IMPACTS OF LABORATORY GINNING METHOD ON COTTON FIBER MICRONAIRE MEASUREMENTS

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Abstract

Recent evaluations have demonstrated the feasibility of measuring micronaire in remote locations (e.g., in or near the cotton field) using portable Near Infrared (NIR) analyzers. However, several different laboratory ginning methods are available to gin the seed cotton, including hand ginning, roller ginning, and saw ginning. Concerns were expressed as to the influence on micronaire results due to the different laboratory ginning methods. Seed cottons from three varieties were ginned by each laboratory ginning method, and their HVI, Fibronaire, and NIR micronaire and lint yield results were compared. The impacts of laboratory ginning method on both physical methods for measuring micronaire (HVI, Fibronaire) and the NIR measurement of micronaire were determined. Good lint yield agreement was observed between the different gin methods. Good NIR spectral agreement was observed between the three ginning methods. Overall, minimal impacts due to laboratory gin method were observed on Fibronaire, HVI, and portable NIR micronaire results.

Introduction

U.S. cotton is classified for its quality by the Agricultural Marketing Service (AMS) of the USDA by the Uster® High Volume Instrument (HVI). A key classification parameter is the fiber's micronaire, which is composed of the fiber's maturity and fineness. (Montalvo and Von Hoven, 2004; USDA, 2005; Wakelyn et. al., 2007) The HVI measures fiber micronaire using an air resistance technique (fiber's resistance to air flow per unit mass). Although well-established, the HVI measurements require a conditioned laboratory, require expensive instrumentation, and require well trained operators. Much interest has been shown in new quality assessment techniques that could be performed both in the laboratory and in/near the cotton field.

Portable Near Infrared (NIR) instrumentation have the potential for achieving rapid, accurate, and cost effective quality measurements, and they could act as a complement to the HVI measurements. Many NIR techniques and measurements are currently employed in the fiber and textile industries, to include the measurement of cotton fiber micronaire with the use of primarily bench-top, research grade NIR instruments (Beck, 1996; Montalvo and von Hoven, 2004; Rodgers and Ghosh, 2008). The NIR spectral region is normally considered to be between 1100-2500 nm, and the NIR spectrum consists primarily of combination and overtone bands, primarily for the NH, CH_i, and OH chemical groups. The NIR method is calibrated to a reference method.

Previous evaluations established the ability of a portable NIR analyzer (Brimrose Luminar 5030; Figure 1) to monitor cotton fiber micronaire in the laboratory and in/near the cotton field. (Rodgers et.al., 2010a; Rodgers et.al., 2010b) The laboratory NIR method yielded high R^2s, low residuals, and ≤ 15% outliers (HVI-NIR micronaire agreement for ≥85% of the samples was within ± 0.3% micronaire units). For field measurements, NIR measurements are taken directly on the cotton boll, and two field sampling systems were developed—one for in the field and one for near/adjacent to the field. Trends for high-medium-low micronaire levels within lot were established for field samples, with trend HVI-NIR micronaire agreement for ≥85% of the samples measured.

Figure 1. Brimrose Luminar 5030 portable NIR analyzer

The routine laboratory samples were commercially machine harvested and ginned fibers (primarily saw ginning for upland cotton), while our "field" laboratory samples (laboratory NIR and HVI micronaire measurements of the original seed cotton samples collected in the field) were hand picked/harvested cotton bolls that were hand ginned in the laboratory. However, hand ginning is not the only laboratory ginning method available to the industry. Recently, two laboratory gins were obtained at SRRC—a 10-saw saw gin and roller gin (Dennis Manufacturing, Athens, TX). Interest was expressed as to the impact(s) different laboratory ginning methods would have on laboratory micronaire measurements and yield (turn-out) on "field" laboratory samples. A comparative study was carried out to determine the impacts of 3 different laboratory ginning methods on lint weight and various fiber micronaire measurements (HVI, Fibronaire, and NIR).

Materials and Methods

Cotton Samples

The cotton samples for the ginning and laboratory evaluations consisted of 90 hand harvested cotton bolls each of 3 cotton varieties (FM 958, DP 393, SG 105) from the 2009 Regional Breeders Testing Network (RBTN), for a total of 270 cotton bolls. Each 90 boll sample set for each variety was split into three 30 boll sub-sets—one subset for each of the 3 ginning methods to be evaluated.

Ginning Methods

Each 90 boll sample set of each variety was ginned in the laboratory by hand ginning (HG), saw ginning (SG), and roller ginning (RG)—30 boll gin sub-sets for each sample set of each variety. All ginning was performed on an individual cotton boll (1 boll ginned at a time). Hand ginning consists of the operator physically pulling the cotton fiber from the cotton seed to obtain the lint. Saw ginning was performed on the SRRC laboratory 10-saw gin, and roller ginning was performed on the SRRC laboratory roller gin (Dennis Manufacturing, Athens, TX). Manufacturer operational procedures were used for saw and roller ginning.

Micronaire Measurements

Micronaire measurements were made on 3 different instruments in the laboratory—the Brimrose Luminar 5030 portable NIR analyzer, Fibronaire, and HVI. A different sample size was required for each micronaire sample, and the instrument measurement order was:

NIR → Fibronaire → HVI.

The NIR was capable of measuring each cotton boll lint sample individually (30 samples per gin method per variety). The Fibronaire required a larger sample size, and 3 NIR samples were combined to form each Fibronaire sample, resulting in 10 Fibronaire sample per gin method per variety. The HVI required an even larger sample size, and 3 Fibronaire samples were combined to form each HVI sample, resulting in 3 HVI samples per gin method per variety.

The Brimrose 5030 portable NIR analyzer (Brimrose Corporation, Hunt Valley, MD) uses an acousto-optic tunable filter (AOTF) technique to generate the diffuse reflectance NIR spectra for each sample, and its NIR wavelength region is 1100-2300 nm; fiber measurements are taken directly on the 5.0 ± 0.5 grams of cotton lint; each sample was measured 5 times. For the Fibronaire (Motion Control, Dallas, TX) air resistance measurements, 3.24 ± 0.03 grams (50.0 ± 0.5 grains) of fiber were measured; each sample was measured 3 times (> 3 measurements severely degraded the sample). For the HVI (Uster, Knoxville, TN) air resistance measurements, 10.0 ± 0.4 grams of fiber were measured; each sample was measured 5 times. Manufacturer recommended procedures were used for all instruments.

Results and Discussion

The objective of the comparative laboratory evaluations was to determine the impacts of 3 different laboratory ginning methods on lint weight and on the fiber micronaire results from 3 fiber micronaire measurements (HVI, Fibronaire, and NIR). Each cotton boll sample for each variety was either hand ginned (HG), roller ginned (RG), or saw ginned (SG) in the laboratory (n=30 samples per gin method per variety).

The first evaluation was to determine the lint yield for each gin method and each variety. The lint yield is the lint weight divided by the original weight of the seed cotton for each cotton boll, summed for the 30 bolls per gin method per variety. By variety, overall good agreement was observed between the 3 gin methods for lint yield (Table 1). All varieties and gin methods yielded over 40% lint yield. Slightly lower lint yields were observed (~0.5-1.0% from average) for SG compared to the HG and RG methods, but this lower yield was very acceptable for a laboratory ginning method.

Table 1. Comparison of lint weight obtained, by gin method, n = 30 samples per gin method per variety

VARIETY	LINT YIELD, BY GIN METHOD			
	HG	RG	SG	AVG
FM 958	43.0%	43.2%	42.6%	42.8%
DP 393	44.6%	44.8%	43.4%	44.1%
SG 105	42.9%	42.7%	41.9%	42.5%

For the micronaire method comparative evaluations, the impact of laboratory ginning method on both physical methods for measuring micronaire (HVI, Fibronaire) was minimal (Tables 2 and 3). Good agreement was observed between the HG, RG, and SG micronaire results for each variety. The micronaire results ranged from ~4.2 to 4.8. The largest micronaire differences were varietal differences, with FM 958 yielding the lowest average micronaire results for all gin methods. The HVI micronaire results tended to be ~0.10 micronaire units higher than the Fibronaire results; this difference was inherent to the SRRC Fibronaire unit.

Table 2. Comparison of Fibronaire micronaire results, n = 30 samples per gin method per variety

VARIETY	FIBRONAIRE MIC, BY GIN METHOD			
	HG	RG	SG	AVG
FM 958	4.24	4.07	4.26	4.19
DP 393	4.72	4.69	4.53	4.64
SG 105	4.86	4.76	4.76	4.77

Table 3. Comparison of HVI micronaire results, n = 30 samples per gin method per variety

VARIETY	HVI MIC, BY GIN METHOD			
	HG	RG	SG	AVG
FM 958	4.31	4.23	4.45	4.33
DP 393	4.91	4.84	4.62	4.79
SG 105	4.88	4.73	4.85	4.82

For the NIR samples, spectral and micronaire measurements were made with the portable Brimrose 5030 NIR analyzer, in which the fiber sample was placed directly against the NIR sampling port. NIR measures the diffuse reflectance from the sample surface. One concern was the impact of different ginning methods on the fiber's reflectance. Very good spectral agreement was observed between the HG, RG, and SG gin methods for each variety, as shown for FM 958 in Figure 2. No obvious spectral differences were readily discerned.

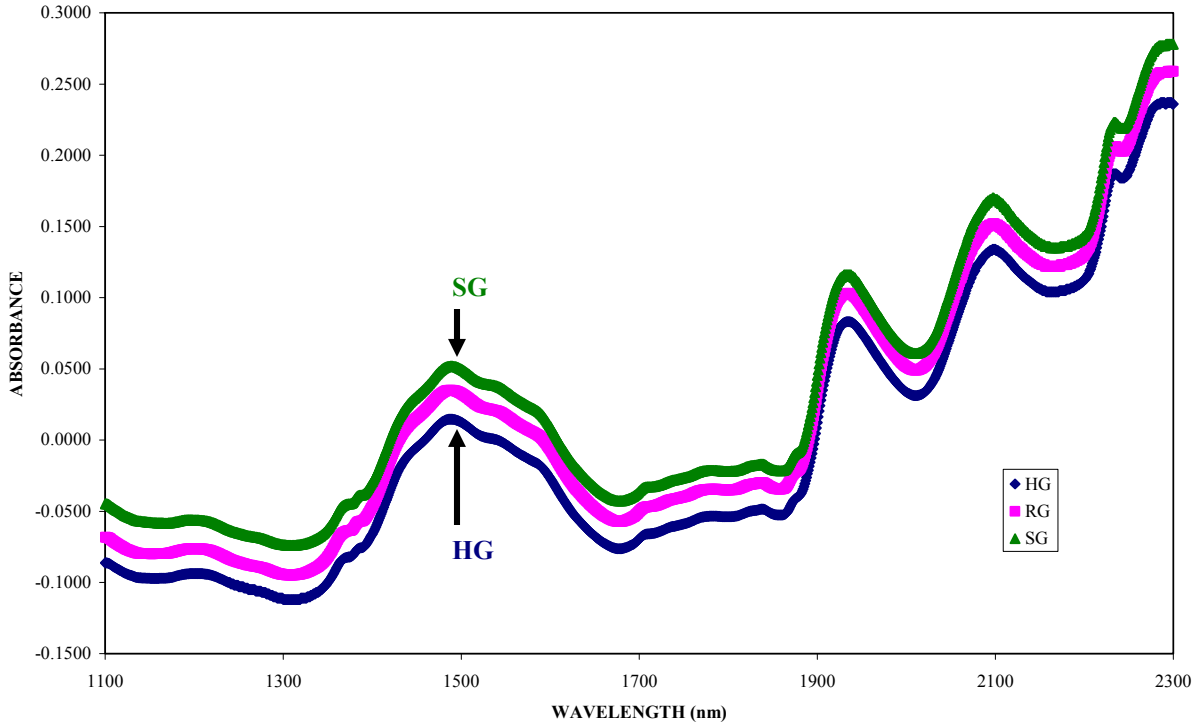

Figure 2. Representative NIR absorbance spectra, HG (blue)-RG (purple)-SG (green), FM 958

Although promising, spectral agreement along cannot portend the actual NIR micronaire agreement between gin methods. NIR micronaire results were obtained for each boll samples, and these results were then combined to compare the NIR results to the Fibronaire and HVI micronaire results. The impact of laboratory ginning method on the NIR method for measuring micronaire was slight (Table 4). Good agreement was observed between the HG, RG, and SG micronaire results for each variety. The micronaire results ranged from ~4.4 to 4.8. The largest micronaire differences were varietal differences, with FM 958 normally yielding the lowest average micronaire results. The NIR micronaire results agreed very well with the HVI micronaire results.

Table 4. Comparison of NIR micronaire results, n = 30 samples per gin method per variety

VARIETY	NIR MIC, BY GIN METHOD			
	HG	RG	SG	AVG
FM 958	**4.37**	**4.33**	**4.63**	**4.44**
DP 393	**4.67**	**4.58**	**4.62**	**4.62**
SG 105	**4.85**	**4.62**	**4.85**	**4.77**

Thus, the impact of gin method on Fibronaire, HVI, and NIR micronaire results was slight, with overall very good average micronaire agreement between the 3 micronaire measurement methods.

Summary

Several different laboratory ginning methods are available to gin the seed cotton, including hand ginning (HG), roller ginning (RG), and saw ginning (SG). A comparative study was carried out to determine the impacts of 3 different laboratory ginning methods on lint weight and on the fiber micronaire results from 3 fiber micronaire measurements (HVI, Fibronaire, and NIR). Seed cottons from 3 varieties were ginned by each laboratory ginning method, and their HVI, Fibronaire, and NIR micronaire results were compared. Good lint yield agreement observed between the different gin methods, with >40% lint yield for all methods. For the physical methods for measuring

micronaire (HVI, Fibronaire), minimal impacts of gin method were observed. For the NIR measurement of micronaire, very good NIR spectral agreement was observed between the different gin methods. Overall, minimal impacts due to laboratory gin method were observed on Fibronaire, HVI, and portable NIR micronaire results.

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The use of a company or product name is solely for the purpose of providing specific information and does not imply approval or recommendation by the United States Department of Agriculture to the exclusion of others.

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