The *Journal of Cotton Science* 2:53-61 (1998)
http://journal.cotton.org, © The Cotton Foundation 1998

GINNING

Field Evaluations of Air and Saw Lint Cleaning Systems

Gino J. Mangialardi, Jr. and W. Stanley Anthony*

INTERPRETIVE SUMMARY

Lint cleaners at cotton gins improve the grade and market value of cotton, but excessive cleaning can reduce bale values and some quality factors. Textile mills prefer that ginned lint be cleaned at gins with only one saw-type lint cleaner, but many gins use two stages of saw lint cleaning to obtain higher grades. Experiments were conducted to study the characteristics and efficiency of flow-through air-type lint cleaners operating under commercial gin conditions. Comparisons were also made to a controlled-batt saw-type lint cleaner that followed the air-type lint cleaner. One air-type lint cleaner was only 25% as effective at cleaning as one of the saw-type lint cleaners. However, the air-type cleaners caused less fiber damage than the saw-type lint cleaners. Information from the field study will be used to (i) advise cotton ginners on the proper use of air-type lint cleaners and (ii) plan new studies to develop air-type lint cleaners that better supplement lint cleaning with only one saw-cylinder cleaner and ensure acceptable market return.

ABSTRACT

Experiments were conducted at three commercial gins to study the characteristics and efficiency of flow-through air-type lint cleaners operating under standard field conditions. Overall, one air lint cleaner gave a cleaning efficiency of 9% compared to 36% for one saw lint cleaner following an air lint cleaner. However, the air-type cleaners caused less fiber damage than the saw-type cleaners. Although textile mills prefer that ginned lint be cleaned at gins with only one saw-type lint cleaner, many gins use two stages of saw lint cleaning to obtain higher grades. An air-type lint cleaner can be substituted for one of the gin's usual saw machines. These results, however, indicate that air-type cleaners need to be improved to better supplement lint cleaning with only one saw-cylinder lint cleaner to ensure acceptable grades and market return.

G.J. Mangialardi, Jr., 1752 McClain St.,Greenville, MS 38701; and W.S. Anthony, USDA, ARS, U. S. Cotton Ginning Res. Unit, P. O. Box 256, Stoneville, MS 38776. Received 19 July 1997. *Corresponding author (anthonys@ars.usda.gov).

Abbreviations: HVI, high volume instrument; AFIS, advanced fiber information system; LSD, least significant difference; Rd, reflectance; ASTM, American Society for Testing & Materials.

Flow-through air lint cleaners are built by several manufacturers and are commercially known as the Air Jet/Super Jet, Centrifugal Cleaner, or Super Mote Lint Cleaner. They have no saws, brushes, or moving parts (Van Doorn, 1954) and are usually installed immediately behind the saw gin stands. Loose lint from the gin stand is blown to a duct within the chamber of the air lint cleaner. Air and cotton (*Gossypium hirsutum* L.) moving through the duct make an abrupt change in direction as they pass across a narrow trash-ejection slot. Foreign matter that is heavier than the cotton fibers and is not too tightly held by fibers is ejected through the slot by inertial force. The amount of trash taken out by the air lint cleaner is controlled by opening and closing this cleaning slot. In some cases, boost air is added to maintain an air velocity of 50 to 60 m/s (10 000–12 000 ft/min) at the cleaning nozzle.

The controlled-batt saw cleaner is the most common type used in the saw-type ginning industry. Lint from the gin stand, or from a preceding lint cleaner, is formed into a batt on a screen-drum condenser. The batt is then fed through one or more sets of compression rollers, passed between a very closely fitted feed roller and feed plate or bar, and fed onto a saw-cylinder. The feed roller and plate grip the batt so that a combing action occurs as the saw teeth seize the fibers. While the fibers are on the saw cylinder, they are cleaned by a combination of centrifugal force, scrubbing action between saw cylinder and grid bars, and gravity assisted by an air current. The fibers are usually doffed from the saw teeth by a revolving brush. The number of stages of saw cleaning refers to the number of saws over which the fibers pass.

Flow-through air lint cleaners are less effective than saw lint cleaners in improving the grade of cotton because they do not open the stream of cotton fibers by an aggressive combing action, but they also remove less fiber from the bale. Fiber quality is unaffected by the air lint cleaner (Griffin and McCaskill, 1957; St. Clair and Roberts, 1958).

In one study (Mangialardi, 1990), an air-type lint cleaner extracted an average 2.0 kg (4.3 lb) of waste per bale compared to 8.5 kg/bale (18.8 lb/bale) for one saw-cylinder lint cleaner, and improved the classer's leaf grade by about one-half grade. It also reduced the weight of seed-coat fragments in ginned lint by 12%. Seed-coat fragments, motes, and funiculi together comprised about 55% of the waste extracted by the air-type cleaner.

Saw-type lint cleaning generally improves the grade classification of the lint. As the number of lint cleaners increases, grade tends to increase. However, as grades improve, bale weights are reduced and staple length may decrease. These opposing factors affect bale value. In some cases, such offsetting losses may cause the bale value to be reduced by saw-type lint cleaning. When price spreads between grades are small, the grower can obtain maximum bale value most often on upland cottons by using one saw lint cleaner on early season clean cottons and two stages of saw lint cleaning on late-season, more trashy, or light spotted cottons (Baker, 1972; Mangialardi, 1972).

Yarn manufacturers are focusing more attention on the need for cotton gins to provide improved cleaning efficiency with less fiber damage. This would reduce yarn imperfections and percent short fiber content at the mill. Therefore, the cotton-ginning research group of USDA-ARS and equipment manufacturers have started investigations to examine concepts of air-type lint cleaning that give acceptable cleanness and grades for the grower, and yet produce the fiber qualities desired at the mill. The investigations involve field and laboratory tests and design work to make air-type lint cleaners more efficient in removing foreign matter and improving the cotton classer's grade. Improved air-type lint cleaners, in place of adding a second stage of saw-type lint cleaning, might be sufficient to supplement lint cleaning with one saw-cylinder lint cleaner. Field tests were conducted to determine the effectiveness of air-type lint cleaners under standard operating conditions and obtain information that would help with new air cleaner designs. This paper discusses the results from the field tests.

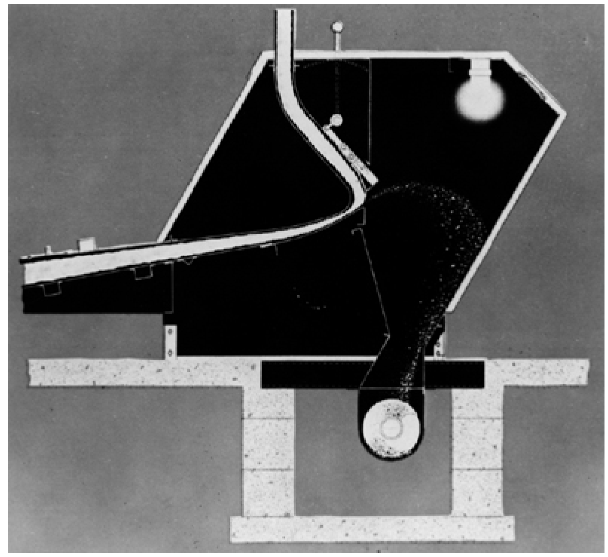

Fig. 1. Flow-through air lint cleaner used in 1994 experiment.

MATERIALS AND METHODS

The experimental ginnings were conducted in 1994 at two commercial gins in the Mississippi Delta near Stoneville, MS, and in 1995 at one commercial gin in northeast Arkansas. Those gins in Mississippi will be referred to as Gins A and B, and the one in Arkansas as Gin C. All gin plants included flow-through air-type lint cleaners behind each gin stand in their lint cleaning sequence.

Gin A

The seed-cotton drying and cleaning sequence of Gin A consisted of tower drier, six-cylinder cleaner, stick machine, tower drier, and six-cylinder cleaner. This cleaning system was a split-stream arrangement with the temperature control sensor located at the top of the driers. There were three gin stands, two with 158 saws and one with 108 saws, each stand followed by the air-type lint cleaner (Figure 1) and two saw lint cleaners with both the split-stream and series option. The seed fingers in the gin stands were adjusted to operate in the

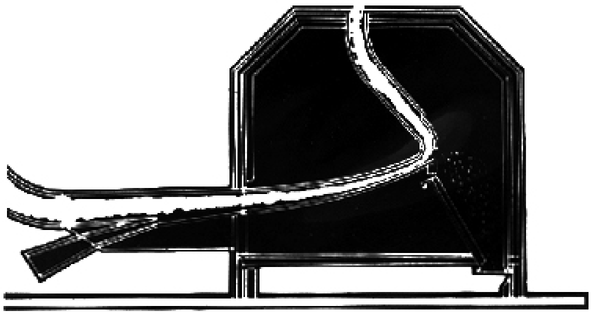

Fig. 2. Flow-through air lint cleaner used in 1995 experiment.

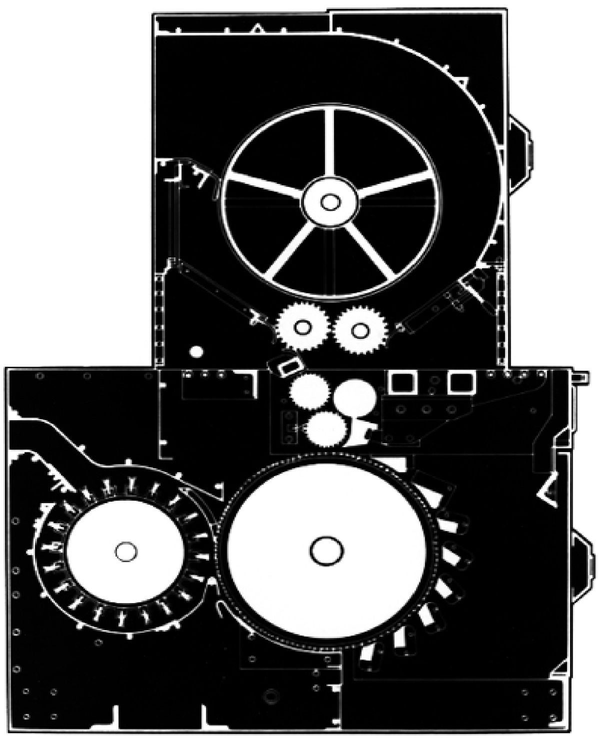

Fig. 3. Saw lint cleaner with 0.61 m (24 inch) diameter saw.

completely open position. Model 108[1] saw lint cleaners were used with the 158-saw gin stands and a Model 86 saw cleaner with the 108-saw gin stand. This gin plant normally operated at a ginning rate of 25 to 30 bales per hour.

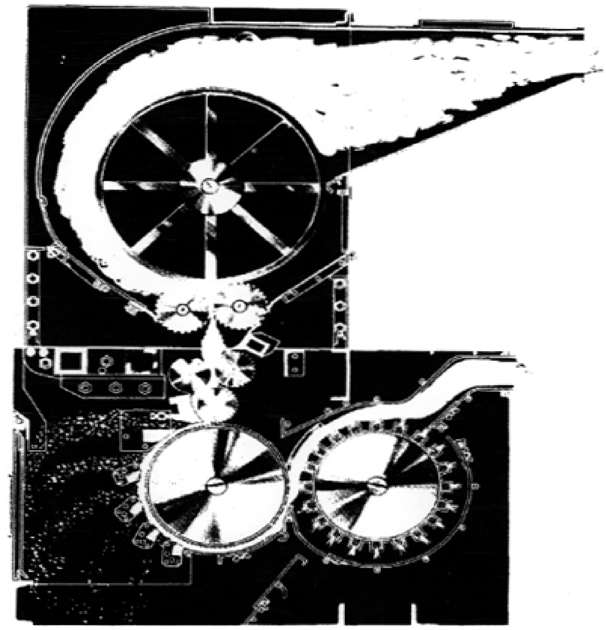

Fig. 4. Typical saw lint cleaner with 0.41 m (16 inch) diameter saw.

Gin B

Gin B was also a split-stream system. The seed-cotton drying and cleaning sequence of Gin B consisted of a tower drier, six-cylinder cleaner, stick machine, tower drier, and six-cylinder cleaner. Temperature sensors near the bottom of the driers controlled the drying temperature. There were three 158-saw gin stands, each followed by an air-type lint cleaner (Figure 1) and two Model 86 saw lint cleaners having the split-stream and series options. Seed fingers in the gin stands were set at the fully open position. The plant normally operated at a ginning rate of about 30 bales per hour.

Gin C

The seed cotton drying and cleaning sequence of the gin plant consisted of tower drier, six-cylinder cleaner, stick machine, tower drier, six-cylinder cleaner, and impact cleaner. The second tower drier and the seed cotton machinery after it were operated in a split-stream arrangement. Temperature control sensors were located near the top of the driers. There were two 161-saw gin stands, each followed by the air-type lint cleaner (Figure 2) and two saw lint cleaners in series. The

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

first saw lint cleaner (Figure 3) was a 2.57 m (101-in) model equipped with a 0.61-m (24-in) diam. saw, and the second saw cleaner (Figure 4) was a 2.39 m (94-in) model equipped with a 0.41-m (16-in) diam. saw. The plant normally operated at a ginning rate of 24 to 30 bales per hour.

The air lint cleaners used at Gins A and B were of the same type and were built by the same manufacturer. A second manufacturer designed the air lint cleaners used in Gin C.

Procedures

Seed cotton used in the experiments was grown and spindle-harvested in the Mississippi Delta in 1994 and in northeast Arkansas in 1995 by customers of the gins. Ten one-bale test lots were selected from six modules at Gin A and 10 bales each from five modules at both Gins B and C. In most cases, two bales were ginned from a module. Each set of 10 test bales was grown by a single grower. The cottons were ginned in October of each test year.

During the processing of each experimental lot, samples were obtained for seed cotton moisture and foreign matter contents at the module and after seed cotton cleaning at the feeder apron, and for cottonseed moisture level. Lint was sampled for moisture content before lint cleaning; and for classer's grade and staple length, lint foreign matter content and lint-cleaning efficiency, and for selected fiber tests at three locations. The lint sampling locations were (i) before air-type lint cleaning, (ii) after air-type lint cleaning, and (iii) after air-and saw-type lint cleaning. This procedure allowed a comparison between an air-type lint cleaner and a saw-type machine following the air type. At each of the three gins, the lint cleaners that were sampled were those located behind the first gin stand.

Gin A

During ginning, the drying temperatures on both tower driers varied from 54 to 57 °C (130-135 °F). The air-type lint cleaner sampled in the study was 2.44 m (8 ft) wide and its cleaning-slot adjuster was set to a 50% open position. The air-type lint cleaner was followed by one stage of standard saw-type lint cleaning.

Gin B

The drying temperatures were set at about 79 °C (175 °F) on the first tower drier and 57 °C (135 °F) on the second drier during the tests. A 2.59-m (8.5 ft) wide air-type lint cleaner with its cleaning slot adjuster set to a 40% open position was sampled at this gin. Cleaning slot adjusters were visually set by the ginner to extract a reasonable amount of motes with minimum cotton loss. The saw lint cleaners following the air-type machine were operated in the single stage split mode at twice the sequential-mode combing ratio.

Gin C

The drying temperatures were set at about 49 °C (120 °F) on the first tower drier and 48 °C (118 °F) on the second drier during the tests. A 2.44-m (8 ft) wide air-type lint cleaner with its cleaning slot adjuster set to a 40% open position was sampled at this gin. Cleaning slot adjusters were visually set by the ginner to extract a reasonable amount of motes with minimum cotton loss. Only one saw lint cleaner, the 0.61 m (24-in) diameter saw model, was used during this study.

Fiber tests included high volume instrument (HVI) measurements, nep counts, Peyer length measurements, and seed-coat fragment levels. The USDA Agricultural Marketing Service classed the samples and made the HVI measurements at Dumas, AR. Lint foreign matter content, Peyer length measurements, nep count tests, and seed-coat fragment counts were made at the USDA Cotton Ginning Laboratory, Stoneville, MS.

Lint foreign matter content was determined by the Shirley Analyzer method, American Society for Testing Materials Standard Method D 2812 (ASTM, 1985a). Lint-cleaning efficiency was calculated from total 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.

Samples for the nep count analysis were tested using the advanced fiber information system (AFIS). Seed-coat fragment, cottonseed, mote, and funiculi counts and weights were made on 3 g lint specimens from each test sample. One sample per lot was tested in the 1994 ginnings, and two samples per lot were tested in the 1995 experiment. These measurements were made by operators using illuminated magnifiers, analytical balances, and forceps as described in ASTM Method D2496 (ASTM, 1985b).

The study was analyzed as three experiments, one experiment conducted at each of the three gins. Modules were the replications. Data were averaged over lots within modules prior to the analysis. There were three lint cleaner treatments (sampling locations) per test lot -- (i) before lint cleaning, (ii) after one air lint cleaner, and (iii) after one air and one saw lint cleaner. The first location described the initial condition of the lint, the second location showed the effects of the air-type cleaner, and the third location showed the combined effects of both cleaners. Comparisons were made between lint cleaner treatments (locations) at the 0.05 level of probability using the least significant difference (LSD) technique (Steel and Torrie, 1980). After comparisons were made for the individual gins (three experiments), data from the three gins were pooled and further comparisons made across gins.

RESULTS AND DISCUSSION

Ginning rate for Gin A averaged 28.5 bale/h for the study that loaded the air lint cleaners at a rate of 4.6 bale/(h m) (1.4 bale/(h ft) of cleaner width and the saw lint cleaners (standard) at a rate of 3.6 bale/(h m) (1.1 bale/h ft) of saw-cylinder length. Corresponding measurements for Gin B were a 26.4 bale/h ginning rate, 3.3 bale/(h m) (1.0 bale/h ft) loading of the air lint cleaners, and 2.0 bale/(h m) (0.6 bale/(h ft) loading (split-stream) of the saw cylinders. Ginning rates at Gin C averaged 28.0 bale/h. At this rate, the air lint cleaners were handling 5.9 bale/ (h m) (1.8 bale/h ft) of cleaner width, and the saw lint cleaners were handling 5.6 bale/(h m) (1.7 bale/h ft) of saw-cylinder length.

Table 1 shows data averages at each gin plant for seed-cotton moisture and foreign matter content, and for lint and seed moisture content. Tables 2 through 6 present data describing cleaning performance, classer's grade, HVI properties, and other fiber quality information.

Table 1. Seed-cotton data and lint moisture contents, lint cleaning experiment, crops of 1994-1995.

Item	Gin plant no. A	B	C	Avg.
Seed cotton moisture, %				
Wagon	9.5a*	8.4b	8.2b	8.7
Feeder apron	8.1a	6.7b	6.9b	7.2
Seed cotton foreign matter, %				
Wagon	7.4a	4.8b	6.6a	6.3
Feeder apron	2.0b	1.8b	2.9a	2.2
Moisture, %				
Cottonseed	10.5a	9.4b	9.0b	9.6
Lint	4.1a	3.0b	3.7a	3.6

* Significant differences noted between gin plant averages were determined at the 5% level using the least significant difference (LSD) technique.

Seed Cotton Foreign Matter

Fractionation tests showed that the initial seed cotton foreign matter contents averaged 7.4, 4.8, and 6.6% for the modules ginned at Gin A, Gin B, and Gin C, respectively (Table 1). After seed cotton drying and cleaning, corresponding foreign matter contents of the seed cotton averaged 2.0, 1.8, and 2.9%, respectively.

Cotton Moisture Contents

Moisture determinations showed that the initial seed cotton moisture averaged 9.5, 8.4, and 8.2% for the Gins A, B, and C cottons, respectively

Table 2. Lint foreign matter content and cleaning efficiency, lint cleaning experiment, crops of 1994-1995.†

Lint cleaner treatment no.	Gin plant no. A	B	C	Avg.
Foreign matter content, total waste, %‡				
0	5.82a*	5.16a	6.75a	5.91a
1	5.21b	4.41b	6.54a	5.39b
2	4.02c	2.91c	3.16b	3.36c
Lint cleaner efficiency, %§				
1	10.2c	14.2b	2.2b	8.9c
2A	22.5b	33.5a	51.5a	35.8b
2	30.5a	43.6a	52.8a	42.3a

* Means in a column for lint cleaner treatment numbers followed by different letters are significantly different at the 0.05 level of probability according to the least significant difference (LSD) technique.

† Data are the average of 10 test lots at each gin plant.

‡ Treatments are before lint cleaning (0), after one air-type lint cleaner (1), and after one air and one saw-type lint cleaner (2).

§ Treatments are one air-type lint cleaner (1), one saw-type lint cleaner following an air-type lint cleaner (2A), and one air and one saw-type lint cleaner (2).

(Table 1). After seed cotton drying, moisture content of the seed cotton averaged 8.1, 6.7, and 6.9%, respectively. Cottonseed and lint samples showed that seed moisture after ginning at Gins A, B, and C averaged 10.5, 9.4, and 9.0%, respectively, and the corresponding lint moisture contents averaged 4.1, 3.0, and 3.7%. Thus, the moisture contents of the test cottons varied somewhat from one gin location to another.

Lint Foreign Matter Content

The foreign matter content in ginned lint before lint cleaning (0 lint cleaner treatment), as measured by the Shirley Analyzer total waste content, averaged 5.8% at Gin A, 5.2% at Gin B, and 6.8% at Gin C (Table 2). At Gin A the air-type lint cleaner reduced the foreign matter content to 5.2% and the next cleaner, the saw-type machine, further reduced the foreign matter level to 4.0%. The air and saw (split) lint cleaners at Gin B gave corresponding foreign matter contents of 4.4 and 2.9%. The air and one 0.61-m (24-in) diam. saw lint cleaner at Gin C reduced its foreign matter content to 6.5 and 3.2%. Overall, for the three gin plants, the air-type lint cleaner reduced the foreign matter content about 0.5 percentage point, and the following saw-type lint cleaner provided an additional 2.0 percentage point reduction. The lint foreign matter content reductions attributed to the air-type lint cleaners were statistically significant at the 5% level at Gins A and B, and the further reductions attributed to the saw-type lint cleaners were significant at all gins.

Cleaning Efficiency

Foreign matter content removal expressed as cleaning efficiency, showed that the efficiencies of the air-type lint cleaners (treatment 1) averaged 10% at Gin A, 14% at Gin B, and 2% at Gin C (Table 2). The cleaning efficiencies of the saw-type lint cleaner (treatment 2A) averaged 22% at Gin A, 33% at Gin B, and 51% at Gin C. Overall, the air-type lint cleaner produced an efficiency of 9% compared with 36% for the saw-type lint cleaner. The cleaning efficiency of the saw-type lint cleaner was significantly higher than that for the air-type lint cleaner at all gins. The efficiency of the air-type and saw-type lint cleaner in series (treatment 2) was also significantly higher than that for the saw-type lint cleaner alone at Gin A.

Classer's Grades and Staple Lengths

The cotton classer's manual color grade index showed a trend toward some improvement in color grades with the use of saw-type lint cleaning (Table

Table 3. Classer's grade and staple length data for lint samples in lint cleaning experiment, crops of 1994-1995.†

Lint cleaner treatment no.‡	Gin plant no. A	B	C	Avg.
Color grade index§				
0	86.4b	94.0b	92.3b	90.9b
1	87.8b	92.8b	93.5b	91.3b
2	92.7a	97.4a	98.3a	96.1a
Color grade designation§				
0	52/42	42/32	42/41	42/41
1	42	42/32	41	42/41
2	42/41/32	41/31	41/31	41/31
Leaf grade index				
0	95.0b	93.9b	92.5b	93.8c
1	99.2a	94.2b	93.7b	95.7b
2	101.0a	100.4a	99.9a	100.4a
Leaf grade designation				
0	3.8a	4.0b	4.2a	4.0a
1	3.1b	3.9a	4.0a	3.7b
2	2.7c	2.9a	3.0b	2.9c
Extraneous matter reductions (bark), %				
0	2a	0	68a	23a
1	11a	0	51a	21a
2	2a	0	17b	6b
Extraneous matter reductions (Prep), %				
0	0	20a	0	7a
1	0	0b	0	0b
2	0	0b	0	0b
Staple length, units ¶				
0	35.5a	35.8a	37.4a	36.2a
1	35.0ab	35.7a	37.4a	36.0a
2	34.9b	34.3b	36.6b	35.3b

* Means in a column for lint cleaner treatment numbers followed by different letters are significantly different at the 0.05 level of probability according to the least significant difference (LSD) technique.

† Data at each gin plant are the average for 10 test lots.

‡ Treatments are before lint cleaning (0), after one air-type lint cleaner (1), and after one air and one saw-type lint cleaner (2).

§ Grade index and corresponding grade designations: 100 = 31, 94 = 41, 32 = 97, 42 = 89, 52 = 80. Where multiple grades are shown, the predominate grade is underlined.

3). The air-type lint cleaners, however, did not significantly affect the color grade. The saw-type lint cleaners tended to blend light spots out of most of the test lots and this blending effect changed many of the light-spotted grades into white grades. The saw-type lint cleaners also appeared to improve other color factors, probably by removing background trash and improving reflectance. Generally, color-grade designations averaged 42 before and after the air-type lint cleaner, and were mainly 41/31 after one saw-type lint cleaner.

The leaf grade index improved significantly after the air-type lint cleaner at Gin A, but not at the other two gins. Saw-type lint cleaners, on the other hand, improved leaf grades at all three gin plants. Over the entire test, the air-type lint cleaner improved the average leaf grade designation from 4.0 to 3.7, and the saw-type lint cleaner gave a further improvement to 2.9.

At Gin A some test lots were discounted at level 1 (light) for extraneous matter (bark). However, the levels were low and lint cleaners had no significant effect on bark content. At Gin B 20% of the lots were discounted for rough preparation before lint cleaning, but none were discounted after lint cleaning. Before lint cleaning, two-thirds of the test lots at Gin C were discounted for excessive bark. After the air- and saw-type lint cleaners, 51 and 17% of the samples were discounted for bark. The reduction in bark with the saw lint cleaner at Gin C was significant at the 5% level.

There was a trend toward a shortening of the staple length with increase usage of lint cleaning. However, staple length reductions due to air-type lint cleaning were small, not statistically significant, and inconsistent from gin to gin. The saw-type lint cleaner significantly reduced staple length at two gins and produced an overall reduction of 0.7 unit (0.56 mm). Over the entire study, the average decrease in length due to the saw-type lint cleaner was significant at the 5% level.

High Volume Instrument Measurement

In general, the HVI measurements supported the manual classing data and the lint foreign matter content data (Table 4). Increased amounts of lint cleaning tended to improve the reflectance (Rd) values and the color grade index, and to decrease visible trash (HVI) content.

The micronaire readings averaged 4.2 for the cottons ginned in the study. Fiber strength (1/8-in gage) for the cottons sampled at the three locations ranged from 273 to 283 k*N* m/kg. Overall, the air-type lint cleaner did not affect the fiber strength, but the saw-type lint cleaner gave a 10 k*N* m/kg reduction that was significant.

Fiber Tests

Neps per gram, measured on the AFIS-N, increased slightly but not significantly with the use of the air-type lint cleaner (Table 5). The increase in nep count for the saw-type lint cleaner was

Table 4. High volume instrument (HVI) measurements for lint samples, lint cleaning experiment, crops of 1994-1995.†

Item	Lint cleaner treatment no.‡		
	0	1	2
Micronaire	4.22a*	4.24a	4.24a
Strength (3.2 mm), kN m/kg	282a	283a	273b
Color grade index	93.1b	93.6b	97.8a
Color grade designation	41	41	41/31
Color reflectance (RD), %	72.8b	72.9b	75.2a
Color +b value, units	8.1b	8.1b	8.4a
Trash (non-lint) content, %	0.8a	0.7a	0.3b

* Means for lint cleaner treatment numbers followed by different letters are significantly different at the 0.05 level of probability according to the least significant difference (LSD) technique.

† Data are the average of the three gin plants.

‡ Treatments are before lint cleaning (0), after one air-type lint cleaner (1), and after one air and one saw-type lint cleaner (2).

Table 5. Nep count, high volume instrument (HVI) and Peyer length data for lint samples, lint cleaning experiment, crops of 1994-1995.†

Item	Lint cleaner treatment no.‡		
	0	1	2
Nep count, no./g	182b*	187b	252a
HVI length, cm	2.868a	2.858a	2.794b
HVI length uniformity, %	82.9a	82.6a	81.7b
Peyer 25% length, cm	2.715a	2.710a	2.647b
Peyer mean length, cm	2.299a	2.294a	2.225b
Peyer fibers shorter than 1.27 cm, %	5.8b	6.0b	7.8a
Peyer coefficient of variability, %	25.0b	26.0a	26.1a

* Means for lint cleaner treatment numbers followed by different letters are significantly different at the 0.05 level of probability according to the least significant difference (LSD) technique.

† Data are the average of the three gin plants.

‡ Treatments are before lint cleaning (0), after one air-type lint cleaner (1), and after one air and one saw-type lint cleaner (2).

Table 6. Seed-coat fragment in 3-g-of-lint data for lint samples, lint cleaning experiment, crops of 1994-1995.†

Item	Lint cleaner treatment no.‡		
	0	1	2
Fragments, no.	57.1a*	58.1a	61.0a
Fragments, mg	35.7a	34.8a	28.0b
Motes, no.	4.6a	4.3a	4.8a
Motes, mg	14.1a	11.3a	10.5a
Funiculi, no.	18.1a	17.1a	9.0b
Funiculi, mg	5.8a	5.5a	2.6b
Cottonseed, no.	0.5a	0.1ab	0.0b
Cottonseed, mg	26.4a	2.7a	0.0a

* Means for lint cleaner treatment numbers followed by different letters are significantly different at the 0.05 level of probability according to the least significant difference (LSD) technique.

† Data are the average of the three gin plants.

‡ Treatments are before lint cleaning (0), after one air-type lint cleaner (1), and after one air and one saw-type lint cleaner (2).

significant. Before lint cleaning, after one air-type lint cleaner, and after the saw-type lint cleaner the counts averaged 182, 187, and 252 neps/g, respectively.

The HVI fiber length and length uniformity decreased with lint cleaning. The slight length decrease with one air-type lint cleaner was not significant at the 5% level, but the larger decrease with one saw-type lint cleaner was significant. Overall, the length decreased 0.010 and 0.064 cm with one air type and one saw-type lint cleaner.

Peyer length measurements showed a trend toward decreased fiber length with both air- and saw-type lint cleaning.The decreases in upper 25% length and mean length, and increases in short fiber content were not significant for air-type lint cleaning, but the further length decreases attributed to the saw-type lint cleaner were significant. Over the whole study, short fiber contents average 5.8 and 6.0%, respectively, before and after the air-type lint cleaner, and 7.8% after the saw-type lint cleaner.

Seed-Coat Fragment Content

Seed-coat fragment counts in 3 g of lint averaged 57 and 58, respectively, before and after the air-type lint cleaner, and 61 after the one stage of saw-cylinder lint cleaning (Table 6). Corresponding weights for the fragments averaged 35.7, 34.8, and 28.0 mg/3 g. The counts ranged from 55 to 64 fragments/3 g among the three lint cleaner sampling locations at the three gins. Among these samplings, a small decrease in fragment weight with air lint cleaning was not significant; while the greater decrease in fragment weight, attributed to the saw-type lint cleaner was significant.

Motes in the ginned lint averaged four to five per 3 g among the lint cleaner samplings and showed no significant trend. Full cottonseeds in ginned lint numbered about 0.5 per 3 g before lint cleaning. Most of these were extracted by the air-type lint cleaner; none were measured after the saw-type lint cleaner.

Funiculi counted in ginned lint before lint cleaning, after the air-type cleaner, and following the one stage of saw-type lint cleaner averaged 18.1, 17.1, and 9.0 per 3 g for the study. The slight decreases in funiculi count and weight with air-type lint cleaning were not significant, but the total reductions in count and weight after the saw-type lint cleaner were significant.

CONCLUSIONS

Experiments were conducted in 1994-1995 at three commercial gins to study the characteristics and efficiency of flow-through air-type lint cleaners operating under standard field conditions. Thirty bales were sampled from 16 modules of seed cotton. Measurements included lint foreign matter content, classer's grade, HVI data, nep count, and seed-coat fragment content.

Overall, the air-type lint cleaner produced a cleaning efficiency of 9% compared with 36% for a saw-type lint cleaner following the air-type cleaner. The average cleaning efficiency of the air and saw lint cleaners in series was 42%.

The air lint cleaners did not change the color grade, but they did improve the leaf grade index slightly. Over the entire test, the air-type lint cleaner improved the leaf grade designation from 4.0 to 3.7, and the saw-type lint cleaner gave a further improvement to 2.9.

Average staple length for the study did not decrease significantly with the one air-type lint cleaner, but a 0.7 unit (0.56 mm) decrease due to the saw-type cleaner was significant. Corresponding measurements in HVI and Peyer fiber lengths supported these conclusions.

Nep count was not significantly affected by one air-type lint cleaner, but a large increase in neps due to the saw-type lint cleaner was statistically significant. Most of the full cottonseeds in the ginned lint were extracted by the air-type lint cleaner, and those few remaining were removed by the saw-type lint cleaner.

The textile industry prefers that ginned lint be cleaned at gins with only one saw-type lint cleaner. This helps to preserve fiber quality by minimizing the nep and short fiber content in the bale. It would be much easier for gins to successfully use a single stage of saw lint cleaning if a gentle cleaning machine, such as an air-type lint cleaner, could be used to amplify the saw machine's performance without creating any additional fiber damage. Unfortunately, these field observations suggest that existing air-type lint cleaners are not likely to provide such a boost for the saw-type lint cleaner unless their trash removal performances can be improved. If an improved air-type lint cleaner could be developed that would give better cleaning, it would likely be useful when used in combination with a saw-type lint cleaner to help ensure an acceptable market return for the producer. New air-type lint cleaner designs are being studied to further improve the performance of these cleaners. Air-type cleaners should be designed to remove most of the motes and large trash particles before the cotton reaches the saw-type cleaner. This could prevent seed-coat fragments from breaking into smaller, and more difficult to remove, fragments during saw-type lint cleaning.

This study also illustrated that there was a considerable amount of variation among gins in the performance of existing air-type lint cleaners. This wide variation suggests that gins may be experiencing problems with respect to proper adjustment of these machines, or to other operational factors such as inadequate air velocities. These potential problems need to be investigated further, and additional research needs to be conducted to better identify optimum operating procedures and adjustments for these unique cleaning machines.

ACKNOWLEDGMENT

Part of the funding for this project was provided by the National Cotton Ginners Association, Memphis, TN 38182.

REFERENCES

American Society for Testing and Materials. 1985a. Standard test method for nonlint content of cotton, D2812. p. 626-633. *In* Annual book of ASTM standards, Section 7. Vol. 07.02. ASTM, Philadelphia, PA.

American Society for Testing and Materials. 1985b. Standard test methods for seed-coat fragments and funiculi in cotton fiber samples, D2496. p. 566-571. *In* Annual book of ASTM Standards, Section 7, Vol. 07.02. ASTM, Philadelphia, PA.

Baker, R.V. 1972. Effects of lint cleaning on machine-stripped cotton: A progress report. The Cotton Gin Oil Mill Press 73(21):6-7, 22.

Griffin, A.C., and O.L. McCaskill. 1957. Tandem lint cleaning: Air-saw cylinder combination. The Cotton Gin Oil Mill Press 58(6):25, 52-53.

Mangialardi, G.J., Jr. 1972. Multiple lint-cotton cleaning: Its effect on bale value, fiber quality, and waste composition. USDA Tech. Bull. 1456. U.S. Gov. Print. Office, Washington, DC.

Mangialardi, G.J., Jr. 1990. Performance of air-type lint cleaners in reducing motes and seed-coat fragments. p. 669-674. *In* J.M. Brown (ed.) Proc. Beltwide Cotton Conf. Las Vegas, NV. 9-14 Jan. 1990. Natl. Cotton Council Am., Memphis, TN.

St. Clair, J.S., and A.L. Roberts. 1958. Effects of lint cleaning of cotton: An economic analysis at California gins. USDA Mark. Res. Rep. 238. U.S. Gov. Print. Office, Washington, DC.

Steel, R.G.D., and J.H. Torrie. 1980. Principles and procedures of statistics. McGraw-Hill, New York.

Van Doorn, D.W. 1954. Processing and apparatuses for separating trash from lint cotton and the like. U.S. Patent 2 681 476. U. S. Patent and Trademark Office, Washington, DC.