Australian Fibre Quality and International Feedback

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Abstract

Australian cotton is viewed world wide as a quality fibre and generally performs as expected. A two part study involving a survey of spinning mills that use Australian cotton and an investigation to demonstrate the effects that lint cleaning in gins can have on fibre quality, and yarn and fabric quality, has been conducted. The mill survey found that high nep and short fibre content in Australian cotton and the high micronaire values of the last few years were of particular concern to the spinning companies. The ginning and textile processing trial demonstrated that reducing the number of lint cleaners and controlling moisture during ginning while not removing all the trash was less damaging to the fibre. Further the textile processing trials demonstrated that the textile mill can adequately cope with the higher trash content with no detrimental effects on processing performance, yarn or fabric quality. Indeed there are indications that yarn and fabric properties were improved with this approach.

Introduction

There is no doubt that the Australian cotton industry has seen phenomenal growth over the past 30 years, growing from a small industry to a large high yielding, high quality crop with export earnings in normal years in excess of $1,500 million. Cotton is Australia's third most valuable export crop after wheat and sugar and the industry is a seen as a world leader.

Between 1999 and 2002 Australia produced over 3%, or over 3 million bales, of the world's cotton annually. Up to 95% of the crop is exported and between 1998 and 2002 Australia was the third largest exporter of cotton lint after Uzbekistan and the USA [1]. Australian exports made up over 18% of the medium/high grade cotton volume in the 2002 export market [1].

Australian cotton is viewed worldwide as a quality fibre and is purchased for spinning high quality yarns for the woven and knitted apparel sector. However,

in the recent past the high content of both neps and short fibre in Australian cotton has threatened to reduce its premium position in the marketplace.

The traditional way that cotton is 'classified' according to established standard grades, often forces ginners to over clean fibre to gain a higher price for the grower's cotton. Classer's grade is often a poor indicator of the true spinning value of the fibre, to such an extent that some textile mills now offer price premiums for cotton that is harvested, ginned and shipped according to their specifications, i.e., custom ginned.

This paper summarises two recent studies focusing on quality aspects of Australian cotton. The first part involved surveying local and overseas spinning companies to obtain current information on the quality and processing performance of Australian cotton. The second study involved custom ginning and textile processing to demonstrate the influence that ginners can have on the fibre quality both delivered to mills and in end products. Full technical information from the two studies will be published elsewhere.

Part 1 A Survey of Fibre Quality

Methodology

With the assistance of the Australian Cotton Shippers Association (ACSA), thirty-one spinning companies from across Indonesia, Japan, Thailand, South Korea and Australia were surveyed. In general, the spinning companies selected for the survey produced high quality medium to fine count carded and combed ring spun yarns (Ne 20 to 60). This is the major market for Australian cotton. The two other major spinning systems were also used covered in the survey sample namely open-end (OE) and air-jet spinning including Murata Vortex Spinning (MVS).

Subjective impressions were obtained by interviewing the person(s) responsible for purchasing raw materials on a one-on-one basis around a set of scripted questions. Interviewees were asked to rate Australian cotton fibre on the basis of 15 different properties.

A rating scale was used to represent interviewee's impressions of each of the above properties. The scale ranges from 1 to 5 with 5 representing a *good* impression of the fibre property, 3 *no impression* of the fibre property and 1 a *poor* impression of the fibre property. A rating of 3 meant one of three things; that the fibre property did not cause any problems in the mill, that there was no issue

with regards to the quality of that fibre property or that there was no understanding of that fibre property by the mill. Interviewee's impressions were generally based on their experiences with Australian cotton over several years and measured in relation to other growths they used in their mills. The average and standard deviation of impressions for each fibre property were calculated.

Objective information was obtained by collecting fibre samples from each bale in the bale lay-downs of mills surveyed for testing by CSIRO Textile and Fibre Technology (CTFT). This was repeated 4 times at 3 monthly intervals. A sampling procedure was demonstrated by CTFT at the time of the survey interview. These samples, which were tested on an Uster Spectrum High Volume Instrument (HVI) line and an Uster Neptester 720, provided an independent and objective benchmark of the actual fibre quality being used in each mill and enabled Australian cotton quality to be compared directly with the quality of cotton from other countries. In total 141 different cotton samples from over 60 lay-downs were received, of which Australian cotton made up 49% of these samples followed by cotton from California with 23% , China with 11%, West Africa and Zimbabwe each with 6% and USA other with 3%.

Results

1) Subjective impressions

The average and standard deviation of impressions of Australian cotton fibre quality by the spinning companies surveyed are depicted in Figure 1. The results confirm that Australian cotton is generally rated highly, particularly on the basis of contamination, grade, colour, spinning ability, staple length, trash content and elongation.

The impressions also confirm the principal adverse comments about Australian cotton over the last several years, i.e. the high nep and short fibre content (SFC) found in Australian cotton. The higher micronaire of Australian cotton of the last two to three years was also a particular issue with spinning companies, particularly those that spun fine counts.

Other technical concerns raised anecdotally by spinning companies during interviews included:

- The variation in bale size and density. Variations caused problems when bales are opened; bales of different densities open to different heights in a bale lay-down and this leads to reduced blending in the initial stages of opening.

- The amount of noil (discarded short fibre) produced during combing in order to achieve quality standards.
- Lack of information regarding the cotton spinners buy; for example the fibre properties of each bale, the region where the cotton was grown and where or how it was ginned.
- The consistency in the fibre quality supplied. Some spinning companies found quality varied to their detriment between the beginning and end of a season.
- The requirement for environmental and/or eco-labelling assurances. Exporters, in particular those exporting to Europe, are starting to be pressured into producing eco-friendly products and thus need assurances that the cotton being used is produced under environmentally sustainable conditions.
- Dyed yarn and fabric produced from Australian cotton are less lustrous and hence have a dull appearance when compared to yarn and fabric produced with other growths.

2) Objective information

In the majority of the overseas mills, Australian cotton is blended with other growths from around the world including cotton from the USA, particularly from SJV and other regions in California, China, West Africa and Zimbabwe.

The proportion of Australian cotton used by the participating mills in their lay-downs varied from 10% through to 100% with the average being a little over 50%.

Figures 2 to 5 show the measured characteristics Australian fibre samples relative to the six other growths tested in the survey. Australian cotton ranks second behind SJV cotton in terms of staple length. It was ranked middle in terms of strength behind SJV and Zimbabwean growths. Confirming the subjective impressions, Australian cotton was ranked low in (had high levels of) SFC and neps.

Table 1 lists the preferred sales contract of spinning companies that were surveyed. The preferred test values for the fibre properties listed in Column 2 of the Table are averages of the values given by spinning companies and Column 3 lists the performance of Australian cotton in meeting these standards as measured against ACSA crop data and test results collected from bale lay-down samples.

Table 1 – The Spinners Preferred Sales Contract

Fibre Properties	Preferred Value	Performance of Australian Cotton
Micronaire	3.8 - 4.2	56% in 2002 & 34% in 2003 in 3.8 – 4.5 range*2
Staple Length	1.125 inches	76% in 2002 & 61% in 2003 >1.125 inches*2
Uniformity	>81%	In 2002/03 UNI averaged 82.1% with 24% ≥83%*3
SFC	<8%	In 2002/03 SFC averaged 10.1% with 20% < 8%*3
Strength	>29 g/tex	54% in 2002 & 53% in 2003 >29 g/tex*2
Grade	>31-3	94% in 2002 & 88% in 2003 graded ≥31-3 *2
Neps*1	250 neps/g	In 2002/03 nep counts averaged 276 neps/g with 32% < 250 neps/g. Range extended from 164 – 496 neps/g*3
Contamination	Low/none	Considered part of the least contaminated destinations in the world*4
Stickiness	Low/none	Considered part of the least affected by stickiness destinations in the world*4

*1 as tested by the Uster Nep Tester 720, *2 Fibre properties of the Australian crop (ACSA), *3 Results from mill samples, *4 ITMF Contamination survey 1989-2003.

Part 2 The effect of ginning on yarn and fabric quality.

Methodology

Cotton for the custom ginning trial was grown under irrigation in the Namoi Valley during the 2002/03 season. It was ginned at the Merah North gin (Namoi Cotton Co-operative) under the supervision of CTFT. The aim of the trial was to demonstrate the effects of lint cleaning on cotton quality. To examine lint cleaning effects three cleaning treatments were devised:

- Standard cleaning using two lint cleaners
- Custom cleaning (ginning) using single lint cleaner
- Zero cleaning, i.e. using no lint cleaners.

Cotton ginned under these treatments was subject to tight moisture control. Seed cotton moisture was kept between 6.5% and 8.5% during ginning by controlling dryer temperature.

Two separate trials were conducted. In the first trial 12 modules of cotton provided by AG & NL Schwager (AS) were ginned to test the effects of each

treatment on lint quality. A follow up trial was then conducted with 2 modules of cotton supplied by J&J Farming (JJ) to produce lint to be tested in spinning and fabric trials at CTFT.

Both series of cottons had a micronaire of 4.8, which while being out of the preferred range (see Table 1) was typical of the 2003 crop.

Bales of JJ cotton subject to each ginning treatment were processed under controlled conditions at the modern textile mill at CTFT in Geelong to evaluate the effect of the different ginning treatments on yarn and fabric properties.

Each cotton lot was blended, opened, cleaned and carded using modern processing equipment. Thirteen spinning trials covering a range of yarn counts (5 Ring, 4 OE, and 4 MVS) were conducted for each gin treatment (39 in total). In each case spinning performance and yarn quality were measured. For brevity this report will only list the data for Ne 30 yarn count.

Figure 6 lists the textile machinery used to process fibre through to spun yarn. Yarns were then subsequently knitted into single jersey fabric and dyed using standard commercial equipment.

The fibre, yarn and fabric samples were evaluated with a range of standard tests.

Results

Quality after ginning

As expected, based on previous ginning studies conducted by the National Centre for Engineering in Agriculture (NCEA), a reduction in the number of lint cleaners had an affect on the grade of cotton as shown in Table 2. Grades fell with the reduction in lint cleaners due to the uneven appearance of the cotton and increased levels of trash and dust, which affected the grade colour value. Standard cleaned cotton, i.e., two lint cleaners, was classed as Strict Middling with the custom and zero cleaned cotton, i.e., with one and zero lint cleaners, classed as Middling because of increased trash levels and in the case of zero cleaned cotton, poor preparation.

Table 2 – Effect of Lint Cleaner Treatment on Cotton Grade

Lint Cleaner Treatment	AS Cotton	JJ Cotton
Standard	21-3	21-2
Custom	31-3	31-3

Zero	31-4	31-4

Staple length, short fibre content, strength and neps (Figures 7 to 10) show that fibre properties of the custom ginned cotton were generally superior to the cotton ginned under standard conditions, i.e., two lint cleaners. On average staple length increased by 2%, short fibre content decreased by up to 4%, nep content decreased by up to 15% and strength improved by 2% when cotton was treated with one instead of two lint cleaners. Further improvements in these properties occurred when no lint cleaning was used. Gin production data also showed that gin turn-out or the cotton lint yield improved by approximately 0.4% as the number of lint cleaners was decreased.

Quality during and after textile processing

Table 3 lists waste figures for each lint cleaner treatment at two key points during the opening and carding processes. As expected if trash is not removed during ginning the textile processes are able to efficiently remove it.

Table 3 – Percent Trash Extracted

Lint Cleaner Treatment	Cleanomat	DK903 Card
Standard	0.80%	1.37%
Custom	1.12%	1.39%
Zero	1.35%	1.40%

Figure 11 shows the residual trash left in cotton for each lint cleaner treatment both in the bale and after carding in textile processing. The graphs show clearly that a modern mill blow-room, i.e. opening through to carding, is able to cope with trashy cotton with minimal fibre damage and loss. This confirms previous studies showing that if minimum cleaning is done at the gin, the opening and cleaning line in a modern spinning mill will be able to cope.

Figure 12 illustrates the effect of the different ginning treatments on the nep levels (measured on the Advanced Fibre Information System, AFIS) on fibre and two points during processing. Reducing the number of lint cleaners effectively reduces the number of neps after carding.

In general the improvements in fibre properties such as fibre length, length uniformity and SFC with reduced lint cleaning were reflected in improvements

in yarn properties, although these improvements were slight and the extent of the differences depended upon the spinning system used. It is noted here that the extent of the differences was also affected, by the high micronaire of the cotton used in the trial.

From the results of the opening and cleaning line which adequately coped with the differences in fibre quality resulting from gin treatments, there was no detrimental effect on textile processing performance, or yarn and fabric quality. In some instances, reducing the number of lint cleaners gave small improvements in yarn quality (better yarn evenness and strength). Figure 13, the yarn strength data is a typical example.

As an example of fabric testing, Table 4 lists the pill ratings. In general the pilling performance improved with the reduction in the number of lint cleaners. This is consistent with the current understanding of pilling - short broken fibres are more prone to pilling.

Table 4 – Single Jersey Fabric Pill Ratings

Lint Cleaner Treatment	Ring	Open End	MVS
Standard	1-2	1-2	2
Custom	1-2	2	2
Zero	2-1	2-3	2

Figure 14 illustrates the effect of the ginning treatments on the level of white speck neps in the dyed fabric samples. (White specks are small neps made up of very immature or sometimes 'dead' fibre. These neps appear as white specks on dyed fabric as the fibres do not take up or hold dye.)

For the ring spun yarns, white speck counts decreased slightly with a decrease in the number of lint cleaners. Carded ring spun yarns are more likely to be affected by white specks due to its yarn formation. OE and MVS yarns had lower white speck counts on open end and MVS fabrics. Custom ginned cotton produced the lowest white speck counts in fabrics constructed from MVS yarn whilst standard lint cleaning produced the lowest white speck in fabric constructed from open end yarn.

Conclusion

Although Australian cotton is generally viewed as a quality fibre by spinning companies the results of the Mill Survey make it apparent that in order for Australian cotton to maintain it's status and continue to command a healthy price, significant and sustained focus on improving Australian fibre quality is required. High micronaire, nep and short fibre content stand out as the first priorities.

The custom ginning trial shows that controlling moisture during ginning and reducing the number of lint cleaners to one or even zero results in cotton with more trash and a lower classing grade. However, other important fibre properties from a textile processing performance perspective such as staple length, length uniformity, SFC and nep content, are improved with reduced lint cleaning passages. Further the textile processing trials demonstrated that the textile mill can adequately cope with the higher trash content with no detrimental effects on processing performance, yarn or fabric quality. Indeed there are indications that yarn and fabric properties are improved with this approach. Further work with finer cotton is needed to confirm the level of the improvements.

Acknowledgements

The authors gratefully acknowledge the financial support of CSIRO Textile and Fibre Technology and the Australian Cotton CRC. They would also like to acknowledge the support of the following companies and organisations:

- Namoi Cotton
- Auscott Limited
- Australian Cotton Shippers Association (ACSA)
- Australian Classing Services (ACS)
- Austrade
- Growers

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1. International Cotton Advisory Committee data, www.icac.org, (2003).

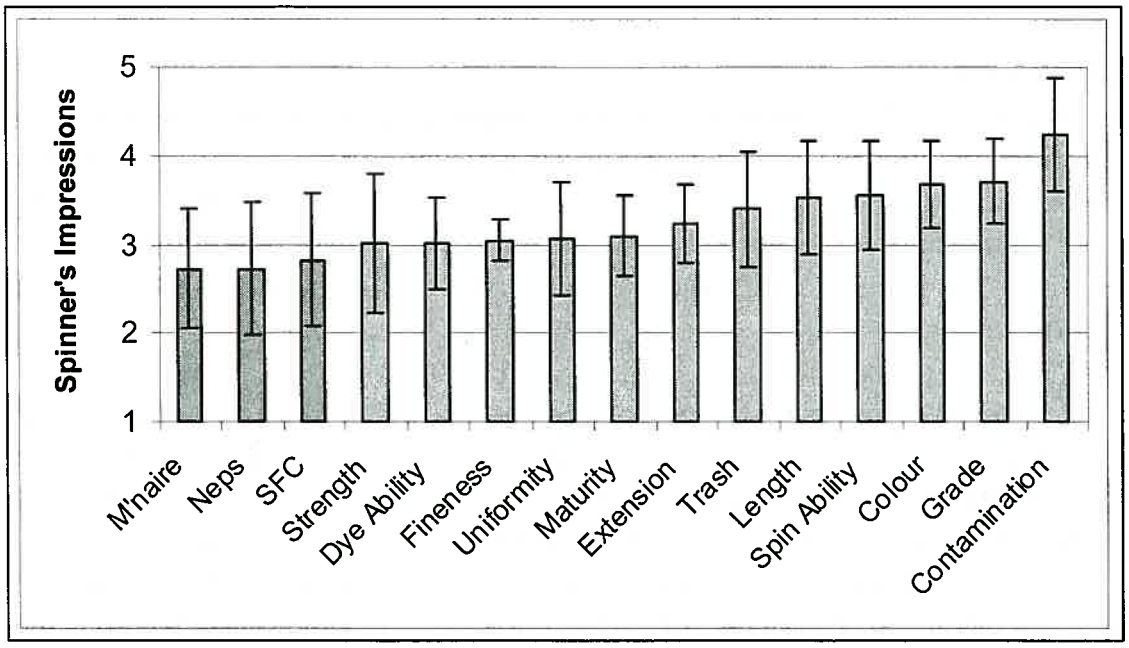

Figure 1 – Spinners Impressions of Australian Cotton Fibre Properties
Impression Scale: 1 = Bad, 5 = Good (error bars show 1 std. dev.)

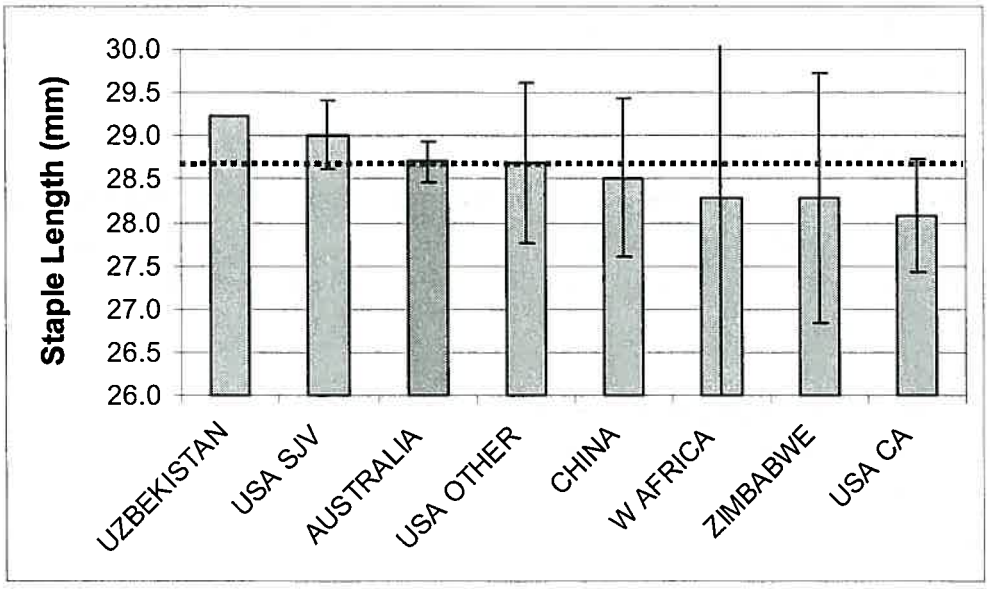

Figure 2 – Staple Length from Bale Lay-Down Samples: Comparison of Australian Cotton with other Growths (error bars = 95% CI of averages)

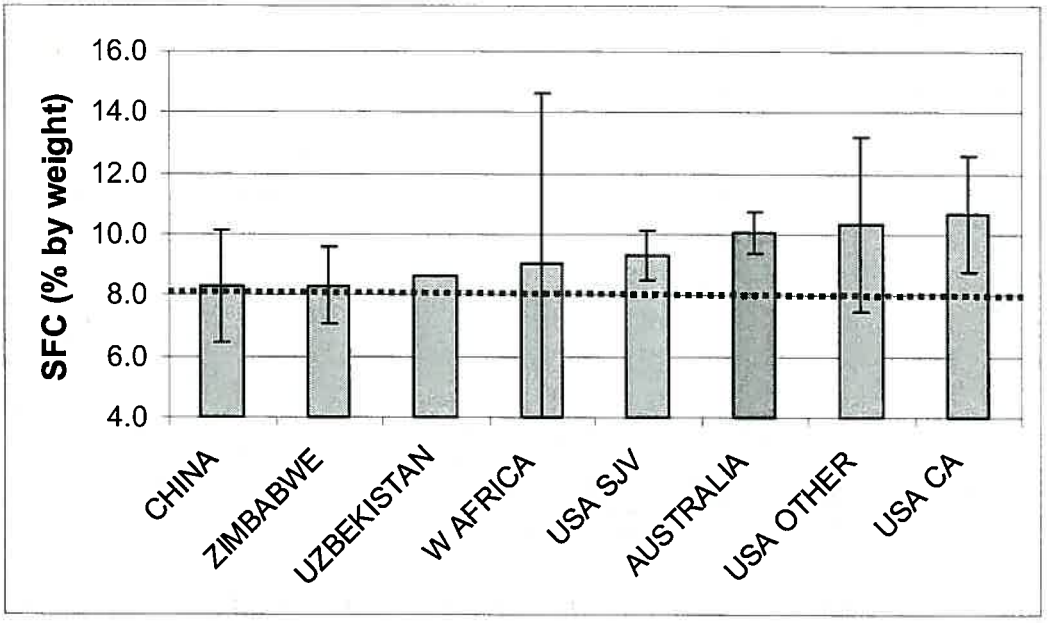

Figure 3 – SFC from Bale Lay-Down Samples: Comparison of Australian Cotton with other Growths (error bars = 95% CI of averages)

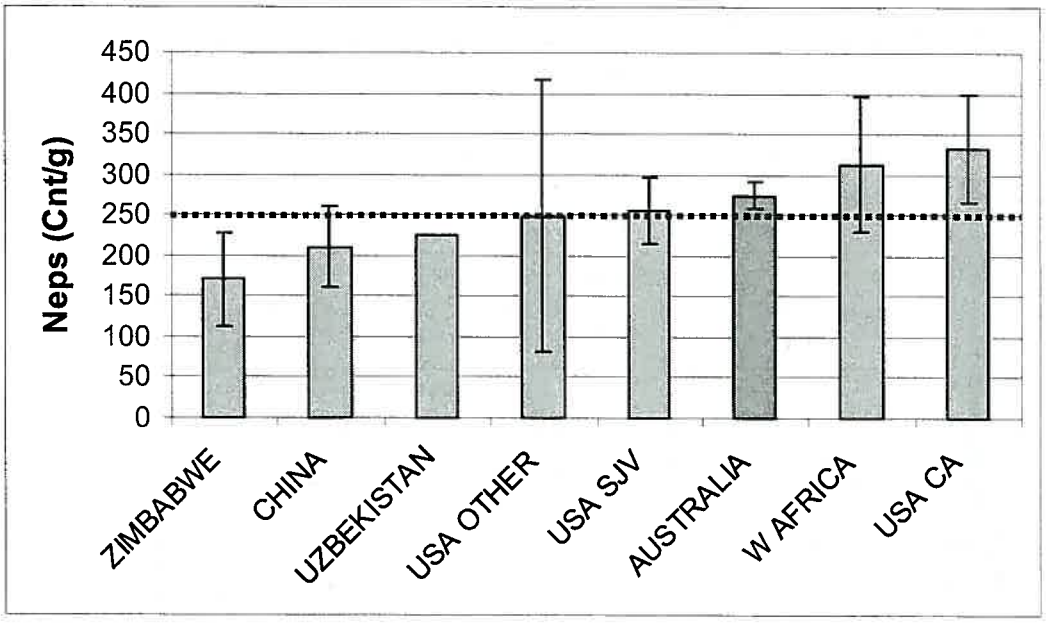

Figure 4 – Neps from Bale Lay-Down Samples: Comparison of Australian Cotton with other Growths (error bars = 95% CI of averages)

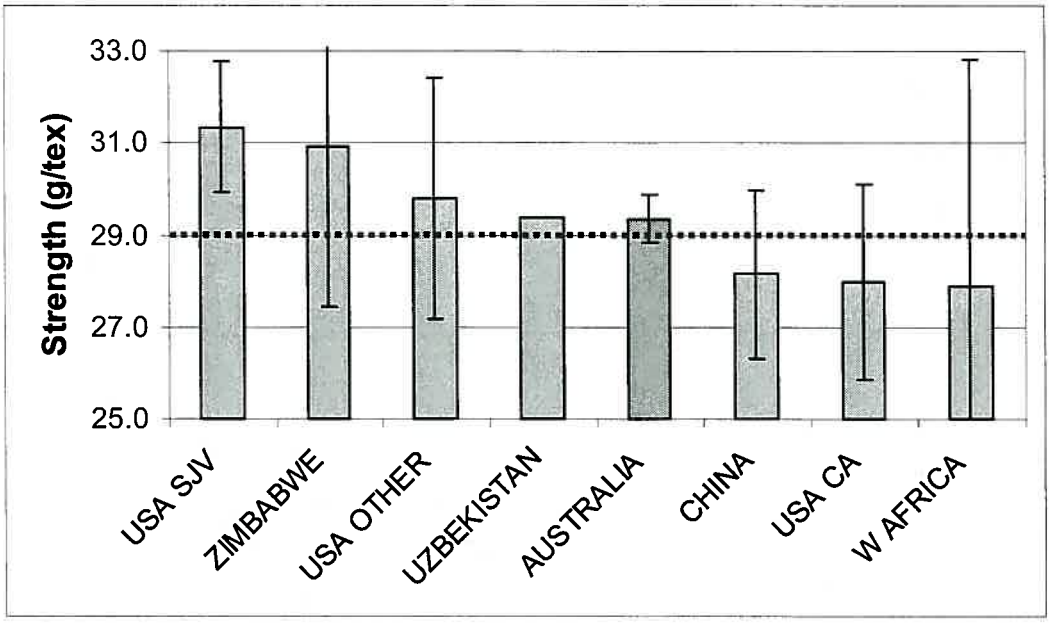

Figure 5 – Strength from Bale Lay-Down Samples: Comparison of Australian Cotton with other Growths (error bars = 95% CI of averages)

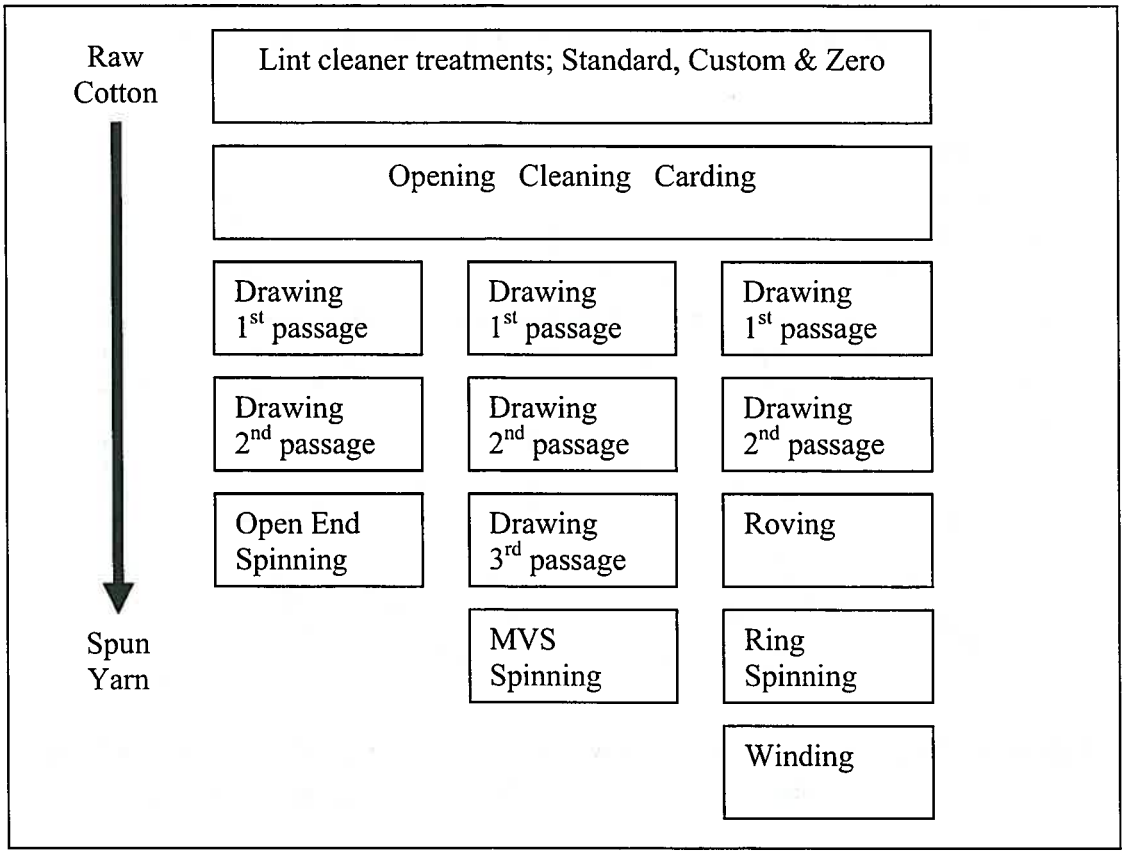

Figure 6 – Processing Routes for Custom Ginned Cotton Trial

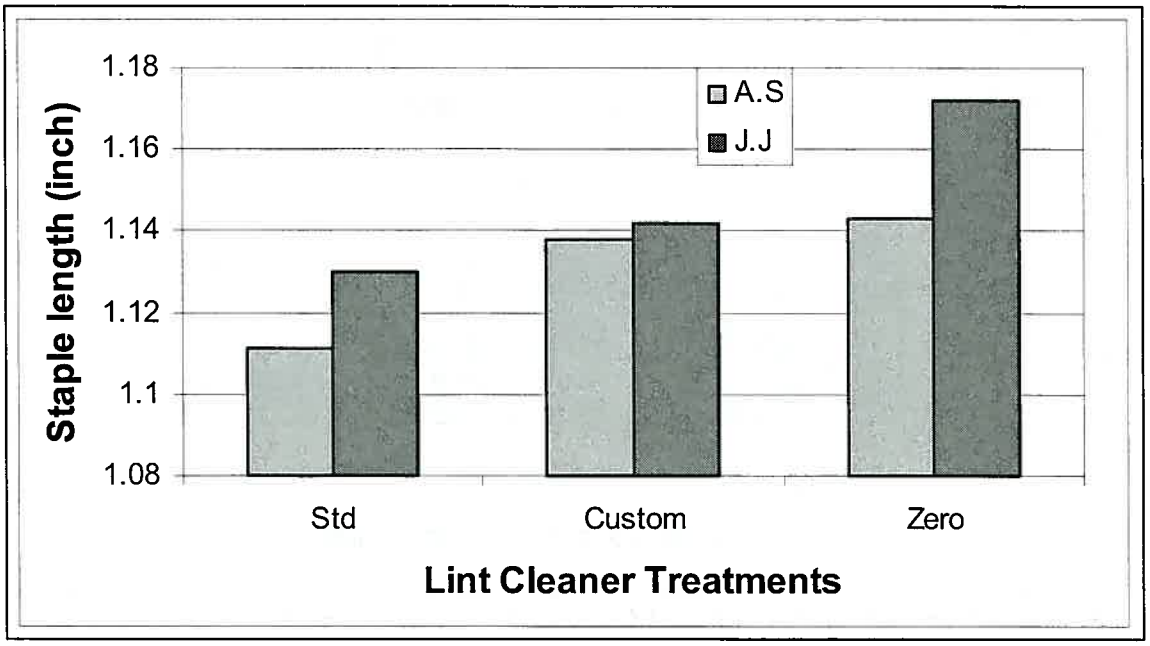

Figure 7 – Effect of Lint Cleaner Treatments on Staple Length

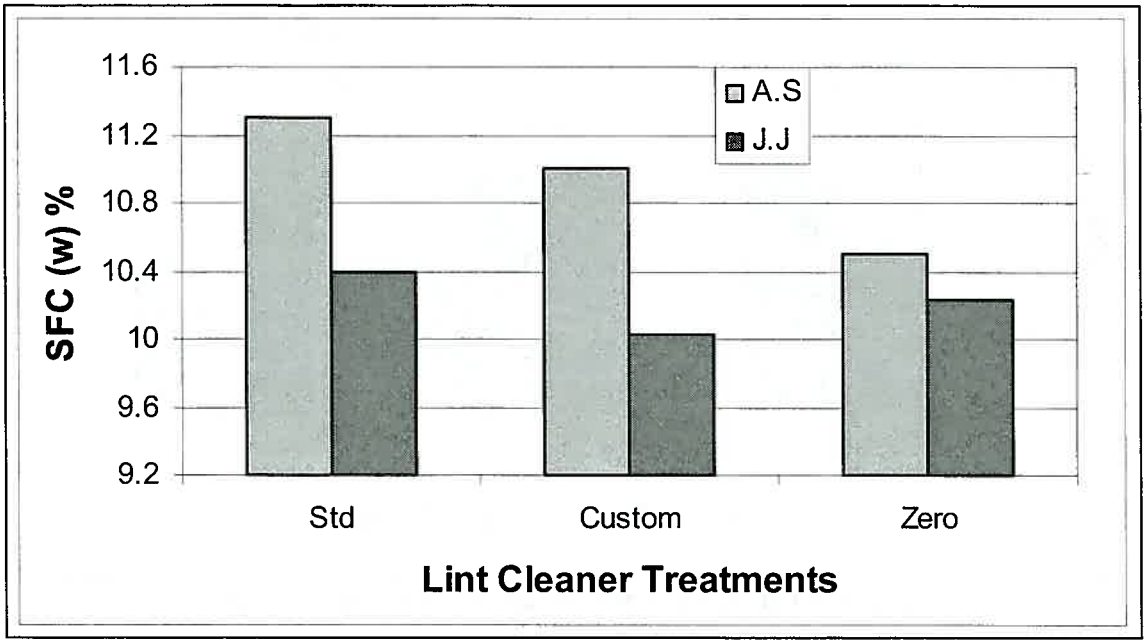

Figure 8 – Effect of Lint Cleaner Treatments on SFC

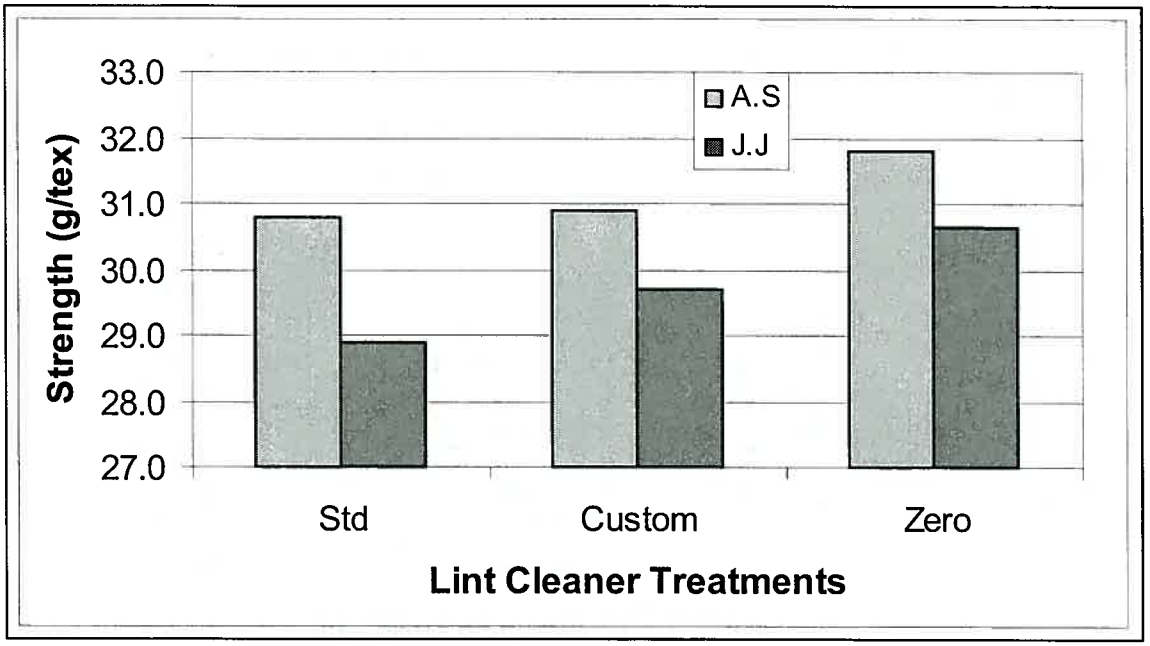

Figure 9 – Effect of Lint Cleaner Treatments on Strength

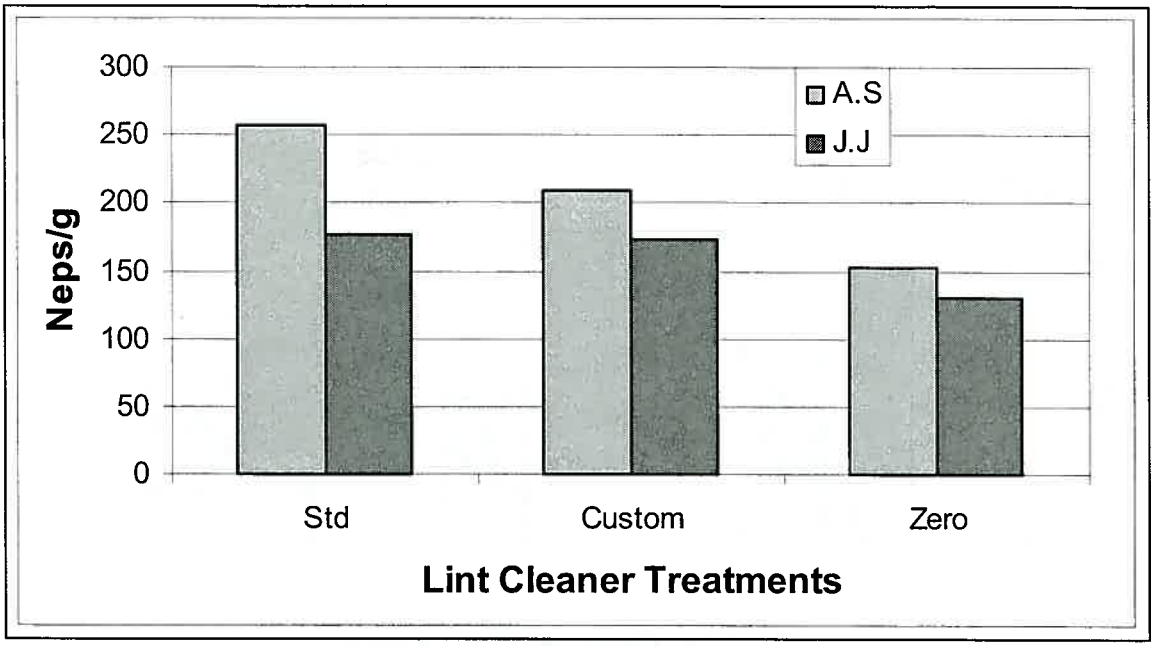

Figure 10 – Effect of Lint Cleaner Treatments on Neps

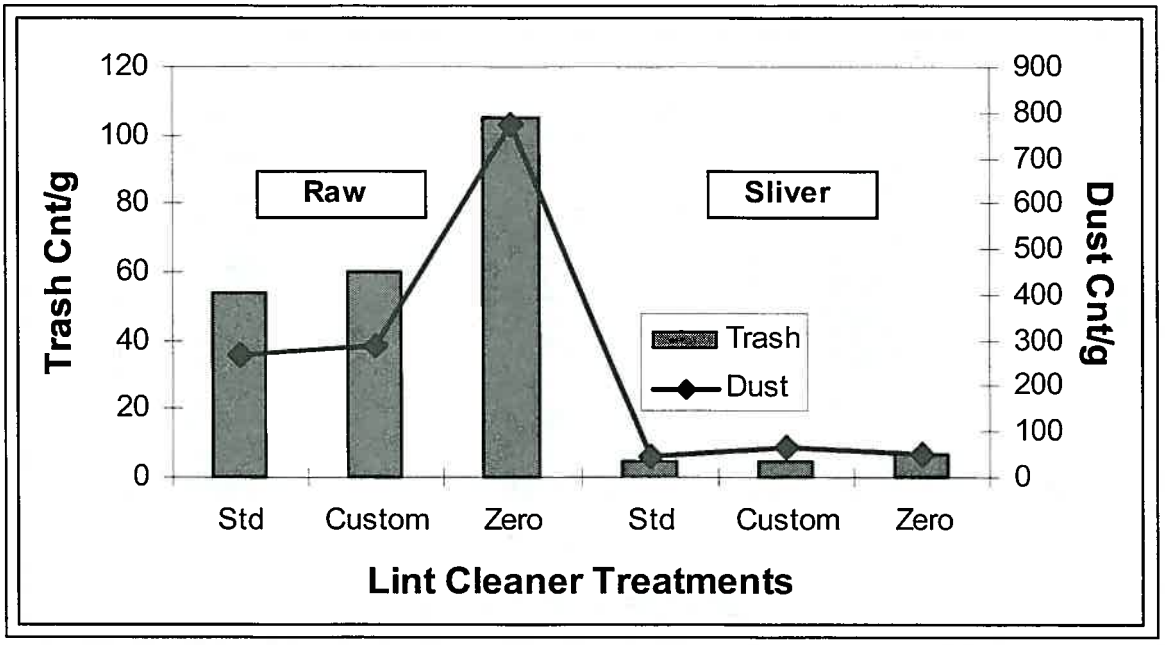

Figure 11 – AFIS Trash and Dust Measurements on Raw Fibre and Card Sliver

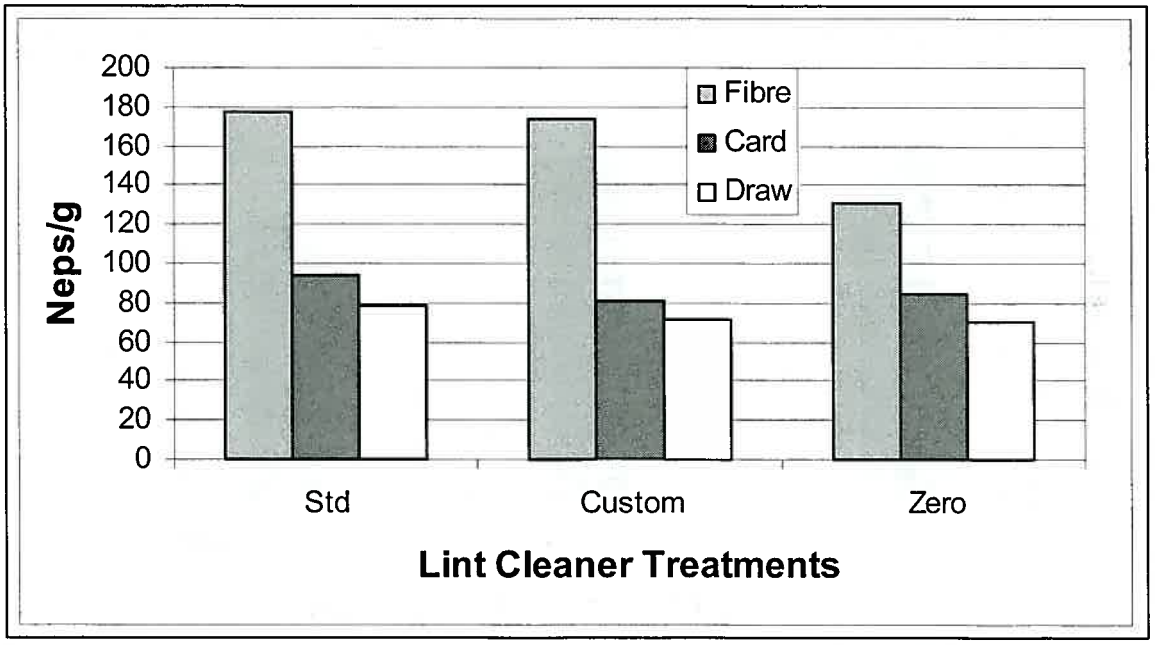

Figure 12 – Effect of Carding and Drawing on Nep Removal

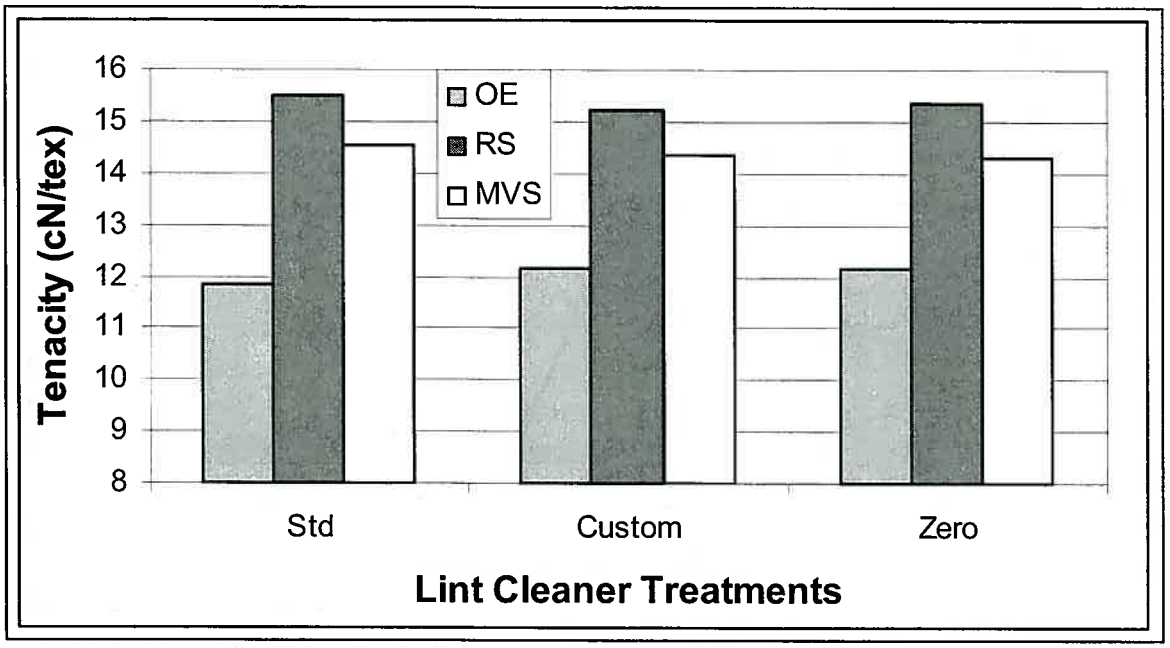

Figure 13 – Effect of Lint Cleaner Treatments on Yarn Tenacity (TR3)

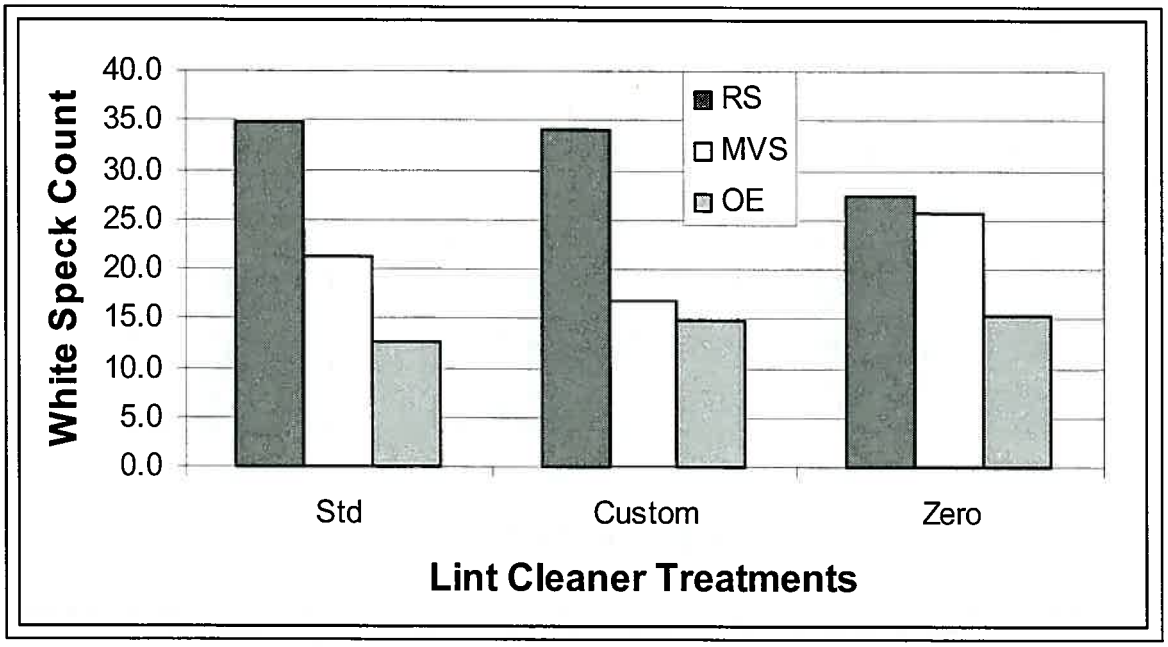

Figure 14 – Effect of Lint Cleaner Treatments on White Speck Count (Manual)