

EXAMINATION OF THE RELATIONSHIPS BETWEEN INDIVIDUAL FIBERS TENSILE PROPERTIES AND BUNDLE TENSILE PROPERTIES

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Abstract

An important cotton fiber characteristics that relates to HVI bundle strength is the strength of the individual fibers in the bundle. We know that cotton fiber strength is an important factor in determining fiber breakage during mechanical handling (harvesting, ginning, spinning preparation) and in determining yarn strength. Therefore, an improved fiber strength should translate into an improved yarn strength and a better textile product.

Our main hypothesis is that HVI bundle strength does not reflect the intrinsic fiber strength. Indeed, fiber bundle strength is resulting from the interaction of several fiber properties, i.e., individual fiber strength (combination of the fiber microstructure and of the quantity of cellulose in the cell), friction forces between fibers mostly related to the specific surface (for a given weight there are more fibers in the bundle for finer cottons than for coarser cottons), surface properties such as wax content, fiber length distribution (the shorter fibers will not extend across the full length of the clamping system. Therefore, some will participate to the determination of the mass of the sample but will not participate to the force to break). The same can be said for the determination of yarn strength. This is the reason why HVI strength is a good estimator of yarn strength. Nevertheless, throughout fiber processing (from the gin to the textile mill) the mechanical devices interact with individual fibers or small tuft of fibers not with fiber bundles. Therefore, it is necessary to evaluate the relationship between the average individual fiber strength using the FAVIMAT and HVI strength, and also to measure the extent of the fiber-to-fiber variability for individual fibers tensile properties.

The results obtained show that:

- FAVIMAT elongation-at-break exhibits an excellent correlation with HVI elongation. HVI elongation is currently very seldom used by the cotton breeders and is not reported by the USDA-AMS because it is deemed unreliable. The results obtained tend to disprove this common misconception about HVI elongation.
- More importantly, average FAVIMAT force-to-break correlates poorly with HVI tenacity. It means the HVI bundle strength is not a good estimator of individual fiber force-to-break.
- Among the 32 samples tested so far, the variability between samples for the elongation-at-break is about twice the one for force-to-break. If confirmed, it means that there is probably a large untapped genetic variability for fiber elongation. This variability could be used by cotton breeders to improve the work-to-break (quantity of energy necessary to break a fiber or a bundle of fibers) of cotton.
- Yarn tenacity of ring spun yarns (30Ne) can be predicted quite accurately with FAVIMAT tenacity and elongation-at-break ($R^2 = 0.887$).

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