YIELD AND FIBER QUALITY COMPARISONS BETWEEN TRANSGENIC AND CONVENTIONAL VARIETIES

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Abstract

Data reported previously suggest no differences in yield or fiber quality performance are evident between transgenic and conventional varieties. However, growers, consultants, and the mill industry continue to express concern regarding the adaptability and acceptance of transgenic cotton varieties. Our data indicate no consistent trends for lint yield, staple length, fiber strength, or micronaire with regard to technology type, which supports previous work. While some trends could be detected for some parameters when averaged over years and variety families, the ranking of technology type was not consistent when data were averaged by year and/or by variety family. The ranking of technology type for all parameters differed slightly between data averaged from Delta and Pine Land Company Agronomic Service Trials and data from the state university official variety trials.

Introduction

Despite documented evidence indicating no differences between transgenic varieties and conventional varieties in terms of yield and fiber quality performance (Kerby, 1999; Kerby et al., 2000; Ethridge and Hequet, 2000), the grower community continues to express concerns and raise questions regarding the adaptation and acceptance of transgenic cotton varieties (e.g., Coley, 2000; personal communication of authors).

Previous work has indicated that no differences in fiber quality (Kerby, 1999; Kerby et al., 2000b) or textile performance (Ethridge and Hequet, 2000) could be detected between transgenic varieties and their conventional, recurrent parent varieties in direct, head-to-head comparisons. Any differences found between any transgenic variety and its recurrent parent were minor in magnitude, and any differences were not consistent from one variety family to another (Kerby et al., 2000b). In addition, environment has been determined to be a significantly influencing factor for lint yield (91%), staple length (84%), fiber strength (48%), and micronaire (69%) (Kerby et al., 2000a).

Additionally, the validity and value of field trials conducted by seed companies (personal communication of authors) and state university official variety trials (OVTs) (May, 2000; Hargett, 2000) have been questioned. The primary concern with the OVTs involve the inability to apply Roundup Ultra on Roundup Ready-containing varieties in that testing protocol (May, 2000; Hargett, 2000), even though recent evidence suggests varieties perform similarly regardless of weed control method (May, 2000).

Our objectives were to compare the yield and fiber quality performance of transgenic varieties to conventional varieties in our Delta and Pine Land Company Agronomic Service Trials (DPL ASTs) and the state university OVTs, and to determine if any observed responses to technology type are consistent between the DPL ASTs and state OVTs.

Methods

Lint yield, staple length, micronaire and fiber strength data were compiled from all plots in the Delta and Pine Land Company performance database that includes data collected from our DPL ASTs as well as the state OVTs for 1998 through 2000 (as of 19 Dec 2000). DPL AST fiber quality data were generated from Delta and Pine Land Company's HVI lab in Scott, MS.

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Lint yield and fiber quality data from the OVTs are those reported through official publications from each university. Data from the following varieties were included in our comparisons: DP20 family (includes DP20, DP20B, DP420RR, and DP422B/RR), DP51 family (includes DP51, DP428B, DP425RR, and DP451B/RR), DP5415 family (includes DP5415, NuCOTN33B, DP448B, DP32B, DP5415RR, and DP458B/RR), and DP5690 family (includes DP5690, NuCOTN35B, DP5690RR, and DP655B/RR). These four variety families are the only families in the current DPL product line that have all four technology types represented. Additionally, these families cover a wide range in maturity (DP20 is very early; DP51 is early-mid; DP5415 is mid-full; DP5690 is mid-full), are well-represented in the DPL ASTs and OVTs from 1998 through 2000, and collectively comprised 29.85% of US planted acreage in 2000 (USDA, AMS, 2000).

Least square means were generated and compared by t tests (SAS, 1990).

Results and Discussion

Lint Yield

When averaged across years, variety families, and test types, Bollgard-only (B) varieties had significantly higher yields than all other technology types; additionally, Roundup Ready-only (R) varieties had yields significantly lower than other technology types (Table 1). However, when averaged by year, no differences could be detected among technology type in 2000 (Table 1). Lint yield data for each variety family also indicate that while significant differences for technology type could be detected either across years for a particular variety family, those significant differences among technology types either were not consistent from year to year, or were not significant in some years for some variety families (Tables 2 through 5).

Staple Length

While R varieties had significantly shorter staple length than the other technology types, when averaged over years, variety families, and test types, data from 1998 and 2000 indicated no significant difference among some (1998) or all (2000) technology types for staple length (Table 1). Staple length data for each variety family show similar results, suggesting a strong year effect for staple length for any of the four variety families (Tables 2 through 5).

Fiber Strength

Varieties with the Roundup Ready gene (R) had significantly stronger fiber than varieties with other technology types, when averaged over years, variety families, and test types; however, that trend is not consistent from year to year (Table 1). Similarly, the trend for fiber strength is variable with regard to technology type, depending on year and variety family (Tables 2 through 5).

Micronaire

Micronaire, when averaged over years, variety families, and test types do not differ significantly among technology types; additionally, 1998 is the only year in which any significant differences were detected for technology type (Table 1). When micronaire values are examined by variety family, no consistent trends are evident with regard to technology type (Tables 2 through 5).

Test Type

Ranking for lint yield by technology type is not consistent between DPL ASTs and state OVTs, when averaged across years and variety families (Table 6). Significant differences among technology type for staple length were detected for data originating from the DPL ASTs, while the state OVTs showed no differences in staple length among technology type (Table 6). Fiber strength values from DPL ASTs for technology type indicate significant differences such that R and Bollgard/Roundup Ready (BR) varieties had stronger fiber than C or B varieties; OVT data indicate

B varieties had significantly weaker fiber than the other technology types (Table 6). DPL AST data show that C varieties had significantly higher micronaire values than B and BR varieties, while OVT data suggest R varieties have higher micronaire values than other technology types (Table 6).

Summary

Technology type for the four variety families (DP20, DP51, DP5415, and DP5690) did not consistently influence lint yield, staple length, fiber strength, or micronaire. While some trends could be detected for some parameters when averaged over years and variety families, the ranking of technology type was not consistent when data were averaged by year and/or by variety family, which supports the conclusions of Kerby et al., 2000b, as well as Ethridge and Hequet, 2000. These data also suggest that the environment plays a very important role in determining the lint yield, staple length, fiber strength, and micronaire of any variety, which supports the findings of Kerby et al., 2000a. While the ranking of technology type differed between DPL ASTs and state OVTs for every parameter, other data analyses by the authors suggest a high degree of correlation between the test types, based on the rankings of individual varieties for lint yield, as well as fiber quality parameters (Kerby et al., 2001).

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References

Coley, Chuck B. 2000. Seed selection: a southeastern grower's perspective. Proc. Beltwide Cotton Conf., National Cotton Council. 1:26.

Ethridge, M. Dean and Eric F. Hequet. 2000. Fiber properties and textile performance of transgenic cotton versus parent varieties. Proc. Beltwide Cotton Conf., National Cotton Council. 1:488-494.

Hargett, Jimmy. 2000. Seed selection: a mid-south grower's perspective. Proc. Beltwide Cotton Conf., National Cotton Council. 1:26.

Kerby, Thomas A. 1999. Fiber quality comparisons of Bollgard, Roundup Ready, and Bollgard/Roundup Ready varieties compared to their recurrent parents. Delta and Pine Land Company publication. 4 p text plus 12 p graphs and tables.

Kerby, Tom, Janet Burgess, Marc Bates, Dave Albers, and Ken Lege'. 2000a. Partitioning variety and environment contribution to variation in yield, plant growth, and fiber quality. Proc. Beltwide Cotton Conf., National Cotton Council. 1:528-532.

Kerby, Tom, Bill Hugie, Kevin Howard, Marc Bates, Janet Burgess, and Jay Mahaffey. 2000b. Fiber quality comparisons among varieties for conventional, Bollgard, and Roundup Ready versions. Proc. Beltwide Cotton Conf., National Cotton Council. 1:484-488.

Kerby, Thomas A., Marc Bates, Janet Burgess, Ken Lege', and Dave Albers. 2001. Fiber quality stability of significant Delta and Pine Land varieties over years and locations. Proc. Beltwide Cotton Conf., National Cotton Council. (in press).

May, O. Lloyd. 2000. Seed selection: a breeder's perspective. Proc. Beltwide Cotton Conf., National Cotton Council. 1:22-23.

SAS Institute. 1990. SAS user's guide: Statistics. Version 6. 4th ed. SAS Inst., Cary, NC.

USDA, AMS. 2000. Cotton varieties planted, 2000 crop. USDA, AMS Cotton Program, Memphis, TN. 11 p.

Table 1. Least square means for lint yield, staple length, fiber strength, and micronaire by technology type averaged over four variety families (DP20, DP51, DP5415, and DP5690) in Delta and Pine Land Agronomic Service Trials and university official variety trials in 1998 - 2000 .

	Over Years		1998		1999		2000	
Gene Type†	n‡	LS mean¶	n	LS mean	n	LS mean	n	LS mean
Lint Yield (lbs. lint/acre)								
B	1835	926 a	315	914 a	919	951 a	674	913 a
BR	2044	885 b	615	894 ab	1055	870 b	301	895 a
C	425	881 b	174	842 bc	201	905 ab	50	922 a
R	1120	827 c	313	835 c	520	817 c	287	837 a
Staple Length (1/32 inch)								
B	1746	34.9 b	611	34.8 ab	904	35.0 b	231	34.8 a
BR	1936	34.7 c	311	34.8 ab	1047	34.7 c	578	34.7 a
C	393	35.1 a	169	34.9 a	199	35.2 a	25	34.9 a
R	1034	34.5 d	306	34.6 b	514	34.5 d	214	34.5 a
Fiber Strength (g/tex)								
B	1746	27.2 c	611	26.7 b	904	27.6 b	231	27.0 b
BR	1936	27.5 b	311	27.4 a	1047	27.7 b	578	27.2 b
C	393	27.3 bc	169	26.4 b	199	27.9 ab	25	28.3 a
R	1034	27.7 a	306	27.2 a	514	28.0 a	214	27.9 a
Micronaire								
B	1746	4.47 a	611	4.48 b	904	4.54 a	231	4.16 a
BR	1936	4.44 a	311	4.50 b	1047	4.53 a	578	4.24 a
C	393	4.52 a	169	4.57 ab	199	4.48 a	25	4.39 a
R	1034	4.50 a	306	4.69 a	514	4.52 a	214	4.18 a

† B = Bollgard® only; BR = Bollgard® plus Roundup Ready®; C = conventional; R = Roundup Ready® only.

‡ n = number of observations.

¶ LS mean = least square mean; values followed by the same letter within a column and within a parameter do not differ significantly based on t tests.

Table 2. Least square means for lint yield, staple length, fiber strength, and micronaire by technology type for the DP20 family (DP20, DP420RR, DP20B, and DP422B/RR) in Delta and Pine Land Agronomic Service Trials and university official variety trials in 1998 - 2000 .

	Over Years		1998		1999		2000	
Gene Type†	n‡	LS mean¶	n	LS mean	n	LS mean	n	LS mean
Lint Yield (lbs. lint/acre)								
B	364	926 b	124	860 b	192	960 b	48	960 a
BR	356	861 c	44	933 ab	228	863 c	84	817 b
C	25	1145 a	9	1092 a	16	1175 a	n/a	n/a
R	176	824 c	38	873 ab	82	841 c	56	766 b
Staple Length (1/32 inch)								
B	348	34.6 b	124	34.6 a	192	34.7 a	32	34.4 a
BR	330	34.3 c	44	34.5 a	228	34.4 b	58	33.9 b
C	25	35.2 a	9	35.1 a	16	35.3 a	n/a	n/a
R	155	33.9 d	38	34.0 a	82	34.0 c	35	33.7 b
Fiber Strength (g/tex)								
B	348	26.4 b	124	26.0 bc	192	26.7 a	32	26.3 a
BR	330	26.6 b	44	25.6 c	228	26.8 a	58	26.5 a
C	25	28.1 a	9	28.7 a	16	27.8 a	n/a	n/a
R	155	26.5 b	38	26.4 b	82	26.6 a	35	26.5 a
Micronaire								
B	348	4.35 a	124	4.33 a	192	4.44 a	32	3.92 a
BR	330	4.19 b	44	4.09 b	228	4.26 b	58	3.94 a
C	25	4.22 ab	9	4.22 ab	16	4.22 ab	n/a	n/a
R	155	4.20 b	38	4.31 a	82	4.23 b	35	3.99 a

† B = Bollgard® only; BR = Bollgard® plus Roundup Ready®; C = conventional; R = Roundup Ready® only.

‡ n = number of observations.

¶ LS mean = least square mean; values followed by the same letter within a column and within a parameter do not differ significantly based on t tests.

Table 3. Least square means for lint yield, staple length, fiber strength, and micronaire by technology type for the DP51 family (DP51, DP425RR, DP428B, and DP451B/RR) in Delta and Pine Land Agronomic Service Trials and university official variety trials in 1998 - 2000 .

	Over Years		1998		1999		2000	
Gene Type†	n‡	LS mean¶	n	LS mean	n	LS mean	n	LS mean
Lint Yield (lbs. lint/acre)								
B	376	915 a	107	883 b	193	964 a	76	859 ab
BR	688	896 a	57	1004 a	347	900 b	284	869 a
C	298	834 b	148	819 b	129	833 bc	21	950 a
R	439	815 b	151	823 b	222	819 c	66	781 b
Staple Length (1/32 inch)								
B	351	35.0 a	106	34.9 a	192	35.2 a	53	34.5 a
BR	643	34.9 a	57	34.9 a	345	35.0 a	241	34.8 a
C	280	35.0 a	147	34.9 a	129	35.1 a	4	34.3 a
R	411	34.4 b	149	34.6 a	220	34.4 b	42	34.0 b
Fiber Strength (g/tex)								
B	351	26.3 a	106	25.5 b	192	27.0 a	53	25.4 b
BR	643	26.5 a	57	25.7 ab	345	26.7 a	241	26.4 a
C	280	26.5 a	147	26.0 a	129	27.0 a	4	25.6 b
R	411	26.3 a	149	26.2 a	220	26.6 a	42	25.8 b
Micronaire								
B	351	4.51 b	106	4.56 b	192	4.56 a	53	4.22 a
BR	643	4.40 c	57	4.39 c	345	4.54 a	241	4.21 a
C	280	4.53 ab	147	4.60 ab	129	4.49 a	4	3.75 a
R	411	4.59 a	149	4.69 a	220	4.61 a	42	4.13 a

† B = Bollgard® only; BR = Bollgard® plus Roundup Ready®; C = conventional; R = Roundup Ready® only.

‡ n = number of observations.

¶ LS mean = least square mean; values followed by the same letter within a column and within a parameter do not differ significantly based on t tests.

Table 4. Least square means for lint yield, staple length, fiber strength, and micronaire by technology type for the DP5415 family (DP5415, DP5415RR, NuCOTN33B, DP32B, DP448B, and DP458B/RR) in Delta and Pine Land Agronomic Service Trials and university official variety trials in 1998 - 2000 .

	Over Years		1998		1999		2000	
Gene Type†	n‡	LS mean¶	n	LS mean	n	LS mean	n	LS mean
Lint Yield (lbs. lint/acre)								
B	963	935 ab	347	908 a	473	947 a	143	961 a
BR	731	907 bc	133	928 a	379	858 b	219	977 a
C	76	1003 a	14	934 a	42	1062 a	20	928 a
R	342	876 c	81	849 a	142	838 b	119	941 a
Staple Length (1/32 inch)								
B	924	34.9 b	347	34.7 b	461	35.0 b	116	35.1 a
BR	721	34.7 c	131	34.8 b	375	34.6 c	215	34.8 a
C	70	35.6 a	12	36.0 a	42	35.6 a	16	35.3 a
R	319	35.0 b	79	35.1 b	140	34.8 bc	98	35.1 a
Fiber Strength (g/tex)								
B	924	27.5 c	347	27.1 b	461	27.8 c	116	27.6 b
BR	721	28.3 b	131	27.5 b	375	28.6 b	215	28.1 b
C	70	29.5 a	12	28.9 a	42	29.9 a	16	28.6 ab
R	319	29.0 a	79	28.1 ab	140	29.6 a	98	28.8 a
Micronaire								
B	924	4.50 b	347	4.53 b	461	4.56 b	116	4.18 b
BR	721	4.68 a	131	4.85 a	375	4.76 a	215	4.40 a
C	70	4.57 a	12	4.51 b	42	4.60 ab	16	4.52 a
R	319	4.59 a	79	5.01 a	140	4.56 b	98	4.26 a

† B = Bollgard® only; BR = Bollgard® plus Roundup Ready®; C = conventional; R = Roundup Ready® only.

‡ n = number of observations.

¶ LS mean = least square mean; values followed by the same letter within a column and within a parameter do not differ significantly based on t tests.

Table 5. Least square means for lint yield, staple length, fiber strength, and micronaire by technology type for the DP5690 family (DP5690, DP5690RR, NuCOTN35B, and DP655B/RR) in Delta and Pine Land Agronomic Service Trials and university official variety trials in 1998 - 2000 .

	Over Years		1998		1999		2000	
Gene Type†	n‡	LS mean¶	n	LS mean	n	LS mean	n	LS mean
Lint Yield (lbs. lint/acre)								
B	132	873 a	37	905 a	61	911 a	34	772 ab
BR	269	833 a	81	816 a	101	831 ab	87	851 a
C	26	810 ab	3	815 a	14	787 ab	9	845 ab
R	163	759 b	43	815 a	74	742 b	46	732 b
Staple Length (1/32 inch)								
B	123	34.9 a	34	35.3 a	59	34.9 a	30	34.6 a
BR	242	34.7 a	79	35.0 a	99	34.7 a	64	34.5 a
C	18	34.4 a	1	31.0 b	12	34.7 a	5	34.3 a
R	151	34.6 a	40	34.6 a	72	34.7 a	39	34.4 a
Fiber Strength (g/tex)								
B	123	29.5 ab	34	28.9 a	59	30.5 a	30	28.3 a
BR	242	29.1 b	79	29.3 a	99	29.5 b	64	28.4 a
C	18	30.6 a	1	26.0 a	12	31.5 a	5	29.4 a
R	151	30.0 a	40	29.7 a	72	30.8 a	39	29.1 a
Micronaire								
B	123	4.46 a	34	4.34 ab	59	4.65 a	30	4.22 a
BR	242	4.20 b	79	4.23 b	99	4.25 b	64	4.10 a
C	18	4.48 a	1	4.20 b	12	4.48 ab	5	4.54 a
R	151	4.39 a	40	4.41 a	72	4.50 ab	39	4.18 a

† B = Bollgard® only; BR = Bollgard® plus Roundup Ready®; C = conventional; R = Roundup Ready® only.

‡ n = number of observations.

¶ LS mean = least square mean; values followed by the same letter within a column and within a parameter do not differ significantly based on t tests.

Table 6. Least square means for lint yield, staple length, fiber strength, and micronaire by technology type averaged over four variety families (DP20, DP51, DP5415, and DP5690) for Delta and Pine Land Agronomic Service Trials (AST) and university official variety trials (OVT) over 1998 - 2000.

	AST		OVT	
Gene Type†	n‡	LS mean¶	n	LS mean
Lint Yield (lbs. lint/acre)				
B	1281	912 a	554	956 a
BR	1706	879 b	338	915 a
C	308	898 ab	117	837 b
R	815	798 c	305	904 b
Staple Length (1/32 inch)				
B	1281	34.8 b	465	35.2 a
BR	1687	34.7 c	249	35.1 a
C	307	35.0 a	86	35.4 a
R	810	34.4 d	224	35.1 a
Fiber Strength (g/tex)				
B	1281	27.0 b	465	27.9 b
BR	1687	27.3 a	249	28.8 a
C	307	26.8 b	86	28.9 a
R	810	27.4 a	224	28.8 a
Micronaire				
B	1281	4.46 b	465	4.51 b
BR	1687	4.44 b	249	4.48 b
C	307	4.55 a	86	4.39 b
R	810	4.47 ab	224	4.63 a

† B = Bollgard® only; BR = Bollgard® plus Roundup Ready®; C = conventional; R = Roundup Ready® only.

‡ n = number of observations.

¶ LS mean = least square mean; values followed by the same letter within a column and within a parameter do not differ significantly based on t tests.