REMOVING SEED COAT FRAGMENTS WITH NEWLY-DESIGNED LINT CLEANER GRID BARS

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Abstract

An experiment was conducted to remove seed coat fragments at the saw-type lint cleaner using newly-designed grid bars. The test consisted of four experimental grid bar designs and one control. The experimental grid bar designs included grid bars with angles of the sharp toe of the grid bar (or the clockwise angle from vertical) of 105°, 60°, and 45° and a grid bar design that had a rounded tip with a 0.79-mm (0.031-in) radius. The 105° and 60° grid bars were unique in that they had a second edge a short distance from the toe of the grid bar. Two types of cotton were used, a common upland cultivar and a cultivar known to have a fragile seed coat that breaks easily and contaminates lint with seed coat fragments. Due to many problems with the control grid bar treatment, it was eliminated from the analysis and the experimental grid bars were compared. Results showed noticeable differences in fiber and lint cleaner trash properties between the cultivars. However, there were very few differences in fiber properties among grid bar treatments, especially AFIS seed coat nep count which was used as an indicator for seed coat fragments. There were differences in lint trash content and lint loss in the lint cleaner trash among grid bar designs. It appeared that the 105°, 60°, and 45° grid bars (those with one or more active edges) had less lint loss as the angle of the sharp toe of the grid bar decreased. The clearance between the grid bar and lint cleaner saw may be more sensitive than previously thought in testing the experimental grid bars. Future work includes using a high-speed video camera to help determine the interaction between grid bar design and clearance between the grid bar and lint cleaner saw. The experiment will be rerun with treatments that use different clearances between the grid bar and lint cleaner saw, as well as using a control set of grid bars mounted on the same lint cleaner as the experimental grid bars.

Introduction

Seed coat fragments (SCFs) in ginned lint continue to be a problem at the textile mill. The most recent research at the USDA-ARS Southwestern Cotton Ginning Research Laboratory, focuses on trying to alleviate SCFs at the saw-type lint cleaner with newly-designed grid bars. Past studies by Mangialardi and Shepherd (1968) and Mangialardi (1987) showed that SCFs were not reduced with different levels of saw-type lint cleaning, but both of these studies used conventional grid bars in the lint cleaners.

Recent research has shown that newly-designed lint cleaner grid bars may be effective in removing a SCF (Armijo et al., 2009). This research used 10 model-sized grid bars mounted on a lint cleaner simulator (figure 1). A fiber bundle with an attached SCF was subjected to the grid bars and a high-speed video camera recorded the action that took place as the SCF collided with the grid bar.

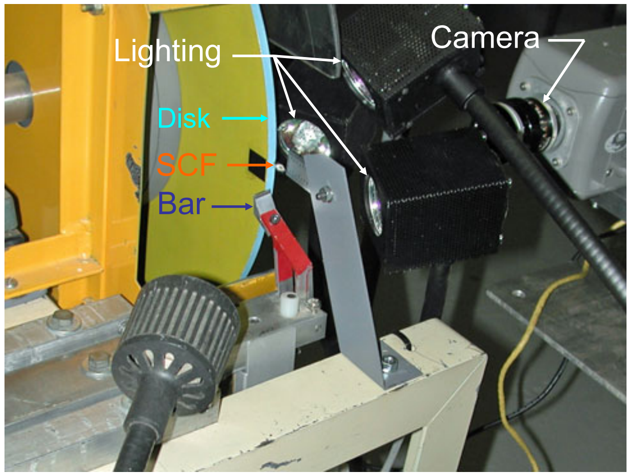

Figure 1. Lint cleaner simulator and high-speed video camera used to test 10 newly-designed, model-sized grid bars.

Armijo et al. (2009) found that four out of 10 experimental grid bars performed best in removing a SCF from the fiber bundle and warranted full-size testing on a commercial saw-type lint cleaner. The objective of this study was to determine the performance of these four newly-designed lint cleaner grid bars in a full-sized lint cleaner. The study was performed at the USDA-ARS Southwestern Cotton Ginning Research Laboratory in Mesilla Park, New Mexico in 2010.

Materials and Methods

Figure 2 shows a cross section of the 10 experimental grid bars tested by Armijo et al. (2009). The four grid bars that performed best and were in this study are shown in green and labeled as follows: 105°, 60°, 45°, and 0°R. The grid bars are labeled as to the included angle from the sharp toe (or the clockwise angle from vertical) that the grid bar makes. The 0°R grid bar did not have a definite angle, but instead had a rounded surface with a defined radius. The test by Armijo et al. (2009) showed that the SCF reacted well on those grid bars that had a second edge (the 105° and 60° bars).

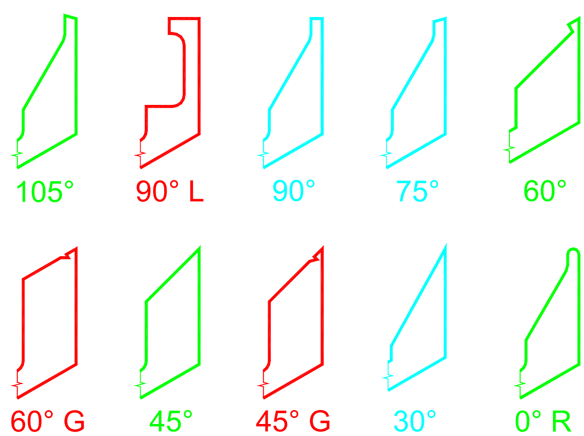

Figure 2. Cross section of the 10 experimental grid bars previously tested. The 105°, 60°, 45°, and 0°R grid bars (shown in green) were tested in this study.

Figure 3 shows a close-up view of the 105°, 60°, 45°, and 0°R grid bars. The 105º and 60º grid bars had a small surface of about 1.7 mm (0.069 in) from the toe of the bar, giving these bars a second edge to help remove the SCF. The 45º grid bar did not have a second edge; the surface length from the toe of the grid bar was about 14 mm (0.563

in). The 0ºR grid bar did not have an edge at all, but instead had a 0.79-mm (0.031-in) radius. Each of the four designs contained five grid bars that measured 1.64 m (64.375 in) in length. The experimental grid bars were made out of aluminum.

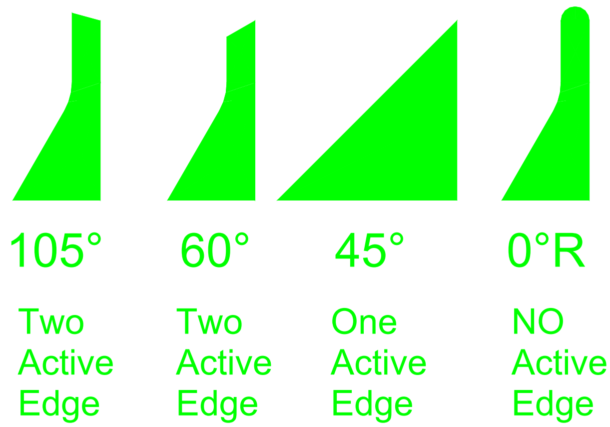

Figure 3. Close-up view of the four grid bar designs used in this study.

Figure 4 shows a side view of the 45° grid bars as an example of how the experimental grid bars were placed in relation the lint cleaner saw. A commercial Continental Lodestar saw-type lint cleaner was used in the test. The Lodestar was 1.7-m (66-in) wide, had a 406-mm (16-in) diameter saw cylinder that ran at 1033 rpm and contained five grid bars. The distance from the feed plate to the lint cleaner saw was 1.6 mm (0.063 in), from the feed roller to the feed plate was 0.25 mm (0.010 in) (floating-spring-loaded), and from the grid bar to the saw was 1.6 mm (0.063 in). The Lodestar had a 457-mm (18-in) diameter doffing brush. Saw-type lint cleaners typically use a combing ratio (the ratio between the rim speed of the saw and the rim speed of the feed roller) between 16 and 28 (USDA, 1994); the combing ratio averaged 25 during the test.

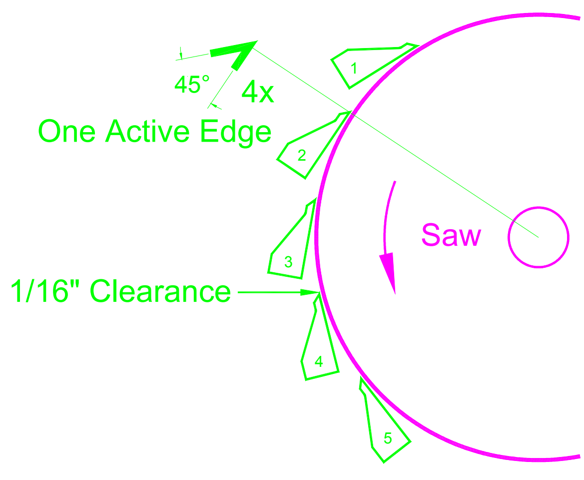

Figure 4. Side view of 45° grid bars in relation to the lint cleaner saw.

The test included a control design of grid bars to compare against the experimental grid bars. The control treatment was run on a different Continental Lodestar lint cleaner with the same specifications as the lint cleaner that had the experimental grid bars. The control grid bar set had an included angle from the sharp toe of 32º on the first grid bar and an included angle of 55º on the remaining four bars of the set. The control grid bars were made out of steel. Figure 5 shows the control grid bars in relation the lint cleaner saw.

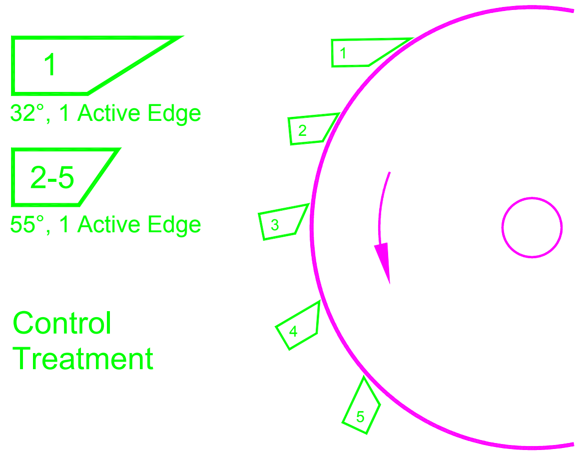

Figure 5. Side view of control grid bars in relation to the lint cleaner saw.

The test consisted of five sets of grid bars (four experimental and one control), two types of cotton, and three replications for a total of 30 lots. The cottons included a common upland cultivar (FiberMax 9063), and a cultivar known to have a fragile seed coat which may be more sensitive to differences in grid bar design. Both cottons were grown in the Mesilla Valley of Southern New Mexico. Sampling included seed cotton at the wagon and feeder, cottonseed at the seed belt, lint samples before and after lint cleaning, and trash samples at the lint cleaner. There were two sub-samples taken during each ginning lot of which the quality measurements were averaged together. The trash contents of the seed cotton samples were determined using the pneumatic fractionation method and the moisture content of lint samples was determined using the oven drying method (Shepherd, 1972). The USTER Advanced Fiber Information System (AFIS) and the High Volume Instrument (HVI) at Cotton Incorporated (Cary, NC) were used to determine the fiber properties of lint samples. Cottonseed analysis was performed at Mid-Continent Laboratories (Memphis, TN) according to the Trading Rules of the National Cottonseed Products Association (National Cottonseed Products Association, 1997). A manual count of SCFs was determined using the Standard Test Method for Seed Coat Fragments and Funiculi in Cotton Fiber Samples (ASTM, 1979). Foreign matter content of the lint cleaner trash was determined by the Shirley Analyzer at the USDA-ARS Cotton Quality Research Station (Clemson, SC). The experimental design was a randomized complete block with replications serving as blocks. Analysis of variance was performed with the General Linear Models procedure of SAS (version 9.1; SAS Institute, Inc.: Cary, NC) and differences between main effect treatment means were tested with Tukey's studentized range test.

Results and Discussion

There were problems with the control treatment that warranted removing it from the analysis. As mentioned earlier, the control grid bar set had an included angle from the sharp toe of 32º on the first grid bar, and an included angle of 55º on the remaining four bars of the set which was standard for the Continental Lodestar lint cleaner. The grid bars were not set to manufacturer's recommendation. The grid bar-to-saw toe clearance was set at 1.6 mm (0.063 in) rather than 0.8 mm (0.031 in) as called for in the Cotton Ginners Handbook (USDA, 1977) and the heal clearance was not set to 0.24 mm (0.09 in); nor was the bottom surface of all the grid bars tangent to the lint cleaner saw (figure 5) as with the experimental grid bar sets (figure 4). Another problem with the control treatment was that the feed roller speed could not be reliably controlled, causing the combing ratio to vary during the tests and resulted in significantly different combing ratios between the control and experimental grid bar grid bar treatments. Also, the lint flue air flow on the control treatment declined throughout ginning of the test lots due to poor cleaning of the inline filter screen by the filter brushes. And finally, less variability would have been introduced to the test if the control bars had been run on the same lint cleaner as the experimental bars. For these reasons, the control treatment was eliminated from the analysis and the remaining experimental grid bar designs were compared.

Because there was no significant interaction between lint cleaner and cultivar treatments, the data was analyzed by lint cleaner and cultivar treatments separately. Differences between cultivars were prevalent throughout the analysis, but this was expected.

Table 1 shows ginning rate, turnout, trash content at the feeder, moisture content at the lint cleaner, and ginning plant conditions during the experiment. Ginning rate was not different among grid bars and averaged 1009 kg/m/h (678 lb/f/h), but was different between cultivars with the fragile cultivar ginning a bit slower than the FiberMax cultivar. Turnout was not different among gird bars and averaged 36.5%, but was considerably different between cultivars; the fragile cultivar was about 41% and FiberMax was about 32%. High turnout has been a strong point of the fragile cultivar.

As not to contaminate the samples taken during each lot, the two cultivars were pre-cleaned separately prior to running the lint cleaner treatments. Trash content at the wagon was 10.0% and 11.1% (dirty base) for the fragile and FiberMax cultivar, respectively. Table 1 shows that trash content (dirty base) at the feeder was different between cultivars; the fragile cultivar was 1.3% and the FiberMax was 2.2%. Trash content at the feeder was not different among grid bars and averaged 1.7%. Moisture content (dry base) at the lint cleaner, room temperature and relative humidity were not different among grid bars or between cultivars and averaged 5.5%, 26.7°C, and 33%, respectively.

Table 1. Means and statistical analysis of ginning rate, turnout, trash and moisture content at the wagon and feeder, and gin plant conditions, by lint cleaner and cultivar treatment.

	Gin process rate	Turn-out	Trash content feeder	Moisture content LC	Room temp.	Room r.h.
	kg/m/h	%	%	%	deg C	%
			Lint Cleaner Treatment			
105° Grid Bar	1002	36.4	1.65	5.34	26.2	29.5
60° Grid Bar	1009	36.8	1.73	5.48	26.3	29.3
45° Grid Bar	1007	36.6	1.73	5.66	26.2	40.8
0°R Grid Bar	1016	36.2	1.83	5.48	27.9	33.2
			Cultivar Treatment			
Fragile	1028	41.3	1.26	5.40	26.6	32.6
FiberMax	990	31.7	2.21	5.58	26.8	33.8
			Observed Significance Level[z]			
Lint Cleaner	NS	NS	NS	NS	NS	NS
Cultivar	0.0024	<0.0001	<0.0001	NS	NS	NS
Cultivar x LC	NS	NS	NS	NS	NS	NS

[z] NS = not statistically significant at (P>0.05).

Table 2 shows the cottonseed properties. None of the cottonseed properties were different among grid bar designs, but there were differences between cultivars. The fragile cultivar was about three percentage points higher in linters content and contained 0.2% less foreign matter. The fragile cultivar was 0.12 percentage points lower in free fatty acids and one percentage point higher in oil content. Cottonseed grade was different between cultivars and averaged 112 and 104 for the fragile and FiberMax cultivar, respectively.

Table 2. Means and statistical analysis of cottonseed properties, by lint cleaner and cultivar treatment.

	Linters	Total foreign matter	Moisture	Free fatty acids	Oil	Ammonia	Net quality Index	Quantity index	Grade
	%	%	%	%	%	%	Index	Index	Index
					Lint Cleaner Treatment				
105° Grid Bar	11.5	0.28	5.48	1.13	19.4	4.35	100	109	109
60° Grid Bar	11.6	0.39	5.73	1.16	19.4	4.34	100	109	109
45° Grid Bar	11.3	0.38	5.55	1.28	19.4	4.31	100	109	109
0°R Grid Bar	11.2	0.33	5.49	1.18	19.3	4.13	100	107	107
					Cultivar Treatment				
Fragile	12.8	0.25	5.48	1.13	19.9	4.60	100	112	112
FiberMax	10.0	0.45	5.65	1.25	18.9	3.96	100	104	104
					Observed Significance Level[z]				
Lint Cleaner	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cultivar	<0.0001	0.0019	<0.0228	NS	<0.0001	<0.0001	NS	<0.0001	<0.0001
Cultivar x LC	NS	NS	NS	NS	NS	NS	NS	NS	NS

[z] NS = not statistically significant at (P>0.05).

Tables 3 and 4 show the AFIS results for lint samples taken after lint cleaning at the press. As with the cottonseed properties, none of the AFIS properties were different among grid bar designs, but there were many differences between cultivars. Table 3 shows that length and upper quartile length were about 3 and 4 mm (0.12 and 0.16 in) longer, respectively, with FiberMax. Short fiber content was not different between cultivar and averaged 12.7%. FiberMax had 2.4 percentage points more immature fiber and 64% more neps (534 versus 325). Table 4 shows the total trash count was higher with FiberMax (385 versus 284 for the fragile cultivar), but the fragile cultivar had larger trash particles (407 versus 329 for FiberMax). Visible foreign matter was 0.61 percentage points higher in the fragile cultivar.

AFIS seed coat nep count was the fiber property used as an indicator of the level of SCFs. Table 4 shows that seed coat nep count was different between cultivars; the fragile cultivar had about 57 seed coat neps and FiberMax had about 33. This was expected as the fragile cultivar was chosen due to its larger amount of seed coat neps. However, seed coat nep count was not different among grid bar designs, averaging 44.6 counts per gram across both cultivars. Although not shown, the same results were found with a manual count of SCFs; SCF count was not different among grid bar designs, but was different between cultivars.

There may have been more response from seed coat nep count if the grid bar to lint cleaner saw clearance had been set tighter. In the study by Armijo et al. (2009) in which model-sized grid bars were tested, the clearance between the grid bar and tube (which simulated a saw tooth) was 1 mm (0.040 in). Video clips and statistical analysis showed certain grid bar designs (the same designs used in this study) remove SCFs better, especially those bars that had a second edge a very short distance from the leading edge. In this study, the grid bar-to-saw clearance was set to 1.6 mm (0.063 in) to avoid damaging the aluminum grid bars. The 60% increase in gap between the grid bar and saw may have been significant. In retrospect, a treatment that varied grid bar clearance may have added an important factor to the analysis.

Table 3. Means and statistical analysis of fiber properties measured by the Advanced Fiber Information System (AFIS) on samples after lint cleaning, by lint cleaner and cultivar treatment.

	Length	Length CV	Upper quartile length	Short fiber content	Fineness	Immature fiber content	Maturity ratio	Nep count	Nep size
	mm	%	mm	%	m-tex	%	-	per g	µm
					Lint Cleaner Treatment				
105° Grid Bar	23.2	38.6	29.1	12.6	152	8.68	0.85	434	726
60° Grid Bar	23.4	38.7	29.4	12.5	151	8.74	0.85	438	724
45° Grid Bar	23.4	39.1	29.4	12.7	151	8.71	0.85	429	731
0°R Grid Bar	23.4	38.8	29.4	12.7	150	8.76	0.85	416	729
					Cultivar Treatment				
Fragile	22.0	36.7	27.1	12.5	163	7.53	0.88	325	745
FiberMax	24.7	40.9	31.5	12.8	139	9.92	0.82	534	710
					Observed Significance Level[z]				
Lint Cleaner	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cultivar	<0.0001	<0.0001	<0.0001	NS	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cultivar x LC	NS	NS	NS	NS	NS	NS	NS	NS	NS

[z] NS = not statistically significant at (P>0.05).

Table 4. Means and statistical analysis of fiber properties measured by the Advanced Fiber Information System (AFIS) on samples taken after lint cleaning, by lint cleaner and cultivar treatment.

	Seed coat nep count	Seed coat nep size	Dust count	Trash count	Total trash count	Trash size	Visible foreign matter
	per g	mm	per g	per g	per g	µm	%
				Lint Cleaner Treatment			
105° Grid Bar	41.8	1035	297	60.9	358	362	1.68
60° Grid Bar	44.4	1070	271	57.5	329	366	1.52
45° Grid Bar	47.6	1077	289	64.9	354	376	1.82
0°R Grid Bar	44.7	1083	242	55.4	298	369	1.38
				Cultivar Treatment			
Fragile	56.6	1123	227	56.6	284	407	1.91
FiberMax	32.6	1009	322	62.8	385	329	1.30
				Observed Significance Level[z]			
Lint Cleaner	NS	NS	NS	NS	NS	NS	NS
Cultivar	<0.0001	<0.0001	0.0002	NS	0.0009	<0.0001	0.0040
Cultivar x LC	NS	NS	NS	NS	NS	NS	NS

[z] NS = not statistically significant at (P>0.05).

Table 5 shows the HVI results. Micronaire was different among grid bars with the 105° grid bar having the lowest micronaire (3.68) and the 45° grid bar having the highest (3.77). Micronaire readings are sometimes related to trash levels in the fiber, and there were differences in trash levels among grid bars which are shown later. None of the other HVI fiber properties were different among grid bar designs. There were differences in some of the HVI properties between cultivars. FiberMax fiber length was considerably longer, averaging about 5 mm (0.2 in or six staple lengths) longer than the fragile cultivar. FiberMax was 0.1 percentage points higher in uniformity and had a more favorable leaf grade (2.7 versus 3.0) than the fragile cultivar. Color grade was not different between cultivars and averaged 105 (old code). Color grade must be analyzed using old code because the new code numbering system is not linear. Examples of the conversion between color grade old code and new code follow: old code 94 = new code 41, old code 100 = new code 31, old code 104 = new code 21, and old code 105 = new code 11.

Table 5. Means and statistical analysis of High Volume Instrument (HVI) results on samples taken after lint cleaning, by lint cleaner and cultivar treatment.

	Micron-Aire[z]	Upper half mean length	Staple length	Unifor-mity	Stre-ngth	Reflec-tance	Yellow-ness	Color grade[y]	Leaf grade
	Reading	mm	32-in	%	g/tex	Rd	+b	Index	index
					Lint Cleaner Treatment				
105° Grid Bar	3.68 b	28.2	35.7	80.2	28.7	81.9	9.35	105	2.83
60° Grid Bar	3.75 ab	28.4	35.7	80.4	27.8	82.3	9.36	105	3.00
45° Grid Bar	3.77 a	28.3	35.7	80.7	28.1	82.4	9.47	105	2.67
0°R Grid Bar	3.74 ab	28.4	35.8	80.3	28.2	81.7	9.42	105	2.75
					Cultivar Treatment				
Fragile	4.58	25.8	32.5	80.3	27.2	80.5	9.63	105	2.96
FiberMax	2.89	30.9	38.9	80.4	29.1	83.6	9.16	105	2.67
					Observed Significance Level[x]				
Lint Cleaner	0.0187	NS	NS	NS	NS	NS	NS	NS	NS
Cultivar	<0.0001	<0.0001	<0.0001	NS	<0.0001	<0.0001	<0.0001	NS	0.0176
Cultivar x LC	NS	NS	NS	NS	NS	NS	NS	NS	NS

[z] Means followed by the same letter in each column are not different based on Tukey's studentized range test ($P \leq 0.05$).
[y] Old code, 100=31, 104=21, 105=11
[x] NS = not statistically significant at ($P > 0.05$).

Tables 6 and 7 show the AFIS results on the lint separated from the lint cleaner trash with the Shirley Analyzer. There were no differences among grid bar designs with respect to fiber length, short fiber content, nep size, seed coat nep count and size, total trash count, trash size, and visible foreign matter. As mentioned earlier, seed coat nep count was used as an indicator for SCFs. As was found before in the lint sample taken at the press after lint cleaning, there were no differences among grid bar designs for seed coat nep count in the lint portion separated from the lint cleaner trash.

There were small differences in fineness, immature fiber content, maturity ratio, and nep count of the lint portion of the lint cleaner trash among grid bar designs (table 6). Fineness ranged from 145 m-tex with the 60° grid bar to 147 m-tex with the 0°R grid bar, immature fiber content ranged from 10.7% for both the 105° and 0°R grid bars to 11.3% for the 60° grid bar, maturity ratio ranged 0.79 for the 60° grid bar to 0.81 for the 0°R grid bar, and nep count ranged from 634 neps per gram with the 0°R grid bar to 708 neps per gram with the 45° grid bar.

Tables 6 and 7 also show that most of the AFIS fiber properties on the lint portion found in the lint cleaner trash was different between cultivars. Fiber length averaged 19.8 mm (0.78 in) for FiberMax and 18.1 (0.71 in) for the fragile cultivar, which as expected was considerably shorter than fiber length found in the lint sample at the press (about 23.4 mm or 0.92 in, table 3). Nep count averaged 993 per gram for FiberMax and 370 per gram for the fragile cultivar and total trash count averaged 633 per gram for FiberMax and 336 per gram for the fragile cultivar.

Short fiber content and seed coat nep count on the lint portion found in the lint cleaner trash was not different between cultivars; short fiber content averaged 27.2%, about double the amount of short fiber found in the lint sample at the press (12.7%, table 3), and seed coat nep count averaged 39.3 counts per gram. It is interesting that seed coat nep count was different between cultivars on lint samples taken at the press, but was not different between cultivars on the lint portion found in the lint cleaner trash.

Table 6. Means and statistical analysis of fiber properties in the lint portion of the lint cleaner trash measured by the Advanced Fiber Information System (AFIS) on samples after lint cleaning, by lint cleaner and cultivar treatment.

	Length	Length CV	Upper quartile length	Short fiber content	Fineness[z]	Immature fiber content[z]	Maturity ratio[z]	Nep Count[z]	Nep size
	mm	%	mm	%	m-tex	%	-	per g	µm
					Lint Cleaner Treatment				
105° Grid Bar	18.9	47.9	25.0	27.4	146 b	10.7 b	0.80 ab	693 ab	699
60° Grid Bar	18.6	48.0	24.6	28.1	145 b	11.3 a	0.79 b	691 ab	698
45° Grid Bar	19.1	47.9	25.3	26.8	146 ab	10.9 ab	0.80 ab	708 a	702
0°R Grid Bar	19.1	47.6	25.1	26.4	147 a	10.7 b	0.81 a	634 b	701
					Cultivar Treatment				
Fragile	18.1	45.8	23.6	27.5	159	9.50	0.83	370	705
FiberMax	19.8	49.9	26.4	26.8	133	12.3	0.76	993	695
					Observed Significance Level[y]				
Lint Cleaner	NS	NS	NS	NS	0.0110	0.0096	0.0278	0.0347	NS
Cultivar	<0.0001	<0.0001	<0.0001	NS	<0.0001	<0.0001	<0.0001	<0.0001	NS
Cultivar x LC	NS	NS	NS	NS	0.0117	0.0267	NS	NS	NS

[z] Means followed by the same letter in each column are not different based on Tukey's studentized range test (P≤0.05).

[y] NS = not statistically significant at (P>0.05).

Table 7. Means and statistical analysis of fiber properties in the lint portion of the lint cleaner trash measured by the Advanced Fiber Information System (AFIS) on samples taken after lint cleaning, by lint cleaner and cultivar treatment.

	Seed coat nep		Dust	Trash	Total trash	Trash	Visible foreign
	count	size	count	count	count	size	matter
	per g	mm	per g	per g	per g	µm	%
			Lint Cleaner Treatment				
105° Grid Bar	37.6	1122	507	17.0	525	144	0.36
60° Grid Bar	42.6	1113	501	15.9	518	141	0.33
45° Grid Bar	44.3	1118	529	21.8	552	152	0.47
0°R Grid Bar	32.9	1168	330	13.0	344	145	0.27
			Cultivar Treatment				
Fragile	40.0	1173	322	13.4	336	146	0.27
FiberMax	38.6	1087	612	20.5	633	146	0.44
			Observed Significance Level[z]				
Lint Cleaner	NS	NS	NS	NS	NS	NS	NS
Cultivar	NS	<0.0001	0.0013	0.0218	0.0013	NS	0.0144
Cultivar x LC	NS	NS	NS	NS	NS	NS	NS

[z] NS = not statistically significant at (P>0.05).

Table 8 shows the Shirley Analyzer results on trash content in the lint sample taken at the press and trash content in the lint cleaner trash. Visible trash content in the lint was different among grid bar designs and between cultivars. The 45° grid bar was the least effective in trash removal since it had the highest trash content in the lint; visible lint trash content was 2.83% with the 45° grid bar and 2.65% on the three remaining grid bars. The fragile cultivar was trashier to start with (table 1), thus it is not surprising that the visible trash in the lint was 3.24% for the fragile cultivar versus 2.16% for FiberMax.

Visible trash content in the lint cleaner trash was different among grid bar designs but not between cultivars (table 8). The 0°R grid bar had the lowest amount of trash (53.5% versus 61.6% for the three remaining grid bars). Lint loss in the lint cleaner trash was different among grid bar designs and between cultivars. The 0°R grid bar removed the lint with the trash at 4.05% and the 45° grid bar was less aggressive as it removed the least amount of lint (2.43%). Also, it appeared that among those grid bars with a definite edge or edges (the 105°, 60°, and 45° grid bars), the amount of lint loss decreased as the angle of the grid bar decreased. With respect to cultivar, lint loss in the lint cleaner trash averaged 3.37% and 2.88% for the fragile cultivar and FiberMax, respectively.

Table 8. Means and statistical analysis of foreign matter content in the lint and foreign matter content in the lint cleaner trash measured by the Shirley Analyzer and lint loss in the lint cleaner, by lint cleaner and cultivar treatment.

	Trash content in lint, vis.[z]	Trash content in lint, inv.	Trash content in LC trash, vis.[z]	Trash content in LC trash, inv.	Lint loss in LC trash[z]
	%	%	%	%	%
			Lint Cleaner Treatment		
105° Grid Bar	2.68 b	1.13	59.2 a	4.62	3.14 b
60° Grid Bar	2.68 b	1.15	62.0 a	4.34	2.88 bc
45° Grid Bar	2.83 a	1.15	63.7 a	4.38	2.43 c
0°R Grid Bar	2.60 b	1.21	53.5 b	4.38	4.05 a
			Cultivar Treatment		
Fragile	3.24	0.91	58.6	3.56	3.37
FiberMax	2.16	1.41	60.6	5.30	2.88
			Observed Significance Level[y]		
Lint Cleaner	0.0003	NS	0.0005	NS	<0.0001
Cultivar	<0.0001	<0.0001	NS	<0.0001	0.0014
Cultivar x LC	NS	NS	NS	NS	NS

[z] Means followed by the same letter in each column are not different based on Tukey's studentized range test (P≤0.05).
[y] NS = not statistically significant at (P>0.05).

Summary

As expected, there were noticeable differences in fiber and lint cleaner trash properties between the fragile seed coat and FiberMax cultivars. However, there were very few differences in fiber properties among grid bar treatments. Seed coat nep count, used as an indicator for the presence of SCFs, was not different among grid bar designs in either the lint sample after lint cleaning or the lint portion of the lint cleaner trash. It should be noted that there was quite a bit of variability in seed coat nep count, as well as the manual count of SCFs. There were differences in trash content in the lint and lint loss in the lint cleaner trash, among grid bar designs. It appeared that the 105°, 60°, and 45° grid bars (those with one or more active edges) had less lint loss as the angle of the sharp toe of the grid bar decreased.

Future work includes using the high-speed video camera in real time on the full-size lint cleaner. The high-speed camera is a valuable tool that may help in understanding the interaction between grid bar design and grid bar-to-saw clearance. This study used a larger clearance between the grid bar and lint cleaner saw than what was used on a previous study, using a lint cleaner simulator. The experiment will be rerun with treatments that use different clearances between the grid bar and lint cleaner saw, as well as using a control set of grid bars mounted on the same lint cleaner as the experimental grid bars.

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