A Method for Measuring Cotton Seed Compression Force as a Potential Indication of Propensity to Create Seed Coat Fragments

Zach Hinds [1], Suman Lamichhane [1], Brendan Kelly [1,2], and Eric Hequet [1]

[1] Plant & Soil Science, Texas Tech University, Lubbock and [2] Texas AgriLife Research, Lubbock

Background

Cotton fiber neps cause significant problems within the textile industry resulting in decreased yarn quality, decreased production efficiency and increased production cost. Among the three main types of neps found in cotton, only seed coat fragments (SCF) have been described as genetically inherited by several authors (Mangialardi, 1988). A recent report published in 2014 by the International Textile Manufacturers Federation (Cotton Contamination Survey 2013) revealed a noticeable jump in seed-coat fragments contamination. Forty-two percent of cotton spinners worldwide claim that they have encountered moderate or significant amounts of seed-coat fragments in the cotton growths consumed against 38% in 2011. Seed-coat fragments may arise from compacting (modules), cleaning and ginning the seedcotton as these processes may break the seed coats or tear off part of the seed coats (Figure 1). As fibers are attached to these fragments they are not completely removed from the lint during cleaning and carding at the spinning mill. The seed-coat fragments with fibers attached are integrated in the structure of the yarn and create defects and weak spots, lowering productivity of the textile mills and market value of the yarns and fabrics (Curran, 1992). A measurement method for the determination of SCF potential suitable for breeding does not currently exist. Such a method would provide an objective measurement for determining the genetic basis for seed coat fragment formation and would enable the development of varieties less prone to seed coat fragment formation.

Figure 1: Broken cotton seed with associated seed coat

Objective

A Universal Tensile Machine (Figure 2) was used to measure the seed compression force of 18 cotton varieties. We hypothesized that varieties whose seed coats break more easily will be more likely to form seed coat fragments during cotton processing. By measuring seed coat compression, we hope to show that there are clear differences between cotton varieties and establish a protocol for screening propensity to create seed coat fragments. Such a protocol could be suitable for breeding and investigating the genetic basis for seed coat formation and could identify and remove problematic germplasm from a cotton breeding program before major issues occur during textile production.

Materials and Methods

Eighteen cotton varieties representing a range of variability were selected for comparison and their fuzzy seed utilized for subsequent testing. Seed samples where conditioned for seven days at 21±1 ˚C and 65±2% relative humidity prior to testing. For each variety, 6 statistical replications were performed. Each replication consisted of 15 seeds of the associated cotton variety. Therefore, 90 seeds were compressed for each variety totaling 1620 tested cotton seeds. A Universal Testing Machine (UTM) was utilized to measure the compression force of the fuzzy cotton seeds (Figure 3) with a breaking speed of 25.4 mm per minute.

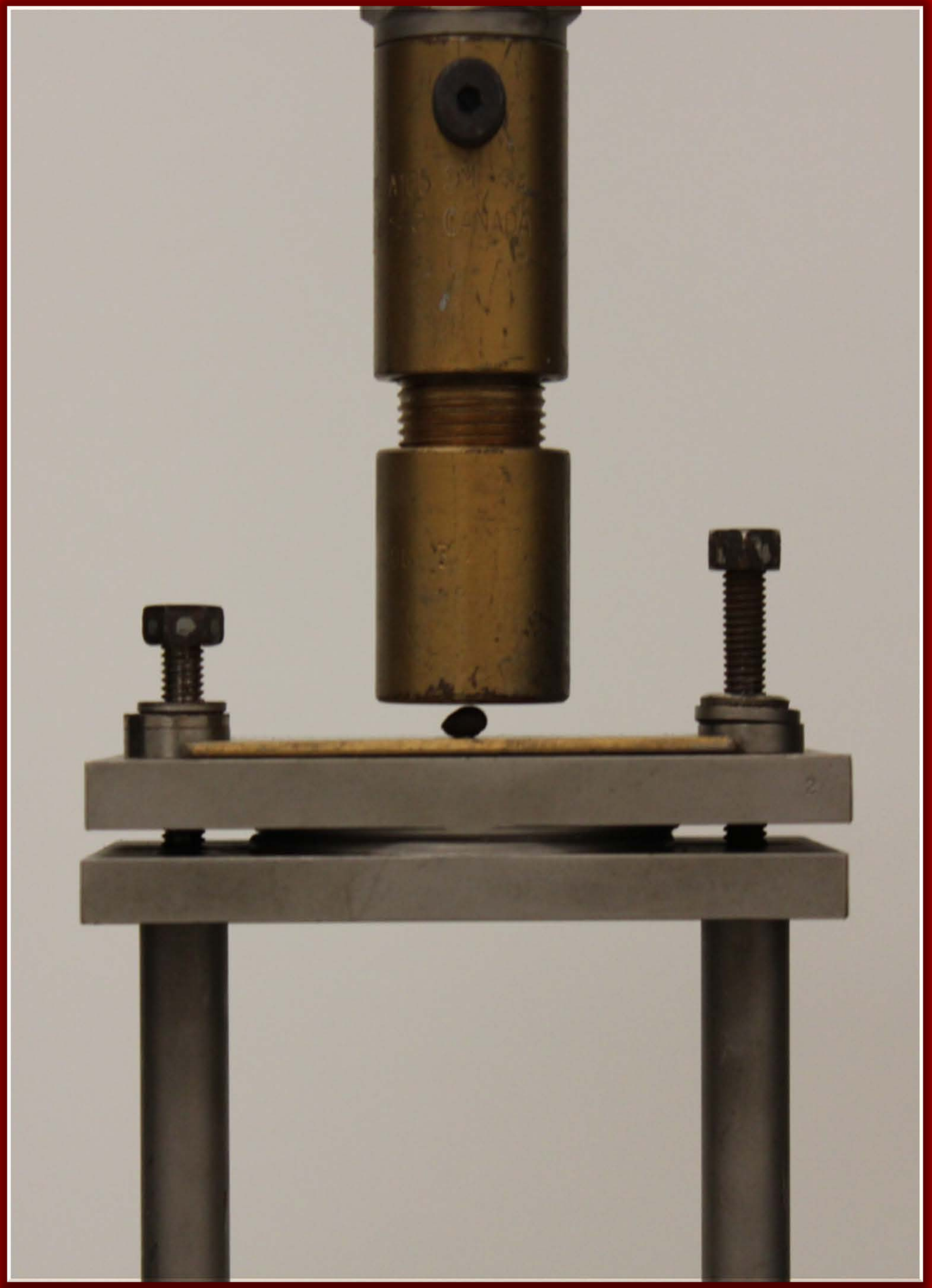

Figure 2: Compression force of a typical cotton seed

Results

There are clear statistical differences in seed breakability among the 18 cotton varieties tested (Figure 4). The average breaking force ranged from 40.2 N to 80.1 N with a mean value of 62.4 N. Breaking seeds with the UTM most frequently resulted in a single distinguishable peak at which point the seed was deemed broken. However, breaking some seeds results in two peaks and is likely caused by some internal structural properties of the seed. The infrequent occurrence of the second peak and the fact that some point of rupture had already been achieved resulted in the use of only the first peak for analysis in this study.

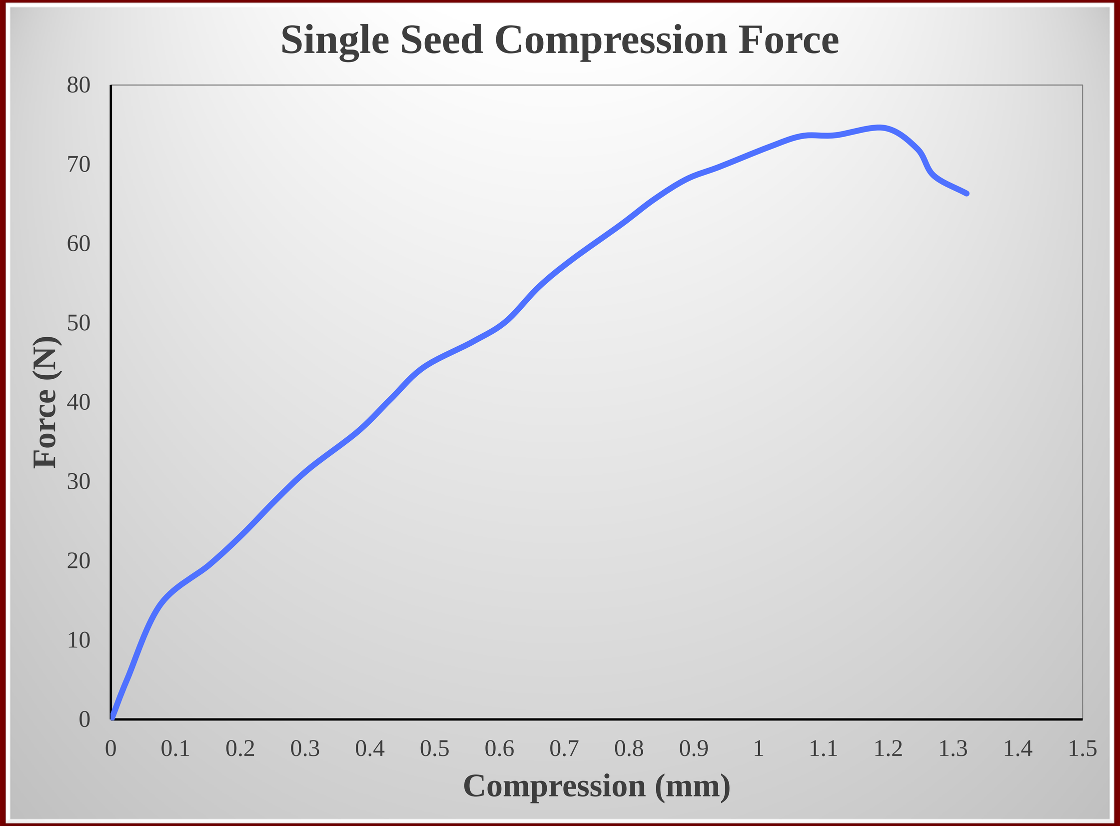

Figure 3: Compression force of a typical cotton seed

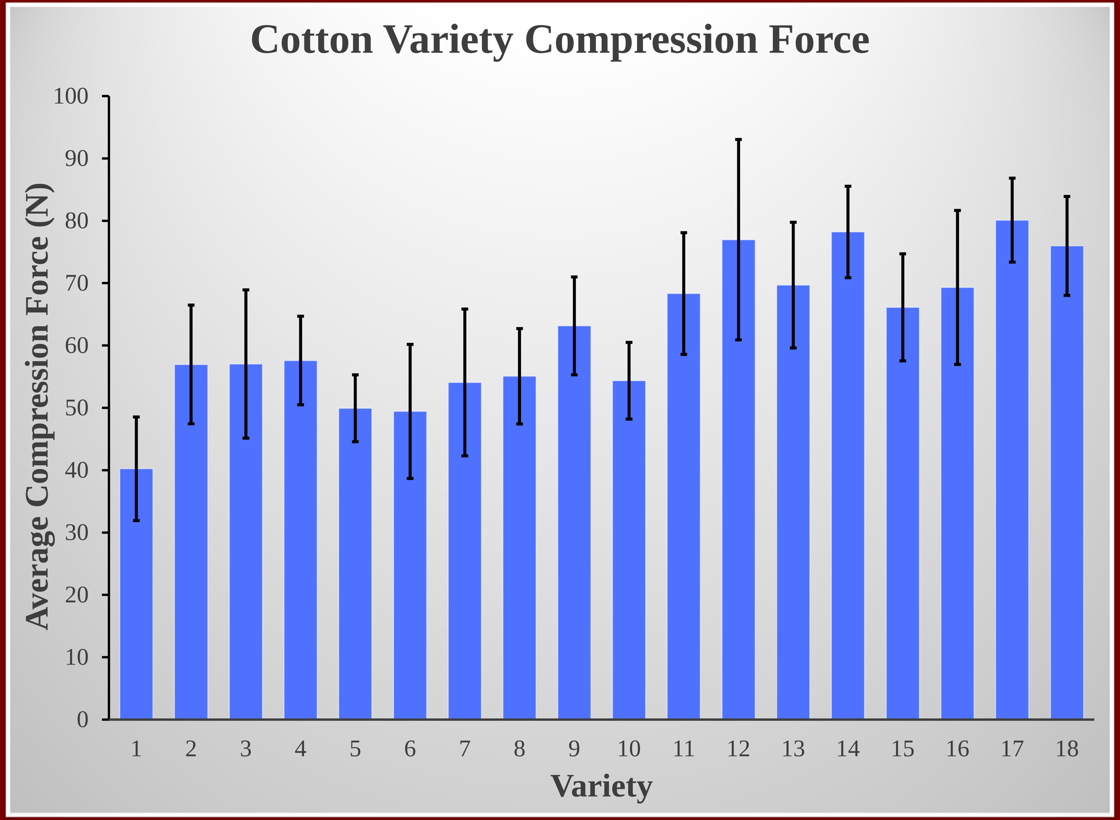

Figure 4: Average cotton seed compression force of 18 varieties

Conclusion

The fact that there are clear differences in the compression force of the varieties tested shows that this method could be used to rank germplasm within a breeding program. Because the presence or absence of seed coat fragments depends on the combination of genotype and the many external factors that come into play during development, harvest, and processing breeders could not be certain of the likelihood a cotton would have seed coat issues from year to year. Therefore, cotton breeders could use this seed testing procedure to make selection decisions based on breeding materials propensity to have seed coat fragments. Preliminary results from an additional test of fiber attachment force appear reveal additional information about cotton seed coat fragments and will likely complement this seed compression test.

Future Work

A complimentary test of fiber attachment force performed on the same 18 varieties using the same UTM has been conducted. These two experiments will be followed by spinning tests to observe the impact of seed coat fragments on textile manufacturing (Figure 5). The results of the spinning tests will be used to validate seed compression and fiber attachment force as good predictors of propensity to create seed coat fragments.

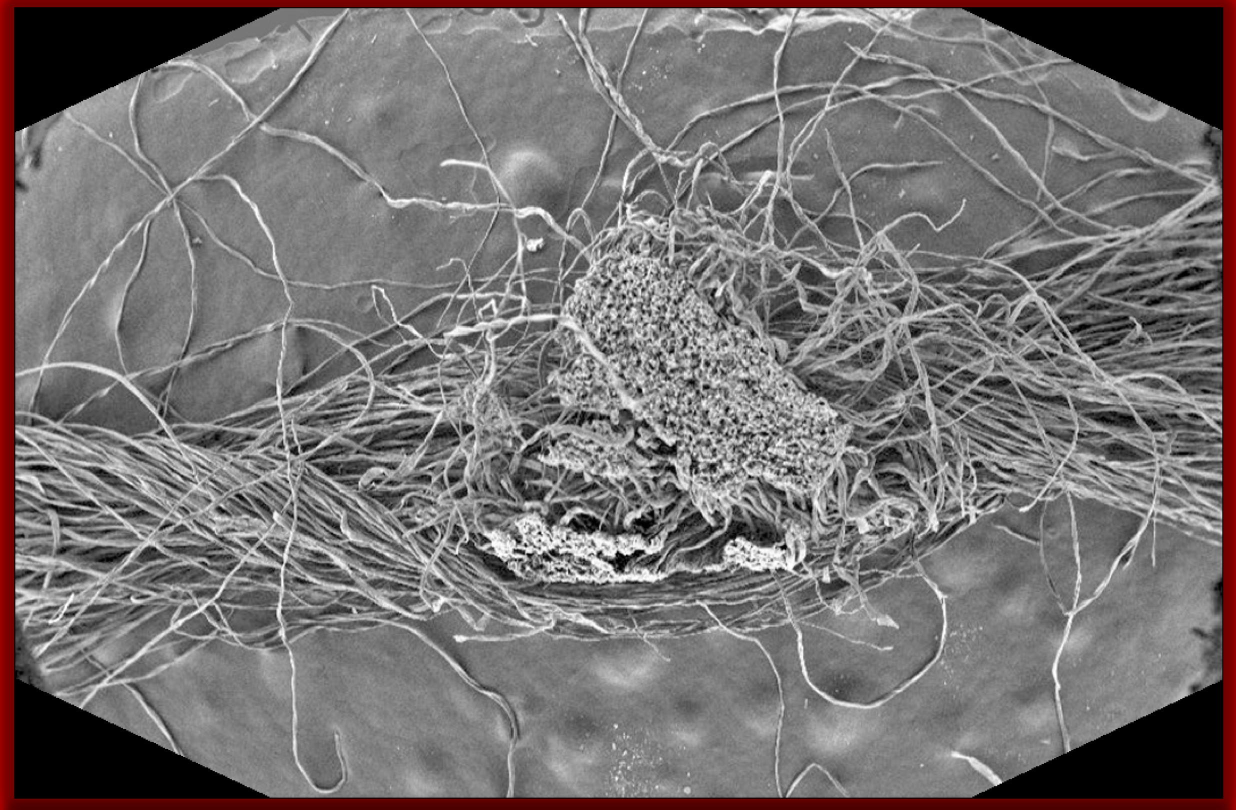

Figure 5: Scanning electron microscope image of a seed coat nep within ring spun yarn

References

- Curran J. M. 1992.What are the qualitative needs of the modern spinning industry? Technical seminar of the International Cotton Advisory Committee, Cotton Marketing Systems and Quality Evaluation, Liverpool, pp. 3-6.
- International Textile Manufacturers Federation. 2014. Cotton Contamination Survey 2013.
- Mangialardi, G.I. (1988). A Review of Seed Coat Fragment Research. Proceeding of the Beltwide Cotton Conference, USA, pp. 592-594.

TEXAS TECH UNIVERSITY
College *of* Agricultural Sciences & Natural Resources™

Acknowledgments

Fiber and Biopolymer Research Institute

Texas Tech University