PNEUMATIC FRACTIONATOR FOR CLEANING GINNED LINT

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Abstract

The pneumatic fractionator has long been used to determine foreign matter content of seed cotton at the USDA Cotton Ginning Laboratories. Spawned from discussions at a Cotton Incorporated lint cleaning summit and building on 1970s research at the Southwestern Cotton Ginning Research Laboratory, an experiment was designed and conducted to evaluate the pneumatic fractionator as a lint cleaning device. No modifications were made to the standard device, except that air pressure was set to 40 psi, instead of 70 psi. Seven lint cleaning treatments after normal saw ginning were used: no lint cleaning, one standard saw-type lint cleaner, and cleaning with the fractionator for 5, 10, 15, 20, and 30 seconds. Lint samples from each treatment were collected for USDA-AMS Classing Office classification, and AFIS, HVI, and MDTA3 fiber analyses at Cotton Incorporated. While maintaining fiber quality parameters such as length, short fiber content, and nep count at levels similar to those of no lint cleaning, the fractionator cleaned lint and produced color measurements similar to one saw-type lint cleaner.

Introduction

Recent concern about the short fiber content and neps in US cotton and the tendency of international markets to consider leaf grade 4 as a discount cotton, though it is the base grade for the US loan chart (Laws, 2006), has spurned new efforts to improve cotton quality to keep US cotton competitive on the international markets.

In a modern gin plant, foreign matter removal is accomplished with seed-cotton cleaning machines (i.e. inclined cleaners and stick machines) prior to ginning (Baker, et al., 1994) and lint cleaners (i.e. air-type and saw-type lint cleaners) after ginning (Mangialardi, et al., 1994). Lint cleaning research, for the most part, has concentrated on saw-type cleaners with grid bars (Mangialardi and Anthony, 2003). This type of lint cleaner is efficient at removing foreign material, but reduces fiber length and increases short fiber content and nep counts.

Based on discussions at a recent summit held at Cotton Incorporated to address lint cleaning issues, researchers from Cotton Incorporated, the USDA-ARS Ginning Labs, and Texas A&M University developed the following goal:

> To clean fiber and maintain fiber quality as well as or better than current technology, and reduce neps and short fiber content.

To work towards this goal, a lint cleaning research program called “Innovative Approaches to Lint Cleaning” was initiated at the USDA-ARS Southwestern Cotton Ginning Research Laboratory (SWCGRL) in Mesilla Park, NM, in cooperation with Cotton Incorporated and researchers from the other USDA-ARS Ginning Labs.

For years, the USDA-ARS Ginning Labs have used a pneumatic fractionator as a standard method to separate foreign matter from seed cotton to measure trash or foreign matter levels (Shepherd, 1972). The fractionator consists of a rectangular chamber about 18-in. high × 24-in. wide × 8-in. deep with rounded ends at the top and bottom and is split and hinged in the middle (Figure 1). A pre-weighed sample is placed in the chamber, the chamber is closed, and compressed air from 8 jets across the back of the chamber cause the cotton to tumble and flow around the perimeter of the chamber. The tumbling action and rubbing action on 3/16-in. slots across the front of the chamber cause small trash and dust to be dislodged from the cotton. The foreign matter exits the chamber through the slots, aided by a slight flow of air pulled from the chamber, and collects on two 8-in. diameter sieves (Tyler No. 6 [0.13-in. opening] and No. 200 [75-µm opening]).

There has been some research in the past with the fractionator. Brashears (1983) modified the fractionator to collect fine bur cotton material. Optimum line pressure and fractionation time for this application were 40 psi and 30 seconds. Work at the SWCGRL explored using the fractionator as a faster means of determining foreign matter content in classer's samplers than the Shirley Analyzer (Chapman, W.E. and J.V. Martinez, 1972. Unpublished report. Mesilla Park, NM: USDA-ARS SW Cotton Ginning Res. Lab). The results from the tests showed a positive and highly significant correlation between the fractionator and Shirley foreign matter measurements and the time required to process a sample averaged 4 minutes for the fractionator and 20 minutes for the Shirley. The objective of this research was to explore the effectiveness of the fractionator as a lint cleaner.

Figure 1. USDA Pneumatic Fractionator.

Procedure

The gin facilities and fractionator at the SWCGRL were used for the tests. Upland cotton (DP 33) was processed through the Lab's gin with a typical machine sequence: cylinder cleaner, stick machine, cylinder cleaner, extractor-feeder, gin stand. Three lint cleaning treatments were used: one saw-type lint cleaner, air lint cleaning with the fractionator, and no lint cleaning. Five replicate samples for each type of lint cleaning treatment were collected.

Fractionation times of 5, 10, 15, 20, and 30 seconds were evaluated with line pressure set at 40 psi. Initial samples weighed approximately 0.11 lb and final weights were recorded for the cleaned lint remaining in the fractionator chamber, the material captured on the No. 6 sieve, and the material captured on the No. 200 sieve.

Lint samples were sent to the USDA-AMS Classing Office for official classing, specifically to determine if the air cleaned lint would receive any prep calls due to the intense tumbling in the fractionator. Lint samples were also analyzed at Cotton Incorporated with the Advance Fiber Information System (AFIS) and Micro Dust and Trash Analyzer III (MDTA3). Results were analyzed to evaluate differences in fiber quality, especially trash content and fiber length, among the lint cleaning treatments with the GLM procedures in SAS (SAS. Ver. 9.1. Cary, N.C.: SAS Institute, Inc.).

Results

None of the samples from any of the lint cleaning treatments received any prep calls, despite the fact that the air cleaned lint appeared more twisted than the lint cleaned with one saw-type cleaner (Figure 2). The fractionation time had little affect on the fiber quality results. Results from the fiber analyses showed that the fractionator cleaned about as well as the saw-type lint cleaner, but without the fiber damage. Lint cleaned with the fractionator had foreign matter levels (Figure 3: leaf grade 2, 1.1% AFIS visible foreign matter, and 2% MDTA3 trash) and color measurements (Figure 4: 78.9% Rd and 10.2 +b) not different from lint cleaned with one lint cleaner. The fractionator cleaned lint tended to be the same length (37.5 staple length) or longer (1.01-in. AFIS length by weight) than lint not cleaned at all (Figure 5). The fractionated lint had significantly less short fiber (8.67%) than the other two lint cleaning treatments (9.7%) (Figure 5). Nep counts for the fractionator cleaned lint (270 per g) fell between no lint cleaning and saw lint cleaning, but was not statistically different from either (Figure 6).

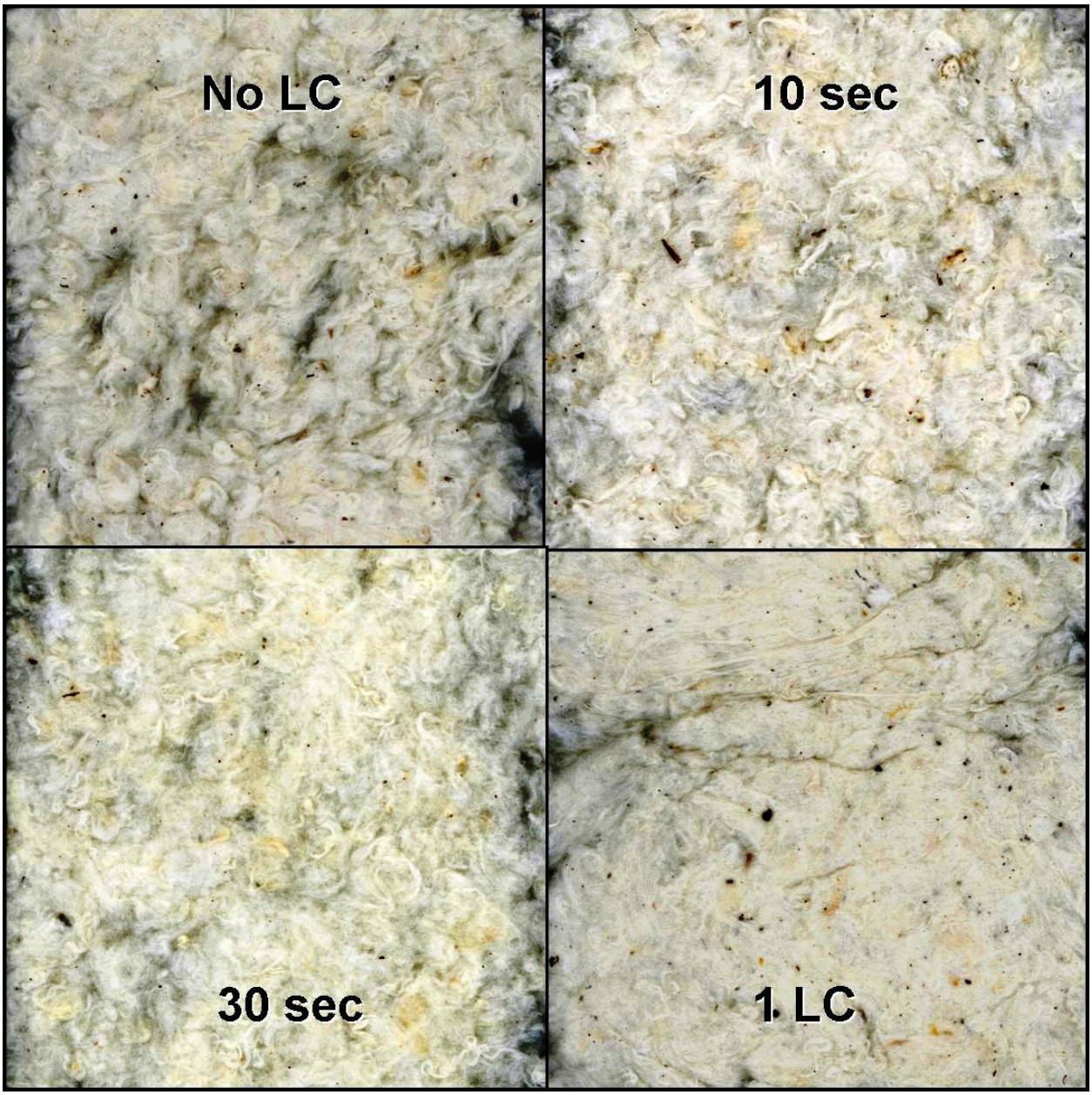

Figure 2. Lint with no lint cleaning (No LC), cleaned with the fractionator for 10 and 30 seconds, and cleaned with on saw-type lint cleaner (1 LC).

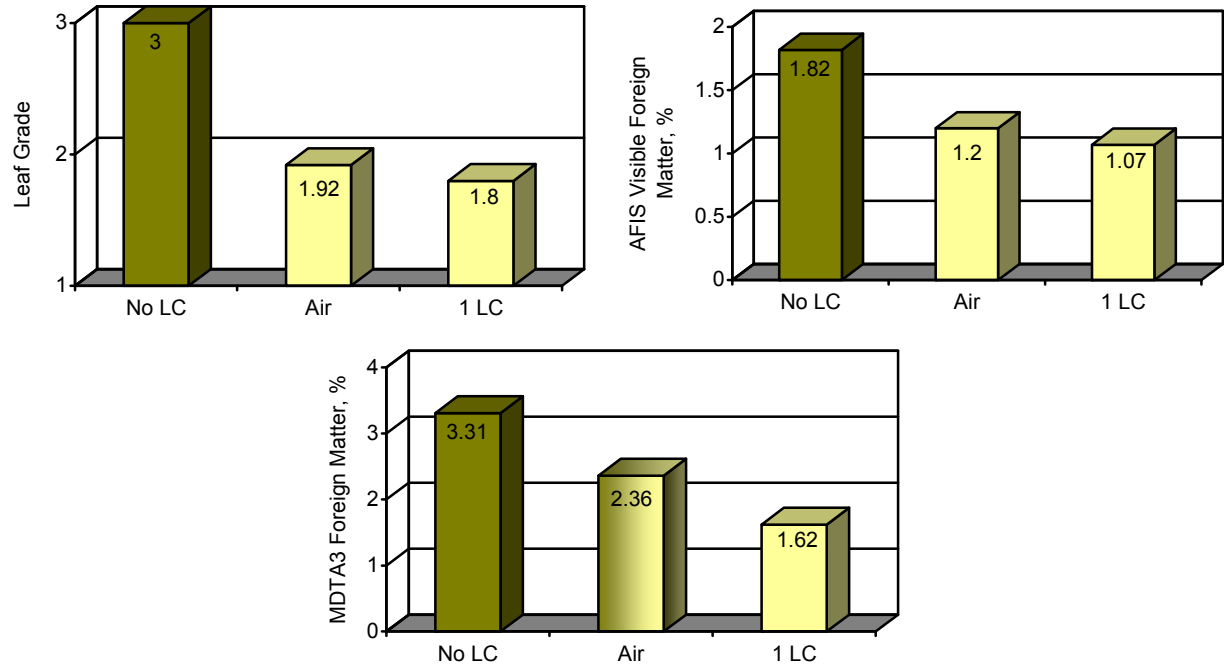

Figure 3. Leaf grade, AFIS visible foreign matter, and MDTA3 foreign matter content for no lint cleaning (No LC), fractionator cleaned (Air), and one saw-type cleaner cleaned (1 LC). Bars that contain the same color (including two-tone bars) are not significantly different ($p \leq 0.05$).

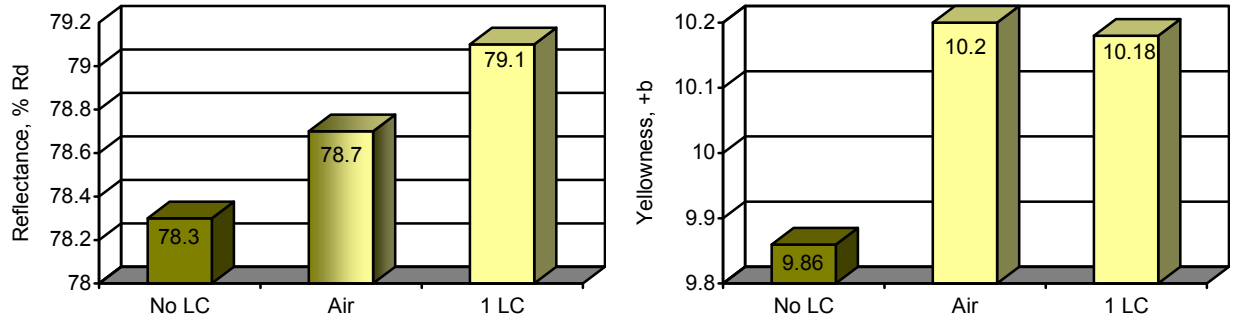

Figure 4. Reflectance and Yellowness for no lint cleaning (No LC), fractionator cleaned (Air), and one saw-type cleaner cleaned (1 LC). Bars that contain the same color (including two-tone bars) are not significantly different ($p \leq 0.05$).

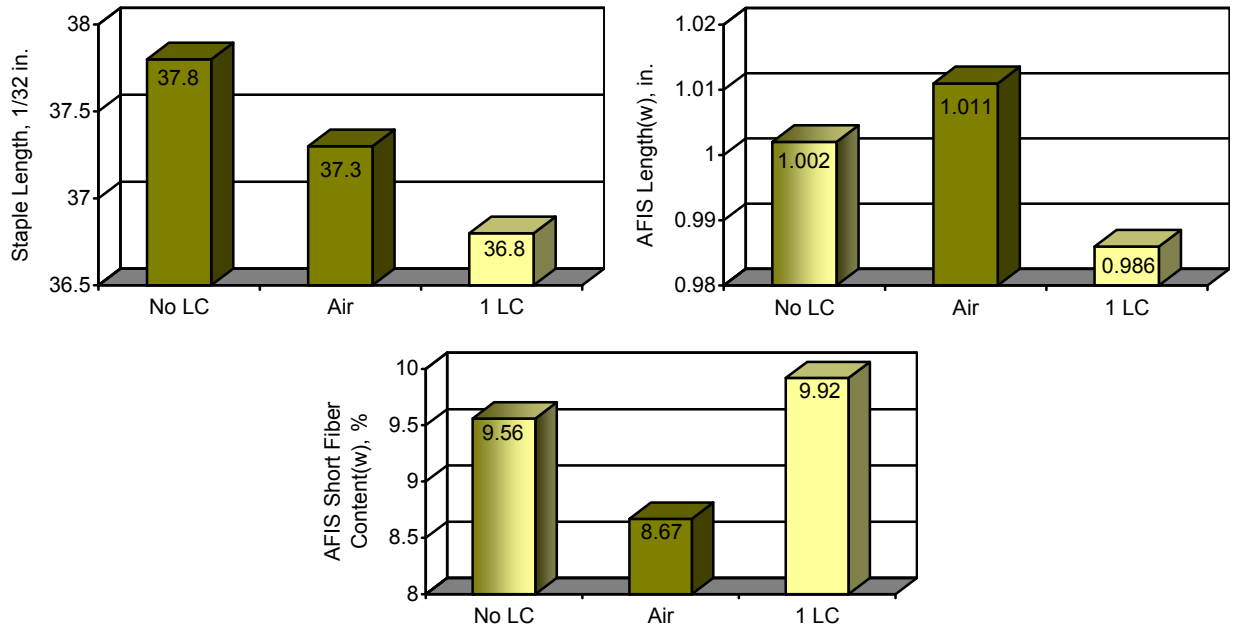

Figure 5. Staple length, AFIS length by weight, and AFIS short fiber content by weight for no lint cleaning (No LC), fractionator cleaned (Air), and one saw-type cleaner cleaned (1 LC). Bars that contain the same color (including two-tone bars) are not significantly different ($p \leq 0.05$).

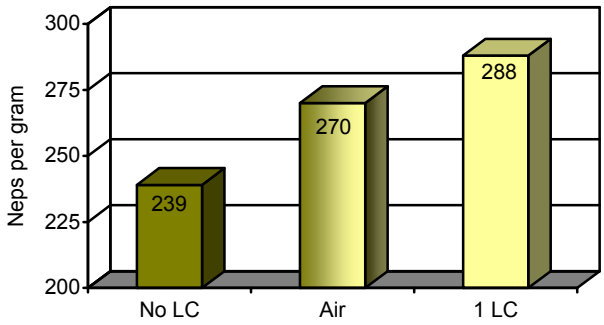

Figure 6. Nep count for no lint cleaning (No LC), fractionator cleaned (Air), and one saw-type cleaner cleaned (1 LC). Bars that contain the same color (including two-tone bars) are not significantly different ($p \leq 0.05$).

The results from this exploratory test were encouraging. A full test to better quantify and explain the effectiveness of the fractionator as a lint cleaner is needed. In particular, the amount and composition of the lint cleaner waste from the fractionator needs to be studied to better understand the effect of the fractionator on properties like turnout and short fiber content. Also, further work is needed if a large scale, continuous process device with lower energy requirements for the commercial gin is to be developed.

Conclusions

The pneumatic fractionator uses compressed air to tumble and fluff seed cotton or lint and scrub it across a set of narrow slots multiple times to remove trash. Tests conducted to evaluate the fractionator as a lint cleaner showed that the fractionator cleaned lint about as well as a saw-type lint cleaner, but damaged fiber less. Foreign matter content and color measurements for the fractionator were not different from the saw lint cleaner. Fractionated lint

length measurements were similar to lint that was not cleaned and always better than lint cleaned with a saw lint cleaner. Results showed that multiple passes over slots, facilitated by air-induced fluffing and tumbling, may clean cotton fiber well with little damage. Further testing with added trash analyses is warranted.

Disclaimer

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Acknowledgements

The authors would like to thank Cotton Incorporated for funding this research and conducting the fiber analyses.

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