COMPARISON OF UPGRADED FMTS AND OPERATOR EFFECTS. PART I. DATA ANALYSIS

S.M. Buco
Statistical Resources, Inc.
Baton Rouge, LA
J.G. Montalvo, Jr. and S.E. Faught
USDA, ARS, Southern Regional Research Center
New Orleans, LA
J. Knowlton
USDA, Agricultural Marketing Service
Memphis, TN

Abstract

Two calibration protocols were developed to match between instrument readings of the FMT Micromat model. Each protocol is a two-step process that involves adjustment of the digital pressure indicator sensitivity followed by the PL and PH piston stroke lengths. In one protocol, instrument controls are set at responses corresponding to a range of Micronaires. For the other protocol, the controls are set using a high Micronaire cotton. The calibration procedures are described and evaluated over a range of Micronaire values.

Introduction

The FMT Micromat model has been improved using headspace resistance standards (HRS), a leak detector module, refined acceptable sample weight ranges, and improved ambient temperature control. Two FMTs — the one at the Southern Regional Research System (SRRC) and another at the Agricultural Marketing Service (AMS) — have been upgraded with the indicated improvements. This paper focuses on the effects of two calibration protocols as well as operator differences on the upgraded instruments.

Materials and Methods

Samples

The cottons were provided by the Agricultural Marketing Service (AMS) in Memphis, TN as in-house quality control samples. In Experiment I, the seven cottons used had Micronaire values of 2.67, 3.15, 3.63, 4.24, 4.49, 4.93, and 5.76. In Experiment II, the four cottons used had Micronaire values of 3.15, 4.24, 5.31, and 5.85. Each cotton was cleaned by carding.

FMT

All cotton samples were analyzed by the Shireley Developments Limited (SDL) 089 Micromat Tester (FMT). (Names of companies or commercial products are given solely for the purpose of providing specific information.)

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The FMT was calibrated following two different calibration protocols described below. For each cotton specimen two readings, PL and PH, are collected and stored in the FMT's computer. From these readings, various measures of maturity and fineness can be derived (Montalvo and Grimball, 1994.) Two FMT instruments were available for this study - the SRRC FMT and the AMS FMT.

Experiment I

In Experiment I, the FMTs were calibrated using a two step protocol (Protocol I) which matched the digital pressure indicator sensitivity of the two FMTs in a dynamic way with air flowing through the system. Step 1: Operate the SRRC FMT in the *Headspace Resistance Standards Recalibration* phase. (See Part II of this two paper series for details on *Headspace Resistance Standards Recalibration*.) With 4 L/min of air flowing through the HRS select a PL tube that gives a pressure drop of about 250 mm water. With 1 L/min of air flowing through the HRS select a PH tube gives a pressure drop of about 210 mm water. Connect the same HRS to the AMS FMT. Operate the AMS FMT in the *Pause* mode. With 4 and then 1 L/min of air flowing through the HRS adjust the digital pressure indicator sensitivity (DPIS) control on the AMS FMT to minimize the observed HRS PL and PH differences between the two instruments.

Step 2: Operate the SRRC FMT in the *Routine Analysis* phase. With 4.0 g specimens of the 4.24 Micronaire cotton in the sample chamber, observe the sample PL and PH values. Compute mean PL and PH values. Operate the AMS FMT in the *Routine Analysis* phase. With 4.0 g specimens of the 4.24 Micronaire cotton in the sample chamber, observe the sample PL and PH values. Compute mean PL and PH values. Adjust the PL and PH piston stroke lengths on the AMS instrument until the PL and PH values are matched on both FMTs.

Three operators, labeled DF, DR, and SF collected data using both FMTs. Due to scheduling, not all operators were able to collect data on all cottons.
The number of cotton specimens analyzed in a cycle is limited to 6 to insure there is insignificant drift in instrument readings.

Experiment II

In Experiment II, the FMTs were calibrated using a two step process (Protocol II) which matched the digital pressure indicator s of the two FMTs in a static way with no air flowing through the system. Step 1: Operate the SRRC FMT in the *Leak Detection* phase except do not turn on the FMT vacuum pump. (See Part II of this two paper series for details on *Leak Detection*.) With no air flowing through the SRRC FMT, connect a digital pressure indicator calibrator to the funnel glued to the sample chamber lid using a flexible hose. Using the vacuum pump in the calibrator, evacuate the FMT to give a 400 mm water pressure drop reading on the digital monitor of the calibrator. Adjust the FMT DPIS control to get 400 mm water pressure drop. Repeat this procedure on the AMS FMT. Step 2: Repeat step 2 given under protocol I above except use the 5.31 Micronaire cotton.

Only one operator – SF, the most experienced operator, – collected all data in Experiment II. The number of cotton specimens analyzed in a cycle is limited to six to insure there is insignificant drift in instrument readings.

For each of the four cottons run on each upgraded FMT, mean PL and PH values were computed based on 24 replicates. The total number of specimens analyzed was: 2 FMTs x 2 calibration protocols/FMT x 4 cottons/calibration protocol x 24 specimens/cotton = 384 specimens.

Results and Discussion

Experiment I

Because data were missing due to operator scheduling conflicts, three analyses of variance were performed on data collected after calibrating instruments using Protocol I, each analysis comparing pairs of operators on their common subset of cottons. As to be expected, the effect of Micronaire is highly significant for both PL and PH for all pairs of operators as seen in Tables 1 and 2. For PL, the FMT effect and the FMT*Micronaire interaction are significant for one pair of operators – SF and DR – and the Micronaire*Operator interaction is significant for the other two pairs of operators. Inspection of the means plotted in Figure 1 indicate that these differences are primarily due to observed differences of as much as 11 mm among readings for the lowest Micronaire cotton and observed differences of as much as 4 mm for the highest Micronaire cotton. It should be noted that the most experienced operator, SF, has only a 4 mm difference between the two FMTS on the lowest Micronaire cotton and no difference on the highest Micronaire cotton.

For PH, the FMT effect is significant for one pair of operators – SF and DF – and the Micronaire*Operator interaction is significant for one pair of operators – DF and DR. Inspection of the means plotted in Figure 2 indicate that these differences are primarily due to observed differences of as much as 8 mm among readings for the lowest Micronaire cotton and observed differences of as much as 3 mm for the highest Micronaire cotton. The calibrated FMTs matched most precisely on the cotton with a Micronaire of 4.24 used to calibrate the two instruments. The most experienced operator has a 1 mm difference on the lowest Micronaire cotton and no difference on the highest Micronaire cotton.

Calibration Protocol II

The digital pressure indicator sensitivity of the AMS FMT was matched to the SRRC FMT in a static way — with no air flowing through the system. For PL and PH, the analyses of variance shown in Tables 3 and 4 yield significant differences for all effects – Micronaire, FMT, and the Micronaire*FMT interaction. Inspection of the means plotted in Figure 3 indicate that these differences are primarily due to observed differences of as much as 8 mm among readings for the lowest Micronaire cotton.

In general, Protocol I used in Experiment I, which had the largest range of Micronaires, resulted in the smallest differences between FMTs for the most experienced operator.

References

Montalvo, J.G., Jr. and Grimball, R. 1994. SRRC maturity and fineness equations, version 1.0 software.

Table 1. Analysis of variance of PL in Experiment I (Protocol I).

SOURCE	Operators DF & SF MIC=3.15, 3.63, 4.24, 4.93, 5.76		Operators DR & SF MIC=2.67, 3.15, 5.76		Operators DF & DR MIC=3.15, 4.49, 5.76	
	F	Prob.	F	Prob.	F	Prob.
FMT	0.3		14.1	0.0003	0.1	
Mic	14946	0.0001	32334	0.0001	16071	0.0001
Operator	0.1		0.1		0.8	
FMT*Mic	0.9		6.2	0.0029	0.5	
FMT*Operator	2.7		1.9		1.4	
MIC*Operator	2.4	0.05	1.4		6.8	0.002
FMT*Mic* Operator.	1.6		2.1		2.3	

Table 2. Analysis of variance of PH in Experiment I (Protocol I).

SOURCE	Operators DF & SF Mic=3.15, 3.63, 4.24, 4.93, 5.76		Operators DR & SF Mic=2.67, 3.15, 5.76		Operators DF & DR Mic=3.15, 4.49, 5.76	
	F	Prob.	F	Prob.	F	Prob.
FMT	4.6	0.03	2.7		1.3	
Mic	13605	0.0001	22908	0.0001	13708	0.0001
Operator	0.4		0.5		1.4	
FMT*Mic	0.2		0.9		0.6	
FMT*Operator	3.1		1.6		2.0	
Mic*Operator	1.7		2.3		5.3	0.007
FMT*Mic* Operator	1.8		2.1		1.9	

Table 3. Analysis of PL in Experiment II (Protocol II).

SOURCE	Mic=3.15, 4.24, 5.31, 5.85	
	F	Prob.
FMT	85.2	0.0001
Mic	71282.2	0.0001
FMT*Mic	172.3	0.0001

Table 4. Analysis of PH in Experiment II (Protocol II).

SOURCE	Mic=3.15, 4.24, 5.31, 5.85	
	F	Prob.
FMT	35.4	0.0001
Mic	53681.9	0.0001
FMT*Mic	17.92	0.0001

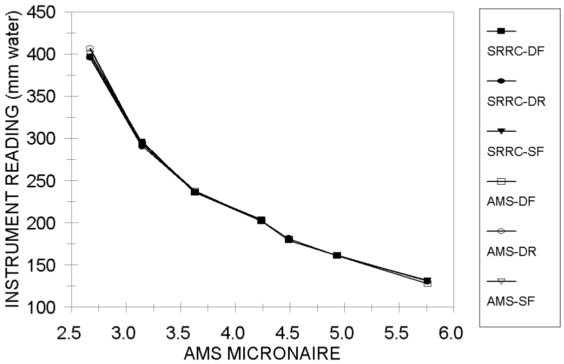

Figure 1. Effects of Micronaire, FMT, and operator on PL in Experiment I (Protocol I).

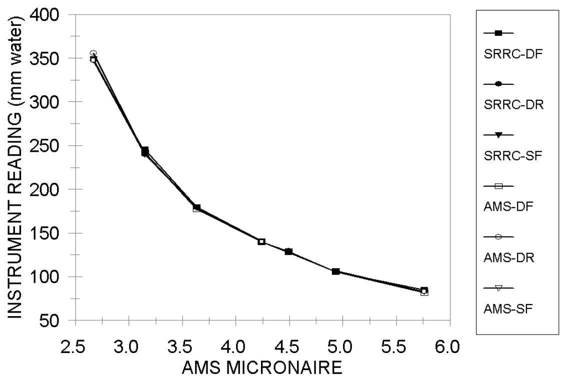

Figure 2. Effects of Microniare, FMT, and operator on PH in Experiment I (Protocol I).

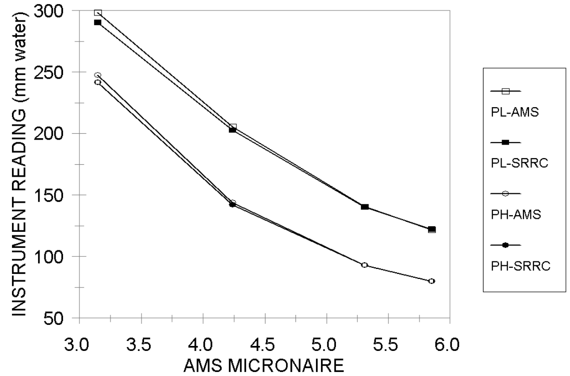

Figure 3. Effects of Micronaire and FMT on PL and PH in Experiment II (Protocol II).