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EFFECTS OF GINNING AND CARDING RATES ON YARN AND HVI BUNDLE TENSILE PROPERTIES OF COTTON

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Abstract

Two different varieties of harvested cotton were ginned and carded with different processing conditions. As an auxiliary objective for finding the effects of ginning and carding rates on single fiber tensile properties, the HVI cotton properties and yarn tensile properties were examined. HVI tests were conducted and bundle strengths analyzed for ginned cottons and card slivers. The HVI bundle strength data for 8 different processing conditions were compared to each other, and the changes were tracked for existence of a possible trend in the strength along with the processing stages. Cotton properties were HVI tested and the results compared after ginning, and after carding. Based on the ginned cotton, neither the effects of ginning nor the effects of the number of lint cleaners in ginning were shown to be significant. This may be due to lack of uniformity in cotton samples in ginning processes. However, based on HVI tests performed on card slivers, the effects of ginning rates were shown to exist whereas the effects of carding rates were negligible. In this 2x2x2 factorial design, no HVI data after ginning were applied; only the HVI data from slivers were used for analyses. Overall, the high ginning rate and/or single lint cleaner produced a higher average bundle strength based on card sliver HVI data. The Mantis single fiber tensile data also showed the same trend for the effects of ginning rates and the number of lint cleaners. On yarn tensile properties, however, we could not find consistent effects of ginning and carding rates.

Introduction

The ginning and carding processes are designed to enhance fiber uniformity and degree of orientation in addition to removing trashes and foreign matters for the production of yarn. However, these processes are also known to damage the fibers during the processing, lowering the qualities of the fibers. In addition, these negative effects of processing conditions may be reflected in the morphological characteristics of fibers. However, the extent of the damage, with regard to the fiber properties, has not been well quantified by scientific means. This research was designed to elucidate the effects of ginning and carding processes on the fiber quality by applying two ginning rates, two lint cleaner systems, and two carding rates by means of HVI and yarn tensile data analyses. We wanted to uncover a possible hidden relationships between fiber bundle properties and individual fiber properties.

Materials and Methods

Ginning and Carding Conditions

Two cotton varieties, Stoneville (STV) 747 and Deltapine 33B, were selected. These cottons were processed under 8 different processing conditions; two levels of ginning rates (75% and 125% of normal ginning rate), two lint cleaning methods (1 and 2 lint cleaners), and two levels of carding rates (60 lbs./hr and 120 lbs./hr). The cotton samples were ginned at USDA ginning laboratory, Stoneville, MS. The cotton stocks were shipped to USDA-ARS Clemson for carding and spinning.

After carding, the card slivers were processed in an RS 951draw frame without auto-leveler and then by an RS 351 with auto-leveler, to produce 0.75 hank rovings with a 1.30 TM. Details of the experimental scheme are shown in Table 1

Spinning

Each cotton was processed to produce 20/1 Ne ring spun yarns with a Sinzer 321 Ring–spinning machine at spindle speed of 14,000 rpm.

HVI Bundle Test and Yarn Tensile Test

In this paper, we examine the HVI bundle strength data only. The data for ginned cotton were provided from USDA ginning laboratory, Stoneville, MS, whereas the HVI data for card slivers were obtained from USDA−ARS Cotton Quality Research Station, Clemson, SC, and also in part from the Agricultural Marketing Service (AMS) in Memphis, TN. Yarn tensile properties were provided by the USDA Clemson laboratory.

Results and Discussions

HVI Bundle Strength for STV 747 and DPL 33B Ginned Cotton and Card Slivers

Based on the analyses, the HVI bundle strengths were shown to have been affected by neither the ginning rate nor the number of lint cleaners applied in ginning.

Although two lint cleaner resulted in a slightly higher bundle strength for STV 747 ginned cotton, the opposite was true for DPL 33B cotton. The inconsistency of the effects on the bundle strength might have been due to lack of uniformity in the test samples at ginning.

Unlike the case for ginned cottons, HVI bundle strengths of card slivers showed somewhat consistent effects of the processing conditions for the two varieties. For both, the high ginning rate produced higher strengths than the low ginning rate. Also, the bundle strengths were shown to be higher for cottons processed with 1 lint cleaner than that from 2 lint cleaners. The effects of carding rates on HVI bundle strengths were not statistically significant.

However, the above result may not be conclusive in view of the small sample size and the lack of uniformity in cotton samples. The differences in bundle strengths with respect to the two ginning rates, as well as that from two different numbers of lint cleaners and that from two carding rates, were all very small and were found to be not statistically significant.

When the bundle strengths of card slivers were compared against the results from Mantis single fiber strengths, the effects seem quite consistent; at the higher ginning rate, and with one lint cleaner, the strengths were higher than that from the lower ginning rate or two lint cleaners. This may be explained by a hypothesis that the weaker and longer fibers are more readily broken at a high ginning rate, making the surviving fibers at carding to be stronger to begin with. As lumps of fibers are put into the gin, ginning action makes fibers more oriented and aligned, enhancing the bundle strength. This phenomenon was reported by Shofner (1994). He found that more brushing increased HVI bundle strength. This aligning action continues throughout the entire ginning and carding processes. When the mechanical impacts during the processing go beyond the yield point of the fibers, permanent physical damage of fibers becomes inevitable. Use of multiple lint cleaners also expedites this process.

It is a well-known fact with synthetic fibers that repeated loading and unloading within their yield points often increase the tensile properties of the fibers. This “mechanical conditioning” in fact is not limited to synthetic fibers. What we observed in this study might very well be the same phenomenon. The question, of course, is whether the effects are temporary or permanent throughout the life cycle of the fibers.

Tensile Strength for STV 747 and DPL 33B Spun Yarn

The strengths of spun yarns produced from the two cotton varieties were analyzed for the effects of the processing conditions. The results, however, were quite conflicting to each other and complex to draw a general conclusion. The reasons might be due to various other factors including twists and frictional force that originate from the two fiber varieties.

References

Shofner, K. - *The Effects of High Volume Instrument Sample Preparation on Tensile Properties of Cotton Fibers*, an Unpublished Master's Thesis at College of Textiles, North Carolina State University, pp 23 - 27, Raleigh, NC, 1994.

Table 1. Detailed Experimental Scheme for Opening, Carding and Spinning.

Line Used in Opening and Carding	Truetzschler Opening Line and DK 740 Card
Sliver Produced	70 gr. Sliver
Carding Rate	60 lbs./hr and 120 lbs./hr
Card Mat Testing	Collect ½ lb. sample. Record beginning wt, sliver wt, and waste at each cleaning point.
Shirley Analyzer	Save all waste for Shirley Analyzer
Evenness Test	Carry out the test on the card sliver and save the samples for AFIS tests.
1st Drawing	60 gr. sliver 6 ends up
2nd Drawing	61 gr. sliver 8 ends up Do an evenness test on the finisher drawing sliver and save samples.
Roving	Produce .75 hank roving with a 1.30 TM.
Spinning Ring	The lots were run on the Ring Spinning Frame. Spun all of the cotton into 20/1's yarn at 14,000 Spindle speed, 3.85 TM. Record ends-down for the entire tests. Perform Classimat tests on each lot and then send all yarns to testing lab.

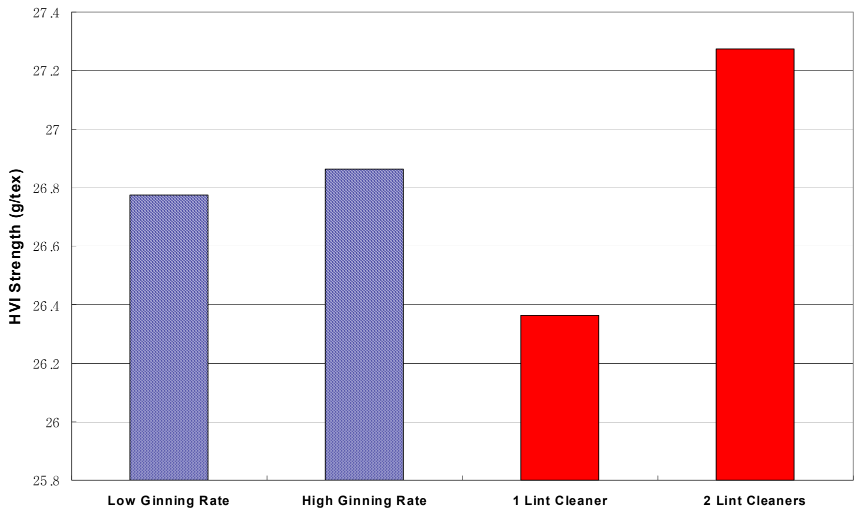

Figure 1. HVI Strength vs. Process Conditions for STV 747 Cotton.

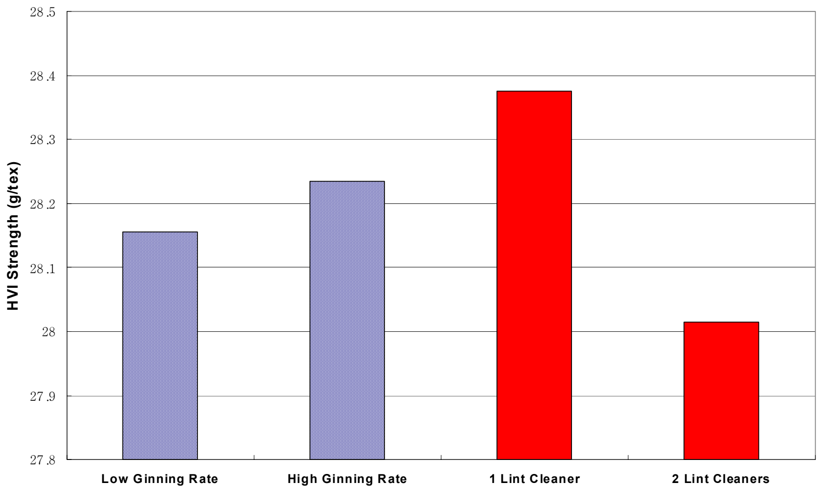

Figure 2. HVI Strength vs. Process Conditions for DPL 33B Ginned Cotton.

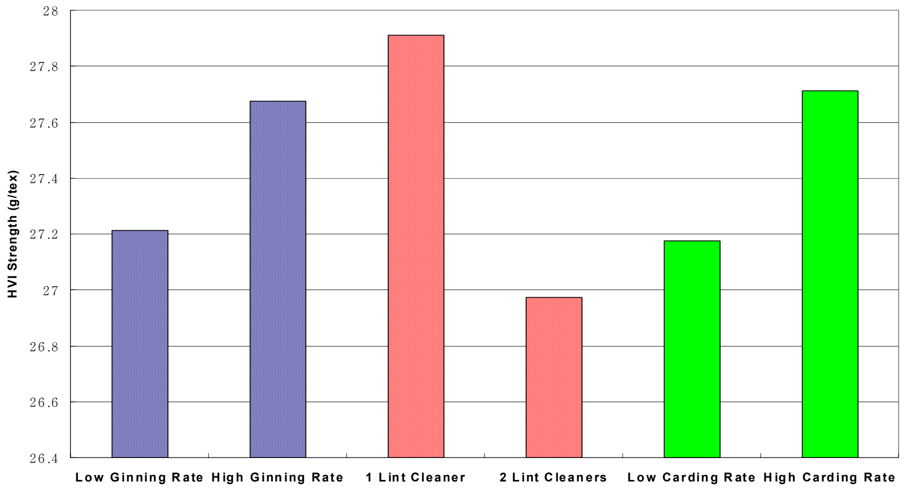

Figure 3. HVI Strength vs. Process Conditions for STV 747 Card Sliver.

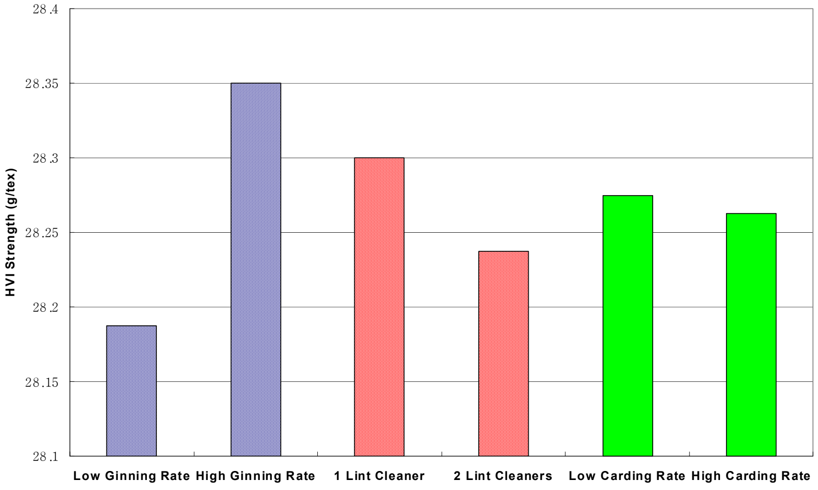

Figure 4. HVI Strength vs. Process Conditions for DPL 33B Card Sliver.

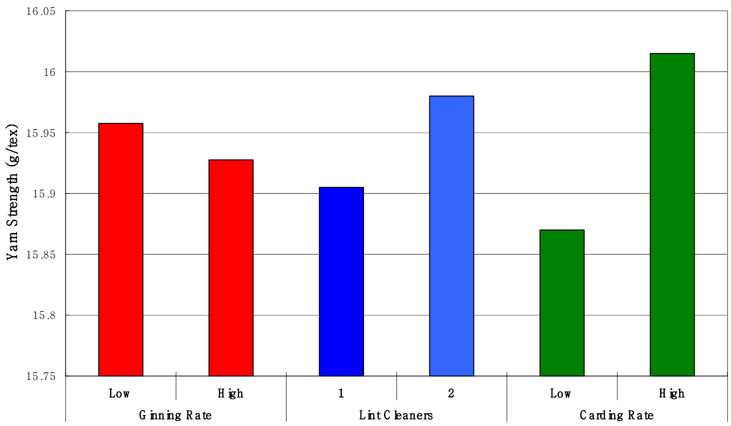

Figure 5. Yarn Strength vs. Process Conditions for STV 747 Ring-spun Yarn.

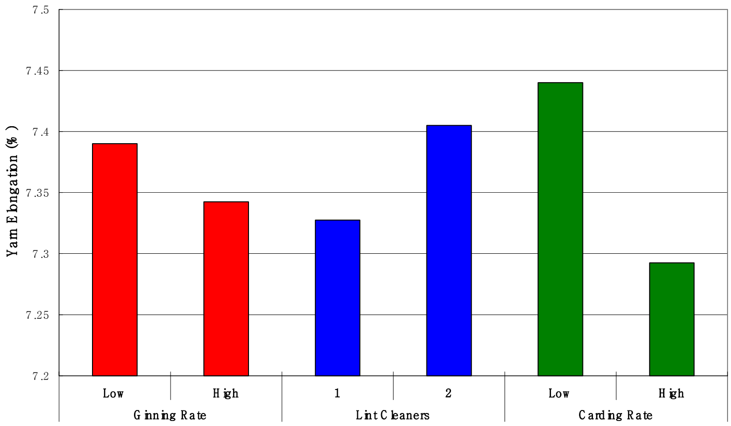

Figure 6. Yarn Elongation vs. Process Conditions for STV 747 Ring-spun Yarn.

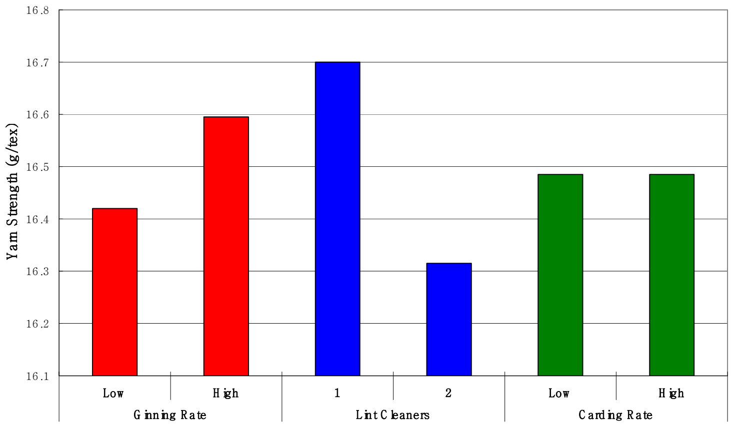

Figure 7. Yarn Strength vs. Process Conditions for DPL 33B Ring-spun Yarn.