exception to the trend line analysis is with staple length, where the USDA-Smith Doxey summary has a negative slope over the past 7 years, while NuCOTN 33 B has a positive slope. Two example states were used to assess changes in varieties planted over the past 6 years. The number of varieties planted in GA has more than doubled between 1995 and 2000, while the number of varieties planted in MS has remained relatively constant at near 12 varieties to plant 90% of the acres. The shift in variety selection from 1995 to 2000 has resulted in fewer acres in both states of varieties with staple length greater than 35 (32's inch) planted, fewer acres of varieties with strength greater than 30 g/tex planted, and different shifts in micronaire between MS and GA: fewer acres in GA planted to varieties with 4.4 to 4.6 micronaire and MS planting more of the varieties in the same range of micronaire. These changes in the fiber quality of the varieties planted indicate that fiber quality may not be the primary variety selection factor. Varieties are likely being selected by growers based primarily on yield, maturity, and profitability.

Introduction

A shift in trends of fiber properties for the U.S. cotton crop and the introduction of transgenic varieties during the period of 1996 to present has brought forth discussion of the factors causing some changes in fiber quality. The same areas of the Cotton Belt that have experienced changes in fiber quality have also experienced extended drought during the same period. Both variety planted and environment (weather, soil, pests, etc.) contribute to variation in fiber properties and yield. Previous studies have shown that environment has a major influence on fiber length, micronaire, yield, and cotton growth parameters (Kerby, et al., 1996; Kerby et al., 2000a). Kerby et al. (2000b) reported that transgenic varieties and conventional parents have fundamental equivalency of fiber properties. Cases were identified when individual transgenic varieties had fiber properties different from the conventional parent variety, as would be expected in the normal variation from a breeding program. When they combined all tests and gene groups, transgenic varieties were only 0.1 staple unit shorter, 0.1 g/tex stronger, and 0.03 micronaire unit less than the conventional parents. A detailed study of fiber and textile properties of transgenic varieties and their conventional parent varieties by Ethridge and Hequet (2000) found no statistically significant differences between the two types.

The impact of variety, environmental stresses, acres planted to cotton are confounded within the annual summaries of Smith-Doxey classed bales. Performance of a single variety (in a representative number of locations) across years may provide a measure of year to year variation to help separate the variety component and the year component of any fiber quality trends. The objective of this paper is to demonstrate the relative influences of year (environment) and variety on fiber properties over the past 7 years.

Materials and Methods

Fiber quality trends were looked at in three different ways in this paper: 1) Smith-Doxey versus single variety data (1994 to 2000); 2) impact of year and variety on fiber quality data for 8 varieties (2 from each gene family: conventional, Roundup Ready, Bollgard, and BG/RR) over the past 7 years; 3) impact of change in varieties planted from 1995 to 2000.

Smith-Doxey Comparison

Smith-Doxey annual summaries of staple length, micronaire, and fiber strength were plotted and regressed against the values for NuCOTN 33 B from the D&PL Technical Service database. NuCOTN 33 B was selected because it is well represented in the database (over 750 observations) across the years being considered and its acreage planted in the same period.

Year and Variety Evaluation

Eight varieties were selected from the D&PL Technical Service database, two from each gene family: conventional (Deltapine 51, DP 5415), Roundup Ready (DP 425 RR, DP 5415 RR), Bollgard (DP 428 B, NuCOTN 33 B), and stacked BG/RR (DP 451 B/RR, DP 458 B/RR). Data for the past 7 years (1994 to 2000) was included for over 3700 observations. Analysis of variance was carried out to determine the relative contribution of year and variety to the variation in the fiber parameters: micronaire, staple length, and fiber strength.

Change of Varieties Planted 1995-2000

The varieties planted each year for 1995 to 2000, according to the USDA-AMS publication "Cotton Varieties Planted" were counted to determine the minimum number of varieties required to plant 90% of the acreage within a state. The varieties represented in the 90% acreage list were assigned their fiber quality value from the D&PL Technical Service database to characterize the relative distribution of fiber properties for the acres planted each year. Two states, MS and GA, are used in this study as examples.

Results and Discussion

Smith-Doxey Comparison

Trend-line analysis of Smith-Doxey data and NuCOTN 33 B data from 1994 to 2000 resulted in similar trend-lines for both micronaire values (Fig. 1). The slopes for both NuCOTN 33 B and Smith-Doxey micronaire were both positive, with the Smith-Doxey slope, slightly greater than NuCOTN 33 B. The similar slope and year to year variation indicates that the influence of year (environment) is greater than the influence of variety planted. The positive slope of the NuCOTN 33 B micronaire over the past 7 years would indicate a trend toward recent years with higher micronaire conditions across the U.S. Cotton Belt where NuCOTN 33 B was widely tested. However, the slightly steeper slope of the Smith-Doxey trend line, might indicate that the variety selection in recent years has been toward more acres (bales) of higher micronaire varieties.

Fiber strength trends were again similar between NuCOTN 33 B and Smith-Doxey data (Figure 2). NuCOTN 33 B had a larger intercept and a slightly more negative slope than Smith-Doxey, which indicates that NuCOTN 33 B has stronger fiber than the average bale classed by USDA. The amount of variation from year to year for the fiber strength of NuCOTN 33 B indicates that the year environment does influence fiber strength, although to a lesser degree than variety (Kerby, et al. 2000a).

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 1:402-405 (2001)
National Cotton Council, Memphis TN

The trends in staple length diverge (Figure 3) between Smith Doxey and NuCOTN 33 B. USDA classed bales show a decrease in staple over the past 7 years, while NuCOTN 33 B has a slightly positive slope. These differences could indicate several things: first, the selection of varieties planted may be moving toward more acres (bales) of varieties with shorter staple. In addition, the drought period of the past several years could be impacting the Smith-Doxey classed bales more than the NuCOTN 33 B samples from test plots. For example, the High Plains of Texas that has been greatly impacted by drought in 1998 and 2000, would have had very few test plot locations that included NuCOTN 33 B.

Year and Variety Evaluation

Analysis of variance for staple length, micronaire and fiber strength across 8 varieties and 7 years of D&PL testing are summarized in Table 1. For both micronaire and staple, the year contributed the majority of the variation in the data, with F ratios of 50.6 and 41.9, respectively. In this data set, 85% of the variation in micronaire was accounted for by year, and 59% of the variation in staple length is accounted for by year. Fiber strength showed the opposite response, as the F ratio for variety was 91.2, compared to 59.7 for year. The variation accounted for by variety 53% of the total. These results are similar to those of Kerby et al. (2000a) who found that environment had a major influence on micronaire and staple length, while variety had the strongest influence on fiber strength of any of the variables considered.

Change of Varieties Planted 1995-2000

The number of varieties planted were determined from USDA-AMS data from GA and MS to illustrate the changes from the 1995 season to 2000 (Figure 4). In GA, the number of varieties planted has more than doubled since 1995, where only 10 varieties were required to plant 90% of the acreage, while in 2000 over 25 varieties were listed by USDA. The number of conventional varieties planted (in the 90% acreage category) was 10 each year. This seems to indicate that GA growers have showed interest in growing new transgenic varieties but have kept a selection of conventional varieties on their farms, as well.

In MS, number of varieties required to plant 90% of the acreage was 12 in 1995 and 12 again in 2000, with a low of 7 varieties in 1996 and a high of 15 varieties in 1997. The number of conventional varieties planted in MS dropped from 12 in 1995 to two in 2000, (among the top 90% category). Evidently, MS growers have adopted transgenic technology in a different manner than GA growers, moving away from conventional varieties more quickly. In recent years, growers in GA have tended to plant more early maturing varieties, along with the standard full season types, while MS tends to grow early to mid season varieties only. The adoption of more early maturing varieties may account for a part of the increase in varieties planted in GA.

With the change in variety mixed planted, potentially comes a change in the fiber quality of the variety-mix. Table 2 indicates that variety selection in GA has potentially shifted the staple length from over 80% of the acres planted to varieties with 35 to 36 staple in 1995 to less than 30% of the acres planted to the same staple grouping in 2000. The majority of the shift has been filled with staple 34 to 35 range varieties. The shift in MS was similar to GA, changing from over 70% of the acres planted to varieties with 35 to 36 staple in 1995, and shifting to approximately 25% planted to 35 to 36 staple and replaced with 45% of the crop plant to 34 to 35 staple varieties in 2000.

Fiber strength shifts summarized in Table 2 show different trends for GA and MS across the 6 year period. GA data shows a slow increase of 28 to 30 g/tex varieties (from 20% to over 50%) at the expense of acres planted to varieties over 30 g/tex. The trend in MS showed more acres of 28 to 30 g/tex varieties planted in 1996 to 1999 (after transgenics were introduced) than were planted in 1995 (prior to transgenic variety release). The year 2000 returned to levels of 26 to 28 g/tex varieties planted similar to those planted in 1995. The MS data, in particular, indicates that variety selection has not been based on fiber strength, with great amounts of year to year variation.

Changes of acres planted to various micronaire groupings again show different patterns between GA and MS. Over the period from 1995 to 1996, GA acres have been planted to more acres of 4.2 to 4.4 micronaire (10% in 1995 up to over 30% in 2000); fewer acres of 4.4 to 4.6 varieties (70% in 1995 down to 30% in 2000) and more acres of greater than 4.6 micronaire varieties (5% in 1995 up to >15% in 2000). In GA, increases in varieties on the low end and the high end, with less of the middle range micronaire. Again, this response indicates that growers are likely not using the micronaire level of a cotton variety as a strong variety selection criteria. In contrast, the amount of MS acres planted to lower micronaire (4.2 to 4.4) has decreased from over 30% to less than 10% from 1995 to 2000. The mid-range micronaire varieties (4.4 to 4.6) have increased from less than 20% in 1995 to over 60% in 2000. The higher range micronaire varieties decreased from over 20% in 1995 to less than 15% in 2000. Even though the MS trends are not consistent with the GA micronaire trends, there is no indication that micronaire level of a variety is a strong variety selection criteria.

The analysis indicates that the fiber quality parameters of the varieties predominately planted over the past 6 years are shifting in the two example states of GA and MS to fewer acres of varieties with staple longer than 35 staple (32's of an inch), to fewer acres of varieties with greater than 30 g/tex fiber strength, and either less acres of 4.4 to 4.6 micronaire varieties in GA and more acres of the same class micronaire in MS. Growers may be looking at factors other than fiber quality as their primary variety selection criteria. Lint yield, maturity, and profitability of the variety and its production system utilizing transgenic traits are likely factors that predominate in grower variety selection, assuming fiber parameters of a variety are typically in the base-range or better.

Summary

The impact of year and variety on fiber quality parameters were compared utilizing two methods: trend line analysis and partitioning the variation from different sources by analysis of variance. Both methods indicate that more of the total variation in staple length and micronaire are due to year, than to variety planted. The trend line analysis of USDA-Smith Doxey data from 1994 to 2000 had very similar trend line to a single variety, NuCOTN 33 B, for micronaire and fiber strength, indicating that the year to year variation is a stronger source of variation than variety. The exception to the trend line analysis is with staple length, where the USDA-Smith Doxey summary has a negative slope over the past 7 years, while NuCOTN 33 B has a positive slope. This may be indicative that the test locations of NuCOTN 33 B were not in the most stressed locations contributing to the shorter staple in 1998 to 2000. Differences in variety selection over the years, may also explain the dissimilarities of the USDA and NuCOTN 33 B trend lines for staple.

Changes in the number of varieties planted in the example states of MS and GA showed different trends. The number of varieties planted in GA has more than doubled between 1995 and 2000, while the number of varieties planted in MS has remained relatively constant at near 12 varieties to plant 90% of the acres. MS has moved to a larger proportion of the varieties planted as transgenic, while GA has planted a constant 9 to 11 conventional varieties each year from 1995 to 2000. The shift in variety selection from 1995 to 2000 has resulted in fewer acres of varieties with staple over 35 planted, fewer acres of varieties with strength greater than 30 g/tex planted, and different shifts in micronaire between MS and GA: with GA planting less 4.4 to 4.6 micronaire and MS planting more of the varieties in the same range of micronaire. These changes in the fiber quality of the varieties planted indicate that fiber quality is not the primary variety selection factor. Varieties are likely being selected by growers based primarily on yield, maturity, and profitability.

References

Ethridge, M. Dean, and Eric F. Hequet. 2000. Fiber properties and textile performance of transgenic cotton versus parent varieties. Pp.731-737. Beltwide Cotton Conferences. National Cotton Council, Memphis, TN.

Kerby, Tom; Lowell Zelinski, Janet Burgess, Marc Bates, and Jim Presley. 1996. Genetic and environmental contributions to earliness. Pp.592-594. Beltwide Cotton Conferences. National Cotton Council, Memphis, TN.

Kerby, Tom; Janet Burgess, Marc Bates, Dave Albers, and Ken Lege. 2000. Partitioning variety and environment contribution to variation in yield, plant growth, and fiber quality. Pp.528-532. Beltwide Cotton Conferences. National Cotton Council, Memphis, TN.

Kerby, Tom; Bill Hugie, Kevin Howard, Marc Bates, Janet Burgess, Jay Mahaffey. 2000. Fiber quality comparisons among varieties for conventional, Bollgard, and Roundup Ready versions. Pp.484-488. Beltwide Cotton Conferences. National Cotton Council, Memphis, TN.

Table 1. Analysis of variance of staple length, micronaire, and fiber strength for 8 varieties (2 conventional, 2 Bollgard, 2 Roundup Ready, and 2 BG/RR) over 7 years of testing (1994 to 2000).

Variable	Source	DF	F Ratio	Prob>F
Staple Length	Year	6	41.9	<.0001
Staple Length	Variety	7	14.5	<.0001
Micronaire	Year	6	50.6	<.0001
Micronaire	Variety	7	8.2	<.0001
Strength	Year	6	59.7	<.0001
Strength	Variety	7	91.2	<.0001

Table 2. Fiber quality groupings of predominant varieties planted in GA and MS, 1995 - 2000.

		% Acres planted by state					
		1995	1996	1997	1998	1999	2000
GA							
Staple	< 34	0	0	0	1	0	4
	34 to 35	0	0	6	42	60	61
	35 to 36	88	87	82	46	31	26
	> 36	3	4	3	2	0	0
MS							
Staple	< 34	4	0	0	0	0	16
	34 to 35	13	17	11	33	39	49
	35 to 36	73	73	77	57	52	28
	> 36	0	0	0	0	0	0
GA							
Strength	< 26	0	0	0	0	0	0
	26 to 28	10	10	12	18	9	17
	28 to 30	20	27	26	35	60	54
	> 30	61	54	53	38	22	20
MS							
Strength	< 26	0	0	0	0	0	0
	26 to 28	54	47	18	38	22	67
	28 to 30	12	37	48	47	58	24
	> 30	25	7	22	5	11	0
GA							
Micronaire	< 4.2	8	7	3	8	7	4
	4.2 to 4.4	10	15	22	29	40	38
	4.4 to 4.6	71	65	57	35	26	30
	> 4.6	5	4	9	18	18	18
MS							
Micronaire	< 4.2	4	0	4	0	0	8
	4.2 to 4.4	37	19	23	8	16	4
	4.4 to 4.6	26	54	51	54	48	65
	> 4.6	23	18	10	29	28	15

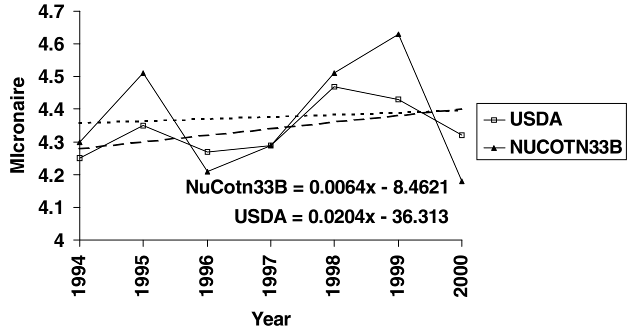

Figure 1. Micronaire trends of USDA Smith-Doxey and NuCOTN 33 B (data from D&PL Technical Service database) from 1994 to 2000.

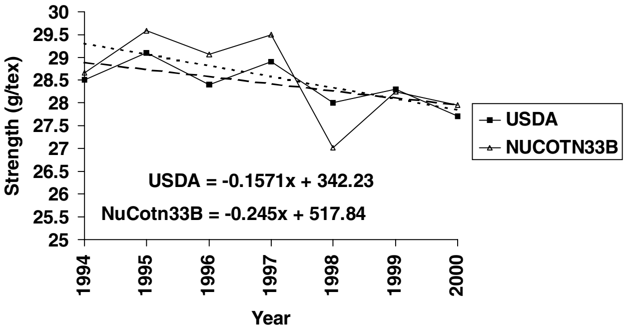

Figure 2. Fiber strength trends of USDA Smith Doxey and NuCOTN 33 B (data from D&PL Technical service database) from 1994 to 2000.

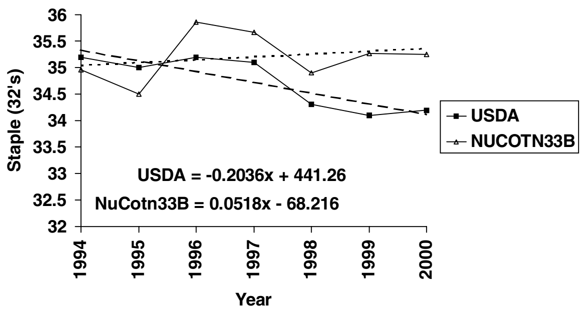

Figure 3. Staple length trends of USDA Smith-Doxey and NuCOTN 33 B (data from D&PL Technical Service database) from 1994 to 2000.

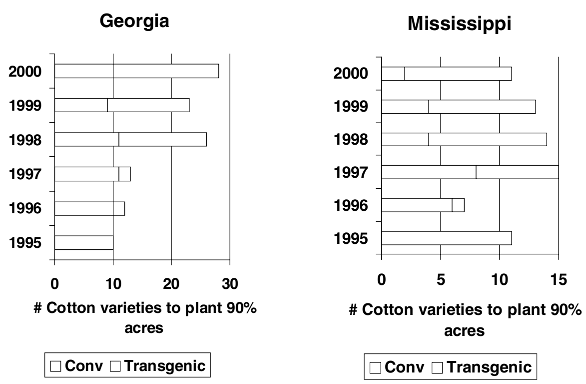

Figure 4. Number of cotton varieties to plant 90% of the acres in GA and MS, 1995 to 2000. (from Cotton Varieties Planted, USDA, AMS)