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Part 1 - Summary Project Details

Final Report

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Project Title:
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Lubricants for Improved Ginning and Spinning of Cotton

Part 2 - Project Contact Details

Admin Contact: Mr | Hayden | Smith
Title (ie Mr/Ms) | First Name | Last Name

Organisation: CSIRO Textile & Fibre Technology
(Name of organisation that will be administering the funding)

Postal Address: P O Box 21 | Henry Street
PO Box | Street

Belmont Geelong | Vic | 3216
Town | State | Postcode

03 52 46 4000 | 03 52 46 4057 | hayden.smith@tft.csiro.au
Phone | Fax | Email

Principal Researche Mr | Gary | Robinson
Title (ie Mr/Ms) | First Name | Last Name

Organisation: CSIRO Textile & Fibre Technology
(Name of organisation that will be administering the funding)

Postal Address: P O Box 21 | Henry Street
PO Box | Street

Belmont Geelong | Vic | 3218
Town | State | Postcode

03 52 46 4000 | 03 52 46 4057 | gary.robinson@tft.csiro.au
Phone | Fax | Email

Supervisor:
Title (ie Mr/Ms) | First Name | Last Name

Organisation:
(Name of organisation that will be administering the funding)

Postal Address:
PO Box | Street

Town | State | Postcode

Phone | Fax | Email

PART 3

1. Summary

This study is aimed at improving the quality of cotton lint by reducing the fibre to metal friction in the ginning of seed cotton. Several lubricants were used to apply to ginned lint prior to ginning on a small laboratory gin at Narrabri, NSW. The results indicated that small reductions in fibre to metal friction resulted in small improvements in the 2.5% span length of the ginned lint. There were no difficulties encountered with applying lubricants prior to ginning. With other lubricants, not evaluated in the ginning study, have been found to reduce the fibre to metal friction to a greater extent than those used in the ginning study. It is proposed that these lubricants be further evaluated in the next phase of the project.

2. Background

In the high speed ginning, carding and spinning of cotton, the fibre undergoes considerable fibre metal interactions. Traditionally, it has always been assumed that the natural wax provides the required lubrication to overcome any defects this might introduce during the process. It was proposed in this project that the addition of sophisticated synthetic lubricants to the raw cotton could improve the quality, especially the fibre length and it's distribution of the ginned lint and also reduce dust liberation, the cause of the OH&S problem - bysonosis.

3. Objectives and extent to which these have been achieved.

The objectives of the project were to ascertain whether the addition of lubricant to unginned cotton can improve the fibre length distribution of the ginned lint.

A second objective was to measure the fibre to metal friction of the lubricants used to see if there was an association between this property and any changes in the fibre quality.

The selection of a limited range of lubricants with small differences in their fibre to metal friction were applied to seed cotton and to the level of 0.2% on the weight of seed cotton. The fibre length of the ginned lint was marginally improved, but there was no influence on the variation in fibre length. This is somewhat disappointing as reductions in the amount of short fibre were anticipated. Higher additions at 0.6% on the weight of seed cotton have generally given poorer results for fibre length.

An additional screening of lubricants to further reduce the fibre to metal frictional properties of cotton have been successful and at least one and possibly two prime candidates have been identified for further work.

4. Methodology

LUBRICANT SELECTION

The following lubricants were suggested for the experimental trial by a local chemical representative.

- Nopcostat LV40 - Water soluble, antistatic lubricant with low fibre-to-metal friction and medium to low inter-fibre cohesion.
- Nopcostat 762 - Water soluble, non-ionic, antistatic lubricant with high inter-fibre cohesion.

□ Selbana CO - Blend of non-ionic emulsifiers and antistatic agents.

These were the products tested in laboratory ginning trials described below.

Unfortunately, coefficient of fibre-to-metal friction tests were not able to be performed before the ginning trials because the apparatus, usually used with wool fibre, needed to be modified and its reliability established to cope with the much shorter fibre length available with cotton fibres.

GINNING

Field cotton was sourced from a suitable agronomy trial by L Heal, CSIRO - Narrabri.

The seed cotton was hand blended after a single pass of the gin pre-cleaning unit.

Sub-samples were prepared by selection, weighing and randomising prior to spraying with neat additive from an air-brush unit so that the small qualities of lubricant could be added to the seed cotton with a reliable amount of control.

Before each major change of lubricant type, the surface of the saw gin wires was cleaned with unlubricated seed cotton. This was not done within a single lubricant type. Before each lubricant was tested, the wire surface was conditioned using 100g sample of seed cotton.

Lint, after ginning, was tested for fibre length, strength and micronaire on the HVI unit at Narrabri.

Add on levels of 0.2 and 0.4 % on weight of seed cotton were used as the major test levels.

A short run using 0.6 % on weight seed cotton was also assessed because this would nominally add about 0.25 % on weight of fibre alone. This is the add-on level recommended by the lubricant manufacturer.

A check on the affect of applying the lubricant prior to the pre-cleaner was also made during the experiment.

5. Detail results including the statistical analysis of results

No difficulties were encountered in ginning the seed cotton with lubricant applied indicating scale-up to industrial ginning could be undertaken with some confidence.

Micronaire data is very stable across all tests indicating satisfactory uniformity of the supply seed cotton.

The addition of 0.2 % additive to the seed cotton has marginally improved the length of fibre but has not influenced the variation in fibre length. This is somewhat disappointing as reductions in the amount of short fibre were anticipated. Higher additions, at 0.6 % on weight seed cotton have generally given poorer results for fibre length.

As expected, fibre strength and elongation have not been altered.

Adding lubricant before the pre-cleaner has not had any significant effect on determining the point of application.

FIBRE TO METAL FRICTION TESTING

Fibre to metal friction is measured by a capstan method . The test surface used for wool fibres, a 2cm diameter, stainless steel, toothed cylinder, is prepared for each lubricant by cleaning and lubricant application. First, the surface is scrubbed with Decon and hot tap water, then rinsed under hot tap water. Two rinses in a 1:1 mixture of Isopropanol/Methylene Chloride, with agitation, follow. Each lubricant is prepared for application by dilution in Methylene Chloride at one part active matter in 320 by volume. This solution is then applied to the previously cleaned surface at 1□L per tooth. Fibres are prepared for tensioning by gluing cartridge paper tags to each end. A single wool fibre is put under tension between the end of the measuring cantilever and a mass of 500mg, then wrapped through an angle of 180 degrees round the cylinder, prepared with the lubricant under test. The cylinder is then rotated at a speed typical of the fastest parts of a modern worsted card and the tension difference in the fibre is measured. A measurement is performed in each direction, on each fibre, to account for the effects of the scales on the fibre surface. From the two tension readings, the coefficient of friction is calculated. The test is performed on five fibres selected at random from a stock which has been laboratory scoured and held for use in friction testing.

The same principle has been adopted for the measurement of cotton fibre-to-metal friction but with modifications to allow for the shorter fibre. A 5mm spindle, prepared to a consistent surface roughness with 600-grade emery paper has replaced the larger, toothed capstan wheel. The pedestal, from which the cantilever is mounted, has been augmented to maintain the working dimensions of the cantilever and the essential geometry of the system while reducing the working length of fibre required to a minimum. The fibre was found to be not only shorter but individually weaker. The 500mg tension was found to be sufficient to break individual cotton fibres. A mass of 250mg has been substituted. The angular velocity of the wheel as used with the 2cm toothed wheel for wool, consistently broke cotton fibres when applied to the 5mm smooth wheel. To overcome this, the surface velocity has been reduced to 25m min-1. The surface velocity used in wool tests is usually 475m min-1. Even with these conditions many of the test fibres broke during testing.

Measurements made once the apparatus was working adequately are presented in Table 2. Nopcostat LV40 has resulted in a slight reduction in friction below that obtained from cotton oil alone. Nopcostat 762 has resulted in an increase in the coefficient of friction. The product Selbana 4554A, unfortunately not included in the ginning trial, has shown a substantial reduction in the coefficient of friction.

Table 1: Addition of Lubricant to Cotton Seed: HV1 Test Data

Addition of Lubricant to Cotton Seed

id	lube	%	length len	uniformity uni	short fibre sfi	strength str	elongation el	diameter mic	comment
1	CONTROL		1.2	84.8	2.4	31.2	6.8	3.9	
7	CONTROL		1.18	84.6	2.5	29.8	6.9	3.9	
8	CONTROL		1.19	85	2.5	32.5	6.3	3.7	
14	CONTROL		1.16	84.7	3.2	30.5	6.9	3.9	
15	CONTROL		1.19	84	2.3	29.8	6.8	3.8	
20	CONTROL		1.17	84.1	3.3	28.5	7.1	3.6	
			1.18	84.5	2.7	30.4	6.8	3.8	average
			0.01	0.40	0.49	1.37	0.27	0.13	standard deviation
2	762	0.2	1.19	84.5	2.5	30.4	7.2	3.8	
9	762	0.2	1.2	84.3	2.4	29.4	6.6	3.8	
16	762	0.2	1.2	84	3	31.7	6.5	3.8	
			1.20	84.3	2.6	30.5	6.8	3.8	average
			0.01	0.25	0.32	1.15	0.38	0.00	standard deviation
			0.07	0.27	0.80	0.90	0.90	1.00	t-test v control
			0.28	0.62	0.78	0.93	0.46	0.00	F-test v control
4	CO	0.2	1.2	83.7	2.4	31.7	6.5	3.8	
11	CO	0.2	1.18	83.9	2.6	30.4	6.8	3.7	
18	CO	0.2	1.18	84.3	3.1	31.4	6.8	3.8	
			1.19	84.0	2.7	31.2	6.7	3.8	average
			0.01	0.31	0.36	0.68	0.17	0.06	standard deviation
			0.60	0.06	1.00	0.29	0.52	0.60	t-test v control
			0.85	0.82	0.91	0.42	0.64	0.36	F-test v control
3	LV40	0.2	1.2	84.9	2.5	30.5	6.9	3.8	
10	LV40	0.2	1.19	84	3.2	30.3	6.9	3.9	
17	LV40	0.2	1.2	85.1	2.2	31.2	6.8	3.8	
			1.20	84.7	2.6	30.7	6.9	3.8	average
			0.01	0.59	0.51	0.47	0.06	0.06	standard deviation
			0.07	0.75	0.86	0.66	0.58	0.60	t-test v control
			0.28	0.42	0.66	0.22	0.09	0.36	F-test v control
5	CO	0.4	1.2	83.8	2.8	30.6	7	3.8	
12	CO	0.4	1.19	84.2	3.1	29.7	6.9	3.8	
19	CO	0.4	1.18	83.7	3.1	29.7	6.6	3.7	
			1.19	83.9	3.0	30.0	6.8	3.8	average
			0.01	0.26	0.17	0.52	0.21	0.06	standard deviation
			0.36	0.03	0.18	0.57	0.85	0.60	t-test v control
			0.69	0.67	0.29	0.26	0.83	0.36	F-test v control
6	LV40	0.4	1.2	84.4	2.5	29.3	6.7	3.8	
13	LV40	0.4	1.19	83.7	2.9	31.2	7	3.7	
			1.20	84.1	2.7	30.3	6.9	3.8	average
			0.01	0.49	0.28	1.34	0.21	0.07	standard deviation
			0.16	0.37	1.00	0.92	0.81	0.53	t-test v control
			0.70	0.54	0.91	0.74	0.93	0.80	F-test v control

Table 2: Coefficients of Fibre to Metal Friction

	Average	Std Dev
Selbana 4554A on Wool	0.235	0.021
Selbana 4554A on Cotton	0.314	0.040
Selbana CO on Cotton	?	?
Nopcostat LV40 on Cotton	0.531	0.069
Nopcostat 762 on Cotton	0.708	0.074
No Lubricant on Cotton	0.679	0.050
Residual Cotton Oil on Cotton	0.582	0.073

6. Provide an assessment of the likely impact of the results and conclusions of the research project for the cotton industry. Where possible include a statement of the costs and potential benefits to the Australian cotton industry and future research needs.

These preliminary results indicate that small improvements can be made with the addition of lubricants to the seed cotton before ginning and if there remains a good correlation between the reduction in fibre to metal friction and improvement in fibre length, then the use of even lower fibre to metal friction lubricants can be anticipated to make even further improvements to the length of the ginned lint. An improvement of 1-2mm would have a dramatic impact upon the value of the Australian cotton crop.

7. Describe the project technology (e.g. commercially significant developments, patents applied for or granted, licenses, etc).

In this first preliminary phase of the project, commerically available lubricants were used. It is anticipated within the second phase, with the introduction of a lubricant manufacturer to the project, that better understanding will be gained of the requirements of the lubricant for optimising the application to ginned lint. There may be some issues with the method of application that could be developed and/or protected technology.

8. Provide a technical summary of any other information developed as a part of the research project. Include discoveries in methodology, equipment design, etc.

Not applicable to date.

9. State the recommendations on the activities or other steps that may be taken to further develop, disseminate, or to exploit the project technology.

The project is in the very initial stages of the development. However, even at this stage it is considered relevant to contact a lubricant manufacturer and ask them to enter into the next phase of the project as a partner to help develop optimum lubricant formulation for this application and to make available via an in-kind contribution various lubricants to develop the second phase of the project.