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EFFECT OF CULTIVAR AND AREA OF GROWTH ON MOISTURE PROPERTIES OF COTTON FIBER

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Abstract

Southern Regional Research Center (SRRC) is participating in a multi-year area-of-growth study of selected cotton cultivars. We report here preliminary moisture data (water of imbibition) on the cottons from the 2001 crop year, and compare them to maturity properties determined by image analysis and to micronaire.

Introduction

Recently the issue of moisture in cotton fiber has come under renewed study. Backe's recent review of 70 years of fiber-moisture research (Backe 2002) cites some of the reasons for this new interest, including new technologies for moisture restoration at the gin. It has long been known that lint moisture plays a role in fiber strength (Byler et al., 1993), and that the reproducibility of strength measurements is improved by correcting for moisture content (Byler et al., 1994). Improved measures of length, uniformity ratio, fiber and yarn strength, and yarn quality and appearance can be obtained by ginning cotton at the proper moisture content (Anthony 1999; Hughs 1985).

The Cotton Structure and Quality (CSQ) research unit at SRRC is beginning a study to profile moisture response of a group of cottons available from a 5-year area-of-growth study (the American Textile Manufacturers Institute Cotton Variety Processing Trials). This study was begun to document the suitability of modern cultivars for high-performance spinning. A database of fiber, yarn, and fabric properties, and processing performance in spinning and weaving, will be compiled by researchers at ARS's Cotton Quality Research Station (CQRS) at Clemson SC and at SRRC.

We report here the first moisture data (water of imbibition) from CSQ's moisture studies, and compare them to maturity properties and micronaire for cottons from the 2001 crop year. Additional samples from the 2002-2005 crop years will be evaluated in the future.

Materials and Methods

Table 1 lists the cultivars selected by William R. Meredith, Jr., ARS Crop Genetics & Production Research, Stoneville, MS, for inclusion in the 5-year study. Paymaster (PM), Fibermax (FM), Deltapine (DPL), Phytogen PSC (PSC), and Suregrow (SG) varieties were grown in Texas, Georgia, and Mississippi. FM-832 and FM-966 were grown in all three states.

Maturity, perimeter, thickness, wall area, and lumen area of cottons from the 2001 crop year were measured by image analysis and micronaire was measured using the Micromat Fineness/Maturity Tester (F/MT) as previously reported (Thibodeaux et al., 2003). Water of imbibition was determined by a modification (Bertoniere and Rowland 1985) of the method of Welo (Welo et al., 1952), with an additional modification of boiling to ensure complete wetting-out of the raw fibers. Briefly, cotton fiber specimens were boiled in distilled water, soaked overnight, centrifuged at 4194*g,* transferred to glass weighing bottles, and moisture content (dry basis) of the specimens was determined after oven-drying at 110^{o}C.

Results and Discussion

Maturity data measured by image analysis and micronaire measured by the F/MT are shown in Table 1, with water of imbibition data. These data demonstrate that the samples provide a range of parameters related to maturity, cell-wall development, and fineness. They also indicate that the cottons grown in Texas were the least mature.

Water of imbibition (WOI) measures water that is within cell walls, in inter-fiber spaces, or in pores. This reflects the imbibition of water by what are essentially water-extracted cotton fibers. We determined WOI on randomized sets of samples as indicated in Table 1, running each sample twice with 6 replicates in each set.

Cottons grown in Texas had the highest values of water of imbibition and cottons from Mississippi the lowest values, with cotton from Georgia falling in between those from Texas and Mississippi. This same trend held for the two cultivars (FM-832 and FM-966) that were grown in all three states. WOI values of the cottons from Mississippi had the narrowest range, from 41.32 to 43.36% (range of 2.04%). For Georgia-grown cottons, WOI values were from 42.98 to 45.20% (range of 2.22%).

Cottons grown in Texas had the widest range of WOI, 43.22 to 51.97%, for a range of 8.75%. Within each state, there was no correlation between physical properties and WOI.

Pooled date for all three states were plotted (Figure 1) and demonstrate a moderate overall inverse correlation (Table 2) between WOI and micronaire, thickness, and wall area, low inverse correlation with maturity, and no correlation with perimeter and lumen area.

Cottons grown in Texas were the least mature, and yielded the highest values for WOI. One possible explanation might be that the primary wall has a looser more open arrangement of microfibrils (Dinand et al., 2002; Roelofsen 1959) than secondary wall. The presence of a higher proportion of primary wall in the immature fibers might then cause immature cotton to imbibe more water.

The immaturity of the Texas cottons confounds any attempt to detect an area-of-growth effect on moisture response. The moisture response of these cottons and those from the full 5-year study will be more fully explored through other moisture assays, and through comparison with a wider range of fiber and yarn properties and processing performance.

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Table 1: Image analysis data, micronaire, and water of imbibition (WOI) of selected cotton cultivars grown in Texas, Georgia, and Mississippi during the 2001 crop year.

Growing Region	Variety	M_{IA}* (θ)	P_{IA} (µm)	T_{IA} (µm)	WA_{IA} $(\mu m)^2$	LA_{IA} $(\mu m)^2$	$M_{F/MT}$	WOI set #	WOI (% ± std dev)
Texas	FM-832	0.44	52.49	2.08	96.58	13.01	2.8	1	51.97 ± 0.80
	PM-2800	0.46	54.17	2.28	107.84	12.66	3.2	3	43.22 ± 0.49
	PM-2200	0.42	53.38	1.99	94.26	13.29	3.3	2	49.94 ± 1.33
	FM-819	0.48	49.66	2.18	93.60	12.21	3.4	3	51.28 ± 0.68
	FM-989	0.46	51.68	2.17	98.58	12.53	2.9	2	53.01 ± 1.93
	FM-958	0.50	51.90	2.41	104.07	15.69	3.1	3	44.07 ± 0.78
	FM-966	0.48	50.22	2.24	97.22	12.95	3.2	1	49.50 ± 0.95
	PM-2326	0.43	54.01	2.07	99.51	15.26	3.8	2	44.42 ± 1.51
Georgia	DPL-491	0.53	50.52	2.51	107.43	15.63	4.0	2	45.12 ± 1.57
	PSC-355	0.54	53.25	2.72	122.30	19.91	4.3	3	44.20 ± 0.71
	FM-966	0.53	53.44	2.62	116.65	10.53	4.4	1	45.20 ± 2.36
	DPL-DP	0.50	57.72	2.65	126.80	15.71	4.8	3	42.98 ± 1.49
	FM-832	0.48	53.53	2.39	108.17	11.62	4.0	1	44.04 ± 1.48
	SG-747	0.53	57.15	2.81	132.43	14.85	4.8	2	43.49 ± 0.69
Mississippi	DPL-DP	0.58	50.58	2.83	119.10	15.01	3.9	2	42.35 ± 0.81
	PSC-355	0.59	53.85	3.05	136.04	19.91	4.5	3	43.36 ± 1.50
	FM-832	0.59	53.19	3.05	129.81	11.40	4.5	1	41.32 ± 1.87
	DPL-491	0.50	58.02	2.70	129.40	14.53	4.8	3	42.74 ± 2.76
	FM-966	0.50	51.72	2.40	102.79	13.29	4.0	1	42.62 ± 0.95
	SG-747	0.55	57.38	2.97	138.38	16.19	5.1	2	42.58 ± 5.09
	PM-1218	0.60	56.32	3.27	148.25	19.23	5.6	1	41.84 ± 1.69

* M_{IA}, P_{IA}, T_{IA}, WA_{IA}, LA_{IA} = Maturity, perimeter, wall thickness, wall area, and lumen area, respectively, as measured by image analysis.

Table 2: Correlation coefficients for fiber physical properties determined by image analysis vs water of imbibition for samples grown in Texas, Georgia, and Mississippi during the 2001 crop year.

Property	r^2
Micronaire	0.5291
Thickness	0.5267
Wall area	0.5135
Maturity	0.4088
Perimeter	0.2519
Lumen area	0.1416