EFFECT OF PROCESSING RATE ON SEED COTTON CLEANING EQUIPMENT PERFORMANCE

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Abstract

The processing rate per unit width of seed cotton cleaning equipment– cylinder cleaners and stick machines– recommended by manufacturers is 4.9-8.2 bales hr^{-1} m^{-1} (1.5-2.5 bales hr^{-1} ft^{-1}). Survey data has indicated that many gins exceed this processing rate. Previous research with picker-harvested cotton only tested rates up to 6.6 bales hr^{-1} m^{-1} (2.0 bales hr^{-1} ft^{-1}). Machinery design and cleanability of cotton cultivars has changed since this work was conducted. Two independent experiments were performed to evaluate the effects of processing rates significantly higher than recommended. Seed cotton was processed through a typical sequence of gin machinery- cylinder cleaner, stick machine, cylinder cleaner, extractor-feeder, gin stand, and lint cleaner. The foreign matter content after each stage of seed cotton cleaning was determined and the cleaning efficiencies of each machine were calculated. Foreign matter content of the ginned lint and fiber quality parameters were also measured. The first study tested four cultivars of cotton harvested in 2008. Varying the processing rate did not affect cleaning performance for the picker-harvested cultivars; however, these cultivars had low initial foreign matter contents. Higher processing rates resulted in increased foreign matter content through the second stage cylinder cleaner for the stripper-harvested cultivar. The second experiment tested two cultivars and two seed cotton moisture levels. Preliminary data from this experiment indicated that higher processing rates resulted in less foreign matter removed by the first stage cylinder cleaner, but only the highest processing rate contained significantly more foreign matter after the second stage cylinder cleaner.

Introduction

Gin equipment manufacturers recommend processing rates for seed cotton cleaning equipment of 3130–5210 kg hr^{-1} m^{-1} (2100–3500 lb hr^{-1} ft^{-1}) (Baker et al., 1994). This flow rate is equivalent to 4.9–8.2 bales hr^{-1} m^{-1} (1.5–2.5 bales hr^{-1} ft^{-1}), with 636 kg (1400 lb) of seed cotton processed to produce 227 kg (500 lb) bales. Commercial gins often process 7000 kg hr^{-1} m^{-1} (4700 lb hr^{-1} ft^{-1}), and some gins may exceed 10000 kg hr^{-1} m^{-1} (6700 lb hr^{-1} ft^{-1}). The effect on cleaning performance at these processing rates with modern cultivars and machinery is unknown.

The number of operating gins in the US has steadily decreased; consequently, the average number of bales produced per gin has increased. As gins have become larger, the recommended capacity of the seed cotton cleaning equipment is often exceeded. Additional or higher capacity gin stands may be added, but it is often economically or physically infeasible to install additional seed cotton cleaning equipment.

Objectives

The primary goal of this research was to determine the effects of higher than recommended processing rates on the performance of seed cotton cleaning equipment. The main objectives of this research were:

- Evaluate the effect of processing rates significantly higher than recommended on the cleaning efficiency of cylinder cleaners and stick machines
- Determine seed cotton losses in cylinder cleaners and stick machines at higher processing rates

Literature Review

Machine-picked cotton generally contains approximately 7% foreign matter, while machine-stripped cotton typically has a foreign matter content of 32.5% (Baker et al., 1994). Removing foreign matter before ginning is necessary to maximize lint value for the cotton producer and reduce maintenance and downtime at the gin. Cotton gins typically use two kinds of machines to remove foreign matter from seed cotton. Cylinder cleaners utilize rotating cylinders with spikes to convey seed cotton across grid rods, allowing small foreign matter (primarily leaf and soil particles) to be removed. Stick machines have rotating saws that hold seed cotton while larger foreign matter particles (burs and sticks) are removed by centrifugal force.

The recommended processing sequence for picker-harvested cotton prior to ginning is a dryer, cylinder cleaner, stick machine, dryer, cylinder cleaner, and extractor-feeder. Extractor-feeders commonly combine features of both

cylinder cleaners and stick machines and regulate the flow of cotton to the gin stand. Anthony and Calhoun (1997) tested 49 picker-harvested cultivars and found that the average cleaning efficiency of this recommended sequence was 63%, while individual cultivars ranged from 45% to 71%. However, this study was conducted at low processing rates- less than 2100 kg hr^{-1} m^{-1} (1400 lb hr^{-1} ft^{-1}).

Several researchers have determined the cleaning efficiency of a conventional first-stage cylinder cylinder cleaner to be between 20-30% on picker-harvested cotton (Cocke, 1972; Read, 1972). However, the fine foreign matter cleaning efficiency is much higher. Laird et al. (1984) found the fine trash removal efficiencies to be 60.9% for a cylinder cleaner with 9.5 mm (0.375 in.) diameter grid rods with 9.5 mm (0.375 in.) spacing. Baker (1971) determined that the cleaning efficiency of a first-stage stick machine was approximately 60% with stripper-harvested cotton. For picker-harvested cotton, the stick machine cleaning efficiency was less than 20% due to the much lower bur and stick content (Read, 1972).

Using picker-harvested cotton, Cocke (1972) studied processing rates from 1610 kg hr^{-1} m^{-1} (1080 lb hr^{-1} ft^{-1}) to 3680 kg hr^{-1} m^{-1} (2470 lb hr^{-1} ft^{-1}) through a dryer, cylinder cleaner, and stick machine and observed no significant differences in cleaning efficiency, lint quality or value. However, these processing rates are significantly less than the maximum rates currently recommended.

Processing rates up to 10000 kg hr^{-1} m^{-1} with stripper-harvested cotton were examined by Baker et al. (1982). Higher rates decreased the overall system cleaning efficiency and resulted in lower lint grades, even though two lint cleaners were used. Experiments with individual machines also demonstrated reduced cleaning efficiency and increased seed cotton loss at higher processing rates. However, the cotton used by Baker et al. (1982) contained significantly more foreign matter than cotton harvested by pickers or strippers-harvester with field cleaners.

A recent survey of 30 Mid-South gins indicated that the processing rate of seed cotton cleaning machinery averaged 9.4 bales hr^{-1} m^{-1} (2.9 bales hr^{-1} ft^{-1}) (T. Valco, unpublished data, 2009, USDA ARS, Stoneville, MS). The average rate at 14 gins exceeded the recommended maximum of 8.2 bales hr^{-1} m^{-1} (2.5 bales hr^{-1} ft^{-1}), while five gins exceeded 13.1 bales hr^{-1} m^{-1} (4 bales hr^{-1} ft^{-1}).

Materials and Methods

The effect of seed cotton processing rate on cleaning efficiency and seed cotton loss was determined for both a cylinder cleaner and a stick machine. The cleaning performance of the typical sequence of machinery for processing picker-harvested seed cotton was also evaluated, as the seed cotton was processed through the cylinder cleaner, stick machine, and through the cylinder cleaner a second time. Two independent experiments were conducted, using cotton harvested in 2008 and 2009.

Experimental Apparatus

Processing rates significantly higher than recommended could not be achieved in the small-scale gin at the USDA-ARS Cotton Ginning Research Unit, Stoneville, MS, due to small conveying pipes and separators. Consequently, equipment was constructed to feed seed cotton at desired rates to a narrow-width cylinder cleaner and stick machine (figure 1). Seed cotton was distributed in the bin at the top of the apparatus and manually fed into the vertical chute. A variable-speed DC motor was used to adjust the speed of the feed control, which determined the flow rate of seed cotton through the machinery. Seed cotton was initially processed through a cylinder cleaner and a stick machine. To simulate the typical sequence of seed cotton cleaning equipment, the partially cleaned seed cotton was collected, transported to the top of the apparatus, and processed through only the cylinder cleaner a second time.

Figure 1. Seed cotton cleaning experimental apparatus.

The six cylinder cleaner used was 25.4 cm (10 in.) wide and had 9.5 mm (0.375 in.) diameter grid bars, with a 9.5 mm (0.375 in.) spacing. The cylinder-grid bar clearance was 12.7 mm (0.5 in.) and the cylinder speed was 480 rpm. The three saw stick machine was 30.5 cm (12 in.) wide.

No drying was used during testing. After cleaning, the seed cotton was ginned in the laboratory's microgin. All test lots were processed through the extractor-feeder, gin stand, and one saw cylinder lint cleaner, using identical settings.

Five processing rates were tested in this study (table 1). The picker-harvested processing rates through the cylinder cleaner were calculated assuming 636 kg (1400 lb) seed cotton required per bale, while the stripper-harvested rates were calculated using 908 kg (2000 lb) seed cotton per bale. The target rates are only provided for informative purposes, as only the feed control speed was varied for different treatments. The processing rate through the slightly wider stick machine would be 83% of the rate through the cylinder cleaner. The actual processing rates were different between the two experiments because the feed control speed was adjusted to more closely match the target processing rates.

Table 1. Target processing rates.

Target Feed Rate (kg min^{-1} [lb min^{-1}])	Target Cylinder Cleaner Processing Rate- Picker-Harvested (bales hr^{-1} m^{-1} [bales hr^{-1} ft^{-1}])	Target Cylinder Cleaner Processing Rate- Stripper-Harvested (bales hr^{-1} m^{-1} [bales hr^{-1} ft^{-1}])
17.7 (38.9)	6.56 (2)	4.59 (1.4)
26.5 (58.3)	9.84 (3)	6.89 (2.1)
35.3 (77.8)	13.12 (4)	9.19 (2.8)
44.1 (97.2)	16.40 (5)	11.48 (3.5)
53.0 (116.7)	19.69 (6)	13.78 (4.2)

2008 Cotton

Four cultivars were tested- DP 147 RF, DP 454 BR, DP 555 BR (Monsanto, St. Louis, MO), and a stripper-harvested variety. DP 555 BR is a smooth-leaf cultivar, while DP 147 RF and the DP 454 BR have intermediate leaf pubescence. The stripper-harvested cultivar was grown near Lubbock, TX, while the other cultivars were machine-picked at Stoneville, MS. A factorial combination of the processing rates and cultivars was tested with three replications of each treatment combination planned. However, adequate amounts of cotton were only available to conduct two full replications. A full third replication was performed for two cultivars (DP 555 BR and stripper-harvested), while a third replication of the low and second highest processing rate was completed for DP 147 RF. The experiment was designed as a randomized complete block with replication as the blocking factor.

2009 Cotton

Two cultivars, FM 960 B2 and ST 4554 B2RF (Bayer CropScience, Research Triangle Park, NC) were used in the second experiment. These cultivars were selected to provide a wider range of foreign matter content in picker-harvested cotton, as FM 960 B2 is a smooth-leaf cotton, while ST 4554 B2RF is a hairy-leaf cotton. Both cultivars were machine picked at Stoneville, MS. Two moisture contents were also tested. One-half of the cotton was stored at ambient conditions, while the remainder was stored in a conditioning chamber at 85% relative humidity for at least one week. A factorial combination of processing rate, cultivar, and moisture content was used. Three replications of each combination were completed, and the experiment was blocked by replication.

Data Analysis

Each test lot of seed cotton was weighed. The processing time through the seed cotton cleaning equipment was recorded to calculate the actual feed rate. The ginned lint and cottonseed were also weighed to determine turnout.

Seed cotton samples were collected from the test lots before processing and after each cleaning machine for pneumatic fractionation (Shepherd, 1972). Cleaning efficiency was calculated for both individual machines and the entire seed cotton cleaning system by the following equation:

$$CE = \frac{FM_i - FM_f}{FM_i}$$

where

CE = cleaning efficiency
FM_i = initial foreign matter content (% by weight)
FM_f = final foreign matter content (% by weight).

The foreign matter removed by each cleaner was also weighed and collected for manual fractionation. Samples were collected from the initial test lots, at the feeder apron, and after the lint cleaner for determination of moisture content by oven drying (Shepherd, 1972). Shirley Analyzer, High Volume Instrument (HVI), and Advanced Fiber Information System (AFIS) samples were taken before and after the lint cleaner to determine if the processing rate through the seed cotton cleaning equipment affected fiber quality. For all measurements, three samples were taken for each treatment combination. All samples from the experiment with 2008 cotton have been analyzed. With the 2009 cotton, all moisture content samples and seed cotton fractionation samples collected before processing, after the first stage cylinder cleaner, and after the second stage cylinder cleaner have been analyzed.

Cleaning efficiency, seed cotton loss, and fiber quality parameters were used as dependent variables in the statistical analysis. The mixed models procedure in SAS, *PROC MIXED*, was used for the statistical analysis (SAS 9.2, SAS

Institute, Inc., Cary, N.C.). Least squares means of dependent variables were calculated for processing rates, cultivars, and the interaction between processing rate and cultivar. The *SLICE* option was used where the interaction effect was significant to determine the effect of processing rate for each cultivar or moisture conditioning treatment.

Results and Discussion

2008 Cotton

The initial foreign matter content of the seed cotton tested is shown in table 2. The foreign matter content of the picker-harvested cultivars is lower than often encountered in commercial gins. Data collected from 30 modules at eight Mid-South gins in 2009, indicated an average foreign matter content of 7.8%. While unfavorable harvesting conditions likely resulted in higher foreign matter levels, machine-picked cotton typically has a foreign matter content of 7% (Baker et al., 1994). Average moisture content of the seed cotton was 8.1% (w.b.) initially and 7.0% at the feeder apron. The ginned lint had a moisture content of 5.2%.

Table 2. Initial foreign matter content- 2008 cotton.[a]

Cultivar	Foreign Matter Content (% by weight)
DP 147 RF	4.6a
DP 454 BR	7.2b
DP 555 BR	5.2a
Texas stripper-harvested	26.4c

[a]Means in a column followed by the same letter are not significantly different at the 5% level.

The actual processing rates of the seed cotton differed from the target processing rates (table 3). This deviation likely occurred because the seed cotton used to determine feed control settings was from different cultivars than those used in testing. Additionally, due to material limitations, not all feed control settings were tested prior to conducting the experiment.

Table 3. Actual processing rates- 2008 cotton.

Target Feed Rate ($kg\ min^{-1}$ [$lb\ min^{-1}$])	Actual Feed Rate ($kg\ min^{-1}$ [$lb\ min^{-1}$])	
	Picker-Harvested	Stripper-Harvested
17.7 (38.9)	22.4 (49.3)	28.0 (61.6)
26.5 (58.3)	36.0 (79.3)	45.6 (100.5)
35.3 (77.8)	47.8 (105.4)	52.5 (115.6)
44.1 (97.2)	53.9 (118.7)	66.4 (146.3)
53.0 (116.7)	55.1 (121.4)	62.3 (137.2)

As expected, the cultivar had a significant effect (at the 5% significance level) on the foreign matter content after each seed cotton cleaning machine. Furthermore, the cultivar–processing rate interaction was significant after all seed cotton cleaners up to the extractor-feeder and the processing rate had a significant effect on the foreign matter content of the seed cotton after the stick machine and second cylinder cleaner. Although the processing rate main effect was significant, this result was due to differences observed with the stripper-harvested cotton. The least-squares means for foreign matter content of the stripper-harvested cotton after each stage of seed cotton cleaning are shown in table 4.

Table 4. Least-squares means for foreign matter content of stripper-harvested cotton.[a]

Target Feed Rate (kg min^{-1} [lb min^{-1}])	Foreign Matter Content (% by weight)				
	Initial	After 1st Stage Cylinder Cleaner	After Stick Machine	After 2nd Stage Cylinder Cleaner	After Extractor-Feeder
17.7 (38.9)	26.5a	23.0a	12.3a	9.7a	5.4a
26.5 (58.3)	26.1a	22.4a	13.2a	11.8b	5.6a
35.3 (77.8)	27.8b	25.8b	14.5b	13.8c	5.8a
44.1 (97.2)	26.2a	25.0b	15.7c	14.8cd	5.7a
53.0 (116.7)	25.4a	24.7b	15.8c	15.6d	5.9a

[a]Means in a column followed by the same letter are not significantly different at the 5% level.

Lower processing rates of the stripper-harvested cotton resulted in significantly improved cleaning through the second-stage cylinder cleaner. No differences were observed due to processing rate at the extractor-feeder, likely due to the low processing rate (8 kg/min) through the extractor-feeder. The extractor-feeder processing rate cannot be easily increased, due to limitations of the small-scale gin stand used. With this extremely low processing rate, the extractor-feeder was an effective cleaner, regardless of the foreign matter content of the seed cotton. While the processing rate per unit width through the extractor-feeder would be much higher in a commercial gin than in this study, the total width of extractor-feeders in a gin typically exceeds the total width of other seed cotton cleaning equipment. Consequently, the processing rate per unit width would be lower and the effects of higher processing rates through other seed cotton cleaning equipment would likely be diminished.

Cleaning efficiency tended to decrease with higher processing rates of stripper-harvested cotton; however, these differences were often not significant (table 5). Although three seed cotton fractionation samples were taken from each treatment, cleaning efficiency was only calculated using the average foreign matter content for each treatment. The average foreign matter was used because individual samples at different locations were not correlated in time-all samples except after the first cylinder cleaner and extractor-feeder were randomly drawn from the seed cotton. Since only one cleaning efficiency measurement was made per treatment replication, the standard error was larger. Cleaning efficiency through the extractor-feeder was highest for the seed cotton containing the most foreign matter, which was processed through the other machinery at the highest rates. Consequently, the overall cleaning efficiency for the entire system was similar for all processing rates.

Table 5. Least-squares means for cleaning efficiency of stripper-harvested cotton.[a]

Target Feed Rate (kg min^{-1} [lb min^{-1}])	Individual Machine Cleaning Efficiency (%)				Overall Cleaning Efficiency (%)		
	1st Stage Cylinder Cleaner	Stick Machine	2nd Stage Cylinder Cleaner	Extractor-Feeder	Through Stick Machine	Through 2nd Stage Cylinder Cleaner	Through All Machines
17.7 (38.9)	12.6a	46.3a	23.2a	33.4a	53.3a	63.3a	79.4a
26.5 (58.3)	14.1a	41.2a	9.9a	51.9ab	49.6ab	54.7a	78.7a
35.3 (77.8)	7.0a	44.0a	5.2a	56.7ab	47.9ab	50.3a	79.0a
44.1 (97.2)	4.0a	36.6a	5.2a	61.3b	40.1b	43.3a	78.2a
53.0(116.7)	2.6a	36.1a	1.2a	62.1b	37.7b	38.5a	76.5a

[a]Means in a column followed by the same letter are not significantly different at the 5% level.

Shirley Analyzer measurements showed no differences in foreign matter content of ginned lint for picker-harvested varieties; however, the stripper-harvested cotton generally had higher visible waste content with greater processing rates (table 6).

Table 6. Least-squares means for Shirley Analyzer visible waste in stripper-harvested cotton.[a]

Target Feed Rate (kg min^{-1} [lb min^{-1}])	Visible Waste Before Lint Cleaner (% by weight)	Visible Waste After Lint Cleaner (% by weight)
17.7 (38.9)	5.53a	2.60a
26.5 (58.3)	5.79ab	2.61a
35.3 (77.8)	5.87bc	2.72ab
44.1 (97.2)	6.23c	2.98c
53.0 (116.7)	6.02bc	2.89bc

[a]Means in a column followed by the same letter are not significantly different at the 5% level.

No significant differences were observed between processing rates in the AFIS parameters. Since all processing rates within a cultivar had nearly the same foreign matter content after processing at low rates through the extractor-feeder, few differences would be expected in dust and trash measurements of ginned lint. Additionally, seed cotton cleaning has been demonstrated to have little effect on AFIS fiber quality parameters. Mangialardi (1985) found that the entire seed cotton cleaning and drying systems produced a similar increase in nep count to the gin stand and each stage of saw-cylinder lint cleaning. Anthony (1990) determined that seed cotton cleaning equipment did not increase short fiber content or decrease length uniformity.

The processing rate, cultivar, and interaction all had a significant effect on the seed cotton content of the material removed by the stick machine. Differences between processing rates were highly significant for DP 147 RF ($p < 0.0001$), and moderately significant for DP 454 BR ($p = 0.0558$). The mean seed cotton content of the material removed by the stick machine is shown in table 7 for all four cultivars tested, DP 147 RF and DP 454 BR. Differences in seed cotton content of the waste of the stripper-harvested cotton were more difficult to observe since the seed cotton content was low due to the large amount of foreign matter removed. The reason for the absence of significant differences between processing rates with DP 555 BR was unclear.

Table 7. Seed cotton content of material removed by stick machine- 2008 cotton.[a]

Target Feed Rate (kg min^{-1} [lb min^{-1}])	Seed Cotton Content of Stick Machine Waste (% by weight)		
	All Cultivars	DPL147	DPL454
17.7 (38.9)	1.15a	1.48a	1.44ab
26.5 (58.3)	1.65ab	2.84ab	0.75a
35.3 (77.8)	1.37a	1.34a	2.40bc
44.1 (97.2)	2.47c	3.79b	2.82b
53.0 (116.7)	2.13bc	5.68c	1.23ac

[a]Means in a column followed by the same letter are not significantly different at the 5% level.

Although the seed cotton content of the stick machine waste increased with processing rate, the differences in seed cotton loss (as a percent of the initial seed cotton content) were not significant and extremely low, with an average of 0.05%. This seed cotton loss corresponds to a loss of 0.11 kg (0.24 lb) lint per 227 kg (500 lb) bale.

2009 Cotton

The initial foreign matter content of the two cultivars was significantly different. The mean initial foreign matter content of FM 960 B2 was 6.6%, while the ST 4554 B2RF contained 9.8% foreign matter. The different moisture conditioning treatments significantly affected the moisture content of the seed cotton before cleaning seed cotton at the feeder apron, and lint (table 8).

Table 8. Moisture content- 2009 cotton.[a]

Treatment	Moisture Content (% w.b.)		
	Initial	Feeder Apron	Lint
High	11.4a	9.8a	5.9a
Low	7.2b	6.8b	4.9b

[a]Means in a column followed by the same letter are not significantly different at the 5% level.

The actual processing rates are shown in table 9. The three lower rates were much closer to the target rates than in the experiment with the 2008 cotton, and all actual rates were significantly different from each other. The average maximum rate achieved corresponds to a machine loading of 23.9 bales hr^{-1} m^{-1} (7.3 bales hr^{-1} ft^{-1}).

Table 9. Actual feed rates- 2009 cotton.

Target Feed Rate (kg min^{-1} [lb min^{-1}])	Actual Feed Rate (kg min^{-1} [lb min^{-1}])
17.7 (38.9)	19.4 (42.8)
26.5 (58.3)	28.9 (63.7)
35.3 (77.8)	36.5 (80.3)
44.1 (97.2)	51.9 (114.3)
53.0 (116.7)	64.3 (141.6)

The cultivar had a significant effect on the foreign matter content of the samples before processing and after each cleaning machine, as expected. Processing rate had a significant effect on the foreign matter content of the seed cotton after both the first and second stage cylinder cleaners (table 10). The feed rate–moisture conditioning treatment interaction had a significant effect on the initial foreign matter content; however, the differences between treatment combinations were generally small and likely due to the variance of the pneumatic fractionation technique.

Table 10. Least squares means for foreign matter content- 2009 cotton.[a]

Target Feed Rate (kg min^{-1} [lb min^{-1}])	Foreign Matter Content (% by weight)		
	Initial	After 1st Stage Cylinder Cleaner	After 2nd Stage Cylinder Cleaner
17.7 (38.9)	8.3a	7.2a	6.5ab
26.5 (58.3)	8.2a	7.8b	6.1a
35.3 (77.8)	8.3a	8.2b	6.7b
44.1 (97.2)	8.0a	8.0b	6.4ab
53.0 (116.7)	8.1a	8.6c	7.3c

[a]Means in a column followed by the same letter are not significantly different at the 5% level.

The cultivar–moisture conditioning treatment interaction had a significant effect on the foreign matter content of the seed cotton after both the first and second stage cylinder cleaners. Generally, more foreign matter was removed from the lower moisture content cotton for both cultivars. However, the low moisture content ST 4554 B2RF had higher initial foreign matter content (10.1%) than the high moisture content ST 4554 B2RF (9.5%). This difference was moderately significant ($p = 0.0710$). These results may indicate that the effect was actually due to the moisture conditioning treatments and the difference in initial foreign matter content, rather than an actual interaction.

The feed rate had a significant effect on the cleaning efficiency of the first stage cylinder cleaner (table 11). Only the lowest processing rate had a cleaning efficiency significantly different than zero. The negative cleaning efficiencies shown were not significantly different than zero and were likely caused by variability in samples. The feed rate also had a significant effect on the cleaning efficiency through the second stage cylinder cleaner. However, only the highest processing rate had a cleaning efficiency that was significantly different from the other rates. While the first stage cylinder cleaner was more efficient at lower processing rates, the subsequent cleaning machines appear to have compensated for this poorer cleaning performance at intermediate rates. This result is not surprising, since cleaning efficiency typically increases with foreign matter content.

Table 11. Least squares means for cleaning efficiency- 2009 cotton.[a]

Target Feed Rate (kg min^{-1} [lb min^{-1}])	Cleaning Efficiency (%)	
	1st Stage Cylinder Cleaner	Through 2nd Stage Cylinder Cleaner
17.7 (38.9)	12.1a	20.5a
26.5 (58.3)	2.6ab	24.9a
35.3 (77.8)	-0.8b	17.6ab
44.1 (97.2)	-1.1b	19.8a
53.0 (116.7)	-6.7b	9.7b

[a]Means in a column followed by the same letter are not significantly different at the 5% level.

The moisture conditioning treatment also significantly affected the cleaning efficiency through the second stage cylinder cleaner. The cleaning efficiency through the second stage cylinder cleaner for the low moisture content cotton was 21.3%, while the high moisture content cotton only had a cleaning efficiency of 15.7%. However, similar trends were observed between different processing rates for the moisture conditioning treatments, and their interaction was not significant.

Conclusions

Varying the processing rate caused no significant differences in foreign matter content for the 2008 picker-harvested cotton tested. This cotton was already quite clean, with initial foreign matter contents between 4.6 and 7.2%, and adequately dry for seed cotton cleaning. Higher processing rates resulted in increased foreign matter content through the second stage cylinder cleaner with the stripper-harvested cotton. However, the foreign matter content for different processing rates was not significantly different after the extractor-feeder, due to its low processing rate (8 kg/min). Higher processing rates resulted in a slightly higher Shirley Analyzer visible waste content in the ginned lint for the stripper-harvested cotton. For all cultivars, there were no significant differences in AFIS fiber quality parameters due to processing rate. While there were differences in the seed cotton content of the material removed by the cleaners due to processing rate, the total mass of seed cotton lost was extremely low.

For the 2009 cotton, increasing the processing rate resulted in increased foreign matter content after the first stage cylinder cleaner. However, after processing through the second stage cylinder cleaner, only the highest feed rate had significantly more foreign matter than the lowest feed rate. Seed cotton with higher moisture content was not cleaned as efficiently; however, higher processing rates resulted in increased foreign matter after cleaning for both moisture conditioning treatments.

This preliminary data indicates that, under some conditions, higher processing rates than currently recommended may be used without adversely affecting cleaning performance. With clean, dry seed cotton, the processing rate did not affect the performance of the cleaning equipment. Cleaning performance was affected with seed cotton containing more foreign matter. However, the number and condition of seed cotton cleaners in a commercial gin would have a significant impact on the foreign matter content of the seed cotton entering the gin stand, as additional cleaners may compensate for the decreased performance of individual cleaners. Furthermore, the processing rate through a gin's extractor-feeders is typically lower than through the preceding equipment and the extractor-feeders may also compensate for poorer cleaning by cylinder cleaners and stick machines. Additional analysis and research are needed to identify specific situations where increased processing rates through seed cotton cleaners can be used without additional lint cleaning to achieve desired leaf grades.

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