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DESIGN AND IMPLEMENTATION OF AN UPGRADED FMT INCORPORATING A 10 GRAM SAMPLE

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Abstract

An upgraded FMT instrument has been designed and a prototype instrument manufactured. One key new feature is that the sample size has been increased from 4 to 10 grams. In the instrument design the sample chamber has been scaled accordingly so that the numerical values of the measured so called P_L and P_H measurements are unaltered. In this way the existing empirical relations used to calculate fiber fineness and fiber maturity values that were originally derived with the original instrument remain valid. Early commissioning tests of the prototype instrument have validated the design.

Introduction

An accurate measure of the fineness (fiber weight per unit length) and maturity (degree of development of the fiber wall) of a sample of cotton is desired by both cotton classers and the processing industry. Currently no completely satisfactory commercial instruments are available to meet this need.

One technical approach, the Fineness and Maturity Tester (FMT), was originally developed by Shirley Developments Limited (SDL) and their current model the Micromat High Speed Cotton Fineness Maturity Tester is still available. Montalvo, Faught and Buco (2002) identified and overcame some shortcomings of the existing FMT instrument. They identified that the general engineering quality of manufacture of the instrument, e.g., leaks in the pipe system, precision of the sample chamber size and the system of drawing air through the sample limit the reliability and precision of the device.

CSIRO Textile and Fibre Technology has a long history of developing, manufacturing and delivering commercial test instrumentation for the international textile industry. Examples include Sirolan-Laserscan (a fast accurate instrument for measuring full fiber diameter distribution of wool that has been adopted by the industry world wide as the standard test method) and SiroFAST (a suite of instruments to objectively assess fabric properties). As well as textile R&D skills, CSIRO's expertise in this area includes

- Instrument design engineering
- Extensive machine shop facilities for in-house manufacture of scientific components and instruments
- Electronics including both hardware and software aspects of computer controlled instrumentation.

The current paper is a progress report on a project sponsored by Cotton Incorporated to design and build a new prototype FMT instrument incorporating the design features identified Montalvo et al (2002).

Results

Sample Chamber Design

The original FMT utilizes empirical relationships to extract Micronaire equivalent, average fiber fineness and maturity values from P_L and P_H readings, the measured pressure drops when air flows through the samples under the so called low and high compression conditions in the sample chamber. The chamber size was scaled from the original design to incorporate an increased sample size of 10 grams.

General Instrument Design

Figure 1 shows a block diagram of the instrument. Note that a pressure system rather a vacuum system has been utilized (based on the requirement of easily locating leaks).

Figure 2 illustrates a 'Solidworks' model of the main mechanical assembly. The sample chamber and piston shaft are clearly visible. The lid arrangement for the sample chamber is a simple robust design, similar to that used in the HVI Micronaire unit.

Figure 3 shows the completed instrument. It is connected via the USB port to a user friendly windows based PC interface.

Instrument Commissioning

The prototype instrument has been commissioned firstly using the Headspace Resistance Standards (HRS) developed by Montalvo and Faught (1999). This set of physical standards was kindly loaned to CSIRO by Cotton Inc. for this purpose. Figure 4 shows twelve repeated measurements of the 'Low mic' HRS, and Figures 5and 6 shows the correlation between the new instrument and the declared values for P_L and P_H. The agreement with the declared values is encouraging and in essence is a validation of the leak-free status of the 'plumbing system'.

The second aspect of the commissioning of the instrument was to obtain data for six test cotton samples that had also been measured by Montalvo. These results are in Figures 7 to 9. The excellent agreement between the P_L and P_H values for the six cottons is very encouraging.

Conclusion

An upgraded FMT prototype instrument has been successfully designed and manufactured incorporating a 10 gram sample size. Initial instrument commissioning has been successfully completed. Further work is required to evaluate its full potential.

Acknowledgements

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References

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Montalvo, J.G. and S.E. Faught. 1999. Headspace resistance standards for the Shirley Developments Ltd FMT. Text. Res. J. 69(4):269-277.

Montalvo, J.G., S.E. Faught, and S.M. Buco. 2002. Sensitivity of the Shirley Developments Ltd. Micromat Tester to operators and sample preparation. J. Cott. Sci. 6:133-142.

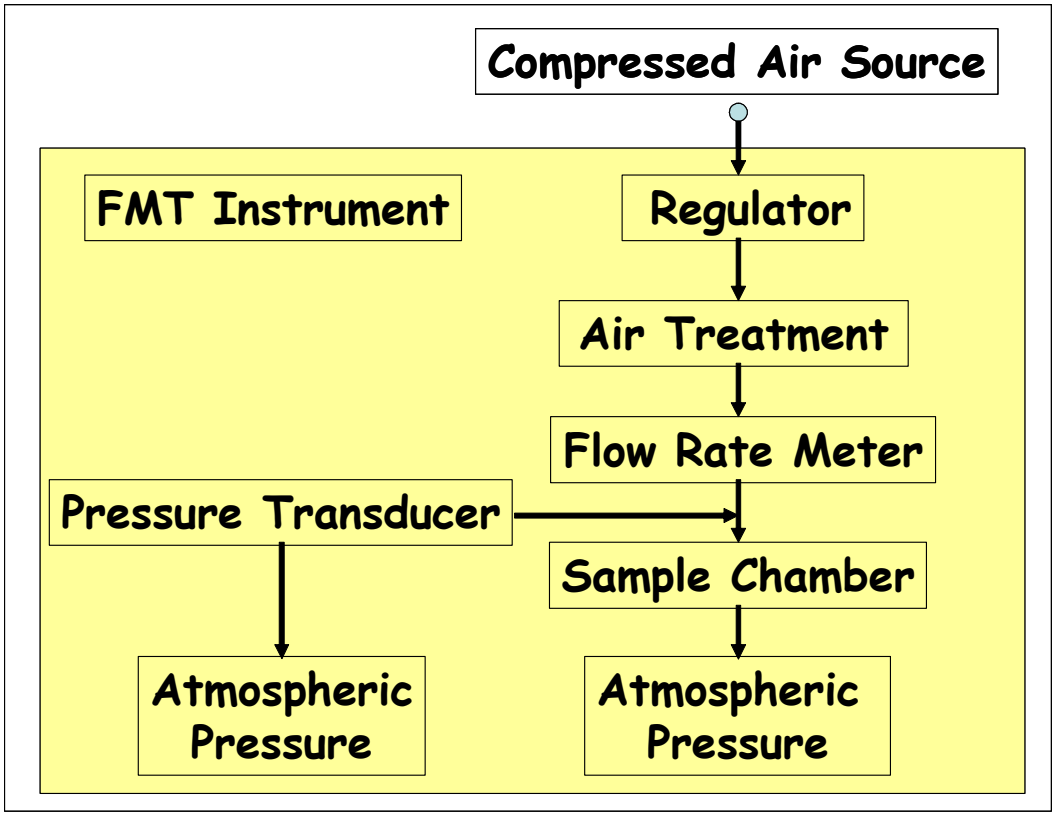

Figure 1. Block diagram of instrument.

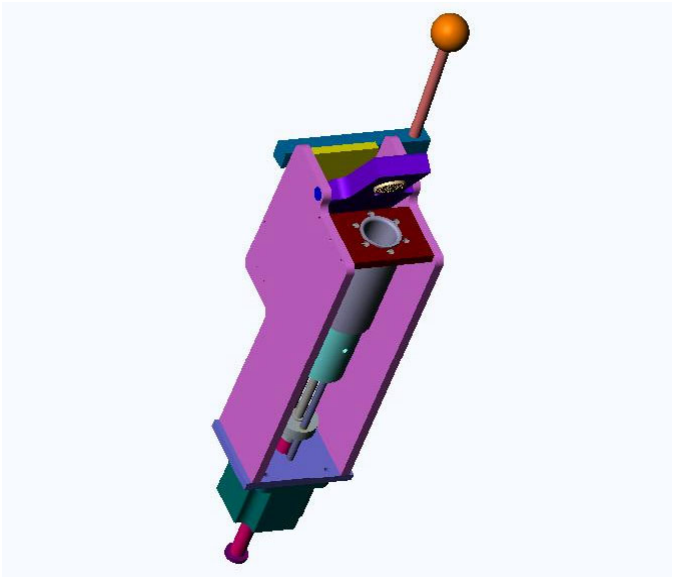

Figure 2. ‘Solidworks’ model the main mechanical assembly.

Figure 3. The new prototype FMT instrument.

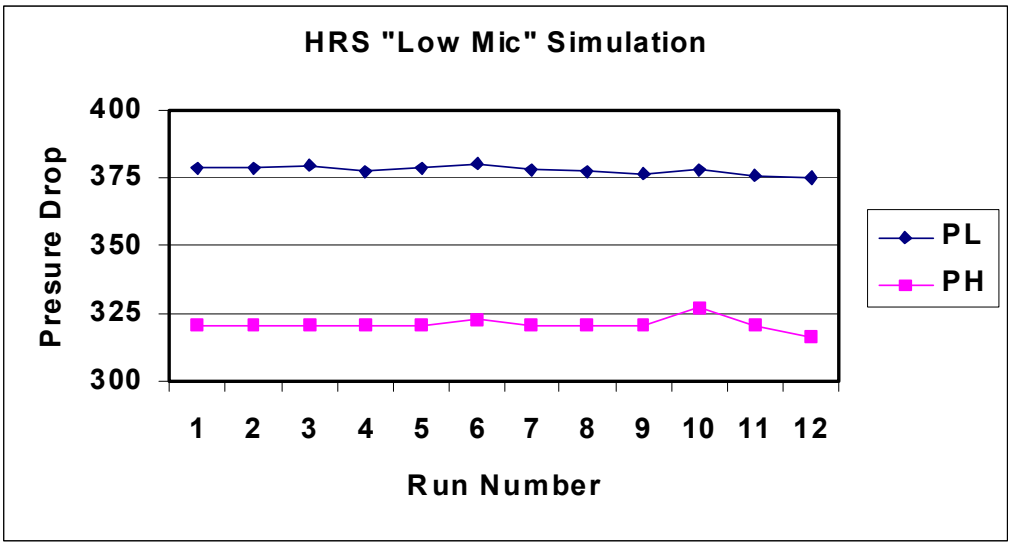

Figure 4. Repeated measurements of the 'Low Mic' HRS Reference Standards.

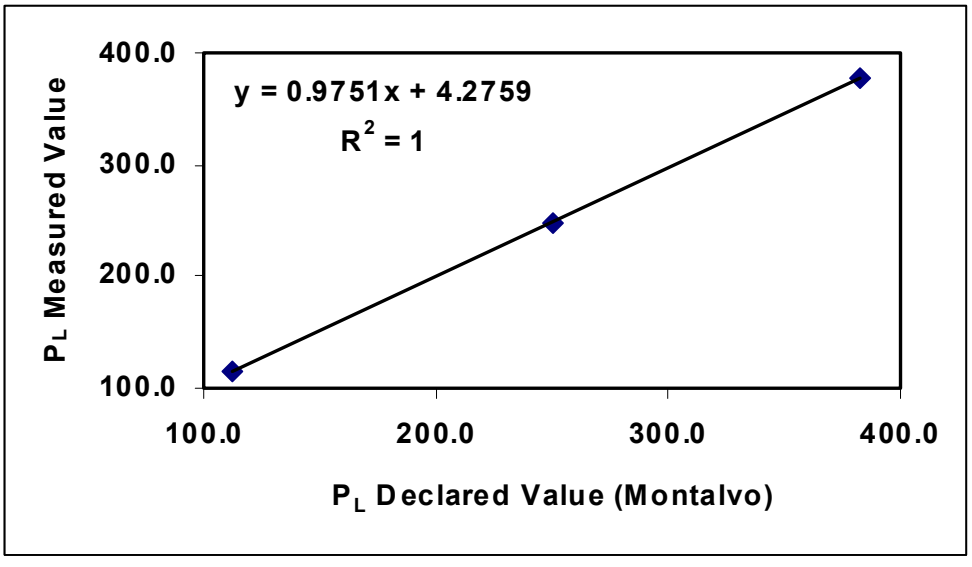

Figure 5. Relationship between the average of 20 measurements of P_L for the HRS Reference Standards and the declared values.

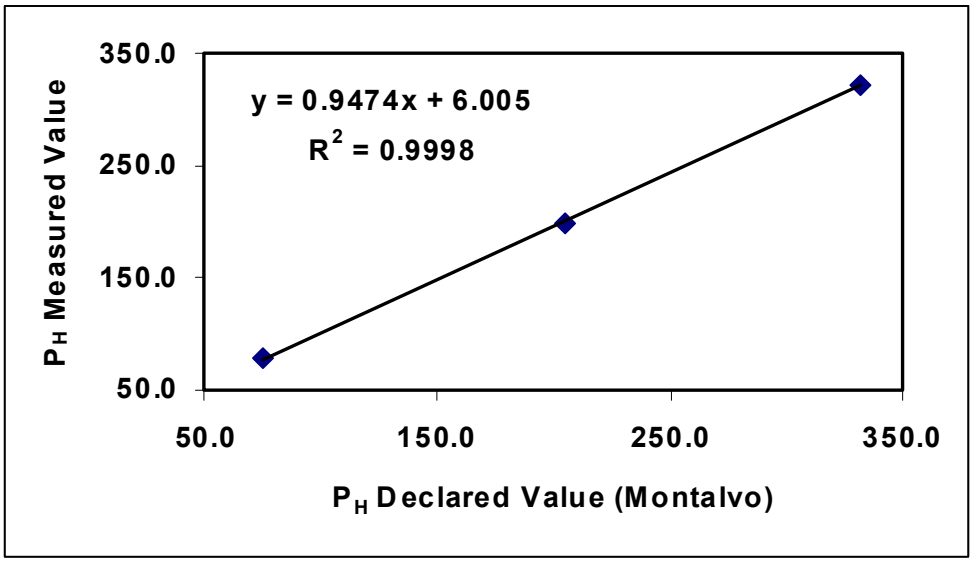

Figure 6. Relationship between the average of 20 measurements of P_H for the HRS Reference Standards and the declared values.

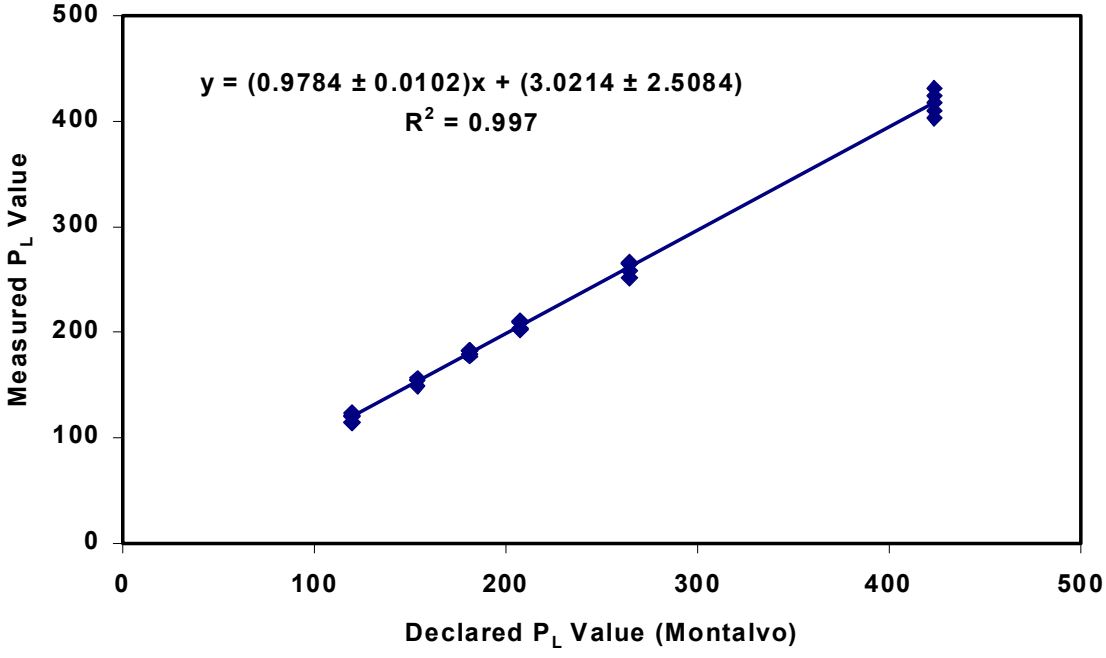

Figure 7. Comparison of P_L values with those obtained by Montalvo for 6 test cottons.

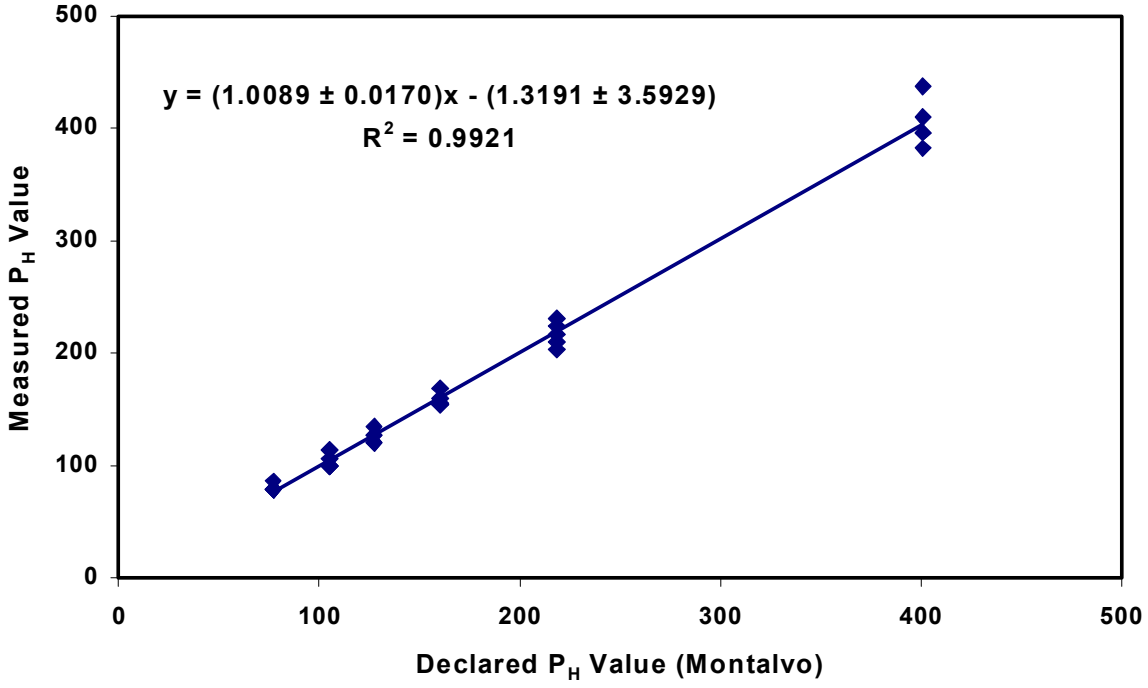

Figure 8. Comparison of P_H values with those obtained by Montalvo for 6 test cottons.

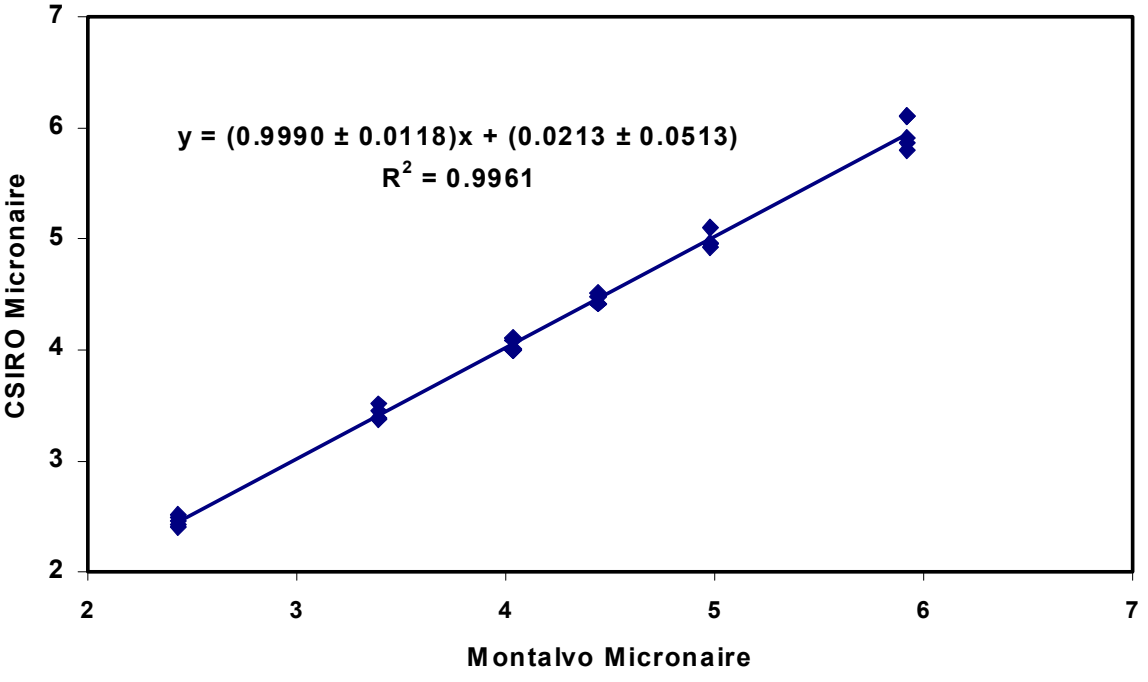

Figure 9. Comparison of Micronaire values with those obtained by Montalvo for 6 test cottons.

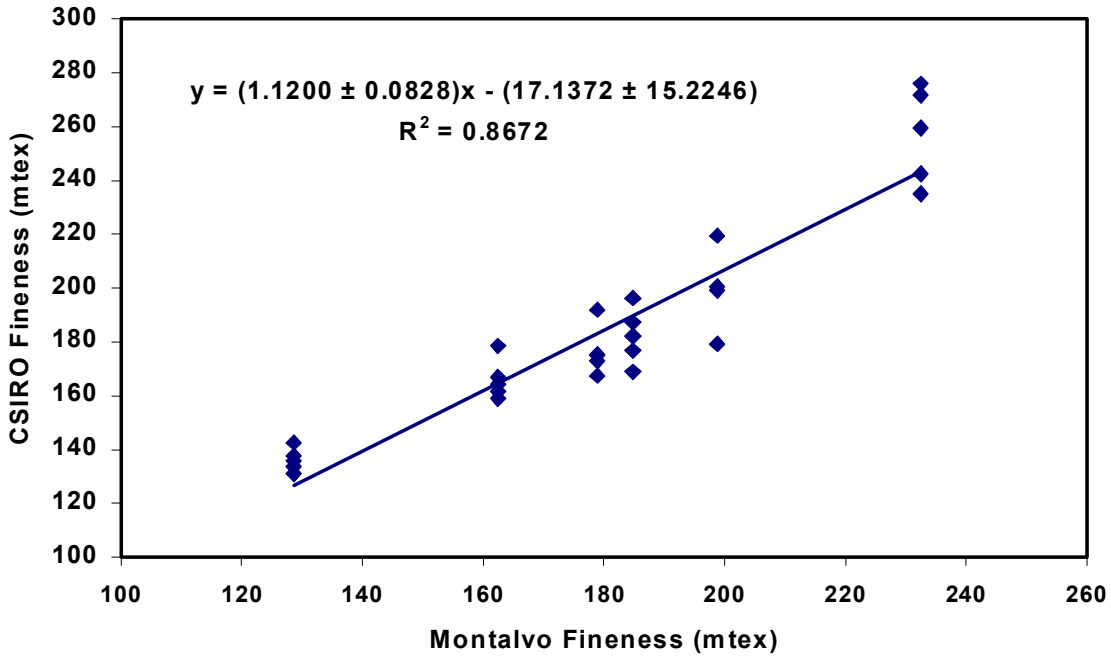

Figure 10. Comparison of fineness values with those obtained by Montalvo for 6 test cottons.

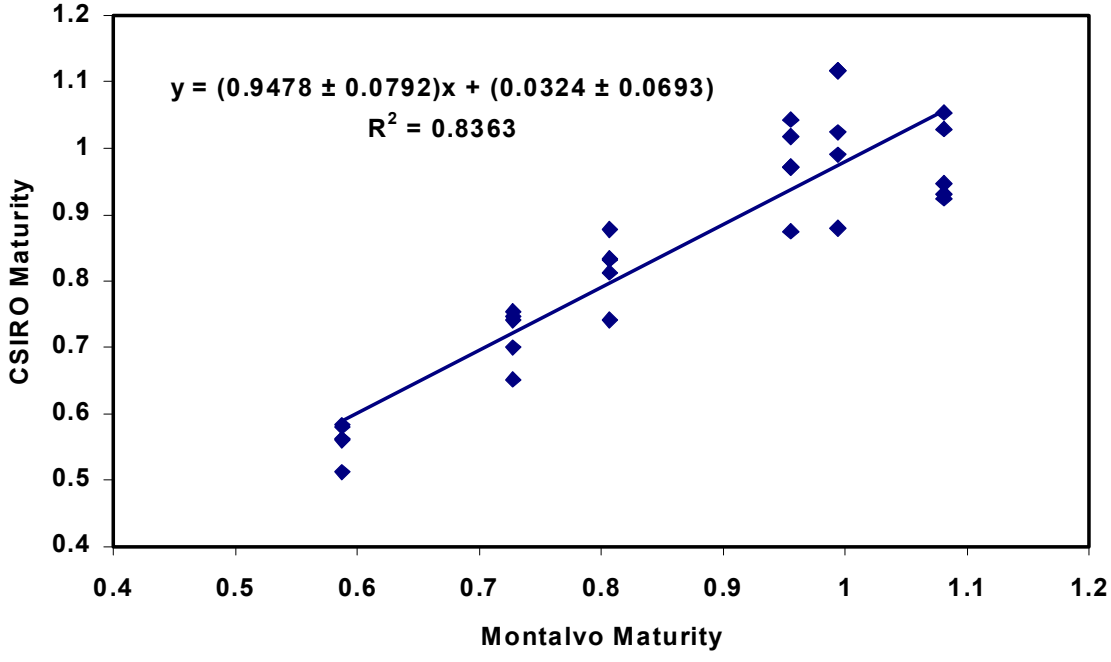

Figure 11. Comparison of maturity values with those obtained by Montalvo for 6 test cottons.