ORIGIN, STRUCTURE AND PROPERTIES OF NON-DYEING LINT FIBERS: DO GINNING AND LINT CLEANING METHODS AFFECT DYEING PROPERTIES OF LINT FIBERS?

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Abstract

Ginning and lint cleaning methods are utilized to remove (or reduce) offending fibers in cotton.

We investigated the effect of the methods on a) the impurity content of cotton fiber samples, b) color measurements of dyed fabrics knitted from the same fibers, c) dye-uptake of individual fibers in the dyed fabrics and d) dye-uptake properties of impurities such as seed coat fragments (SCF) in dyed fabrics. The analyzed effect was concluded to be insignificant.

Introduction

Our goal is to understand the structure of cotton fibers that may be related to their poor dyeing quality. This knowledge is crucial to cotton producers in order to improve fiber quality and to eventually reduce and eliminate white specks and non-dyeing fibers in fabrics and textiles. The sources of white specks are not known. The current understanding is that dye-uptake problems in cotton are caused by the lack of secondary (cellulosic) fiber wall development (Smith, 1991), although the cause-and-effect relationships of this problem have not been identified yet. However, it is not known whether the aggregated fibers that are seen as white specks have their origin within the fibers as they form in the boll, or whether such specks are the result of aggregation of clumps of immature fibers caused by processing methods. We examined various stages of processed lint fiber and by-products (card sliver, combed sliver, carded finisher sliver or combed finisher sliver, comber noil, yarn, fabrics) using microscopic and dyeing techniques and analyzed whether ginning and lint cleaning methods affect a) the nep and seed coat fragment content in cotton, and b) the cell wall properties of cotton fibers that may be related to their poor dyeing quality.

Methods and Materials

Bales of Delta-Pine (DLP-50) cotton (*Gossypium hirsutum* L.) grown in the Chico, California area were the source of cotton fiber samples collected at various stages of processing. Samples were examined, using a dissecting microscope, for fiber impurities such as neps (entangled fibers), seed or mote coat fragments (SCF), and debris of other than seed origin. Fiber samples and impurities were separated, weighed and counted, and the data were analyzed using the software program Statistica (StatSoft Inc., Tulsa, OK) to correlate fiber handling conditions and processing procedures with the impurity content. Fabrics knitted from the same fibers were dyed using reactive and direct dyestuffs. Color measurements on dyed fabrics knitted from eight different fiber handling conditions were made using a Minolta spectrophotometer coupled with Spectra QC software (version 7.3) to measure the lightness (L*) as well as hue and saturation (a*, b*) values of the fibers. Subsequently, the dyed fabrics were microscopically examined to study color response and dye-uptake of individual fibers and of possible impurities (e. g., SCF) in the fabrics.

Results and Discussion

Do ginning and lint cleaning methods affect the content of neps, SCF, and other fiber impurities? A factorial analysis of variance (ANOVA) on the data collected showed much variation between samples (i.e., Fig. 1). However, some basic trends were uncovered. The number of impurities was higher in the cage ginned than in saw ginned cotton fiber samples (Main Effect Gin Type, not shown). This difference was based primarily on the number of neps; the number of seed coat fragments and other (non-seed origin) impurities was slightly less in cage ginned material. The plot of means using lint cleaning as the main effect (not shown) indicated that lint cleaning reduced the number of neps and SCF. However, standard deviations for both types of impurities were overlapping. In cage ginned processed fibers such as lint, combed sliver, and combed finisher sliver, the number of neps was much higher if no lint cleaning was utilized (Fig. 1A). Except for lint fibers, lint cleaning appeared to neutralize the gin effect on the nep content (Fig. 1A). Ginning or lint cleaning did not affect the number of SCF in fiber samples (Fig. 1B).

Do gin type, lint cleaning, and processing procedures affect the color measurements of dyed knitted fabrics? There were no significant differences in color measurements of knitted fabrics dyed with either Reactive Blue 19 or Direct Blue 1. The only significant differences (at the 0.05 level) were in the lightness of the blue color between the carded and the combed samples, both of which were saw ginned without lint cleaning.

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What are the causes of dyeing imperfections and dye-uptake problems? In Reactive Blue dyed knitted fabrics, fibers attached to some seed coat fragments appeared dyed differently than most fibers in the fabric; these SCF fibers were often white (not dyed) or grey-blue. Microscopic examination of individual fibers in the fabrics demonstrated that fiber cell walls responded differently to either dye. Reactive Blue primarily stained the interior of the fiber cell or cell wall and little if any the cellulosic wall (Fig. 2A). Cell wall thickness presumably did not affect the dyeing properties if the Reactive Blue dye bath was used. Direct Blue was taken up by the entire fiber cell wall (Fig. 2B), and cell wall thickness seemed to affect the coloration of individual fibers.

Summary

Ginning and lint cleaning methods insignificantly affect the content of neps and seed coat fragments in fiber samples and the color measurements of dyed fabrics. However, lint cleaning methods that determine the number of impurities affect the dyeing properties indirectly, as, for example, cage ginning in combination with combing, which reduces the number of seed coat fragments including those attached to non-dyeing fibers.

Reference

Smith B. 1991. A review of the relationship of cotton maturity and dyeability. Textile Res. J. 61: 137-145.

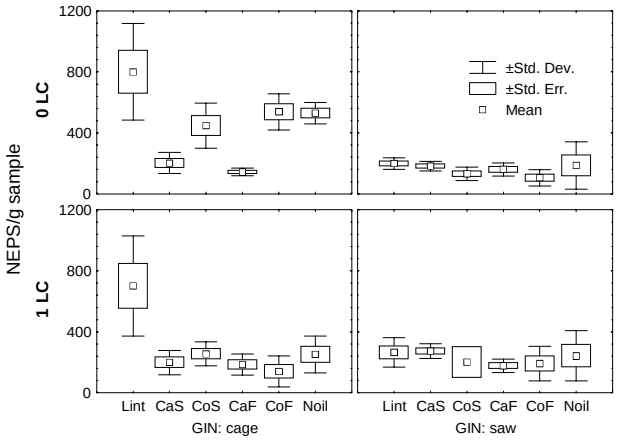

Figure 1A. Categorized plot for variable NEPS.

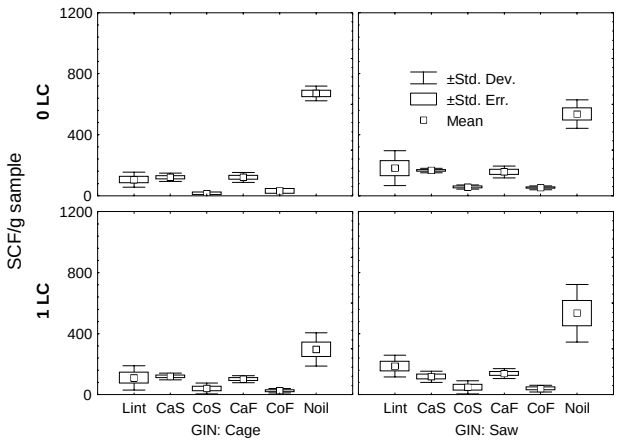

Figure 1B. Categorized plot for variable SCF (seed coat fragment). Carded sliver (CaS), combed sliver (CoS), carded finisher (CaF), combed finisher (CoF), comber noil (Noil).

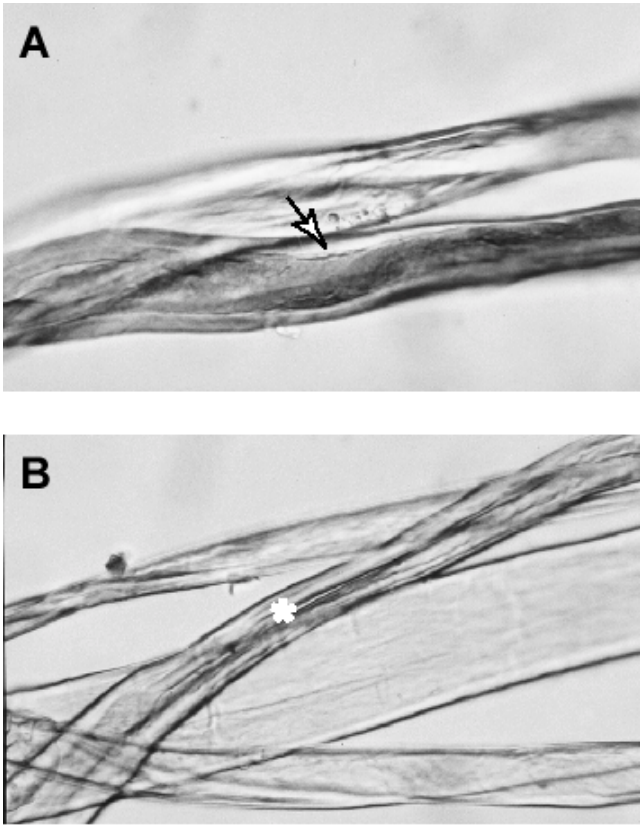

Figure 2. Individual fibers of knitted fabrics dyed with Reactive Blue 19 (A) and Direct Blue 1 (B). Fiber cell walls responded differently to either dye. Reactive Blue primarily stained the interior of the fiber cell or cell wall (A, bottom fiber) and little if any the cellulosic wall (A, arrow, top fiber). Direct Blue was taken up by the entire fiber cell wall (B). Cell wall thickness (* thick cell wall) seemed to affect the coloration of individual fibers.