EXPERIENCE WITH COTTON STICKINESS TESTING

James L. Knowlton
Agricultural Engineer & Assistant Branch Chief
Standardization and Quality Assurance Branch
USDA, AMS, Cotton Division
Memphis, TN

Abstract

Several methods of determining stickiness in raw cotton were evaluated. Although Thermodetector and sugar testing methods were evaluated, the primary emphasis of the evaluation was on the stickiness measurement of a Fiber Contamination Tester (FCT). During the evaluation, a large level shift in the stickiness measurement was experienced in the FCT following a hardware upgrade by the manufacturer. Repeatability in the FCT stickiness measurements was good within the one instrument following the upgrade. At a maximum capacity of one sample every forty five seconds, the FCT was found to easily process approximately 300 samples in a seven and one half hour shift (one replication per sample). Although more variable, the Thermodetector was found to correlate with the FCT. In the cottons tested, sugar tests did not show any correlation with the FCT or the Thermodetector. In addition to a set of known sticky cottons, a set of ordinary samples was tested by all methods to put the results of the sticky cotton set in perspective.

Introduction

The USDA, AMS, Cotton Division has been active in stickiness testing for several years. Although a measure of stickiness is not part of the official USDA cotton classification system, the Cotton Division performs limited stickiness testing for purposes of evaluation and maintaining proficiency in recognized measurement methods. The only stickiness methods utilized by the Cotton Division up to this point have been the SCT Thermodetector and the Perkin's Sugar Test. In recent months, the Standardization and Quality Assurance (S&QA) Branch of the Cotton Division has had the opportunity to evaluate a Lintronic's Fiber Contamination Tester (FCT). This FCT is on loan from Cotton Incorporated and is currently only one of three in the U.S.

The FCT is designed to provide high speed measurement of cotton contaminants. In addition to stickiness, measurements for trash, neps and seedcoat fragments are also performed. Since the emphasis of this evaluation is on stickiness, the other contaminant type measurements were not analyzed.

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Materials and Methods

The primary focus of this evaluation was on the FCT's operating performance and the repeatability of the FCT's stickiness measurement. Sugar testing and Thermodetector tests were also performed for comparison. The primary test material was a set of 500 samples taken from 50 bales (10 samples per bale). This set of cottons, which was provided by the International Textile Center (ITC) in Lubbock, Texas, was put together with cottons containing various levels of stickiness. In addition to this sample set, several hundred ordinary samples chosen randomly from across the U.S. cotton belt were tested.

All five hundred of the ITC samples were tested one time on the Thermodetector and four times on the FCT. In addition, sugar tests were made on three samples out of each of the fifty ITC bales. The ordinary samples were tested once by each method.

Results and Discussion

Fiber Contamination Tester

Many of the bales making up the ITC cotton set were known to have high levels of insect stickiness. In the first testing of this set, considerable difficulty was encountered in processing these sticky samples through the FCT. A great deal of the operator's time was spent manually cleaning various contact points within the instrument. However, soon after this initial test run, an extensive upgrade was performed by the manufacturer on the FCT that provided many improvements. The upgrade included improved automatic cleaning and increased testing speed. Three more replications of the 500 sample test set were made following the upgrade with only occasional interruptions.

Figure 1 shows the correlation between the first two FCT runs on each of the 500 samples in the ITC cotton set. The level difference shown can be attributed to the upgrade that occurred following the completion of the first run. Although the reason for the level shift is not fully understood, there are several aspects of the upgrade that are probably responsible.

The basic operation of the stickiness measurement of the FCT involves feeding a cotton web between two rapidly rotating metal crush roll drums. A vacuum draws the web away for disposal after the web passes between the drums. Sticky fibers will stay on the drums and will be measured when they interrupt a laser beam directed across the surface of each drum. A suction nozzle is located at each laser location on the drum to draw the sticky fibers perpendicular to the drum to facilitate the laser measurement. During the upgrade, the amount of suction on all drum nozzles was increased substantially to improve drum cleaning. The increased suction may have caused increased removal of sticky fibers from the drums before being counted by the lasers. Other factors that may affect the stickiness level include the temperature of the drums, fiber moisture and positioning of the lasers.

Figure 2 shows the improved correlation between the second and third FCT runs following the upgrade. Figure 3 gives the bale averages based on averaging three samples from each bale. This correlation is indicative of three replication sample testing. Bale averages are again given in Figure 4 but are based on the average of the ten samples from each bale. These graphs illustrate good repeatability of FCT stickiness following the upgrade. However, the testing level change due to the upgrade does raise some concern over the lack of standardization in the FCT stickiness measurement. A summary of overall averages and coefficients of determination are given in Table 1. The table shows that the overall averages of the runs was reduced by almost one half following the upgrade.

In order to further demonstrate the repeatability of the FCT data, Table 2 shows the reproducibilities between the runs following the FCT upgrade. Reproducibilities at different tolerances are given for n=1, 3 and 10 replications. Table 2 shows that single measurements can be repeated within a sticky grade of ±50, 85 to 89% of the time. Given the stickiness measurement range of the sample set (0 to 250), a measurement confidence of ±50 may not have adequate precision. However, if three replications per sample are made, the stickiness grade was repeated within ±20 for approximately the same reproducibility percentage.

The time to make one measurement replication was cut from well over a minute to forty five seconds as a result of the upgrade. The highest daily volumes achieved in the evaluation were about 300 samples in seven and one-half hour shifts (one replication per sample). Since the samples require special preparation followed by weighing, the instrument operator is pressured to work rapidly in order to keep pace with the FCT. At the FCT's current operating speed, the maximum potential volume is about 600 single measurements in a seven and one-half hour shift.

Thermodetector

Figures 5 and 6 show Thermodetector results on the ITC samples for two different Thermodetector operators. The variability between the two replications for each operator was about the same. However, the overall testing level of the first operator was much lower than the second operator. Although there is some correlation between the Thermodetector operators, as shown in Figure 7, considerable variability exists. The Thermodetector results would have been improved if the average of three replications per sample had been obtained. The instruction manual for the Thermodetector recommends three replications per sample for reliable testing.

FCT Versus Thermodetector and Sugar Test

Figure 8 compares the first Thermodetector operator to the FCT. The only definite separation is between the non-sticky cottons and the extremely sticky cottons. The stickiness correlation of the cottons in the middle is inconclusive. Figure 9 shows that the sugar test and the FCT have practically no correlation. Figure 10 gives the FCT and sugar test results for the sample set of ordinary cottons. The graph shows some high sugar content cottons (some greater than 0.6) that did not measure sticky on the FCT. Since literature shows that sugar contents around 0.3% are the beginning for concern (Perkins, 1971), tests such as the FCT probably will not account for all cases of stickiness due to high plant sugar.

Conclusion

The measurement of cotton stickiness by physical methods, such as the FCT and the Thermodetector, will always be variable due to the variable nature of stickiness in cotton. Taking this into consideration, the precision of the FCT's stickiness measurement appears to be good. The major deficiency of the FCT seems to be standardization of its stickiness measurement. Since development of a physical calibration standard is unlikely, stickiness instruments such as the FCT must rely on standardized instrument settings. Only then can long term testing and between instrument testing come to a common level that can then be scaled into degrees of stickiness. Another issue is whether or not physical tests are a complete indicator of cotton stickiness. As concluded in this study, high sugar content cottons often times do not measure sticky using the physical tests.

Acknowledgments

I thank Michael Watson and Thang Nguyen of Cotton Incorporated for providing the opportunity to evaluate the Fiber Contamination Tester. I also thank Dean Ethridge of the International Textile Center in Lubbock, Texas for providing the set of sticky cottons.

Disclaimer

Mention of a trade name, proprietary product, or specific machinery does not constitute a guarantee or warranty by the U.S. Department of Agriculture and does not imply approval of the product to the exclusion of others that may be available.

References

Hector, Debra J. and Hodkinson, Ian D. 1989. Stickiness in Cotton. ICAC Review Articles on Cotton Production Research No. 2.

Perkins, Henry H. 1971. Some Observations on Sticky Cottons. Textile Industries. Reprinted from The Textile Management and Engineering Journal.

Table 1. Overall FCT averages and coefficients of determination for the 50 ITC sticky cotton bales (n = the number of replications per bale made to establish bale values).

Test Run	Overall Avg.	Run versus Run	n=1 R^2	n=3 R^2	n=10 R^2
1	151.0	1 vs. 2	0.67	--	--
2	2.4	2 vs. 3	0.83	0.95	0.99
3	88.8	2 vs. 4	0.75	0.94	0.99
4	83.3	3 vs. 4	0.79	0.95	0.98

Table 2. FCT reproducibility data at given tolerances for the 50 ITC sticky cotton bales (n = the number of replications per bale made to establish bale values).

Run vs. Run	n=1 Repro.	n=1 Toler.	n=3 Repro.	n=3 Toler.	n=10 Repro.	n=10 Toler.
2 vs. 3	89%	±50	86%	±20	86%	±17
2 vs. 4	85%	±50	82%	±20	90%	±17
3 vs. 4	88%	±50	92%	±20	88%	±17

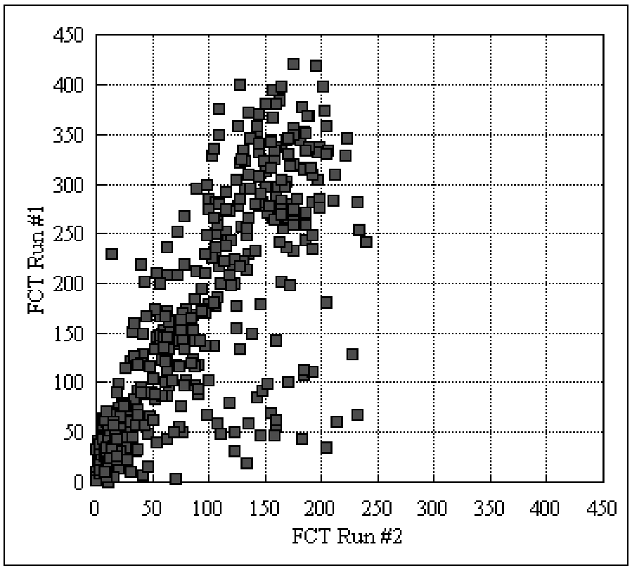

Figure 1. FCT stickiness grade before and after upgrade (single measurements), $R^2 = 0.67$.

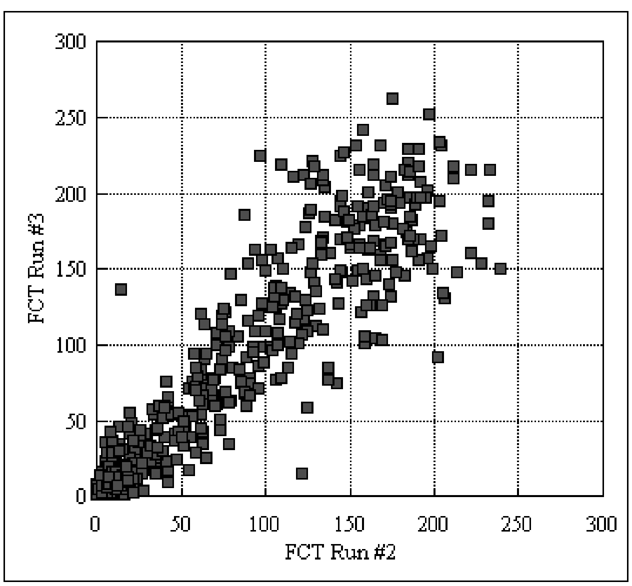

Figure 2. FCT stickiness grade after upgrade (single measurements), $R^2 = 0.83$.

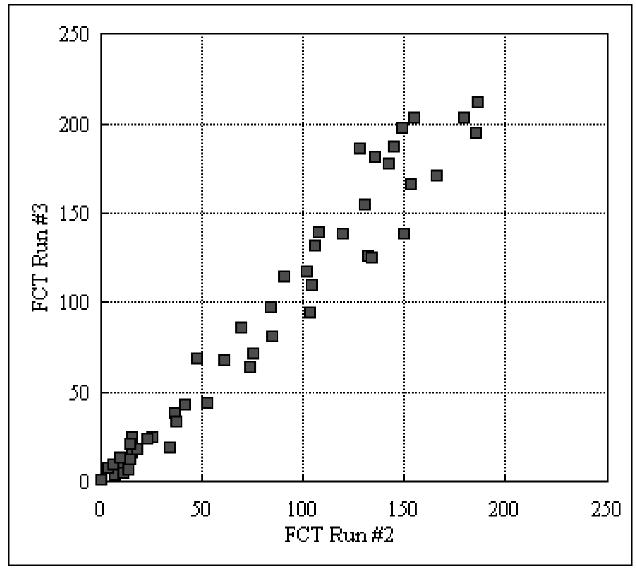

Figure 3. FCT stickiness grade after upgrade (3 reps/bale), $R^2 = 0.95$

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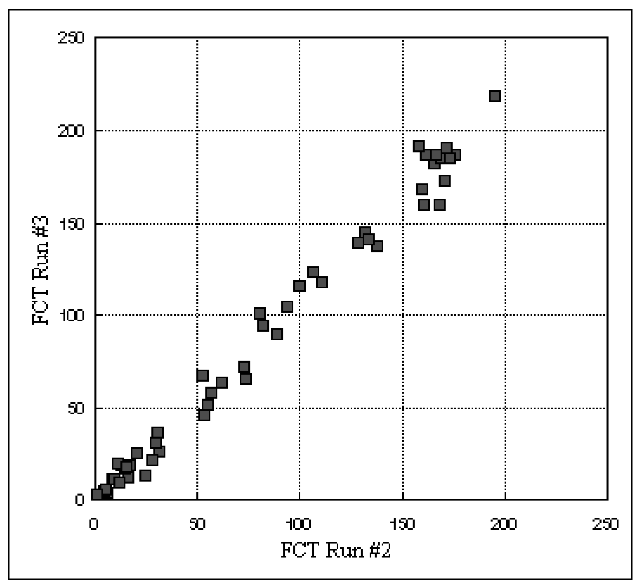

Figure 4. FCT stickiness grade after upgrade (10 reps/bale), $R^2 = 0.99$.

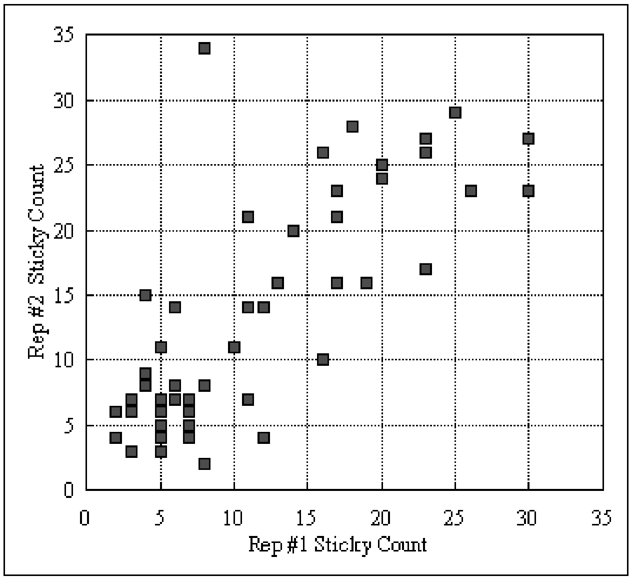

Figure 5. Thermodetector sticky count for operator #1 (single measurements, n= 50), $R^2 = 0.60$.

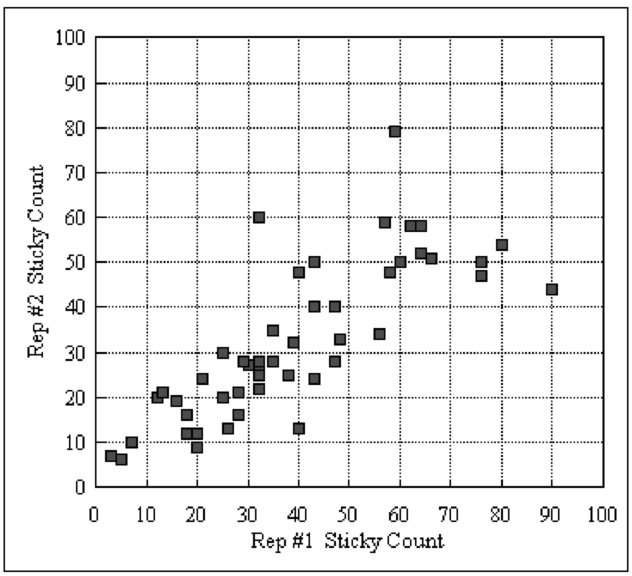

Figure 6. Thermodetector sticky count for operator #2 (single measurements, n = 50), $R^2 = 0.64$.

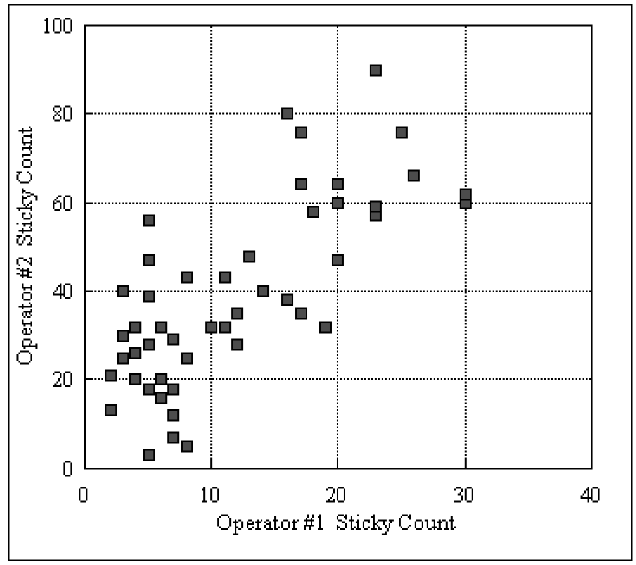

Figure 7. Thermodetector sticky count for operator #1 versus operator #2 (single measurements, n = 50), $R^2 = 0.55$.

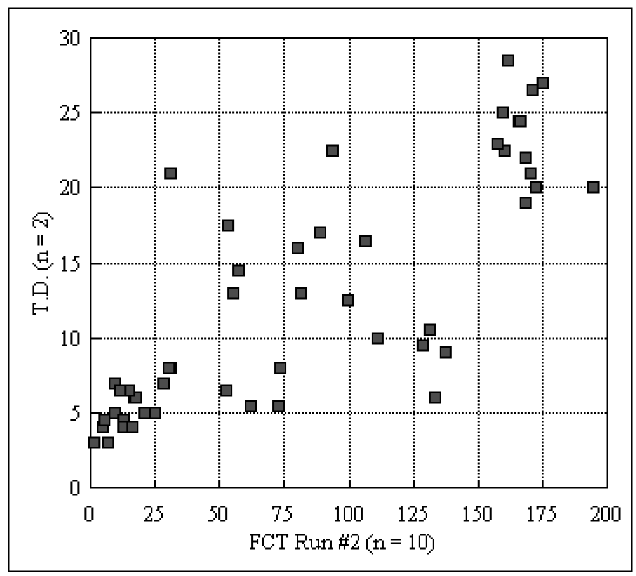

Figure 8. FCT stickiness grade (10 reps/bale) versus operator #1 Thermodetector sticky count (2 reps/bale), $R^2 = 0.66$.

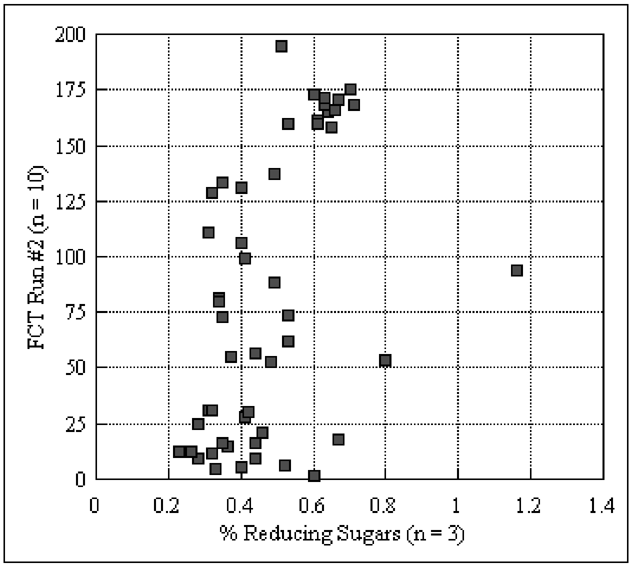

Figure 9. Sugar test (3 reps/bale) versus FCT stickiness grade (10 reps/bale), $R^2 = 0.22$.

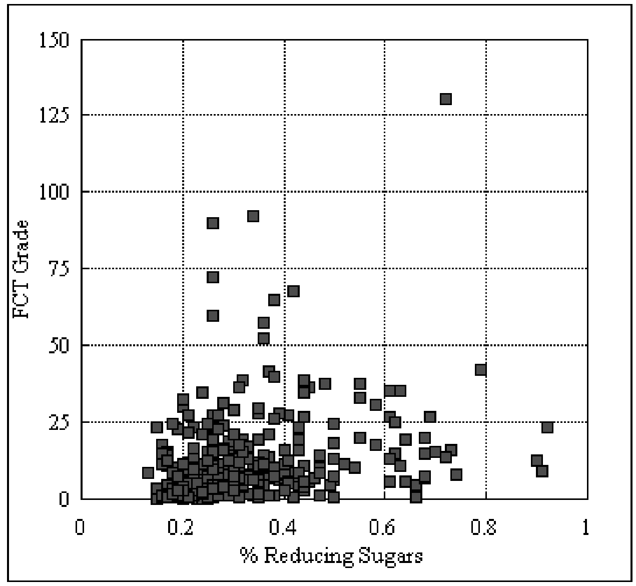

Figure 10. Sugar test (1 rep/bale) versus FCT stickiness grade (1 rep/bale) on ordinary samples (n = 345).