NIR MATURITY MEASUREMENTS USING A FILTER TYPE SPECTROMETER

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Abstract

During the 1995 USDA classing season, random samples of upland cotton were collected from across the U. S. cotton growing belt to be tested for quality at the Agricultural Experiment Station at Clemson, S. C. Approximately 1300 of these samples were tested for fineness/maturity with an FMT Micromat using the double compression test method. Near infrared (NIR) spectra were recorded for a large number of these cottons to use in developing a rapid test method to estimate maturity. This report describes the relationship between maturity and micronaire for these cottons and demonstrates the accuracy of using absorbance values at combinations of wavelengths to estimate maturity.

Introduction

Analysis of the FMT Measurement Data

Due to time constraints, NIR absorbance was measured on only 1003 samples. A comparison of maturity ratio with micronaire values indicated a strong agreement between the two quality parameters (Figure 1) . To determine if there was a seasonal influence on maturity in the data, the data set was divided into four parts (Figures 2a thru 2d). These results showed that the early harvested cottons were generally higher in both micronaire and maturity (Figure 2a) while the remainder of the cottons resembled the total crop distribution (Figures 2b thru 2d). Because of the limited capacity in the NIR computer, only about half of the recorded spectra could be stored in one directory and accessed for the NIR calibration. Therefore, the distribution of those samples actually used for the NIR evaluation was of concern. A similar comparison between micronaire and maturity (Figure 3) was in good agreement with the over crop data.

Description of the NIR Measurements

NIR spectral reflectance values were recorded using a filter type spectrometer provided by Perten Instruments Inc. N. A., Springfield, IL. This instrument illuminates a circular area of a test cotton sample measuring 40 mm in diameter with NIR light that has passed through a band pass filter installed in the unit. The instrument sequentially measures and records data for a total of 44 different filters installed in the unit. Five of these filter wavelengths were positioned in the visible and near visible regions and were not used in this NIR evaluation. The reflected light is measured with NIR detectors installed in a gold integrating sphere located just below the quartz observation window. Reflectance(R) measurements are converted to absorbance in the form of Log[1/R] for storage in the instruments computer. The computer software is designed to select the best combination of filter wavelengths which agrees with the constituent of interest. Because ginned cotton samples (used for HVI testing) are not homogeneous, their measurements are naturally quite variable. Therefore, spectral absorbance was recorded on two surfaces for averaging. Each sample was compressed against the window with the same pressure normally used in cotton color measurements. An effort was made to position a clean area on the window for testing to reduce possible errors caused by viewing extraneous matter. The entire observation window must be covered and uniformly illuminated.

NIR Calibration Development Method

A large number of spectral absorbance files (942) from 471 cottons were used in the calibration. The wavelength positions of all 39 filters in the NIR region were superimposed on a typical cotton spectra for information (Figure 4). Spectra for all calibration samples were provided to the computer software to preform a stepwise regression and establish the combination of wavelengths that gave the best agreement with maturity ratio. Three, four, five and six wavelength models were tested in this manner. The best model used five wavelength filters (Figure 5) .

Results and Discussion

When the calibration model was tested by calculating maturity ratio values from spectral data for the calibration data set, it=s accuracy appeared very good (Figure 6 ; R squared=0.72, Standard of estimate= 0.038 maturity ratio units). Since these cottons were grown commercially across the US cotton belt, they included a wide range of other fiber properties. Therefore, the NIR calibration should be very robust.

Fiber Fineness

A graph of the fiber fineness data from these cottons showed a very high level of it=s agreement with micronaire values (Figure 7).

Conclusions

The comparison of maturity ratio with micronaire values demonstrated why most cotton consumers simply use the micronaire value to select cottons for use in textile mill laydowns. Both quality parameters are highly correlated and micronaire testing is less expensive. However, NIR reflectance results reported here demonstrated that absorbance measurements can be used to find cottons that are more or less mature than one would estimate from micronaire values alone. This added feature should make it easier for cotton consumers to accurately control the

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quality of products that are especially sensitive to small maturity differences.

Since our spectral absorbance data was recorded for samples compressed against a reflectance window (similar in geometry to the present cotton colorimeter), success of a high speed instrument (to be integrated into HVI systems) can be guaranteed if it uses the same optical configuration.

Acknowledgment

The author thanks Mr. Bragg RL at the ARS. Experiment Station at Clemson, S C for permission to test the cotton samples and use the FMT maturity data.

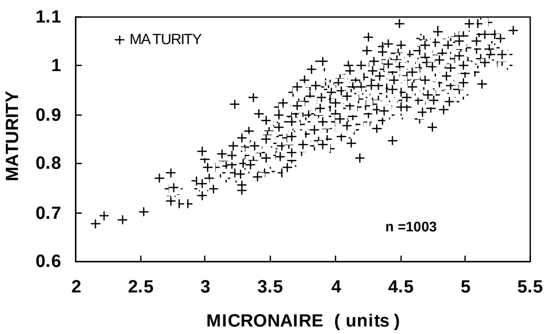

Figure 1. Cotton maturity as a function of fiber micronaire for the 1995 US crop.

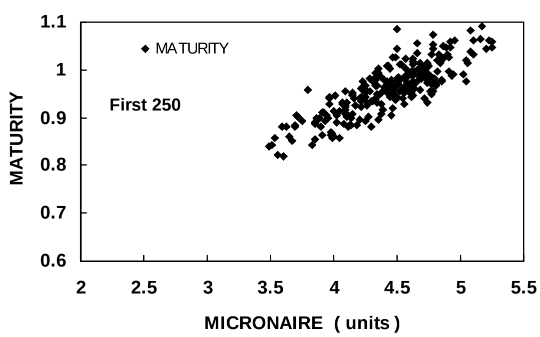

Figure 2a. Cotton maturity as a function of fiber micronaire for early harvested.

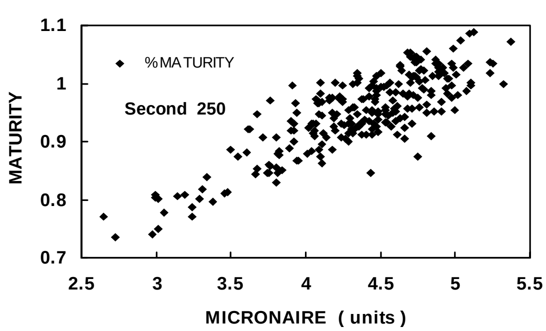

Figure 2b. Cotton maturity as a function of fiber micronaire for second harvested.

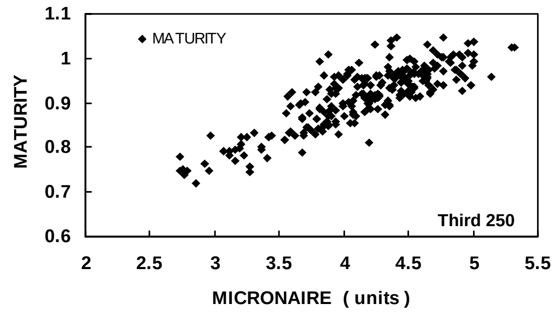

Figure 2c. Cotton maturity as a function of fiber micronaire for third harvested.

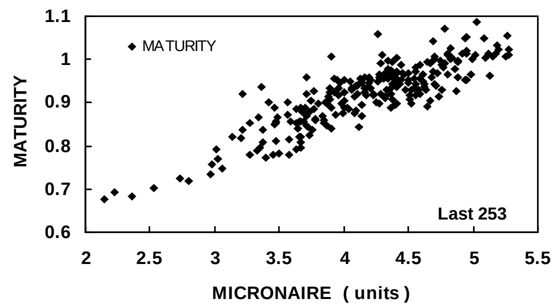

Figure 2d. Cotton maturity as a function of fiber micronaire for late harvested.

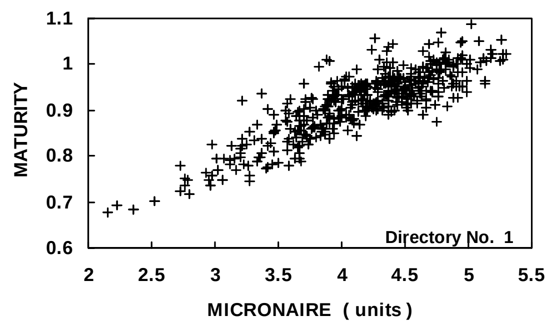

Figure 3. Cotton maturity data used in the NIR calibration for maturity ratio.

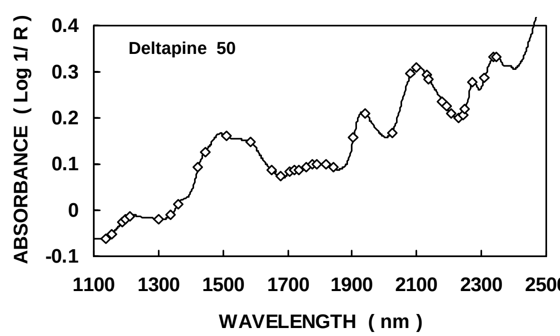

Figure 4. Perten Model 8144 NIR Filter Positions

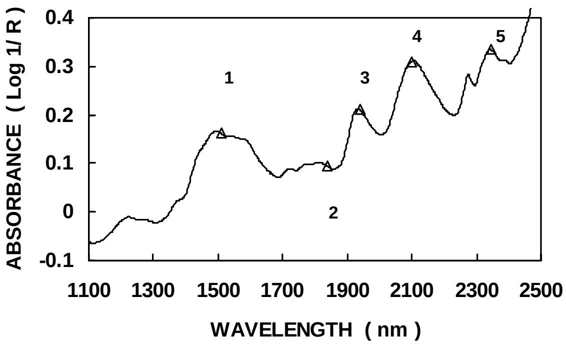

Figure 5. Filter Positions for the Maturity Model

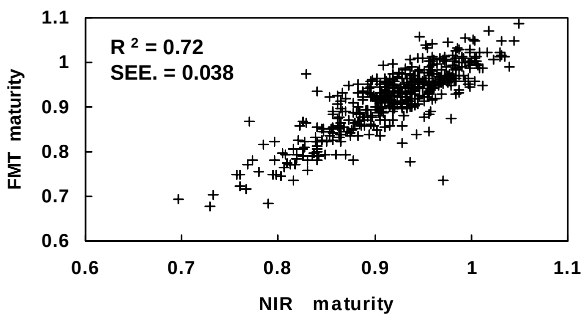

Figure 6. NIR cotton maturity as a function of FMT maturity for the NIR calibration set.

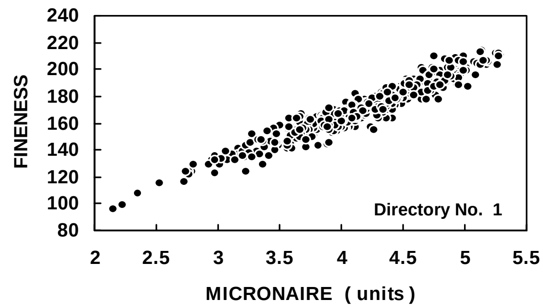

Figure 7. FMT Fineness as a function of fiber micronaire for the 1995 US crop.