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Feasibility of Applying Seedcotton Cleaning Principles to Lint Cleaning

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INTERPRETIVE SUMMARY

The saw-type lint cleaners used at gins to clean upland cotton cultivars improve the grade classification and market value of the bale but reduce some quality factors desired at the spinning mill, mainly long fibers with few neps. Experiments were conducted to evaluate the feasibility of cleaning lint by applying principles and systems normally used to extract foreign matter from seedcotton. It was hoped that the less aggressive seedcotton-type cleaner would cause less fiber damage. The seedcotton-type cleaners used as lint cleaners in the study were individually effective in removing an average 13% of the trash from lint, and the cleaned fibers tended to have longer fibers than those in cotton subjected to a stage of saw lint cleaning. Thus, the experiments showed that it might be feasible to use a stage of seedcotton-type lint cleaner to supplement lint cleaning with one saw-cylinder cleaner, in place of adding a second stage of saw-type lint cleaning.

ABSTRACT

Cotton (*Gossypium hirsutum* L.) fibers are cleaned at gins with saw-type lint cleaners to improve the market value, but the aggressive saws sometimes harm the quality of the fiber. Cleaners for seedcotton are less aggressive than saw-type cleaners. In an attempt to improve fiber quality during ginning, experiments were conducted to evaluate the feasibility of cleaning lint by applying principles and systems normally used to extract foreign matter from seedcotton. The cleanliness and quality of lint cotton cleaned with 10 combinations of seedcotton cleaning machines were compared with saw-type lint cleaners. The cleaning efficiency of one saw-type lint cleaner averaged 54%, and the efficiencies of seedcotton cleaners used as lint cleaners ranged from 9 to 16%. There was a significant improvement in the classers' leaf grade designations when lint was cleaned with each of the seedcotton-type cleaners. Staple lengths tended to be shorter after cleaning with saw-type cleaners. A modified non-saw cleaner appears practical and could help preserve fiber quality at cotton gins.

The generally recommended machinery sequence at gins for spindle-picked cotton is rock and green-boll trap, feed control, tower drier, cylinder cleaner, stick machine, tower drier, cylinder cleaner, extractor feeder, gin stand, lint cleaner, lint cleaner, and press. A complete description of machines for the ginning industry is provided by and Anthony et al. (1994).

Cylinder cleaners use rotating spiked drums that open and clean the seedcotton by scrubbing it across a grid-rod or wire mesh screen that allows the trash to sift through. The stick machine utilizes the sling-off action of channel-type saw cylinders to extract foreign matter from the seedcotton by centrifugal force. In addition to feeding seedcotton to the gin stand, the extractor feeder cleans the cotton using the stick machine's sling-off principle. In some cases the extractor-feeder is a combination of a cylinder cleaner and an extractor.

Sometimes an impact or revolving screen cleaner is used in addition to the second cylinder cleaner. In the impact cleaner, seedcotton is conveyed across a series of revolving, serrated disks instead of the grid-rod or wire mesh screen (Baker et al., 1994).

Lint cleaners at gins are mostly of the controlled-batt, saw type. In this cleaner a saw cylinder combs the fibers and extracts trash from the lint cotton by a combination of centrifugal force, scrubbing action between saw cylinder and grid bars, and gravity assisted by an air current (Mangialardi, 1972).

Seedcotton-type cleaners extract the large trash components from cotton. However, they have only a small influence on the cotton's grade index, visible

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lint foreign-matter content, and fiber length distribution when compared with the lint cleaning effects (Anthony, 1990). Also, the number of neps created by the entire seedcotton cleaning process is about the same as the increase caused by one saw-cylinder lint cleaner (Mangialardi, 1985).

Most cotton gins today use one or two stages of saw-type lint cleaners. The use of too many stages of lint cleaning can reduce the market value of the bale, because the weight loss may offset any gain from grade improvement. Increasing the number of saw lint cleaners at gins, in addition to increasing the nep count and short-fiber content of the raw lint, causes problems at the spinning mill. These show up as more neps in the card web and reduced yarn strength and appearance (Baker, 1972; Mangialardi, 1972).

Pima cotton, extra-long-staple cotton, is roller ginned to preserve its length and to minimize neps. To maintain the highest possible quality bale of pima cotton, mill-type lint cleaners were for a long time the predominant cleaner used by the roller-ginning industry. Today, various combinations of impacts, incline, and pneumatic cleaners are used in most roller-ginning plants to increase lint-cleaning capacity. During the 1989-1990 season the most common lint-cleaning sequence was an incline, impact, and air-jet; 35% of the cotton-ginning plants had such an arrangement (Hughs and Gillum, 1991).

A revolving-screen cleaner, commercially known as the impact cleaner[1] (Continental Eagle of Prattville, AL), was evaluated in its cleaning of roller-ginned upland lint at a commercial gin in 1991. In the study the cleaner, which contained seven sets of spiked cylinders and serrated discs, produced an average cleaning efficiency of 12%. Classer's grades were improved one-fourth to one-third grade. After cleaning, fewer samples were discounted in grade due to bark content (Mangialardi, 1993).

Preliminary experiments were conducted at the U.S. Cotton Ginning Lab, USDA-ARS, Stoneville, MS, in 1991 to show that it may be feasible to utilize seedcotton-type cleaners to serve as lint cleaners in saw ginning plants. These would be used to supplement lint cleaning with one saw-cylinder lint cleaner in place of adding a second stage of saw-type lint cleaning. Among five seedcotton-type cleaners used as lint cleaners, the impact cleaner gave a cleaning efficiency of 12%, and the lowest count and weight for seed-coat fragments and motes. The highest cleaning efficiency of 17% was obtained with the Trashmaster cleaner (Mangialardi, 1992).

The cotton gin and textile mill industries expressed particular interest in the 1991 Stoneville, MS, preliminary tests, indicating their desire for the work be continued to reduce the number of imperfections in ginned lint and improve fiber quality. Therefore, the work of applying to lint cleaning the principles and systems normally used to extract foreign matter from seedcotton was expanded in the 1993-1994 ginning season; this report discusses the results from those experiments.

MATERIALS AND METHODS

Ginning Machinery

The cottons in the study were saw ginned in the small-scale ginning plant at the U.S. Ginning Lab in Stoneville. The saw-ginning sequence consisted of a 24-shelf tower drier, six-cylinder cleaner, stick machine, 24-shelf tower drier, six-cylinder cleaner, extractor-feeder, 20-saw (40.6 cm [16-in] diameter) gin stand, and the experimental lint-cleaning treatments.

Procedures

Seedcotton used in the experiment was grown and spindle-harvested by the Delta Research and Extension Center, Mississippi Agricultural and Forestry Experiment Station, and the USDA-ARS Field Crops Mechanization Research Unit, Stoneville, MS. The cotton was harvested 21 Sept. to 14 Oct. 1993, and ginned 20-22 Oct. 1993.

Forty 16.4 kg (36 lb) size test lots were processed in the experiment. These involved four replications; two replications each of two cotton cultivars that were given 10 lint cleaning treatments. Two cultivars, a smooth and a hairy leaf type, were selected to include the easy- and difficult-to-clean cotton types. The hairy-leaf type was Delta Experiment Station (DES) 119; the smooth,

[1] Mention of a trade name, a propriety product, or specific equipment does not constitute a guarantee or warranty by the USDA and does not imply approval of a product to the exclusion of others that may be suitable.

Deltapine (DPL) 50. Both are widely grown in the Mid-South.

The lint cleaner treatments used combinations of seedcotton cleaning machines and saw-type lint cleaners as lint cleaning processes. The 10 lint-cleaning combinations or cleaners consisted of the following:

Treatment 1	No lint cleaning.
Treatment 2	One saw-cylinder lint cleaner.
Treatment 3	Two saw-cylinder lint cleaners.
Treatment 4	Six-cylinder seedcotton cleaner.
Treatment 5	Stick machine.
Treatment 6	Trashmaster seedcotton cylinder cleaner.
Treatment 7	Impact seedcotton cleaner.
Treatment 8	Extractor feeder.
Treatment 9	Impact cleaner and one saw lint cleaner.
Treatment 10	Six-cylinder cleaner, stick machine, Trashmaster cleaner, impact cleaner, and extractor feeder.

The saw-cylinder lint cleaners used a 40.6 cm (16 in) diameter saw that rotated at 872 rpm with a combing ratio of 26. When used as lint cleaners, the seedcotton cleaning machinery operated with adjustments and at speeds recommended for cleaning seedcotton.

During the experiment, the temperature and relative humidity of the atmosphere within the gin plant were set at 22 ºC (72 ºF) and 55%. The test lots also were conditioned in this atmosphere for at least 24 h prior to the experiment. Test lots were assigned to the lint-cleaning treatments in a randomized arrangement to neutralize the effects of processing order.

The first tower drier was set at a drying temperature of 82 ºC (180 ºF) at the top of the drier (mixpoint), while no heat was used on the second drier. To use a seedcotton cleaner as a lint cleaner, lint ginned with no lint cleaning was fed from the feed controller to a condenser above the seedcotton cleaner; after passage through the cleaner, the cleaned lint was collected at a second condenser. Lint collected from a seedcotton cleaner was fed manually to the saw-type lint cleaner for treatment 9. This procedure ensured that the lint was processed through the same number of condensers for each treatment to preclude any minor differences in trash separation. Lint was fed to all cleaners at a rate consistent with that of the small-scale ginning plant.

During the processing of each experimental lot, samples were obtained for seedcotton moisture and foreign-matter contents before and after seedcotton cleaning; and for lint moisture content, classer's grade and staple length, lint foreign-matter content and lint cleaning efficiency, and fiber tests after lint cleaning. Seedcotton, lint, and lint cleaner waste from each test lot were monitored, collected, and weighed.

Moisture contents (wet basis) were determined by the standard oven method and seedcotton foreign-matter contents by the fractionation procedure. Foreign-matter or nonlint content of the lint was ascertained by subjecting samples to the Shirley Analyzer procedure (American Society for Testing and Materials, 1985a).

The lint cleaners' efficiencies were calculated from lint foreign-matter determinations. Cleaning efficiency is defined as the ratio of foreign matter removed from cotton to the foreign-matter content of the cotton as it entered the cleaner, expressed as a percentage.

Fiber tests included high volume instrument (HVI) measurements, Peyer length distribution, nep counts (USDA, 1982), and seed-coat fragment levels. The U.S. Agricultural Marketing Service classed the samples manually and on the HVI system at Greenwood, MS, and made the nep counts (neps per 100 in^2 of web) at Clemson, SC. Peyer length measurements and seed-coat fragment counts were made at the Cotton Ginning Lab at Stoneville. Seed-coat fragments were counted manually using magnifying lens under light (American Society for Testing and Materials, 1985b).

The study was designed as a randomized complete block experiment, replications being the blocks. Significant differences were tested at the $P = 0.05$ level using analysis of variance (ANOVA). Comparisons among the 10 lint cleaner treatments were made at the $P = 0.05$ level using the Waller-Duncan's multiple range test (Steel and Torrie, 1980).

In the tables of this report the study averages in a column for the cultivars and for the lint cleaner treatments not having a letter in common are significantly different. Where letters are not shown,

the differences were not significant at the $P = 0.05$ level.

RESULTS AND DISCUSSION

The temperature and relative humidity of the atmosphere within the gin plant averaged 24° C (76° F) and 49% during the experiments. Ginning rates in the small-scale ginning plant averaged 0.54 bale h^{-1}, which is equivalent to 5.91 kg (13 lb) of lint per saw per hour or 8.5 kg (18.6 lb) of lint per 2.5 cm (1.0 in) of seed-roll width per hour). The saw lint cleaners were loaded at a rate of 0.51 bale h^{-1} per 30.6 cm (1 ft) of saw-cylinder length. The lint was fed through the seedcotton cleaners at a rate of about 0.61 bale h^{-1} per 30.6 cm (1 ft) of cleaning machinery width.

Tables 1-7 summarize the data for the 10 lint cleaner treatments. Fractionation tests showed that the average initial seedcotton foreign-matter contents ranged from 4.0 to 4.9% among the 10 treatments (Table 1). After seedcotton drying and cleaning, foreign-matter content of the seedcotton averaged about 1.8%. Initial wagon seedcotton moisture content ranged from 88 to 94 g kg^{-1} (8.8-9.4%) for the 10 treatment combinations. After seedcotton drying, moisture content of the seedcotton averaged 83 g kg^{-1} (8.3%) in the conditioned atmosphere saw ginning facility. Lint samples taken after ginning and lint cleaning showed that the lint moisture content for the test treatments ranged from 51 to 58 g kg^{-1} (5.1-5.8%), and averaged 53 g kg^{-1} (5.3%).

Lint Foreign Matter Content

Foreign-matter content in ginned lint, as measured by the Shirley Analyzer total waste content, was 4.7% with no lint cleaning and decreased to 2.1% after two saw lint cleaners (Table 2). The lint foreign matter content (total waste basis) decreased in the following order of lint cleaner treatments: stick machine > Trashmaster cleaner > extractor feeder > impact cleaner > six-cylinder cleaner > stick machine, Trashmaster cleaner, impact cleaner, and extractor feeder combination > one saw lint cleaner > impact cleaner and one saw lint cleaner > two-saw lint cleaners.

Foreign matter content in the ginned lint, based on the Shirley Analyzer visible waste data, showed the same trend as the total foreign matter content but averaged about 1.2% lower. The impact cleaner and one saw lint cleaner combination also gave a slightly lower visible waste content compared with use of one saw lint cleaner alone.

Among the five types of non-saw lint cleaners used, the lint foreign-matter content (visible waste basis) decreased in the following order: stick machine, extractor-feeder, impact cleaner, Trashmaster cleaner, and six-cylinder cleaner.

Table 1. Seedcotton data and lint moisture content for seedcotton type lint cleaning experiment. (Data are the averages for two cultivars.)

Treatment †	Seedcotton				Lint moisture content
	Moisture content ‡		Foreign matter content §		
	Wagon	Feeder apron	Wagon	Feeder apron	
	g kg^{-1} (%)		- - - - - % - - - - -		g kg^{-1} (%)
1	92 (9.2)	86a ¶ (8.6)	4.6	1.8	56ab (5.6)
2	92 (9.2)	82ab (8.2)	4.7	1.7	52bc (5.2)
3	88 (8.8)	84ab (8.4)	4.9	1.9	51c (5.1)
4	89 (8.9)	86ab (8.6)	4.0	1.8	52bc (5.2)
5	90 (9.0)	83ab (8.3)	4.6	1.8	51c (5.1)
6	94 (9.4)	84ab (8.4)	4.5	1.9	54abc (5.4)
7	89 (8.9)	81ab (8.1)	4.8	1.7	52bc (5.2)
8	90 (9.0)	80b (8.0)	4.6	1.8	52bc (5.2)
9	91 (9.1)	82ab (8.2)	4.6	1.9	58a (5.8)
10	89 (8.9)	81ab (8.1)	4.8	1.7	51c (5.1)
Average	90 (9.0)	83 (8.3)	4.6	1.8	53 (5.3)

† Treatments: (1) no lint cleaning; (2) 1 saw lint cleaner; (3) 2 saw lint cleaners; (4) six-cylinder cleaner; (5) stick machine; (6) Trashmaster cleaner; (7) impact cleaner; (8) extractor feeder; (9) 1 impact cleaner and 1 saw lint cleaner; (10) six-cylinder cleaner, stick machine, Trashmaster cleaner, impact cleaner, and extractor feeder.

‡ Based on the oven drying method.

§ Based on the fractionation procedure.

¶ Means in a column not having a letter in common are significantly different at $P = 0.05$ according to the Waller-Duncan's multiple range test. Where letters are not shown, the differences were not significant.

Table 2. Lint foreign-matter content and cleaning efficiency for seedcotton-type lint cleaning experiment†.

	Foreign matter content §		Lint-cleaning efficiency	
Treatment ‡	Visible waste	Total waste	Visible waste basis	Total waste basis
	----------%----------			
1	3.47a¶	4.73a	—	—
2	1.63e	2.93e	53.7b	37.4b
3	1.08f	2.13f	69.1a	53.3a
4	2.92c	4.13c	15.6d	11.9d
5	3.20b	4.58ab	9.0d	5.9d
6	2.97c	4.37bc	14.0d	7.9d
7	2.98c	4.18c	13.5d	11.9d
8	3.06bc	4.25bc	12.2d	10.4d
9	1.50e	2.75e	57.3b	41.0b
10	2.38d	3.67d	29.9c	20.6c
Average	2.52	3.77	30.5	22.2

† Data are the averages for two cultivars.

‡ Treatments: (1) no lint cleaning; (2) 1 saw lint cleaner; (3) 2 saw lint cleaners; (4) six-cylinder cleaner; (5) stick machine; (6) Trashmaster cleaner; (7) impact cleaner; (8) extractor feeder; (9) 1 impact cleaner and 1 saw lint cleaner; (10) six-cylinder cleaner, stick machine, Trashmaster cleaner, impact cleaner, and extractor feeder.

§ Samples were subjected to Shirley Analyser tests.

¶ Means in a column not having a letter in common are significantly different at the $P = 0.05$ according to the Waller-Duncan's multiple range test. Where letters are not shown, the differences were not significant.

Among the seedcotton type cleaners, lint appeared visually to have the greatest resident time in the Trashmaster cleaner. Some of the lint appeared to be recycling between cleaning cylinders.

Cleaning Efficiency

Foreign-matter content removal data (total waste), presented as cleaning efficiency, showed that the efficiencies of the lint cleaner treatments ranged from 5.9% for the stick machine to 53.3% for two saw-cylinder lint cleaners (Table 2); the efficiency for one saw lint cleaner was 37.4%. Using the visible waste data to calculate lint cleaner efficiency gave somewhat higher cleaning efficiencies.

Among the non-saw type lint cleaners, the six-cylinder cleaner gave the higher cleaning efficiency (11.9%) while the combination of five non-saw cleaners (treatment 10) gave an average efficiency of 20.6%. The efficiency of the saw lint cleaner (treatment 2), at 37.4%, was more than three times as high as the best seedcotton cleaner efficiency, which was 11.9%.

Classer's Grades and Staple Lengths

The two stages of saw-cylinder lint cleaning increased the average color grade index from 95.6 to 102.0; 53% of this improvement was obtained with the first stage, and the remaining 47% with the second stage (Table 3). Further discussion on the components of color (greyness and yellowness) is included in the next section.

Ginned lint that was cleaned with one saw cleaner improved an average 1.5 leaf grade designations. Those that were cleaned with two saw lint cleaners averaged two leaf grades higher. There was an improvement in the leaf grade when the lint was cleaned with each of the non-saw type cleaners. The combination of five seedcotton type cleaners (treatment 10) raised the leaf designation about two grades. Among the individual non-saw type of cleaners, the six-cylinder cleaner and Trashmaster cleaner gave the highest (least desirable) leaf grade. Leaf grades for each of the non-saw lint cleaner treatments were discounted at level 1 (light) for preparation.

High Volume Instrument Measurement

Some of the HVI measurements supported the manual classing and lint foreign-matter content data (Table 4). Increased lint cleaning increased the greyness or reflectance (Rd) values, lowered the visible trash content, and gave some improvement in the color grade index. All treatments except the stick machine improved reflectance with the saw-type lint cleaners, and the saw-type lint cleaner combined with the impact cleaner had the most influence. Yellowness (+b) was improved significantly by five of the treatments. These changes in reflectance and +b are responsible for the changes in classer's and HVI color.

The micronaire readings averaged 4.9. Length uniformity decreased somewhat with each lint cleaner treatment used. The reductions obtained with the saw lint cleaners, the impact cleaner, and five-cleaner combination (treatment 10) were each significant. This finding indicated that standard seedcotton cleaners used in series to clean lint could

Table 3. Classer's color and leaf grades data for seedcotton-type lint cleaning experiment†.

Treatment ‡	Color grade §		Leaf grade designation	Preparation
	Index	Designation		
				no.¶
1	95.6e #	41	4.4a	0.2b
2	99.0bcd	31	3.0cd	0.0b
3	102.0a	31/21	2.4e	0.0b
4	97.6bcde	41/31	3.0cd	2.8a
5	97.0cde	41/31	3.6b	2.8a
6	96.6de	41/31	3.0cd	2.8a
7	96.0e	41	3.4bc	2.5a
8	95.5e	41/31	3.4bc	2.2a
9	100.0ab	31	3.0cd	0.0b
10	99.5abc	31	2.6de	3.0a
Average	97.9	41/31	3.2	1.6

† Data are the averages for two cultivars.

‡ Treatments: (1) no lint cleaning; (2) 1 saw lint cleaner; (3) 2 saw lint cleaners; (4) six-cylinder cleaner; (5) stick machine; (6) Trashmaster cleaner; (7) impact cleaner; (8) extractor feeder; (9) 1 impact cleaner and 1 saw lint cleaner; (10) six-cylinder cleaner, stick machine, Trashmaster cleaner, impact cleaner, and extractor feeder.

§ Color grade index and corresponding grade designations: 104 = 21, 100 = 31, 94 = 41, 97 = 32.

¶ Number of samples tested that were discounted because of light levels of bark or poor preparation.

Means in a column not having a letter in common are significantly different at $P = 0.05$ according to the Waller-Duncan's multiple range test. Where letters are not shown, the differences were not significant.

Table 4. High volume instrument (HVI) measurements for lint samples in seedcotton type lint cleaning experiment†.

Treatment ‡	Micronaire reading	HVI length	Length uniformity	Strength	Color grade		Color reading		Trash (non- lint) content
					Index	Designation	Reflectance (Rd)	+b	
		cm (in)	%	0.32cm gauge			%	units	%
1	4.94	2.93 (1.154)	84.2a §	29.4	94.5d	41	73.4d	8.2b	0.7ab
2	4.86	2.88 (1.134)	83.1bc	28.6	99.0a	31	75.2a	8.4ab	0.4c
3	4.87	2.87 (1.130)	83.3bc	28.4	99.5a	31	75.7a	8.6a	0.2d
4	4.88	2.91 (1.146)	83.6abc	28.9	95.5bcd	41	73.9c	8.4ab	0.6b
5	4.93	2.93 (1.154)	83.6abc	29.4	95.0cd	41	73.4d	8.2b	0.9a
6	4.97	2.91 (1.146)	83.7ab	29.1	96.5b	41/31	74.4bc	8.2b	0.7ab
7	4.92	2.90 (1.142)	83.3bc	29.4	96.0bc	41/31	74.2bc	8.3ab	0.6b
8	4.88	2.92 (1.150)	84.0a	29.4	96.5b	41/31	74.0c	8.2b	0.6b
9	4.91	2.87 (1.130)	83.0c	28.6	98.5a	31	75.4a	8.4ab	0.4c
10	4.91	2.88 (1.134)	83.2bc	29.2	96.5b	41	74.7b	8.4ab	0.5c
Average	4.91	2.90 (1.142)	83.5	29.0	96.8	41/31	74.4	8.3	0.6

† Data are the averages for two cultivars.

‡ Treatments: (1) no lint cleaning; (2) 1 saw lint cleaner; (3) 2 saw lint cleaners; (4) six-cylinder cleaner; (5) stick machine; (6) Trashmaster cleaner; (7) impact cleaner; (8) extractor feeder; (9) 1 impact cleaner and 1 saw lint cleaner; (10) six-cylinder cleaner, stick machine, Trashmaster cleaner, impact cleaner, and extractor feeder.

§ Means in a column not having a letter in common are significantly different at $P = 0.05$ according to the Waller-Duncan's multiple range test. Where letters are not shown, the differences were not significant.

Table 5. Peyer length measurements for seedcotton-type lint cleaning experiment†.

Treatment ‡	Upper 25% length	Mean length	Short fiber content	Coefficient of variation
	----------cm (in)----------		----------%----------	
1	2.76 (1.086)a §	2.33 (0.918)a	5.8d	25.8c
2	2.66 (1.048)b	2.23 (0.879)bc	8.2ab	27.3ab
3	2.66 (1.047)b	2.23 (0.879)bc	7.7abc	26.8abc
4	2.69 (1.058)b	2.27 (0.892)b	6.8cd	26.2bc
5	2.69 (1.060)b	2.27 (0.894)b	7.2bc	26.6abc
6	2.68 (1.057)b	2.26 (0.890)bc	7.2bc	26.5abc
7	2.70 (1.062)b	2.27 (0.893)b	7.4bc	26.8abc
8	2.68 (1.057)b	2.26 (0.888)bc	7.8abc	27.0abc
9	2.66 (1.046)b	2.22 (0.874)c	8.9a	27.9a
10	2.68 (1.054)b	2.23 (0.879)bc	8.4ab	27.7a
Average	2.69 (1.058)	2.26 (0.888)	7.5	26.8

† Data are the averages for two cultivars.

‡ Treatments: (1) no lint cleaning; (2) 1 saw lint cleaner; (3) 2 saw lint cleaners; (4) six-cylinder cleaner; (5) stick machine; (6) Trashmaster cleaner; (7) impact cleaner; (8) extractor feeder; (9) 1 impact cleaner and 1 saw lint cleaner; (10) six-cylinder cleaner, stick machine, Trashmaster cleaner, impact cleaner, and extractor feeder.

§ Means in a column not having a letter in common are significantly different at the 5-percent level according to the Waller-Duncan's multiple range test. Where letters are not shown, the differences were not significant.

reduce uniformity to a level similar to that found with saw lint cleaners. Fiber strength (0.32 cm or 1/8 in gauge) averaged 29.0 g tex^{-1} for the study. Strength ranged from 28.4 to 29.4 g tex^{-1} and was not affected significantly by the lint cleaner treatments.

Peyer Fiber Length

Fiber length measurements made on the Peyer Fiber Length Measuring Unit AL-101/Fibroliner FL-101 System showed that the upper 25% length and mean length generally decreased, and the short fiber content (less than 1.27 cm [0.50 in]) and coefficient of variation (CV) increased somewhat with lint cleaning (Table 5).

Treatments using saw-type lint cleaners generally gave the shorter fiber lengths. Throughout the study, one saw lint cleaner decreased the upper 25% length 0.1 cm (0.04 in) and increased the short fiber content 2.4 percentage points. Among the treatments using non-saw type lint cleaners, fiber length differences were small and not significant. The combination of five seedcotton-type cleaners (treatment 10) produced the same overall mean length as one saw-type lint cleaner.

Nep Count

Neps per 645 cm^2 (100 in^2) of web ranged from 7.5 for cotton ginned with no lint cleaning to 12.5 when the ginned lint was cleaned with the Trashmaster cleaner (Table 6). Somewhat surprisingly, the one stage of saw-cylinder lint cleaning gave the lowest nep count increase, lower than any of the non-saw type cleaners.

The Trashmaster cleaner and the six-cylinder cleaner gave the highest increases in nep count among the individual cleaning machines. Differences in count were statistically significant only between cottons ginned with no lint cleaning and those ginned with the six-cylinder cleaner or Trashmaster cleaner. The average counts for these were each higher than those obtained when two saw lint cleaners were used. This suggests that further research to identify the causatives of neps within these machines is necessary.

Seed-Coat Fragment Content

There were no significant differences in the seed-coat fragment counts among the 10 tested treatments. However, the extractor feeder gave the lowest average count (75 fragments per 3 g), followed by the six-cylinder cleaner, while the impact and one saw-cylinder lint cleaner setup gave the highest count of 108 per 3 g (Table 6). The weight of the fragments decreased in the following order of lint cleaner treatments: treatment 10 (five-cleaner combination) > stick machine > impact cleaner and one saw lint cleaner > no lint cleaning > extractor feeder > Trashmaster cleaner > impact cleaner > six-cylinder cleaner > one saw lint cleaner > two saw lint cleaners. Thus, the six-cylinder cleaner gave the

Table 6. Nep count and cottonseed fragment data for seedcotton-type lint cleaning experiment†.

		Seed-coat fragment		Mote		Funiculi	
Treatment ‡	Neps	Count	Weight	Count	Weight	Count	Weight
	no. / 645 cm² (100 in²) of web	no. / 3g	mg / 3g	no. / 3g	mg / 3g	no. / 3g	mg / 3g
1	7.5b §	79	26.9ab	6.0bc	35.7c	21.2a	5.2a
2	8.8ab	106	20.9b	2.8d	12.7de	6.4e	1.9cd
3	11.5ab	94	19.2b	2.6d	10.6de	4.2e	1.3d
4	12.0a	76	23.4b	7.6a	56.2ab	10.5cd	3.1bc
5	11.2ab	102	35.4a	5.8bc	45.7abc	14.6b	5.2a
6	12.5a	86	24.6b	5.2c	38.4abc	12.1bc	3.3bc
7	10.0ab	85	24.0b	5.5bc	30.7cd	10.8bcd	3.0bc
8	10.5ab	75	24.9b	7.0ab	57.6a	13.1bc	3.5b
9	11.0ab	108	27.1ab	2.0d	8.7e	7.2de	2.2bcd
10	11.2ab	90	36.6a	5.0c	36.8bc	8.0de	2.5bcd
Average	10.6	90	26.3	5.0	33.3	10.8	3.1

† Data are the averages for two cultivars.

‡ Treatments: (1) no lint cleaning; (2) 1 saw lint cleaner; (3) 2 saw lint cleaners; (4) six-cylinder cleaner; (5) stick machine; (6) Trashmaster cleaner; (7) impact cleaner; (8) extractor feeder; (9) 1 impact cleaner and 1 saw lint cleaner; (10) six-cylinder cleaner, stick machine, Trashmaster cleaner, impact cleaner, and extractor feeder.

§ Means in a column not having a letter in common are significantly different at $P = 0.05$ according to the Waller-Duncan's multiple range test. Where letters are not shown, the differences were not significant.

Table 7. Lint turnout and bale and lint cleaner waste weight for seedcotton-type lint cleaning experiment†.

Treatment ‡	Lint turnout§	Bale net weight	Lint cleaner waste weight	Bale value ¶
		kg (lb)#	kg/bale (lb/bale)	$/bale
1	35.2 ††	230.6 (508)a	—	335.89
2	33.8ab	221.6 (488)ab	6.6 (14.5)c	326.42
3	33.2b	217.9 (480)b	10.9 (24.1)a	321.07
4	35.0a	229.3 (505)ab	1.3 (2.8)ef	333.91
5	33.7ab	221.1 (487)ab	0.3 (0.7)f	322.00
6	34.6ab	227.5 (501)ab	1.5 (3.2)e	333.19
7	35.0a	229.7 (506)ab	1.0 (2.3)ef	336.52
8	35.1a	230.6 (508)a	1.0 (2.1)ef	337.85
9	33.5ab	220.2 (485)ab	7.6 (16.8)b	324.42
10	34.5ab	226.5 (499)ab	3.3 (7.2)d	329.94
Average	34.4	225.6 (497)	3.7 (8.2)	330.12

† Data are the averages for two cultivars.

‡ Treatments: (1) no lint cleaning; (2) 1 saw lint cleaner; (3) 2 saw lint cleaners; (4) six-cylinder cleaner; (5) stick machine; (6) Trashmaster cleaner; (7) impact cleaner; (8) extractor feeder; (9) 1 impact cleaner and 1 saw lint cleaner; (10) six-cylinder cleaner, stick machine, Trashmaster cleaner, impact cleaner, and extractor feeder.

§ Turnout is based on the amount of seedcotton fed to the gin stand.

¶ Based on average spot market prices for 1993 (USDA, 1998).

Bale net weight is adjusted to 218 kg (480 lb) of lint for the two saw-type lint cleaner treatment.

†† Means in a column not having a letter in common are significantly different at $P = 0.05$ according to the Waller-Duncan's multiple range test. Where letters are not shown, the differences were not significant.

lowest fragment weight among the treatments using non-saw type cleaners.

The lowest count and weight of motes was obtained when using saw-type lint cleaners; the decreases with lint cleaning were significant at $P = 0.05$. These decreases are accomplished by the saw actions extracting some motes and breaking up others. Although saw lint cleaners remove some seed-coat fragments, it is surmised that high fragment counts after saw lint cleaning is related to new fragments being created by the breakup of motes. Two saw-cylinder lint cleaners gave the lowest funiculi count and weight. Among the seedcotton-type cleaners, the six-cylinder cleaner gave the lowest funiculi count and the impact cleaner produced the lowest weight of funiculi.

Lint Turnout, Waste and Bale Value

The lint turnout averaged 34.4% (Table 7). Net lint weight and lint cleaner waste for the test lots were adjusted to 218 kg (480 lb) bales after two saw

lint cleaners. This procedure showed that the first saw lint cleaner extracted about 6.8 kg (15 lb) of waste per bale and the second saw lint cleaner removed an additional 4.1 kg (9 lb). The individual non-saw lint cleaner average waste weights ranged from a high of 1.5 kg (3.2 lb) to a low of 0.3 kg (0.7 lb) in the following descending order of waste removal; Trashmaster cleaner 1.5 kg (3.2 lb), six-cylinder cleaner 1.3 kg (2.8 lb), impact cleaner 1.0 kg (2.3 lb), extractor-feeder 1.0 kg (2.1 lb), stick machine 0.3 kg (0.7 lb).

Bale value, based on the average spot market prices for 1993, ranged from $321.07 for two saw-type lint cleaners to $337.85 for the extractor-feeder only, which clearly indicates the need for more selective cleaning of lint to include development of new technology. These values were calculated without regard to reductions due to "poor preparation" because the classers' calls were inconsistent for the three subsamples, with the exception of those treatments that included a saw-type lint cleaner, which did not have any reductions. Saw-type lint cleaners comb and blend lint and prevent classers from assigning preparation reductions. Future work must consider the preparation aspect of lint cleaning.

SUMMARY AND CONCLUSIONS

Experiments were conducted to determine whether it would be feasible to utilize or modify seedcotton-type cleaners to serve as lint cleaners in saw ginning plants. These cleaners are less aggressive than saw-cylinder lint cleaners and it was thought their use should improve cotton quality by reducing the short fiber and nep content of ginned lint.

Using both hairy leaf and smooth leaf cottons with two replications each for a total of four replications, 10 lint-cleaning treatments were processed. The treatments involved exploring combinations of seedcotton cleaning machines and saw-type lint cleaners as lint cleaning processes. The 10 experimental lint cleaning combinations or cleaners were (1) no lint cleaning, (2) one saw-cylinder lint cleaner, (3) two saw-cylinder lint cleaners, (4) a six-cylinder seedcotton cleaner, (5) a stick machine, (6) Trashmaster seedcotton cylinder cleaner, (7) impact seedcotton cleaner, (8) extractor feeder, (9) impact cleaner and one saw lint cleaner, and (10) six-cylinder cleaner, stick machine, Trashmaster cleaner, impact cleaner, and extractor feeder.

Among the treatments tested, the greater amounts of lint foreign matter (visible waste) were extracted by the following cleaning processes in a declining efficiency order: Efficiency of two-saw-cylinder lint cleaners > one impact and one saw-cylinder lint cleaner > one saw-cylinder lint cleaner > one six-cylinder cleaner > a stick machine, one Trashmaster cleaner, an impact cleaner, and an extractor-feeder combination > one six-cylinder cleaner > one Trashmaster cleaner > one impact cleaner > one extractor-feeder > one stick machine.

The cleaning efficiency of one saw-type lint cleaner averaged 54% (visible waste basis) for the study, and the efficiency of the five non-saw type cleaners ranged from 9.0 to 15.6%.

There was a significant improvement in the leaf grade designation when lint was cleaned with each of the non-saw type cleaners; with the combination of five seedcotton type cleaners raising the designation about two grades. Each of the lint cleaners increased short fiber content with the saw-type lint cleaner and the combination of five lint cleaners producing the highest short fiber contents.

Among the five seedcotton-type cleaners used as lint cleaners, the extractor feeder gave the lowest count for seed-coat fragments, and the six-cylinder cleaner gave the lowest weight of fragments. The lowest count and weight of motes were obtained when using saw-type lint cleaners; it is surmised that some of the motes were not extracted but broken into fragments by the combing saw teeth. Nep counts for cotton cleaned with the six-cylinder cleaner and Trashmaster cleaner were as high or higher than that cleaned with the saw-type lint cleaners.

The first saw lint cleaner extracted about 6.8 kg (15 lb) of waste per bale and the second saw lint cleaner removed an additional 4.1 kg (9 lb). Waste extracted by the non-saw type cleaners ranged from 0.3 to 1.5 kg $bale^{-1}$ (0.7-3.2 lb per bale).

Experiments in search of new lint cleaning systems that would reduce the amount of saw-type cleaners now used in saw ginning plants should continue to increase the data base. Particular

attention should be given to principles used in non-saw cleaners that tend to extend lint residence or cleaning time.

The lint cleaners must be efficient in extracting trash, have low lint losses, and not be detrimental to fiber quality. The effect of the cleaners on the lint quality and the composition and weight of the extracted waste should be evaluated for cottons of various trash levels. Cotton cleaners used in modern textile mills should be tested at capacity levels sufficient for cotton gins as much development work has been done recently on textile mill opening room machinery.

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