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EVALUATION OF SHAFFNER TECHNOLOGIES ISOTESTER

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Abstract

In May of 2003, the USDA Cotton Program began evaluating two Isotester instruments from Schaffner Technologies for their potential in classification of color Rd & +b, color grade, trash percent area, particle count and leaf grade. The Isotester utilizes digital scanning technology for making these measurements and is showing early potential for providing very stable measurements.

In this report, evaluation findings will be presented based on the testing of part of a sample set of approximately 8,000 samples collected from across the 2004 U.S. cotton crop and representing all leaf grade levels. The sample sets will be tested on each Isotester instrument and compared in several ways. All factors for color and trash will be compared to the USDA, Cotton Program's testing levels to determine their ability to test on the USDA level. In addition, the data will also be compared between the two Isotesters to evaluate measurement consistency between the instruments.

Introduction

With the changes in the global cotton markets, it is crucial for the United States to continue moving forward with new developments and technologies in order stay competitive in the marketing of cotton. In order to accomplish this, the USDA, AMS, Cotton Program is striving to provide cotton quality measurements that keep up with globally changing marketing and textile utilization needs. As technology advances, measurements must also advance for U.S. cotton to remain competitive internationally. For cotton classification, this requires research into new testing methods and various types of instrumentation. Currently in USDA classification testing, cotton is measured for color Rd and +b (reflectance and yellowness) and trash percent area and particle count using colorimeter technology with incandescent lighting paired with filtered photodiodes and a black and white camera.

In efforts to advance color and trash measurement, the USDA decided to investigate different technologies by acquiring two Isotester instruments from Schaffner Technologies, Incorporated in June of 2003. The Isotesters utilize digital image analysis through scanner-based technology to measure color and trash. Unlike the USDA's current instruments, the use of digital imagery allows for advancements in detecting such things as color spots that can affect the cotton's color grade. It can also exclude the effects of trash particles on color grade. It also shows potential for detecting extraneous matter such as bark and grass while excluding it from the trash measurement. The Isotester also has the capability to measure trash with a larger window size. The window can be expanded from nine square inches, currently used in USDA testing, to twenty-eight square inches.

The main objective of the USDA's evaluation is to determine if the Schaffner Isotester can effectively measure color Rd and +b and trash percent area and count according to USDA standards. In order for an instrument to be considered by the USDA for use in the High Volume Instrument (HVI) classification system, it must meet certain criteria. The measurements outturned must be meaningful, reliable and reproducible. The instruments must also perform with sufficient speed to be compatible with current systems, and there must be a procedure for calibrating many systems to a common level (Ramey, 1998).

Materials and Methods

During the initial evaluations, the Isotesters were set up to measure Rd +b, percent area and count on the same nine square inch basis as the HVIs currently used by the USDA. During initial calibration with USDA color calibration materials, it became evident that the Isotesters calibrated to a different level due to differences between HVI and Isotester systems including incandescent illumination and scanning technology. To correct this, a specialized regimen was developed for establishing values on USDA color tiles to maintain the USDA cotton testing level. First, the Isotesters were calibrated to a set of twelve cottons known as a USDA Color Check Box whose values were established on the USDA's Master HVI Colorimeter. Following a verification of the calibration, a set of tiles was

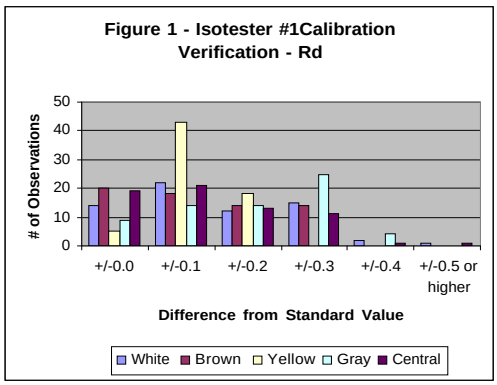
measured on the Isotesters to establish values. Then the Isotesters were calibrated using the newly established tile values and verified with the USDA Color Check Box to assure that the level transferred correctly.

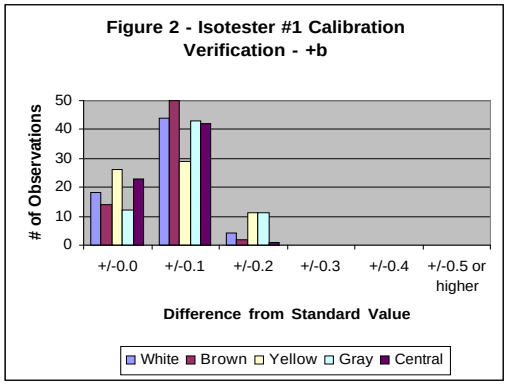
For trash calibration, photographs of cottons under glass were used. Values were established for these with the USDA's master trashmeter. Evaluations were then performed to verify that these instruments could be calibrated and verified with USDA materials such as color check boxes and photographs of cottons under glass. Upon meeting the criteria, the window size of both Isotesters was expanded for percent area and count measurement to twenty-eight square inches for future evaluation.

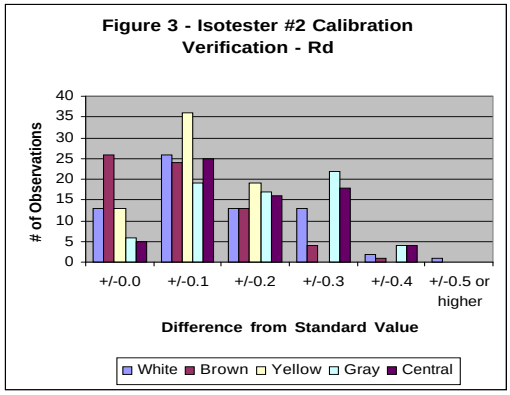
In July of 2004, a large scale study was planned for the 2004-05 cotton season. For this study, approximately 8,000 samples would be collected and tested to evaluate the performance of the two Isotesters. A system was established to collect samples from each of the USDA's twelve classing offices based on classer leaf grades. Although color was not a significant factor in the selection of samples, a varied range of color was represented in the sample set. It was decided that the samples would be tested on both Isotesters as well as on two HVIs at the USDA facility. Data results would be analyzed to reflect the performance of Isotester #1 versus Isotester #2 as well as each Isotester versus the USDA HVIs.

Data Collection and Analysis

At the onset of the study, both Isotesters were calibrated for Rd and +b with a set of USDA color tiles, and for percent area and count using a larger scaled set of photographs of cottons under glass. Due to the time requirements of the calibration procedures, the Isotesters' calibration would be verified each morning before testing began and again at the end of each test day. Calibration was only performed if the verification showed any tile value to be out of the standard USDA tolerance. For HVI testing, calibration of color and trash would be performed every hour, the standard calibration regimen for all USDA HVIs. As shown in Figures 1-4 and in Table 1, the Isotester verifications passed a majority of the time. Calibration levels were stable and could allow operation for extended periods of time without the need for routine calibration.







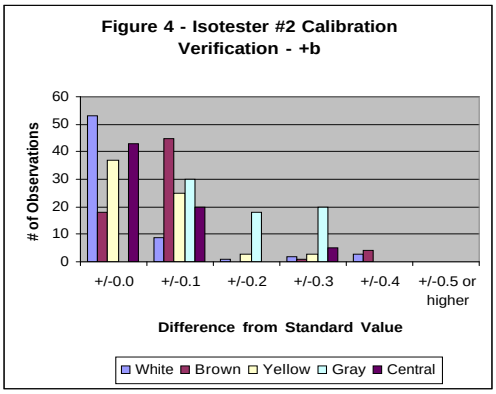


Table 1: Calibration verification results for trash measurements

	% Area	Pass	Count	Pass
Isotester #1	66	100%	66	89%
Isotester #2	68	100%	68	88%

Testing of the samples on all equipment was performed by USDA HVI operators. Each operator received basic training on instrument operations and correct sample placement at the onset of testing and was monitored throughout the process. Sample testing was initiated on September 9, 2004 and will continue with the receipt of samples until a total of 8,000 samples have been tested.

During initial data analysis for the color factors, it became evident that there was a significant difference in the testing levels between the two Isotesters (see Table 2). The level difference was more prevalent in the Rd measurement than the +b measurement. After reviewing some of the test images, several theories were expressed as to why there was a difference between the two Isotesters. One theory was that of human error. Incorrect sample placement, scanning of the sample before the scanner was fully in position, or raising of the scanner prematurely could all cause problems in achieving good window coverage during testing. These were the case in some instances, but they did not account for all the error. Another possibility for the differences included pressure issues caused by the instrument's pivoting design. With the hinged pivot of the scanner, samples having two sides of inconsistent thickness could result in erroneous measurements due to the variation in the pressure applied by the scanner. Since the Rd measurement is more sensitive to pressure, this could explain its lower sustainments. A third theory was that even though the instrument's calibration verifications passed at the beginning and end of each day, some instrument drift may have occurred throughout the day. In comparison of trash, the data showed some difference between the two Isotesters, but no definite bias. Some of the same window coverage issues that affected the color measurements also likely affected the trash measurements.

Table 2: Accuracy results for Isotesters #1 vs. #2 (based on 5384 samples)

	Rd	Bias	+b	Bias	% Area	Bias	Count	Bias
Isotester#1 vs. Isotester#2	82.5%	-0.24	99.2%	+0.02	86.5%	+0.00	96.3%	-0

Since neither the software nor the design of the instruments could be quickly modified, testing continued with a few added steps. Operators were re-instructed on the importance of good sample placement as well as on the timing of operations for the scanner. Also a check bale test was initiated to track the variation in color measurements throughout the day. Because the Rd showed the most bias, it was the main focus in the check bale test. The check bales test included the periodic testing of one to three samples across the USDA colorimeter and testing them on each Isotester to verify the testing level was still within tolerance. The Isotesters were considered to be within tolerance if their measurements were within +/- 1.0 for Rd and +/-0.5 for +b when compared with the colorimeter reading. In reviewing the data from these checks, the levels of testing were relatively stable between the beginning and ending calibration verifications. The verifications passed 100% of the time for Isotester #1 on both Rd and +b, and Isotester #2 passed Rd 93% and +b 100% of the time. Due to the occurrence of the failing readings on Isotester #2, questions were raised concerning the need for additional warm-up time when the instrument was left idle for periods longer that twenty-five minutes during testing.

On December 16, 2004, testing began with a third Isotester. This prototype Isotester was equipped to remove some of the human error from the test data through several design changes. A small sample set of approximately 150 samples was tested on each of the three Isotesters and one USDA HVI to discover whether improvement was achieved. From the limited test shown in Tables 3 and 4, the design changes were not detectable.

Table 3: Data Analysis - Isotester vs. Is Isotester (based on 150 samples)

	RD	Bias	+b	Bias	% Area	Bias	Count	Bias
Isotester #1 vs. Isotester #2	90.3%	-0.27	100.0%	0.00	95.8%	-0.01	99.7%	-0.4

Isotester #1 vs. Isotester #3	88.7%	-0.11	100.0%	-0.08	86.0%	-0.06	96.0%	-2.2
Isotester #2 vs. Isotester #3	80.7%	+0.49	100.0%	-0.07	86.7%	-0.04	98.7%	-1.3

Table 4: Data Analysis - Isotester vs. HVI (based on 150 samples)

	RD	**Bias**	**+b**	**Bias**	**% Area**	**Bias**	**Count**	**Bias**
Isotester #1 vs. HVI	88.2%	-0.35	95.2%	-0.14	88.5%	+0.01	76.4%	-5
Isotester #2 vs. HVI	94.5%	-0.08	94.2%	-0.14	88.5%	+0.02	80.3%	-5
Isotester #3 vs. HVI	71.3%	-0.66	92.0%	-0.23	66.7%	+0.09	67.3%	-9

At the current time, approximately 6,000 of the 8,000 samples have been tested. Once testing of the 8,000 sample set is complete, the next phase of testing will begin. The samples will be tested on two USDA HVIs in the Cotton Program's Quality Assurance Branch. At that point, the data from the Isotesters will be compared to the HVI in a similar manner as is done for the USDA's internal quality check program.

Conclusion

From the results thus far, the Isotester shows excellent calibration stability. In Isotester to Isotester comparisons, there is a level difference between the Isotesters, most evident in its measurement of Rd. The software development for the Isotesters is still in its early stages. For example, the calibration procedures for the instruments are very time-consuming and are too complicated to allow an operator to perform. Also the screen for basic operations is not very user friendly for typical classification operation. The software also needs some development including, but not limited to, such items as retest alerts for questionable data and window coverage algorithms. It is premature to finalize any analysis comparing the Isotester to the HVI until the testing of the 8,000 sample data set is complete on both types of instruments. At this time, the USDA will continue to evaluate the Schaffner Isotester as its development progresses.

Works Cited

Ramey, H. H., Jr. . "HVI Measurement of Short Fiber Content", Proceedings of the Beltwide Cotton Conference, Volume 2 (1998): 1513.