A CLOSE LOOK AT COTTON SEED COAT FRAGMENTS WITH AFISPro

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Abstract

Seed coat fragments (SCF) can cause spinning problems and fabric defects, which ultimately cause financial losses to the cotton industry. SCF are parts of a seed coat that have been broken from the surface of either mature or immature seeds during mechanical processing. The objective of this study was to evaluate AFISPro measurements of SCF (SCN –Seed Coat Neps is the primary measurement) and compare AFISPro data to the dark specks measured on fabrics made from these fibers. First two controls (polyester and combed cotton) were run on AFIS. Five cottons were seeded with specific levels of SCF and Trash (10 SCF, no trash; 10 Trash particles, no SCF; and 10 SCF and 10 trash particles) and then run on AFISPro. U.S. cottons were hand cleaned, sorting trash and SCF from the fiber, to quantify the levels of SCF and Trash before testing on AFISPro. Five 0.5 gram hand cleaned samples were prepared where the SCF and Trash were counted. The fibers were then seeded with the removed SCF and trash and run on AFISPro. The matching bale fiber samples, without any cleaning were also run on AFIS Pro. The fabrics (from these fibers) are measured by Autorate an image analysis tool that detects SCF on fabrics. The fiber data was then related to the fabric data.

Introduction

Cotton fibers often contain two different types of neps (entanglements of fiber), mechanical neps (Figure 1a) (Schleth. and Peters, 2005) and biological neps, both of which affect yarn evenness and fabric appearance (Hebert and Thibodeaux, 1993). Mechanical neps are entangled fiber clusters originated from the manipulation of the fibers during processing (van der Sluijs and Hunter., 1999, Anthony et al.., 1988) Biological neps are neps that contain foreign materials, such as seed coat fragment (SCF), leaf, or stem material (Hebert et al., 1988). One particularly troublesome form of biological nep is the seed coat fragment with attached fiber (Figure 1b) (Schleth. and Peters, 2005). They are created mainly in ginning when the fibers are being separated from the seed (Schleth. and Peters, 2005). According to Hebert and Thibodeaux, 1993 and Anthony et al, 1988 , 13 to 27 % of all neps contain seed coat fragments. Seed coat fragments can cause spinning problems and fabric defects (dark specks), which ultimately cause financial losses to the cotton industry. SCF are parts of a seed coat that have been broken from the surface of either mature or immature seeds during mechanical processing. Seed coat neps (SCN) are fragments of the cottonseed that still have some fibers attached (Figure 1b) (Schleth. and Peters, 2005). Fibrous neps and seed coat fragments result from ginning and are mostly variety dependent (World Bank, 2008).

The objective of this study was to evaluate measurements of SCF by AFISPro, the Advanced Fiber Information System, and compare AFISPro data to the dark specks measured on fabrics. The AFISPro fiber individualizer aeromechanically separates the sample into clean fiber, trash and dust components. These components are transported by air to the respective fiber and trash electro-optical sensors (USTER AFIS PRO, 2005). The trash sensor optically counts the number of trash and dust particles in a sample. The fiber sensor measures fibers and fibrous neps (Figure 1a) including seedcoat neps with fibers attached (Figure 1b) (Schleth. and Peters, 2005). SCN is the primary measurement in AFIS which should represent SCF. In AFIS fibers will produce a rectangular waveform. Nep signals are much greater in magnitude and duration and have a spiked waveform (Hebert and Thibodeaux, 1993). Seedcoat neps have a larger shadow than fibrous neps. Trash particles produce smaller spiked waveforms that are distinguishable from the nep waveforms in magnitude and duration. From these waveforms, data are acquired, analyzed and stored in the AFIS Pro computer (Hebert and Thibodeaux, 1993).

Methods

An experiment was conducted with cottons from the ATMI 2001Variety Study along with two controls, combed cotton and polyester. The two controls along with five of the ATMI 2001 cottons were seeded with specific levels of seedcoat fragments (SCF) and trash. Treatments were as follows:

Control) CLEANED FIBER ONLY;
1) 10 SCF, NO TRASH
2) 10 TRASH PARTICLES, NO SCF
3) 10 SCF AND 10 TRASH PARTICLES.
4)

Samples were tested with five replications on AFISPro (Tables 1 & 2). This was designed to give us baseline data so we could see how AFISPro would handle the SCF and Trash particles.

Experiments were also conducted with 10 cottons from the ATMI 2001& 2002 Variety Studies. Cottons (2.5g) were hand cleaned, sorting trash and SCF from the fiber, to quantify the levels of SCF and Trash before testing on AFISPro. The remaining five 0.5 gram hand cleaned fiber samples were then seeded with the removed SCF and trash and run on AFISPro. The matching standard bale fiber samples for each variety were also run on AFISPro. The fabrics were processed from 100 lb lots to yarn and woven as a filling faced sateen fabric with a common combed warp, where approximately 85% of the experimental yarn is on the face of the fabric. The fabrics (from these fibers) were measured by Autorate, an image analysis tool that detects SCF on fabrics. The fiber data was then related to the fabric data.

AFISPro Terms and Abbreviations (Schleth. and Peters, 2005)
Nep = Total Neps per gram of fiber tested including SCN, entanglements of several fibers. They are generated under mechanical treatment of the cotton fibers (Figure 1). AFIS Neps are written with a capital N.
SCN = Seed Coat Neps per gram of fiber tested. These have a wider waveform than fiber neps. They are fragments of the cottonseed that still have some fibers attached (Figure 2).
Trash= Trash/gram; larger impurities (500+ microns) containing particles from the cotton plant itself and other plants (weeds) contaminating the cotton field (leaf, bark, bract, and non-fibrous trash). AFIS Trash is written with a capital T.
Dust = Dust/gram; smaller particles (20-500 microns) from the plant and simply dirt from the cotton field that sticks with the plant during harvesting AFIS Dust is written with a capital D.
VFM = %Visible Foreign Matter (what would be seen with a video trash meter, both dust and trash)

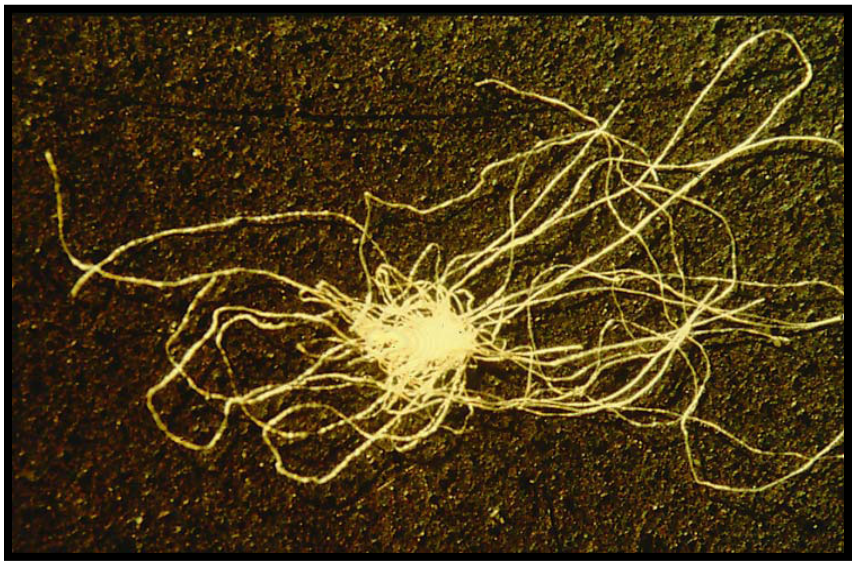

Figure 1 (Schleth. and Peters, 2005): Fibrous Nep

Figure 2 (Schleth. and Peters, 2005): Seedcoat Fragment with fibers attached

Table 1: Fibers Tested on AFISPro -Base line samples A1-1, 9, 12, 19, 21; Combed Cotton & Polyester

Run Number for AFISPro	Investigator Code	
Run 1	A1-1-CF	clean fiber (cotton) only (5 reps)
Run 2	A1-1-SCF	clean cotton seeded with 10 Seedcoat fragments (5 reps)
Run 3	A1-1-T	clean cotton seeded with 10 trash particles (5 reps)
Run 4	A1-1-SCF-T	clean cotton seeded with 10 SCF & 10 trash (5 reps)
Run 5	A1-9- CF	clean fiber (cotton) only (5 reps)
Run 6	A1-9- SCF	clean cotton seeded with 10 Seedcoat fragments (5 reps)
Run 7	A1-9- T	clean cotton seeded with 10 trash particles (5 reps)
Run 8	A1-9- SCF-T	clean cotton seeded with 10 SCF & 10 trash (5 reps)
Run 9	A1-12- CF	clean fiber (cotton) only (5 reps)
Run 10	A1-12- SCF	clean cotton seeded with 10 Seedcoat fragments (5 reps)
Run 11	A1-12- T	clean cotton seeded with 10 trash particles (5 reps)
Run 12	A1-12- SCF-T	clean cotton seeded with 10 SCF & 10 trash (5 reps)
Run 13	A1-19- CF	clean fiber (cotton) only (5 reps)
Run 14	A1-19- SCF	clean cotton seeded with 10 Seedcoat fragments (5 reps)
Run 15	A1-19- T	clean cotton seeded with 10 trash particles (5 reps)
Run 16	A1-19- SCF-T	clean cotton seeded with 10 SCF & 10 trash (5 reps)
Run 17	A1-21- CF	clean fiber (cotton) only (5 reps)
Run 18	A1-21- SCF	clean cotton seeded with 10 Seedcoat fragments (5 reps)
Run 19	A1-21- T	clean cotton seeded with 10 trash particles (5 reps)
Run 20	A1-21- SCF-T	clean cotton seeded with 10 SCF & 10 trash (5 reps)
	Combed Cotton	
Run 21	cc-CF	clean fiber (cotton) only (5 reps)
Run 22	cc-SCF	clean cotton seeded with 10 Seedcoat fragments (5 reps)
Run 23	cc-T	clean cotton seeded with 10 trash particles (5 reps)
Run 24	cc-SCF-T	clean cotton seeded with 10 SCF & 10 trash (5 reps)
	Polyester	
Run 25	P-CF	clean fiber (polyester-Dacron) only (5 reps)
Run 26	P-SCF	clean polyester seeded with 10 Seedcoat fragments (5 reps)
Run 27	P-T	clean polyester seeded with 10 trash particles (5 reps)
Run 28	P-SCF-T	clean polyester seeded with 10 SCF & 10 trash (5 reps)

Results

When fiber is processed through AFISPro, an aggressive fiber individualizer sorts the fiber and trash. The trash and SCF may be broken into smaller particles. Only trash without fiber is measured by the trash sensor. Particles with fiber attached (SCF or trash entangled with fiber) are measured by the lint sensor as SCN or fiber neps. Nep count is total nep count (both fiber neps and SCN). From this data (Table 2) it appears that only the large SCF are counted as SCN; the smaller SCF are counted as fiber neps. The SCF were broken into smaller SCF and counted as fiber neps.

Table 2 shows the following: when just 10 SCF are added (Treatment 1) to the combed cotton and Dacron samples, Neps increase by 16 and 34, SCN increased by 9 and 16 and Trash increased by 4 & 11. Dust stayed the same or

increased by 1. VFM increased by 0.08% and 0.29% respectively as compared to the control, which means that the SCF broke up and the larger particles which have a wider wave form became SCN and when the smaller broken SCF tangled with fibers they were seen as Neps. There was very little dust, so the majority of the seed coat particles without fiber were counted as Trash. VFM increased slightly. When just 10 elements of trash were added (Treatment 2), Neps only increased by 3 and 8, SCN increased by 2 and 2 and trash increased by 35 & 18, dust increased by 55 and 3, and VFM increased by 0.91% and 0.38% respectively as compared to the control, which means that when the trash broke up the bulk of it was measured as Trash, and Dust. Very little of the trash tangled with fiber to form neps or appear as SCN. When both SCF and trash particles were added (Treatment 3), Neps increase by 28 and 27, SCN increased by 20 and 23 and Trash increased by 38 & 37, Dust increased by 57 and 47, and VFM increased by 1.25% and 1.20% respectively as compared to the control, which means that the Nep levels were similar to the levels of Treatment 1. SCN and Trash levels were about the same or slightly higher than if you added the levels for Treatment 1 and Treatment 2. When the SCF and trash broke up, the larger particles which cast a large shadow became SCN and when the smaller broken SCF tangled with fibers they were seen as Neps. The broken seed coat and trash without fiber became Trash, Dust and ultimately VFM.

The following statements are about average values for the two controls (Dacron & combed cotton) and five varieties of cotton (A1-1, 9, 12, 19, and 21). Nep levels show a significant change when the SCFs alone (Treatments 1) were added and when both SCFs and trash elements (Treatments 3) were added there was only a slight increase when trash particles (Treatments 2) were added. Nep size increased slightly when SCFs (Treatments 1 and 3) were added which is another indication that some of the seed coat fragments were incorporated into some neps. As expected the addition of SCFs (Treatments 1 and 3) increased the AFISPro SCN levels, trash did not significantly affect SCN count. SCNs were smaller for Treatment 2. Trash count/g and size increases significantly for each of the treatments. The clean fiber (control) actually has some Trash (4). When the 10 SCFs are added the AFIS Trash level increases to 19; when 10 pieces of trash are added the Trash levels increase to 38; and when 10 SCFs and 10 trash particles are added the AFIS trash level increases to 46.

Visible Foreign Matter (VFM) increases significantly for each of the treatments. The combed cotton (control) actually has some VFM. On average when the 10 SCFs are added the AFIS VFM level increases by 0.67; when 10 pieces of trash are added the VFM levels increase by 0.81; and when 10 SCFs and 10 trash particles are added the AFIS VFM level increases by 1.44. The last data row is the Sum of the Average SCF (Treatment 1) and the Average Trash (Treatment 2) which is very similar to Treatment 3 and shows that VFM increases with SCN and Trash and should be an indicator of the % dark particles in the fiber.

Table 2: AFISPro Base-line Data for ATMI-Yr 1, Cotton & Polyester Samples

Sample	Nep count/g	SCN count/g	Trash count/g	Dust count/g	Total (dust +Trash) count/g	VFM	Nep Size %(Micr)	SCN Size (Micr)	Trash Size (Micr)
A1-1- CF	884	9	9	95	104	0.14	733	1103	239
A1-1- SCF	943	27	18	148	166	0.57	735	1233	304
A1-1- T	942	16	40	184	224	0.85	726	903	348
A1-1- SCF-T	962	30	53	196	250	1.54	740	1244	413
A1-9-CF	394	14	6	146	152	0.19	678	1085	210
A1-9-SCF	423	32	26	192	217	0.96	710	1226	323
A1-9-T	418	9	34	196	230	1.06	695	1034	361
A1-9-SCF-T	392	19	44	236	279	1.47	700	1262	365
A1-12-CF	364	10	4	116	120	0.13	704	1098	216
A1-12-SCF	369	15	38	192	231	2.04	699	1044	437
A1-12-T	385	10	41	204	245	1.01	700	1110	349
A1-12-SCF-T	391	19	58	216	274	2.57	698	1263	466
A1-19-CF	307	3	6	91	98	0.13	667	1172	227
A1-19-SCF	340	24	26	180	206	1.06	728	1396	333
A1-19-T	336	8	36	117	153	0.97	692	1205	439
A1-19-SCF-T	334	23	52	150	202	1.44	708	1294	460
A1-21-CF	174	6	2	40	42	0.13	674	1333	265
A1-21-SCF	173	20	11	66	76	0.44	695	1224	349
A1-21-T	160	6	58	297	355	1.21	648	904	335
A1-21-SCF-T	166	21	40	225	265	1.37	691	1279	353
Combed Cotton									
CC- CF	20	0	1	52	53	0.03	620	0	163
CC - SCF	36	9	5	52	58	0.11	792	1512	234
CC -T	23	2	36	107	143	0.94	661	767	462
CC - SCF-T	48	20	39	109	148	1.28	811	1115	473
Polyester Dacron P-CF	43	2	0	23	23	0	631	1475	117
P-SCF	77	18	11	24	34	0.29	737	1308	447
P-T	51	4	18	26	44	0.38	646	1085	566
P- SCF-T	70	25	37	70	107	1.20	890	1365	559
Avg* CF	312	6	4	80	85	0.11	672	1038	205
Avg* SCF	337	21	19	122	141	0.78	728	1278	347
Avg* T	331	8	38	162	199	0.92	681	1001	409
Avg* SCF-T	337	22	46	172	218	1.55	748	1260	441
Sum SCF & T**	668	28	57	284	340	1.70	1409	2279	755

*Average of Dacron, Combed Cotton and 5 A-1 varieties

** Sum of Dacron, Combed Cotton and 5 A-1 varieties

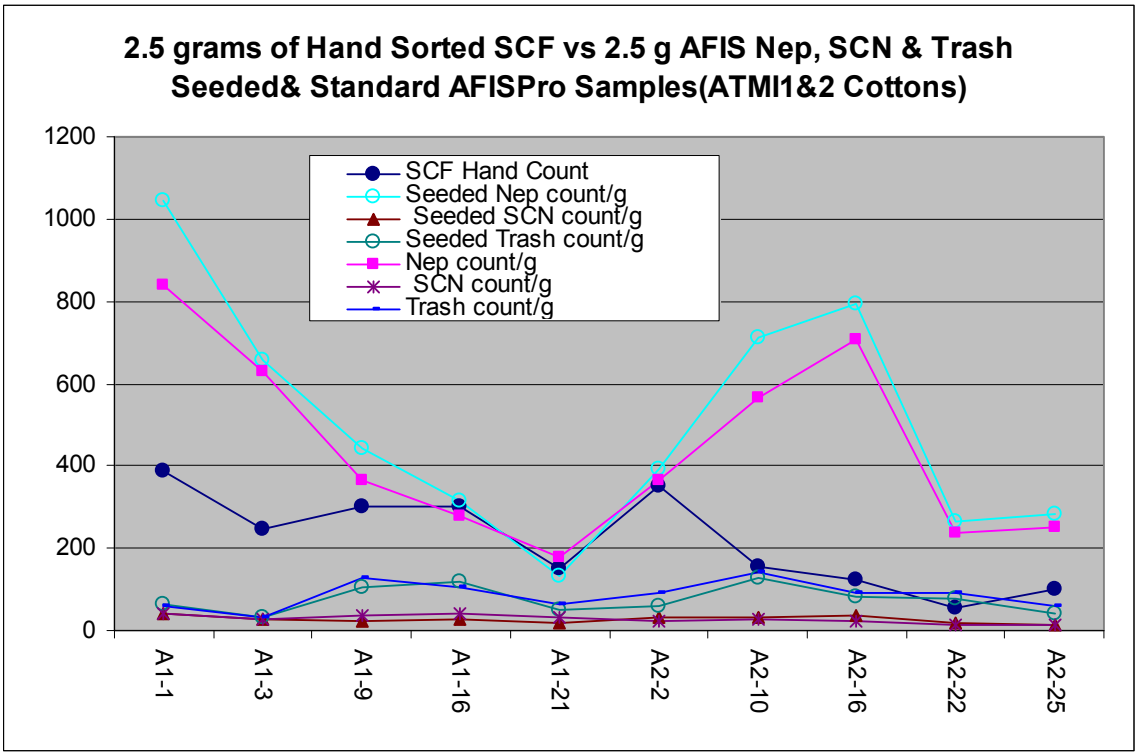

Figure 3: 2.5 gram samples - Hand sorted, Seeded AFIS and Standard AFIS Data.

Figure 3 shows that the Seeded samples had similar results to the Standard samples for AFISPro. The Hand Counted SCF fall between the SCN and the Nep count. This is probably because AFIS counts many SCF as Neps only and not as SCNs because they are too small to meet the criteria (only neps with a large shadow are counted as SCF). The average Nep size is 707 microns whereas the average SCN is 1144 microns. The SCNs are 1.6 times larger than the Neps. Therefore, the smaller SCF are counted as Neps.

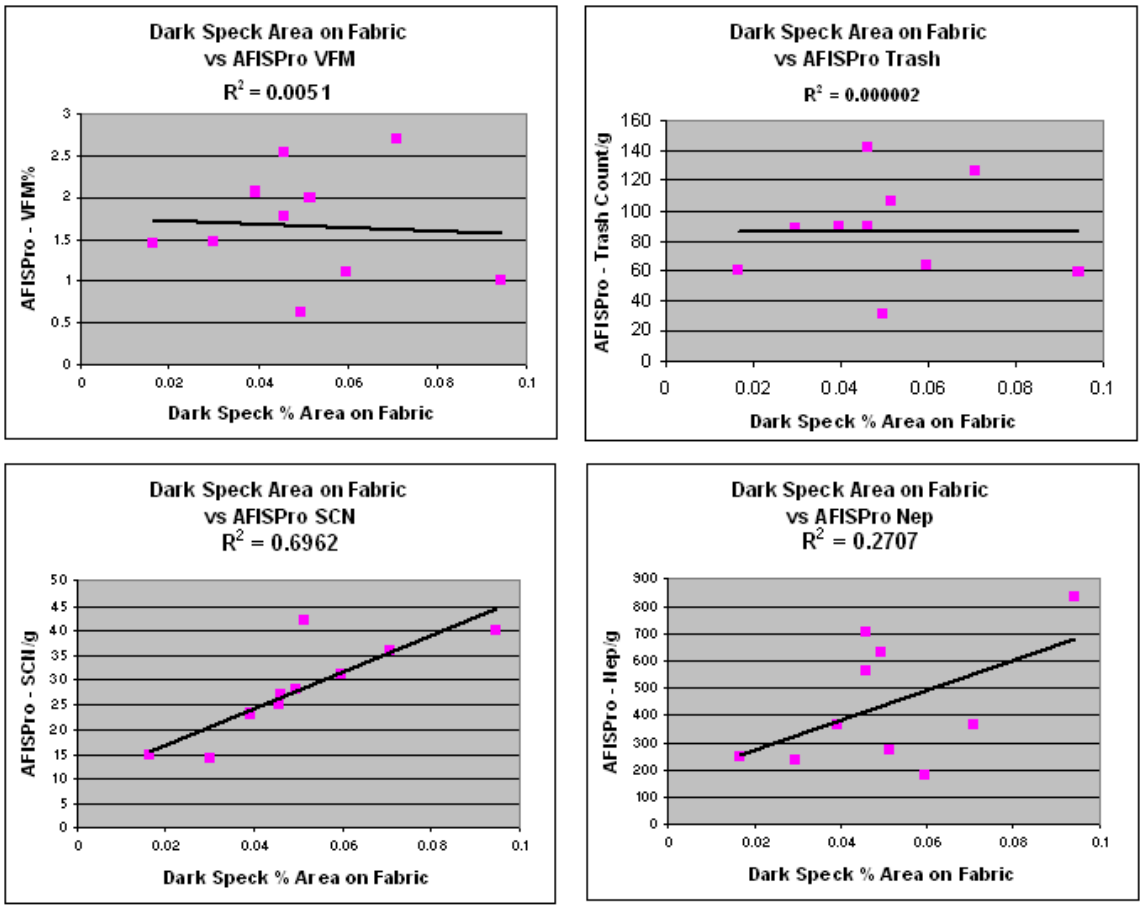

Figure 4: Dark Speck %Area on Fabric as Measured by Autorate vs. AFISPro Fiber Properties.

Figure 4 shows that there isn't a relationship between Dark Speck Area on Fabric and both VFM% and Trash as measured by AFISPro. AFISPro Nep has and R-square of 0.2707 and AFISPro SCN has an R-square of 0.6962 which indicates that most of the dark specks on the fabric are SCN and neps. When a regression was run on these two parameters it resulted in an R-square of 0.7752 and the resulting equation:

% Area dark on Fabric = 0.001689 * SCN + 0.000028 * Nep - 0.0095

Fabrics from the 100 lb. lots of cotton were used to develop the prediction equation of dark specks from fiber (AFISPro Data) to fabric (Autorate Data) (Figure 5).

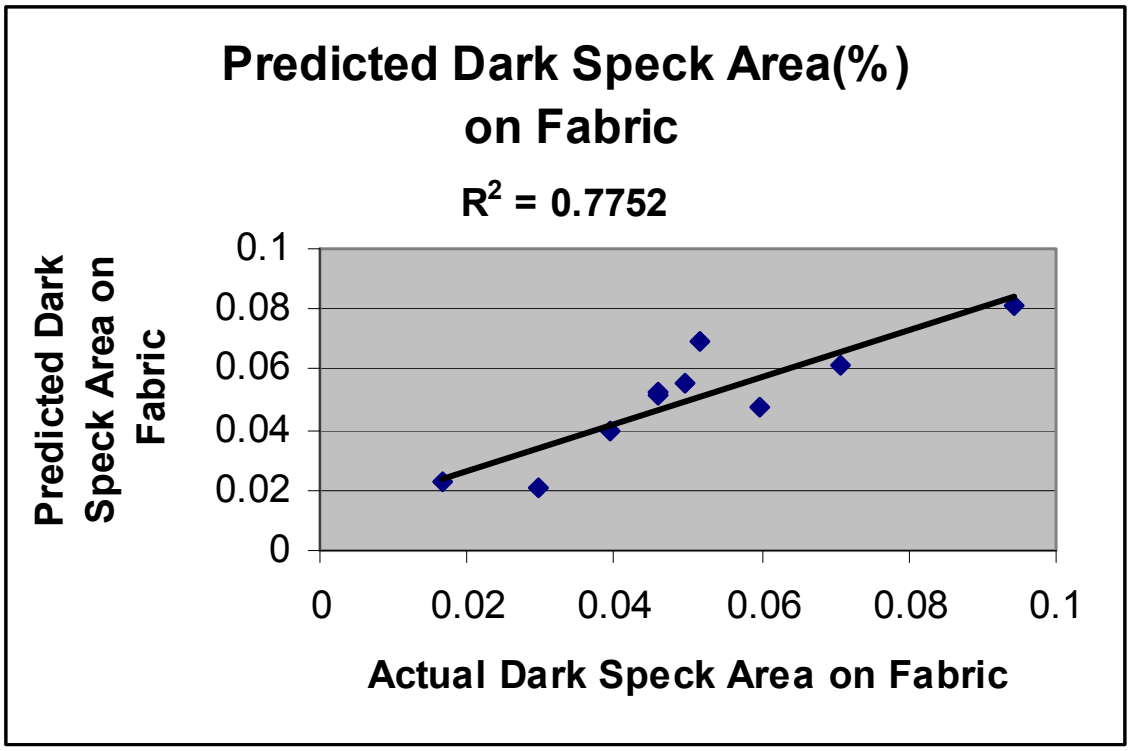

Figure 5: Dark Specks on Fabrics vs. AFISPro Fiber Properties
% Area dark on Fabric = 0.001689 * SCN + 0.000028 * Nep - 0.0095, R^2=0.7752

Summary

In the first study, cottons were seeded with a specific count of SCF and/or trash. Overall the addition of SCFs affected the levels of SCN and Neps, whereas the addition of trash mainly affected the Trash, Dust and VFM with a slight addition to the SCN and Neps. The SCN and Neps created by adding trash are most likely larger trash particles which tangled with fibers. The opener in the AFISPro is aggressive and the SCF break up and the larger particles which cast a large shadow became SCN and the smaller broken SCF tangled with fibers and are seen as Neps. A few of these SCF with minimal fiber may become Trash and some of the seed coat may break off and become Dust. There was very little dust, so the majority of the seed coat particles without fiber were counted as trash. VFM increased slightly. When Trash is processed through the opener it breaks into smaller trash particles and dust. A small portion of the trash particles tangled with fiber to form Neps, and very few of those are large enough to be counted as SCFs. SCNs are 1.6 times larger than the Neps in this study. Smaller SCF are counted as Neps.

Seeded samples had similar results to the Standard samples for AFISPro which leads to the conclusion that AFISPro is consistent in its measurements. The Hand Counted SCF is larger than SCN count. This is probably because AFIS counts many SCF as Neps only and not as SCNs because they are too small to meet the criteria (only neps with a large shadow are counted as SCF).

VFM and Trash were unrelated to the dark specks in the fabric which would mean that the dark specks in the fabrics are SCF, not trash particles. SCN and Neps combined were able to predict the dark specks in the fabric with an R^2 of 0.7752.

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