January, August & Final Reports

REPORTS

Part 1 - Summary Details

Please use your TAB key to complete part 1 & 2.

CRDC Project Number: CTFT5C

January Report:	☐	Due 29-Jan-01
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Final Report:	☒	Due within 3 months of project completion

Project Title: White Speck Detection in Dyed Cotton Yarn

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Part 2 – Contact Details

Administrator: Dr Brett Bateup, Chief of Division.
Organisation: CSIRO Textile and Fibre Technology
Postal Address: PO Box 21
Belmont, Victoria 3216
Ph: 03 52464000 **Fx:** 03 52464057 **E-mail:** brett.bateup@csiro.au

Principal Researcher: Dr Geoffrey Naylor, Senior Principal Research Scientist
Organisation: CSIRO Textile and Fibre Technology
Postal Address: PO Box 21
Belmont, Victoria 3216
Ph: 03 52464000 **Fx:** 03 52464057 **E-mail:** geoff.naylor@csiro.au

Supervisor: Dr Geoffrey Naylor, Senior Principal Research Scientist
Organisation: CSIRO Textile and Fibre Technology
Postal Address: PO Box 21
Belmont, Victoria 3216
Ph: 03 52464000 **Fx:** 03 52464057 **E-mail:** geoff.naylor@csiro.au

Researcher 2 Dr Donald Ramsay, Research Scientist.
Organisation: CSIRO Textile and Fibre Technology
Postal Address: PO Box 21
Belmont, Victoria 3216
Ph: 03 52464000 **Fx:** 03 52464057 **E-mail:** Donald.Ramsay@csiro.au

Signature of Research Provider Representative: ______________________

CSIRO

TEXTILE AND FIBRE TECHNOLOGY

PO Box 21, Belmont, Victoria 3216, Australia

Telephone: +61 3 52464000 Fax: +61 3 52464057

White Speck Detection in Dyed Cotton Yarn

Project Team

Andrew Abbott

Julia Marsh

Geoffrey Naylor

Lisa O'Brien

Donald Ramsay

Final Report for the Australian Cotton Research and Development Corporation

CRDC Ref. No: CTFT 5C

September 2002

Plain English Summary

The 'Fibre Plus' workshops at Narrabri coordinated by both the Cotton CRC and the CRDC identified the need to establish a standardised facility in Australia (a) to process small batches of cotton through the textile pipeline to knitted and woven samples and then (b) to analyse final fabric quality. This facility would be a valuable tool for post-harvest cotton research and in particular be valuable to the CRDC funded project at The National Centre for Engineering in Agriculture (NCEA) in Toowoomba.

As part of this general initiative, an opportunity was identified to utilise the experience at CSIRO in detecting yarn quality online, to construct a simple instrument for evaluating the quality of dyed yarn. In particular the focus of the instrument was to count the level of undyed white speck neps in dyed yarn samples.

Based on an existing yarn detector system a simple computer controlled instrument was developed together with an algorithm for identifying undyed 'white speck' neps. A series of existing samples from trials at NCEA were used to test and evaluate the new instrument.

The project demonstrated that it is indeed possible to measure white specks on dyed yarn using an optical sensor. The experiments and results highlighted that the particular sensor system used in the project did have some limitations for the current application however, despite these, a reasonable agreement with subjective fabric results was obtained.

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1. Background

This project arose from the 'Fibre Plus' workshops at Narrabri coordinated by both the Cotton CRC and the CRDC. These meetings identified the need to establish a standardised facility in Australia (a) to process small batches of cotton through the textile pipeline to knitted and woven samples and then (b) to analyse final fabric quality. This facility would be a valuable tool for post-harvest cotton research and in particular be valuable to the CRDC funded project at The National Centre for Engineering in Agriculture (NCEA) in Toowoomba.

In a previous project (CRC project CRC28C) in this area, work at CSIRO was undertaken to produce a computer system for analysing the quality of dyed fabrics. This project was not entirely successful due to problems with the computer software purchased from the USA. The work has however identified an opportunity for evaluating the quality of dyed yarn rather than fabric, and this became the subject of the present project. Further the CRC project resulted in a large data base of samples (yarns and dyed fabrics) together with subjective visual assessments of white specks in the dyed fabric samples. This data base and samples form a critical set for testing the validity of the new approach.

The approach of analysing dyed yarn rather than fabric is attractive on two counts. Firstly it eliminates the need to produce fabric and so is in principle a more efficient and quicker approach. Secondly the approach of automatically testing yarns will mean that a range of different cones from the one batch of yarn can be quickly tested and thus the approach should lead to a more accurate result than is possible from an analysis of small fabric samples.

2. Objectives and Progress

2.2 Objectives

The main aim of the project was to establish the viability of measuring white specks in cotton from a running dyed yarn using an existing sensor. In establishing this viability, a further aim, within the limited scope of the project, was the development of a prototype instrument for undertaking this yarn testing using as much as possible existing equipment. (It was noted that the project would utilise a range of R&D equipment and textile components currently available at CSIRO. In the interests of prudent cost management, the costs of these items were not billed to the project. If successful, the prototype instrument would be available at CSIRO for sufficient time to test all yarns produced from the 1999, 2000 and 2001 trails of the CRDC funded project at the NCEA.)

2.2 Achievement of objectives

The objectives were largely achieved as described below.

3. Relevance to CRDC Outputs

This project is aimed at improving the profitability and competitiveness of Australian cotton by devising an instrument for use in assessing white specks due to neps. This toll will benefit ongoing CRDC funded ginning research.

4. Methodology

CSIRO Textile and Fibre Technology have extensive experience and expertise in developing detectors for continuously analysing the quality of running yarn eg while the yarn is being wound from one package to another. Recent examples are Siroclear and the Coloured Yarn Clearer.

Based on this experience an existing optical sensing system (the Coloured Yarn Clearer) was mounted and fitted to a laboratory yarn winder. This sensor was originally designed to identify coloured contaminants in white yarns. The three colour outputs of the optical system were integrated into a PC computer using a high speed digital signal processor. An algorithm was developed to analyse these three signals to identify the presence of white specks. The system was then optimised and tested for self consistency by using repeat measurements on yarn samples over a range of operational winding speeds and instrument settings.

Further the set of approximately 45 existing yarns from the 1999 and 2000 experiments from NCEA were used as a reference set to evaluate the prototype instrument. The results obtained were compared with existing results of white specks for the same samples that have been obtained directly by subjective counting on dyed fabric squares. This was used as a good test of the usefulness of the yarn approach as a guide to visual fabric quality.

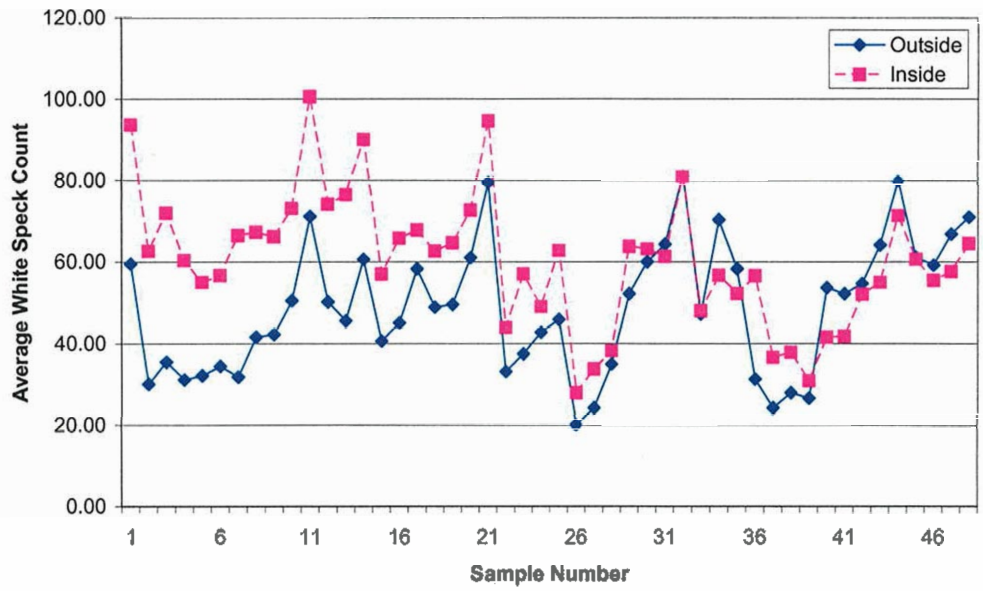
5. Results

5.1 Subjective evaluation of dyed fabrics.

As part of the previous CRC project a set of fabrics were prepared from the 1999 and 2000 ginning trails undertaken by the CRDC sponsored NCEA ginning research. This set of approximately 72 samples had indeed been dyed using the recommended protocol from the USDA to highlight the presence of any neps. As part of the collaboration between CSIRO Textile and Fibre Technology and NCEA, CSIRO had subjectively evaluated the number of white speck neps per unit area on these dyed fabric samples. In this detailed and labour intensive work, for each of the 72 single jersey knitted fabric samples, the number of white speck neps on the 'technical front' face of six different 125mm by 125mm squares to obtain a representative result.

Following this work there was a suggestion from the UDSA that the white speck neps might be preferentially distributed onto the 'back technical' face of the fabric as a result of the knitting process. For the current project where this set of samples and fabrics were to be used to test the new yarn approach it was important to obtain a true value. Thus it was decided to repeat the subjective evaluations on the technical back face of the set of fabrics. At this stage some of the samples had already been forwarded to the US and so it was only possible to undertake this task with a subset of approximately 45 samples. The results are shown below (Figure 1). A good agreement between the results from both sides of the fabric is apparent, and this is good confirmation of the reliability of both the subjective assessment protocol and the actual results.

Figure 1. Subjective evaluation of both front and back faces of dyed single jersey fabrics.



5.2 Comprison of Subjective Evaluation of Whites Specks in Fabrics either Yarn Dyed or Fabric Dyed.

In the planned protocol, samples were to be dyed in yarn form and then tested. It was hoped that the technique could be evaluated by comparing the results obtained with the existing subjective fabric data eg Figure 1. However preliminary results indicated some significant discrepancies were occurring and so it was necessary to test if the discrepancies indicated a problem with the yarn detection system or possibly that changing the dyeing system from fabric to yarn inherently effected the results.

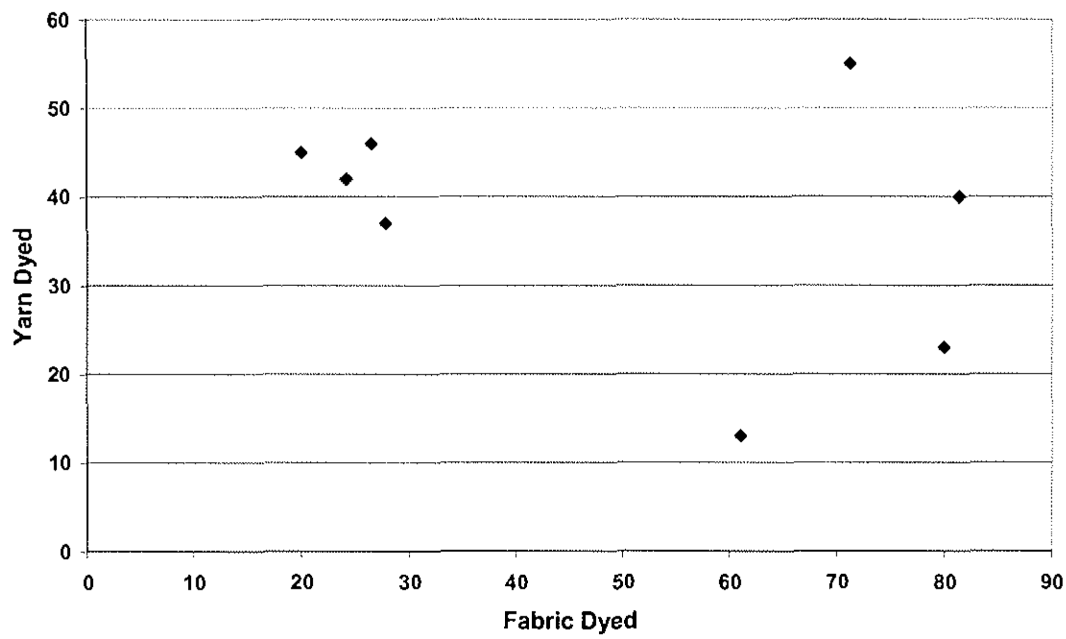
Eight samples were chosen for this experiment. Based on the results in Figure 1, four representing a high level of white speck neps and four with low levels of white speck neps were selected. Samples of all undyed 8 yarns were then packaged dyed together in one lot using the same shade and procedure as for the previous fabric dyeing. After dyeing a small quantity of yarn from each sample was knitted into a single jersey knitted sample (of the same construction as the original fabric dyed samples) and the rest of the dyed yarn kept for later online yarn measurement.

Note that as only small samples of yarn were dyed, knitting was on a different (smaller) knitting machine than the original fabric dyed samples. After knitting the number of white speck neps per unit area was subjectively counted, using the same technique and by the same (now quite experienced) operator. In this case as the quantity of knitted sample was limited, it was only possible to subjectively evaluate two 125mm by 125mm squares on both the inside and outside faces per sample (as opposed to 6 squares for the fabric dyed case). The results comparing the number of observed white specks for the two approaches are shown in Figure 2. In this figure the two groups of samples based on their level of white speck neps when fabric dyed is clear (ie the horizontal axis). However this does not translate into two similar groups on the vertical axis ie there is a poor correlation between the two different dyeing routes. Two possible explanations are:

- some white speck neps are susceptible to the specific geometry of the knitting machine or
- the extra winding steps needed to prepare the yarn for yarn dyeing is sufficient to remove some neps.

This was not explored further in the current project but it would perhaps be interesting to see if there is valuable information in this area. For example are there some white speck neps that can effectively be removed/eliminated by an extra winding stage?

Figure 2. Comparison of subjective counting of fabric white speck neps for samples prepared either by yarn dyeing or fabric dyeing.



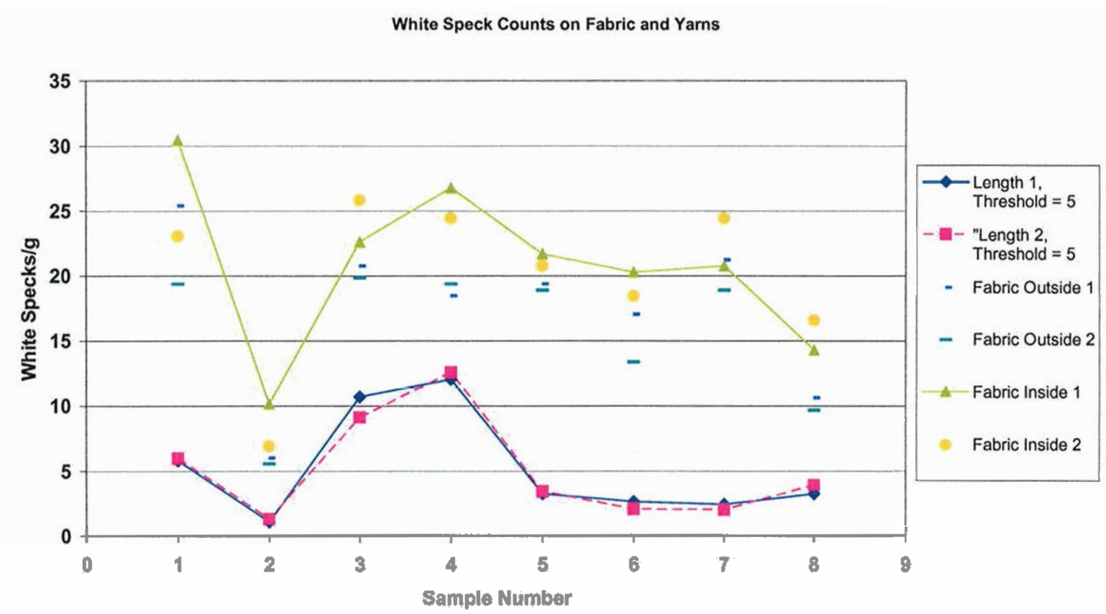
Given the lack of correlation in Figure 2, it was decided that the on line automatic counting of white speck neps in dyed yarn could only effectively be compared with subjective results on fabrics prepared in a similar way ie yarn dyed. To that end all yarn analysis was restricted the set of 8 samples described above.

5.3 Results of On-line Measurement

As explained above, given the size of the project, an existing coloured yarn sensor formed the basis of the technology used to measure white specks neps on yarns. The raw signals from the three colour channels were then analysed to identify the presence of neps. Several different algorithms were developed and evaluated. It became apparent that the hardware system (ie the detector itself) was really not ideal for this application ie it was a struggle to obtain sufficient signal above the noise level to detect white specks. It was decided not to pursue a modification to the inner workings of the detector (eg a brighter light source) as this would then become a significantly larger and more open ended project. Rather it was decided to use the limited resources to work with the present system.

Figure 3 shows typical results obtained. The two sets of data towards the bottom of the graph (the pink squares and the blue diamonds) represent the yarn values obtained from the instrument. For these data sets, each data point is the result obtained from testing a one kilometre length of yarn. (The results have then been normalised to the number of white speck neps per gram for comparison with the fabric data.) Note that the two yarn results per sample represent separate measurements on different one kilometre samples of the yarn. The excellent agreement between these two independent repeat measurements for each yarn sample is very encouraging, confirming that the results are indeed 'real' (as opposed to arising from an artefact of the detection system).

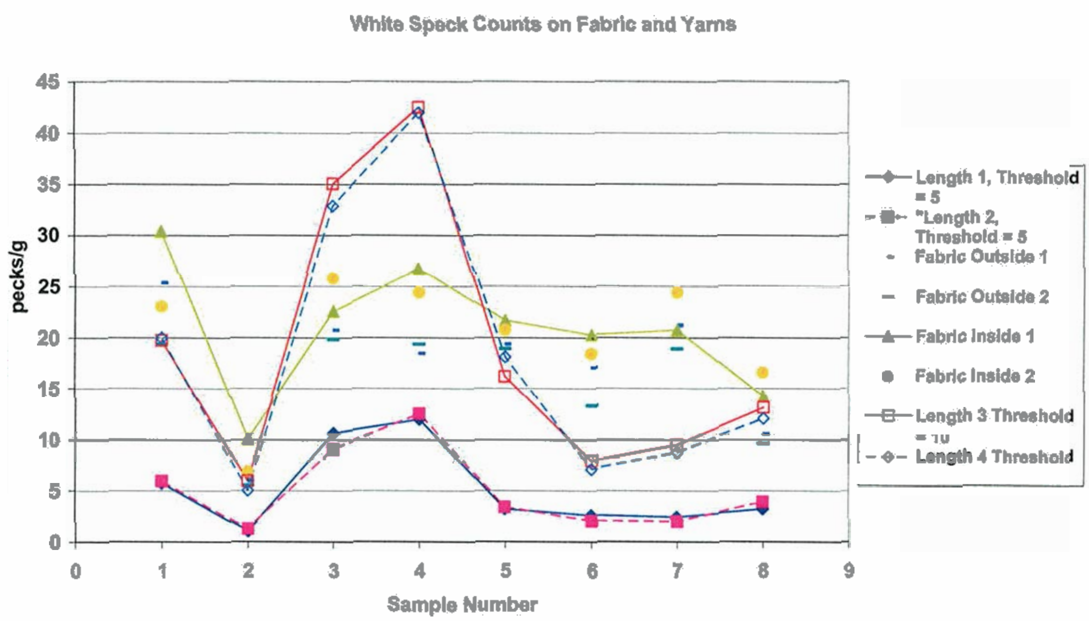
Figure 3. Comparison of white speck neps levels detected with the online yarn instrument with those obtained from subjective evaluation of fabric samples.



For comparison with the yarn results, Figure 3 also contains the results obtained from subjective evaluation of the knitted fabric after yarn dyeing. (For comparison purposes, these data have also been normalised to results per gram.) The results from the four 125mm by 125 mm squares are shown separately. To aid the comparison with the yarn data, a line has been drawn connecting one of the sets of fabric data. Comparing the yarn and fabric results, while the fabric results are numerically larger, there is a reasonable (albeit not perfect) agreement in the observed trends between samples.

In an attempt to improve the fit between the yarn and fabric results, Figure 4 shows the same results as Figure 3 with the addition of two extra sets of yarn results obtained with different parameters (a new threshold value of 10) allowing smaller/less well defined white speck neps to be included. Again note the excellent self consistency between the independent repeat measurements at this more sensitive setting of the instrument. Changing the threshold value has indeed increased the number of white speck neps detected by the instrument but it has not improved the correlation with the fabric results.

Figure 4. Further comparison of white speck neps levels detected with the online yarn instrument with those obtained from subjective evaluation of fabric samples.



6. Research Conclusions

The project has demonstrated that it is possible to measure white specks on dyed yarn using an optical sensor. Due to time and money constraints the project focussed on using an existing sensor. The experiments and results highlighted that this sensor did have some limitations for the current application however, despite these, a reasonable agreement with subjective results was obtained. Should it be deemed important more work could be undertaken to further improve the system (by modifying the sensor to improve the signal to noise levels).

7. Intellectual Property

No new intellectual property was developed as part of this project.

8. Impact on Cotton Industry

The main application of the outcomes of this project is a tool for use by other researchers in ginning research.

9. Recommendations for Future Work

The project has demonstrated that it is feasible to measure white specks on dyed yarn samples. There are two possible areas for further work resulting from this project.

First, it was found unexpectedly that the observed quantity of white speck neps in fabric samples varied when the sample was fabric dyed versus yarn dyed. The reason for this is not known but some hypotheses have been presented. It would potentially be of interest to the cotton industry to follow this up as it could lead to valuable information on either different inherent types of neps and/or possible textile processing techniques for minimising this undesirable effect with problem cottons.

Secondly, there is scope for improving on the on line detection of whites speck neps in yarns by modifying the hardware and design of the detectors. Further industry guidance would be required as to the benefit versus cost of this.

10. Acknowledgments

Financial support for this project was provided by the Cotton Research and Development Corporation and also CSIRO.

11. Publication from Project

There were no publications resulting from this project.