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The Between Bale and Between Lot Variation of South African Grown Cottons

Part II: Bundle Tenacity and Extension at 3,2 mm ($\frac{1}{8}$") Gauge

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THE BETWEEN BALE AND BETWEEN LOT VARIATION OF SOUTH AFRICAN GROWN COTTONS

PART II: BUNDLE TENACITY AND EXTENSION AT 3,2 mm (1/8") GAUGE

by L. HUNTER and E. GEE

ABSTRACT

The between-bale (σ_b) and between lot (σ_l) variations in the bundle tenacity and bundle extension (3,2 mm — 1/8" gauge) have been determined on a Stelometer for a wide range of cottons grown in South Africa. Typical average values for these properties and for their variations for the season 1974/75 have been derived for each class and grade.

INTRODUCTION

In Part I of this series[1] certain physical properties (micronaire, maturity ratio, fineness, length and trash content) of a wide range of cottons, grown in South Africa, were measured. The results so obtained were subjected to statistical analyses which yielded typical values for the means and variations of the various physical properties for each cotton class and grade for the 1974/75 season. These values can be used for both reference purposes and for constructing sampling plans.

In the present report the work, referred to above, has been extended to cover the tensile properties (bundle tenacity and extension) of most of the cottons covered earlier[1], since fibre strength is an important characteristic in deciding the quality of cotton. It was decided to concentrate solely on bundle tenacity (and extension) determined at 3,2 mm (1/8"), gauge since it is generally accepted that this particular gauge length gives a better measure of the strength utilisation of the fibre when converted into yarn.

EXPERIMENTAL

Details of the cotton and sampling thereof have been given in the earlier report[1] and will not be repeated here. In a number of cases insufficient material was available for the test and correspondingly fewer lots could therefore be covered in the present study. In view of the amount of work involved it was decided to randomly select a maximum of only *four bales* per lot and to perform only *three tests* per bale. This was considered adequate for the type of statistical analysis involved which was identical to that used previously[1]. The samples were passed through a Shirley miniature card in order to obtain a sliver with the fibres partly aligned, thereby facilitating the bundle tensile test.

The bundle tensile tests were carried out on a Stelometer at a gauge length of 3,2 mm (1/8″), three tests per bale being conducted. The values for both tenacity

TABLE I

CLASSIFICATION OF COTTONS (1975)

Type	Staple Length (inch)	Micronaire	Strength in 1000 p.s.i. (zero-gauge)	Various Grades
A-CLASS COTTONS				
Discount (A_3) (Deltapine types)	$>1\frac{1}{16}$ (27 mm)	3,8/4,8	75/81 (36/39 cN/tex)	Deal Dirk Doly
Basic (A_2) (CS_2, Albar, Albacala)	$>1\frac{1}{16}$ (27 mm)	3,8/4,8	82/88 (41/43,5 cN/tex)	Duns LFY Deal Dirk Doly Duns LFY
Premium (A_1) (Acala types)	$>1\frac{1}{8}$ (28,6 mm)	3,3/4,2	>90 (44 cN/tex)	Deal Dirk Doly Duns LFY
B-CLASS COTTONS				
Discount (B_3) Basic (B_2) Premium (B_1)	$1 - 1\frac{1}{16}$ (25 – 27 mm) for 1975 but $1\frac{1}{32} - 1\frac{1}{16}$ as from 1976 (26 – 27 mm)	Same as for 'A-Class	Same as for A-Class	Dirk Doly Duns LFY

All cottons not falling in A or B are to be graded as BSG.

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TABLE II

NUMBER OF BALES AND LOTS SAMPLED FOR THE DIFFERENT COTTONS

Various Grades	Number of Lots			Average number of bales per lot tested		
	A_1	A_2	A_3	A_1	A_2	A_3
Deal	1	1	1	12	4	4
Dirk	15	—	2	4	—	4
Doly	4	1	—	4	4	—
Duns	4	2	3	11,75	4	4
LFY	2	—	1	4	—	4
	B_2	B_3		B_2	B_3	
Dirk (BS/1)	—	7		—	4,57	
Doly (BS/2)	1	2		4	4	
Duns (BS/3)	1	5		4	4	
	BSG			BSG		
Deltapine	1			4		
Acala	10			4		

(expressed as cN/tex) and extension (in *per cent*) were corrected, by means of USDA Calibration samples, to the *Pressley* values for 3,2 mm (1/8") gauge. Only the corrected values have been analysed and will be reported.

All tests were carried out at $20 \pm 2°C$ and $65 \pm 2\%$ RH allowing the material sufficient time to attain equilibrium.

For the sake of completeness, Table I of the earlier report is reproduced here. Table II shows the number of lots and lot sizes covered. As before[1] the values were subjected to a hierachial analysis of variance from which estimates could be obtained for the variation associated with:

    (i)   between tests (σ_t)

    (ii)   between bales (σ_b) and

    (iii) between lots (σ_l).

The various σ-values were also expressed as percentages of the means (i.e. as CV's) to facilitate their use and interpretation.

RESULTS AND DISCUSSION

The mean values for bundle tenacity and extension are shown for each quality of cotton in Table III, while in Table IV the values have been averaged over the various grades. The values shown in Table III can therefore be regarded as typical for the bundle tenacity and extension for the various cottons grown in South Africa during the 1974/75 season.

An outstanding feature of Table III is the relatively high tenacity values (about 25 cN/tex) for the A_1 and Acala BSG cottons. The other cottons had very similar tenacity values, of the order of 21 cN/tex. Cotton grade appeared to have little effect on the tensile properties. The A_3 cottons generally exhibited the highest extension values.

Table V shows the values obtained for σ_t and CV_t, Table VI shows the σ_b- and CV_b-values and Table VII gives the σ_l and CV_l values. In Table VIII the weighted means of the σ and CV values are given for the A, B and BSG classes.

TABLE III

MEAN VALUES FOR THE BUNDLE TENACITY
(cN/tex AT 3,2 mm) AND EXTENSION (%)

VARIOUS GRADES	TENACITY (cN/tex)			EXTENSION (%)		
A-class cottons	A_1	A_2	A_3	A_1	A_2	A_3
Deal	25,5	20,5	20,7	6,3	8,4	8,5
Dirk	25,8	—	21,7	5,7	—	8,2
Doly	26,3	21,4	—	5,4	5,7	—
Duns	24,4	23,4	20,7	6,2	6,6	8,2
LFY	24,6	—	19,7	6,3	—	7,7
B-class cottons	B_2	B_3		B_2	B_3	
Dirk (BS/1)	—	21,0		—	7,5	
Doly (BS/2)	20,2	21,1		6,4	6,9	
Duns (BS/3)	21,9	20,9		6,9	7,7	
BSG cotton						
Deltapine	20,3			3,8		
Acala	24,9			5,8		

TABLE IV

AVERAGE VALUES OVER THE VARIOUS GRADES FOR THE BUNDLE TENACITY AND EXTENSION

	A_1	A_2	A_3	B_2	B_3	BSG Deltapine	BSG Acala
Tenacity (cN/tex)	25,3	21,8	20,7	21,1	21,0	20,3	24,9
Extension (%)	6,0	7,0	8,2	6,7	7,4	3,3	5,8

From Table V it is apparent that the CV_t-values showed no consistent trend with either the class or grade of cotton although the values for the BSG cottons were higher than the others. It is noticeable, too, that the CV_t values for extension were generally higher than those for tenacity, confirming the greater variability and generally lower reliability of this property.

The CV_b values given in Table VI shows no consistent trends with either cotton class or grade, although in some instances very high values for the CV_b of extension occurred, again confirming the large variability inherent in this particular test parameter. No definite trends are apparent from the results for CV_l given in Table VII, although it is noticeable that some of the values for the A-class Duns cottons are very high.

By a procedure similar to that used for arriving at Table VIII, the values in Table VIII were averaged by taking their weighted means to give values averaged over all the cotton classes and grades. These values are given in Table IX and show that, for tenacity, the CV values can be taken to equal 4 *per cent*, while for extension a CV value of 7 *per cent* is fairly representative. These values apply to CV_t, CV_b and CV_l. The values in this table can therefore be used in practice as a measure of the variations to be expected in the tensile properties of South African grown cotton. It also enables the calculation of the number of samples and tests required for a certain degree of accuracy to be made (see the previous report for an example of this type of calculation[1]).

In view of the fact that cotton tenacity is still often measured at zero-gauge, the correlation between values obtained previously on a range of cottons at zero and 3,2 mm (1/8″) gauge, respectively, was investigated. A good correlation (correlation coefficient = 0,87 with 44 readings) was found and a table was prepared (see Table X) showing the 3,2 mm-gauge values and the corresponding values for zero-gauge. This table can therefore be used as a *rough guide* when values obtained at one gauge length are available and it is necessary to have an *approximate* idea as to what the corresponding values at the other gauge length would be.

TABLE V

VARIATION BETWEEN TESTS AS REPRESENTED BY σ_t AND CV_t

VARIOUS GRADES	TENACITY			EXTENSION		
A-class cotton	A_1	A_2	A_3	A_1	A_2	A_3
Deal	1,18(4,6)	1,01(4,9)	0,64(3,1)	0,46(7,3)	0,50(6,0)	0,70(8,2)
Dirk	1,01(3,9)	–	1,08(5,0)	0,32(5,6)	–	0,39(4,8)
Doly	1,14(4,3)	0,74(3,5)	–	0,33(6,1)	0,26(4,6)	–
Duns	1,20(4,9)	0,72(3,1)	0,81(3,9)	0,52(8,5)	0,31(4,7)	0,35(4,3)
LFY	1,12(4,6)	–	0,71(3,6)	0,26(4,1)	–	0,35(4,5)

B-class cotton	B_2	B_3		B_2	B_3	
Dirk (BS/1)	–	0,96(4,6)		–	0,34(4,5)	
Doly (BS/2)	0,66(3,3)	0,93(4,4)		0,28(4,4)	0,52(7,5)	
Duns (BS/3)	0,77(3,5)	0,83(4,0)		0,40(5,8)	0,37(4,8)	

BSG COTTON	BSG			BSG		
Deltapine	1,11(5,5)			0,35(10,6)		
Acala	1,23(4,9)			0,31(5,3)		

CV_t values are shown in parenthesis.

TABLE VI

VARIATION BETWEEN BALES AS REPRESENTED BY σ_b AND CV_b

VARIOUS GRADES	TENACITY			EXTENSION		
	A_1	A_2	A_3	A_1	A_2	A_3
A-class cotton						
Deal	1,22(4,8)	0,13(0,6)	0,31(1,5)	0,37(5,9)	0 (0)	0,14(1,6)
Dirk	0,56(2,2)	—	1,0(4,6)	0,08(1,4)	—	0,33(4,0)
Doly	0,73(2,8)	0,24(1,1)	—	0 (0)	0,19(3,3)	—
Duns	1,16(4,8)	0,81(3,5)	0,48(2,3)	0,27(4,4)	0,45(6,8)	0,40(4,9)
LFY	0 (0)	—	0,29(1,5)	0,23(3,7)	—	0,33(4,3)

B-class cotton	TENACITY		EXTENSION	
	B_2	B_1	B_2	B_3
Dirk (BS/1)	—	0,54(2,6)	—	0,27(3,6)
Doly (BS/2)	0,88(4,4)	0 (0)	0,45(7,0)	1,61(23,3)
Duns (BS/3)	0,89(4,1)	0,80(3,8)	0 (0)	0,84(10,9)

BSG Cotton	TENACITY BSG	EXTENSION BSG
Deltapine	0,49(2,4)	0 (0)
Acala	0,81(3,3)	0,14(2,4)

CV_b values are shown in parenthesis

TABLE VII

VARIATION BETWEEN LOTS AS REPRESENTED BY σ_l AND CV_l

VARIOUS GRADES	TENACITY			EXTENSION		
A-class cotton	A_1	A_2	A_3	A_1	A_2	A_3
Deal	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Dirk	1,04(4,0)	– (–)	1,19(5,5)	0,24(4,2)	– (–)	0,45(5,5)
Doly	1,94(7,4)	0 (0)	– (–)	0,24(4,4)	0 (0)	– (–)
Duns	0,54(2,2)	4,64(19,8)	0 (0)	0,51(8,2)	1,39(21,1)	0,86(10,5)
LFY	0,74(3,0)	– (–)	0 (0)	0 (0)	– (–)	0 (0)

B-class cotton	B_2	B_3	B_2	B_3
Dirk (BS/1)	– (–)	0,37(1,8)	– (–)	0,51(6,8)
Doly (BS/2)	0 (0)	0,85(4,0)	0 (0)	0,67(9,7)
Duns (BS/3)	0 (0)	0,81(3,9)	0 (0)	0,62(8,1)

BSG cotton	BSG	BSG
Deltapine	0 (0)	0 (0)
Acala	0,61(2,4)	0,24(4,1)

CV_l values are shown in parenthesis.

TABLE VIII

MEANS OF THE σ AND CV VALUES FOR THE DIFFERENT COTTONS AND FIBRE PROPERTIES

FIBRE PROPER- TIES	A-CLASS						B-CLASS						BSG-CLASS					
	σ_t	CV_t	σ_b	CV_b	σ_l	CV_l	σ_t	CV_t	σ_b	CV_b	σ_l	CV_l	σ_t	CV_t	σ_b	CV_b	σ_l	CV_l
Tenacity (cN/tex)	0,95	4,2	0,66	2,9	1,47	6,5	0,84	4,0	0,72	3,4	0,55	2,6	1,18	5,2	0,66	2,9	0,38	1,7
Extension (%)	0,42	5,9	0,28	4,0	0,54	7,6	0,39	5,5	0,85	12,0	0,45	6,4	0,38	8,4	0,08	1,7	0,13	2,9

TABLE IX

OVERALL MEAN σ AND CV VALUES

	σ_t	CV_t	σ_b	CV_b	σ_l	CV_l
Tenacity (cN/tex)	0,97	4,5	0,67	3,1	0,90	4,2
Extension	0,42	6,7	0,46	7,4	0,37	6,0

TABLE X

RELATIONSHIP BETWEEN COTTON TENACITY VALUES OBTAINED AT TWO DIFFERENT GAUGE LENGTHS (ONLY A ROUGH GUIDE)

TENACITY		
3,2 mm gauge (1/8")	Zero gauge	
(cN/tex)	1 000 p.s.i.	cN/tex
18	72	35,5
20	76	37,5
22	81	40
24	85	42
26	90	44,5
28	94	46,5
30	99	49
32	103	51

SUMMARY AND CONCLUSIONS

Samples were obtained of ginned cotton (lint) from seven important gins in South Africa. These samples were considered to be representative of the various classes and grades of cotton ginned in South Africa during the 1974/75 season and were sub-samples of those drawn for and submitted to the official Cotton Grader in Pretoria. The tensile properties (bundle tenacity and extension at 3,2 mm gauge length) were measured on a Stelometer and typical values for each class and grade of cotton were calculated and tabulated. For bundle tenacity a value of 25 cN/tex can be regarded as typical for the Premium A-Class (i.e. A_1) and Acala BSG cottons, while a value of 21 cN/tex can be regarded as typical for all the other cottons.

From an hierachial analysis of variance estimates were obtained for the variation associated with:

    (i)   between tests (σ_t)
   (ii)   between bales (σ_b) and
  (iii)   between lots (σ_l).

These values therefore quantify the variations typical for each of the two fibre properties tested for the various cottons. Although some variations occurred in these σ-values for the different cottons it was concluded that they could be averaged to facilitate their use in practice.

The various σ-values were expressed as percentages of the means (i.e. as CV's) to facilitate their use and interpretation and typical values were as follows:-

	σ_t	CV_t	σ_b	CV_b	σ_l	CV_l
Tenacity	0,97	4,5	0,67	3,1	0,90	4,2
Extension	0,42	6,7	0,46	7,4	0,37	6,0

These could be condensed further to an average CV value for tenacity of 4 *per cent* and for extension of 7 *per cent*. These values illustrate the greater variability in the extension results.

ACKNOWLEDGEMENTS

REFERENCE

1.   Gee, E., Hunter, L. and Aldrich, De V., The Between Bale and Between Lot Variation of South African Grown Cotton, Part I: Micronaire, Maturity Ratio, Fineness, 2,5% Span Length, Uniformity Ratio and Trash Content, *S.A. Wool and Text. Res Inst* Techn. Rep. No. 319 (August, 1976).

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E R R A T U M

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cN/tex should read gf/tex.