

***Blending Long Staple Upland cotton
with Upland cotton
Final report for CRDC project
Premium Blends TFT 0001***

Marinus H. J. van der Sluijs
CSIRO Materials Science and Engineering,

Summary

There is considerable interest within the Australian cotton industry for new varieties with improved fibre quality that attract a price premium. Upland varieties that approach the long and fine quality attributes of Pima-type cottons are currently being produced by CSIRO Plant Industry (CPI). These are being tested by the Premium Cotton Initiative (PCI) which aims to identify and create markets for these new premium Upland cottons.

In this study a Long Staple Upland (LS) variety; Sicala 350B, produced by CSIRO Plant Industry, was blended in increasing proportions with Sicot 73, a standard Upland variety, also produced by CPI and subjected to spinning trials. The aim of the investigation was to examine the degree to which Sicala 350B could be used to improve the quality of standard Upland cotton in the production of fine count ring spun yarns. Three blend ratios of the two cottons; 80/20, 70/30 and 60/40 Sicot 73 and Sicala 350B, were spun into 10, 12 & 15 tex (Ne 60, 50, 40) ring spun carded yarns and examined against yarns spun from 100% Sicot 73 and Sicala 350B fibre. Processing efficiency and yarn quality results were examined in order to judge the potential of blending Sicala 350B with Upland cottons. Results indicated that a blend of 70/30 Sicot 73/ Sicala 350B did improve the yarn quality and processing performance when compared to 100% Sicot 73.

Introduction

Spinning trials conducted in the cotton mill at CSIRO Materials Science and Engineering (CMSE) highlighted the superior fibre properties of Sicala 350B¹ a Long Staple (LS) Upland variety produced by breeders at CSIRO Plant Industry. Initial trials conducted in 2004 showed Sicala 350B fibre can produce superior Ne 42 (14 tex) and Ne 35 (17 tex) ring-spun carded and combed yarn and subsequently fabric (single jersey) knitted from it. Performance was measured in terms of

¹ Sicala 350B is a specialist high quality Bollgard^R II variety, exhibiting extremely long fibre lengths (> 1 ¼ inches) compared with regular Upland varieties. Fibres are also typically finer and have excellent breaking tenacity (> 32 grams per tex).

process efficiency and quality relative to yarn and fabric produced from standard Upland cotton. Subsequent spin limit trials conducted in 2005 showed Sicala 350B could also be used to process high quality fine count carded and combed ring-spun yarns in the range of Ne 60 to 70 (10 to 8 tex). The Premium Blends project in 2007 further highlighted the fact that a 70/30 blend of Pima/Sicala 350B did not result in a practical deterioration in yarn quality and processing efficiency compared with yarn spun from 100% Pima. The primary advantage for the spinner using Sicala 350B fibre is a substantial savings in raw material costs². Commercial spinning trials conducted in 2009 in India and China confirmed that Sicala 350B can be used as 100% or in blends with Pima to produce high quality fine count ring, compact and low twist yarns.

This objective of this study was to determine the proportion of Sicala 350B that could be used as to enhance or substitute for a standard Upland cotton in order to improve the processing performance and the properties of fine count yarns and fabrics. This would be a huge incentive for the spinner as this will enable Sicala 350B to be used as 100% or in blends with Pima or Upland cotton, depending on the yarn and fabric required. This will enable the merchants to demand a premium for the Premium Upland cotton which will also be to the advantage of the grower, as there are currently yield penalties when growing Sicala 350B.

In this study fine count carded yarns, 15, 12 & 10 tex (Ne 40 - 60), were spun from blends of Sicala 350B and Upland fibre, where the proportion of Sicala 350B in the blend was increased in 10% increments from zero through to 40%. Processing efficiency, yarn and fabric quality were measured in order to demonstrate the effect of blending LS Upland cotton for standard Upland cotton in a spinning mill.

Materials and Methodology

Two bales of commercially saw ginned Sicala 350B cotton and saw ginned Sicot 73 were supplied to CMSE by Auscott Limited. The Sicala 350B and Sicot 73 were grown during the 2008 season under commercial growing conditions in Narrabri. Seed cotton was ginned at Auscott Narrabri under standard commercial ginning conditions.

Fibre Testing

Bale samples were conditioned under standard conditions of 20°C +/-2°C and 65% +/-3% relative humidity for 24 hours and tested on an Uster Technologies 1000

² van der Sluijs M.H.J (2008) *The Market for Australian Long Staple Upland Cotton*, Proceedings 29th Bremen International Cotton Conference, Bremen

High Volume Instrument (HVI) testing 10 replicates per sample. Micronaire, staple length, uniformity, staple strength, elongation and short fibre index (SFI) were measured (Table I). The visual class, using USDA classing boxes, of both bales is also included in Table 1.

Fibre fineness was determined using the Cottonscan™, which determines fibre fineness (linear density) by measuring the length of fibre in an accurately weighed specimen of fibre snippets. Combined with an independently measured Micronaire value from the HVI, the average fibre maturity was also calculated using Lord's empirical relationship between Micronaire, maturity ratio and fineness³ (Table II).

Bale and manually blended fibre samples were also tested for nep, seed - coat neps (SCN) and short fibre content (SFC) by an Uster Technologies Advanced Fibre Information System (AFIS PRO) testing 5 replicates per sample (Table III).

Table I– Raw (Bale) Fibre Results by the HVI 1000

Variety	Length mm	SFI %	Uniformity Index %	Micronaire (µg/inch)	Tenacity cN/tex	Elongation %	Visual Class
Sicala 350B	33.02	7.7	82.1	4.3	33.4	4.9	31 - 3
Sicot 73	30.73	10.8	83.6	4.1	28.8	6.5	21 - 2

Calibrated using HVI ICC Upland and Pima Calibration Cottons

Average of 10 tests

Table II – Fineness Results by Cottonscan™ and Calculated Maturity Results

Variety	Fineness (mtex)	Maturity Ratio
Sicala 350B	204	0.80
Sicot 73	192	0.79

Average of 5 tests

Table III – Nep, Seed-Coat Nep and SFC Results by the AFIS PRO

Treatment	Neps/ gram	SCN/ gram	SFC(W) %
Sicot 73	357	25	8.7
80/20	376	20	8.8
70/30	314	23	8.5
60/40	405	24	8.3
Sicala 350B	237	19	7.0

Average of 5 tests

³ Lord, E. (1956) *Airflow through plugs of textile fibres. Part II. The Micronaire Test of Cotton*. J. Text. Inst. **47**:T16 – T47

Textile Processing

Five blend treatments were examined in this study. The treatments examined are listed below:

- A. 100% Sicot 73
- B. 80/20 Sicot 73/Sicala 350B blend
- C. 70/30 Sicot 73/Sicala 350B blend
- D. 60/40 Sicot 73/Sicala 350B blend
- E. 100% Sicala 350B

Eighty kilograms of fibre from each of these treatments was processed into yarn using machines set to industry standard settings.

Production speeds were kept constant throughout the trial but machine settings e.g. draft distances, were optimised for individual blends as is accepted practice in high-quality spinning mills. The three blend treatments B to D; 80/20, 70/30 and 60/40, were blended prior to opening by weighing each blend component and then manually mixing them together by sandwich blending.

Residual trash in each fibre treatment was measured during the opening, cleaning and carding processes, using a Trützschler BR-WC Waste Collector (Table IV).

Table IV – Percent Trash Extracted in Opening, Cleaning and Carding

Treatments	Opening & Cleaning %	Carding %	Total %
Sicot 73	0.64	1.02	1.66
80/20	0.46	1.02	1.48
70/30	0.51	1.00	1.51
60/40	0.53	1.15	1.68
Sicala 350B	0.33	1.11	1.44

Table V gives the evenness results for the various treatments at the various processing stages.

Table V – Evenness results (in CV %) of preparation processing

Process	A	B	C	D	E
Card	3.75	3.56	3.57	3.47	3.50
1 st Drawframe Passage	3.19	3.32	3.15	3.59	3.10
2 nd Drawframe Passage	3.35	3.43	3.48	3.64	2.94
Roving	7.18	6.59	6.19	6.70	5.96

Roving from each treatment was spun into 15, 12 & 10 tex yarn using a twist factor (α_e) of 4.0. Yarns were wound, cleared and waxed onto 1 kg packages. For each yarn count, spinning performance and yarn quality was measured. We were also able to produce an 8 tex (74 Ne) yarn from 100% Sicala 350B cotton which is further proof that this LS cotton can be used to produce fine count yarns.

Figure 1 summarises the processing steps and equipment used to convert each treatment into yarn.

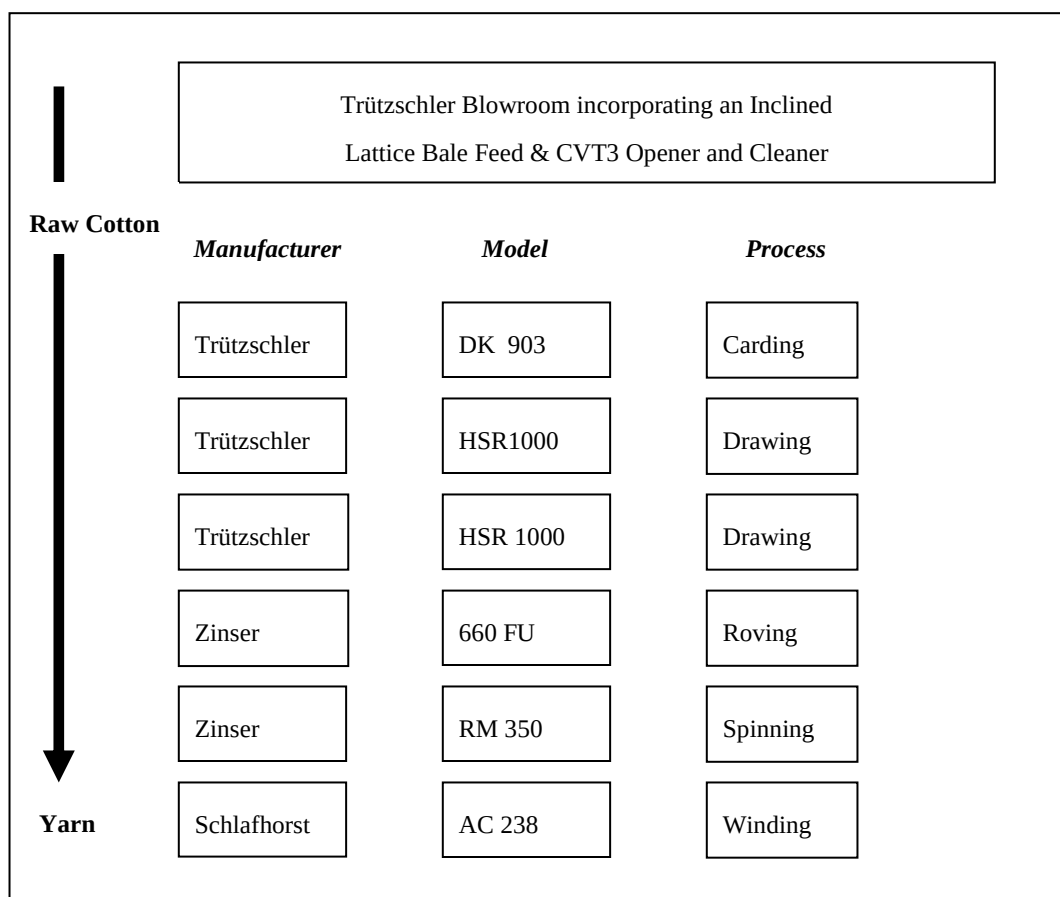


Figure 1 – Yarn Processing Route

The 12 tex yarns from each treatment was knitted on a Monarch XL – 4FA, 28 gauge circular knitting machine producing a single jersey fabric using a machine tightness factor of 15.4 cm/tex to produce a fabric weight of 100g/m².

Yarn Testing

Spun yarns were conditioned under standard conditions of 20°C +/-2°C and 65% +/-3% RH for 24 hours and tested for linear density (count) as per Australian Standard (AS) 2001.2.23, twist as per AS 2001.2.14, evenness, hairiness and imperfections using an Uster Technologies 4-SX evenness tester as per American

Society for Testing and Materials Standard (ASTM) D1425 .Tensile properties were determined using the Uster Technologies Tensorapid 3, as per ISO 2062: 1993(E), Method B (automotive). Table VI shows the test results for the yarns spun from each blend treatment.

Table VI - Test Results for Yarns from various treatments

Instrument & Measurement	15/1 A	15/1 B	15/1 C	15/1 D	15/1 E	12/1 A	12/1 B	12/1 C	12/1 D	12/1 E	10/1 A	10/1 B	10/1 C	10/1 D	10/1 E	8/1 E
Uster Technologies 4-SX																
Evenness#																
CV %	21.0	21.3	21.6	20.9	20.6	22.8	22.5	22.5	22.6	21.6	24.1	24.1	24.0	24.1	22.4	24.3
Thin places - 50 % /1000	387	381	478	335	283	626	527	561	546	390	900	821	792	823	546	889
Thick places + 50 % /1000	1100	1289	1304	1183	981	1702	1611	1552	1670	1395	2135	2160	2035	2123	1591	2119
Neps + 200 % /1000	1681	1895	1841	1868	1365	2537	2547	2187	2688	1971	3178	3412	3094	3415	2332	3328
Hairiness																
Hairiness H	4.3	4.4	4.4	4.5	4.4	4.1	4.1	4.2	4.2	4.1	4.0	4.0	3.9	4.0	3.9	3.8
Sh	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1
UT - Tensorapid 3																
Strength*																
Breaking Tenacity cN/tex	15.3	14.5	15.4	15.3	16.0	14.3	14.6	14.8	14.9	15.4	13.8	14.2	14.5	14.0	15.2	14.8
CV % Tenacity	12.6	12.6	13.9	12.6	12.4	14.8	14.0	14.5	14.6	12.4	15.8	14.6	15.9	15.8	15.1	16.9
Breaking Elongation %	6.1	5.6	5.9	5.8	5.8	5.5	5.4	5.3	5.2	5.1	4.8	4.9	4.9	4.6	4.7	4.2
CV % Elongation	8.9	9.3	8.7	8.9	7.4	10.3	10.9	10.3	11.5	9.1	14.4	12.1	13.0	14.5	12.7	16.4

Average of 12 tests *Average of 120 tests

Fabric Testing

Greige (undyed) fabrics were conditioned under standard conditions (20°C +/- 2°C, 65% +/- 3% RH) and tested for fabric mass as per AS 2001.2.13-87, and bursting force AS 2001.2.19 using a Instron (CRE) tensile testing machine, with the ball burst attachment. Table VII lists the test results for fabric knitted from each blend treatment.

Table VII – Single Jersey (Greige) Fabric test results

Fabric Property	A	B	C	D	E
Bursting Pressure (KPa)	21.0	24.5	22.5	22.0	22.4
Fabric Mass (g/m²)	93	95	98	92	96

Discussion of Results

By any measure, the fibre properties, as tested by HVI, of the two cottons used in this study can be considered to be representative of the cotton produced during the 2008 season. As expected the Sicala 350B was longer and stronger than the Sicot 73 (Table I). Both cottons had similarly low maturity values with the Sicot 73 being slightly finer than the Sicala 350B (Table II)

The Sicala 350B had the least nep and seed coat nep content as well as the lowest short fibre content. In contrast the Sicot 73 cotton had 50 % more neps (from 237 to 357 neps/gram) and 24% more seed coat neps (from 19 to 25 neps/gram) with nearly 30% short fibre content (from 7.0 to 8.7%)(Table III).

The amount of trash extracted from each treatment during processing was generally low and similar across all treatments with only 0.2% by weight separating treatments (Table IV).

The evenness results from the preparation show that 100% Sicala 350B produced the most even roving followed by 70/30 and 80/20 blends (Table V). Thus as expected the 100% Sicala 350B cotton produced the best yarn tenacity results with the lowest variation in strength for all the yarn counts produced, followed by the yarns produced from 70/30 and 60/40 blended yarns. (Table VI) All the yarns achieved yarn strengths above 13 cN/tex, a value that is considered to be strong enough for knitting.

The most even yarns were produced from the 100% Sicala 350B fibre followed by the 70/30 blend followed by the 80/20 and 60/40 blends, with the 100% Sicot 73 fibre producing the most uneven yarns (Table VI). The hairiness values for the 100% Sicala 350B, Sicot 73 and blends were similar.

Another important measure of cotton lint quality is processing performance. The recording of end breakages in spinning is an important measure of processing performance because it indicates whether production levels and quality standards can be achieved. The processing performance of the 15 & 12 tex yarns produced was excellent (see Table VIII) with most treatments and yarn counts recording end break rates at less than 35 breaks per 1000 Spindle Hours (SpH). The processing performance of the 10 tex yarns was poor and would not have been acceptable for commercial processing.

Table VIII – Ends down for various treatments*

Yarn Count	A	B	C	D	E
15/1 tex	7.8	18.4	6.9	7.7	0.0
12/1 tex	34	14.9	10.2	22.1	7.1

**per 1000 Spindle Hours (SpH).*

The properties of fabrics knitted from the 12 tex yarn spun from each treatment tended to reflect yarn properties (Table VI & VII). Fabric burst pressure results, which indicate fabric strength, typically follow yarn tenacity results. Hence the fabrics knitted from 100% Sicala 350B and blends had the highest burst test results, although it is interesting to note that blend treatments with the lowest proportion of Sicala 350B; 80/20 and 70/30, had the highest burst test results.

Conclusion

The aim of this study was to determine the feasibility of blending LS cotton with Upland cotton to improve processing performance and yarn quality of the resulting fine count yarn. The study has shown that LS cotton can be used to successfully produce ringspun carded 15 and 12 tex (60 - 50 Ne) yarns using either 100 % LS or blended with standard Upland cotton.

The results from this investigation further show that Upland cotton blends containing up to 30% Sicala 350B can produce fine count yarns that are stronger, more even and with better processing performance than 100% Upland cotton.

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