

THE ROLE OF LONG STAPLE UPLAND & PIMA COTTON – OPPORTUNITIES FOR MEDIUM & ELS TYPES

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Introduction

The previous paper by (Dall’Alba, 2008) with its segmentation of the international cotton market is indeed a good starting point for this paper. Using price premiums Dall’Alba positions Australian cotton with SJV and Zimbabwe cotton in a ‘Fine Cotton’ category below the ‘Extra Fine’ (including Egyptian ELS and Pima) but above other ‘High Medium’ cottons (including Texas Fibermax SM and Brazil M1-1/8”). Whilst Australia’s strong reputation for logistics (on-time delivery etc) and marketing services contribute to the price premiums that we currently enjoy it is noted that price premiums between different categories largely correlate with a spinning mill’s perception of fibre quality.

It is interesting that Dall’Alba uses the term ‘Extra Fine Cotton’ for the top quality category that is commonly referred to as Extra Long Staple or ELS cotton. It is indeed the case that these cottons are in general both longer and finer than other cottons and so both labels are appropriate. In this paper we retain the term Extra Long Staple (ELS) cotton.

Dall’Alba notes that ‘we have no shortage of competitors’, and ‘we should not take the current high rating of our Australian cotton for granted’. Rather ‘we need to continue improving our Australian cotton while not sacrificing yield’ in the belief that ‘superior products create their own markets’. Adopting this sentiment this paper will (a) explore the key fibre quality attributes that relate to the 25c/lb market gap or barrier between where Australian cotton is currently positioned and ‘Extra Long Staple’ cotton and (b) describe technical opportunities CSIRO has been investigating to ‘capture’ some of this gap for Australian cotton.

The Spinning Process

Small changes in fibre fineness can have big effects in spinning.

During spinning ideally the yarn would be built up with the required number of fibres in the cross-section to give the desired yarn linear density or count with the length of the yarn built up by putting new fibres exactly at the point where the previous fibre ends. Figure 1(a) schematically shows a

section of this idealised yarn. Unfortunately, in the actual spinning process there is no mechanism for placing the fibres precisely end to end and Figure 1(b) (real yarn) is a more realistic representation of a yarn cross-section with the random positioning of fibres giving rise to thicker spots and thinner spots along the yarn.

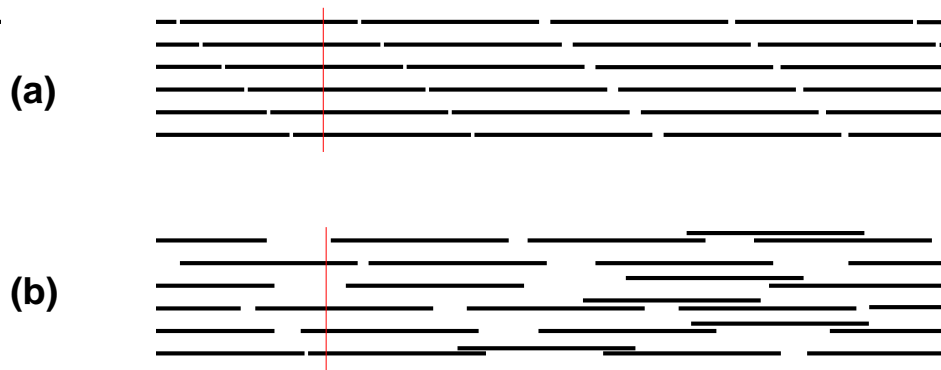


Figure 1. Schematic representation of the arrangement of fibres within a yarn. (a) an idealised yarn and (b) a more realistic yarn illustrating the random positioning of fibres.

A thin place in a yarn is a weak place, which has potential to break during either the spinning process itself or later during fabric manufacture. This can have a significant impact on the efficiency of the processes, so there is considerable pressure on the spinner to ensure that the yarn manufactured and supplied is as even as possible so breakages do not occur. The key to yarn evenness is the average number of fibres in the yarn cross-section. If this is relatively large, then the naturally occurring variations in the thickness of the yarn as illustrated in Figure 1(b) do not lead to practical problems. However if the average number of fibres in the yarn cross-section is small then the natural variations can indeed cause major practical problems. Spinners are well aware of the spinning limit or ‘wall’ whereby it is practically impossible to spin a fine count yarn if the fibre is too coarse. (This is the basis of the discounts for high Micronaire cotton.) Hence particularly fine count yarns demand the use of fine rather than coarse cotton.

A further illustrative example is in the ring spinning of fine wool yarns. Wool fibre diameter or fineness is well characterized and so the average number of fibres in the yarn cross-section can be accurately calculated. In this case workers at CSIRO have been quite successful in developing a software package based on a mechanistic understanding of the spinning process and the random statistics associated with the number of fibres in the yarn cross-section (Lamb and Yang, 1996). Figure 2 reproduced from Lamb and Yang (1996) illustrates that the number of thin places in the yarn increases exponentially as the number of fibres in the yarn cross-section decrease, so that the ‘wall’ defining the spinning limit is indeed very steep. Small changes in fibre fineness can have big effects in spinning.

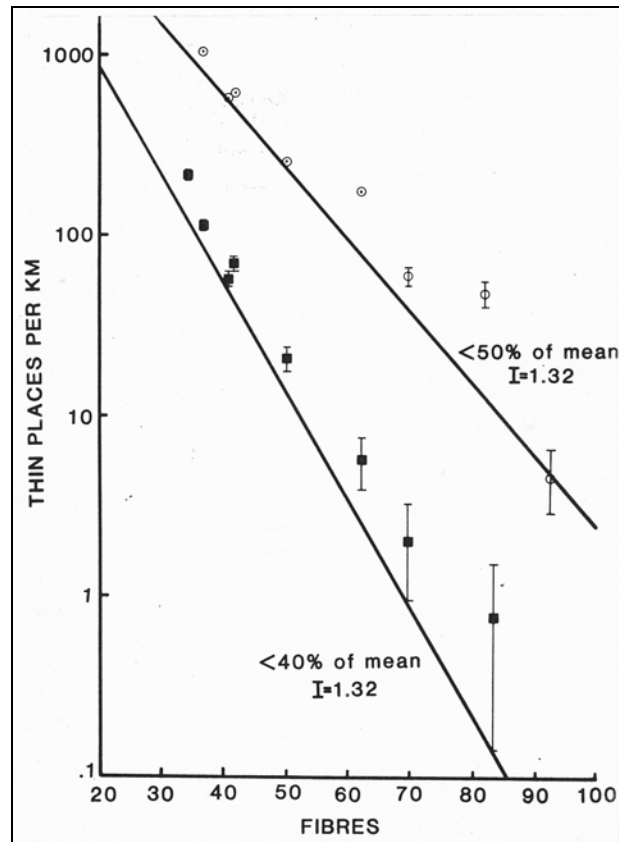


Figure 2. Predicted and measured thin places in ring spun worsted wool yarns plotted against the number of fibres in the yarn cross section (reproduced from Lamb and Yang, 1996)

Fibre length is also important.

Fibre length also contributes importantly to yarn mechanical performance. Returning to Figure 1, as drawn the yarn would be very weak i.e. fibres could easily slip past one another. However after introducing twist by the spinning process the fibres form helical paths as illustrated in Figure 3. Now when an external force is applied to the yarn each fibre naturally presses against its neighbours along its length and this frictional force gives the yarn its strength. As fibre length increases so does this frictional force.

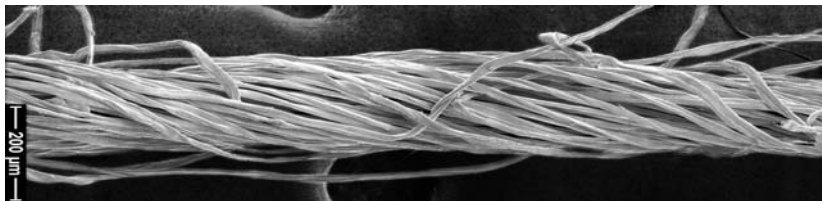


Figure 3. Photograph of a ring spun yarn highlighting the helical paths of individual fibres.

Figure 4 gives the price of cotton yarn for different yarn counts. This graph represents the supply and demand forces in the market. Starting from the right hand side of the graph initially the yarn price is insensitive to yarn count, i.e. the curve is relatively flat. There is however a change in the slope of the curve at the fine yarn count end, reflecting the higher priced fine and long fibre, e.g. ‘Extra fine’ or Pima cotton, required to spin finer count yarns. It is interesting that Australian cotton traditionally sits in the region of the graph tantalisingly close to the change in slope, i.e. a small shift to the left could potentially lead to significant additional value for the spinner. The graph shows that a small sustainable improvement in the key fibre qualities of fibre fineness and length (relative to both our current position and also that of other competitive growths) would, in principle, have potential to add value. It is also interesting to note that the two identified regions in the graph also correspond to the 25c/lb market gap in lint prices identified by Dall’Alba suggesting linkage between yarn and lint prices in the market.

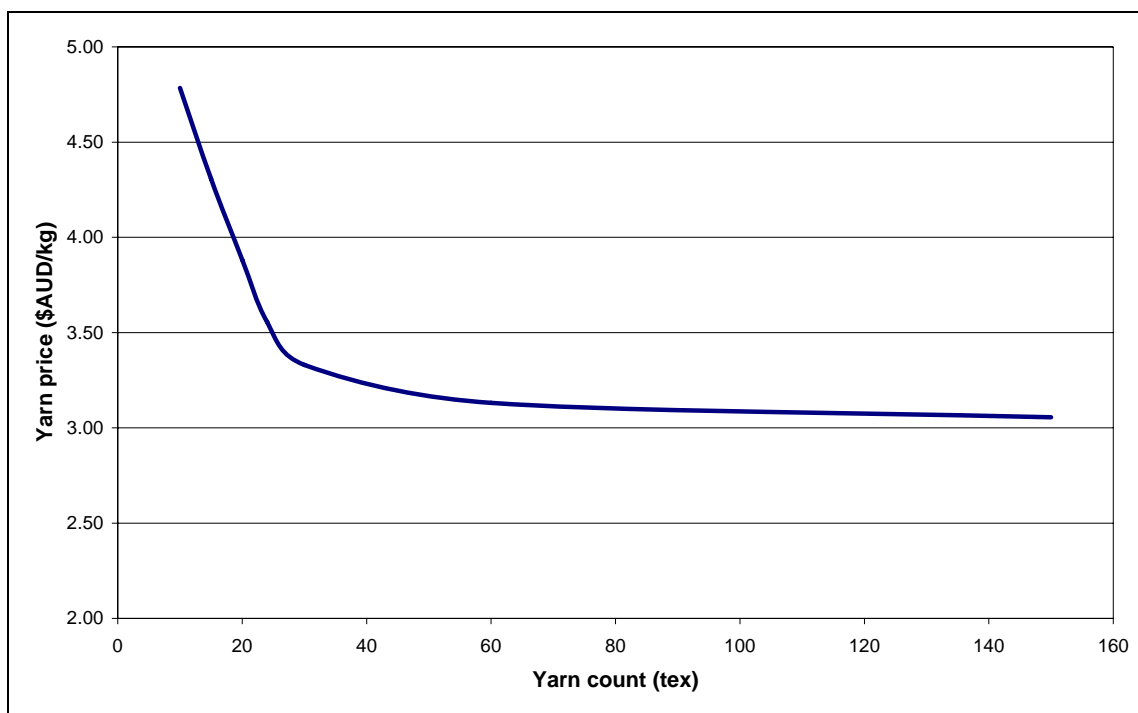


Figure 4. Graph of yarn price vs yarn count.

Long Staple Upland Varieties: Added Value Opportunities

As part of an ongoing drive to improve fibre quality Sicala 350B is the first commercial LS Upland variety developed by CSIRO and released in Australia. It is a specialist high quality Bollgard II® variety, exhibiting extremely long fibre lengths (>1¼ inches) compared with regular Upland varieties. Fibres are also typically finer and have excellent breaking tenacity (> 32 grams per tex).

Thus from a fibre quality perspective, on face value, this new quality sits above the main Australian Upland crop edging towards the ELS cotton category. CSIRO has been exploring through spinning trials the potential of this new variety to be blended with ELS cotton to produce ELS type yarns. In one particular study the objective was to determine the proportion of Sicala 350B that could be used as a substitute for the traditionally more expensive ELS Pima without compromising processing performance and the properties of fine count yarns. Highlights of the results of this study are given below. Fuller details of this study have been reported elsewhere (van der Sluijs, 2008).

Bales of saw and roller ginned Sicala 350B cotton and roller ginned Pima A8 grown during the 2006 season under commercial growing conditions were sourced for the trial. Roller ginning of seed cotton from the same Sicala 350B modules enabled comparisons to be made on the basis of gin treatment.

A fine count 10 tex (60 Ne) combed ring spun yarn with a twist factor (α_e) of 4.0 was produced using the industrial scale mill facility at CSIRO from blends of ELS Pima A8 and Sicala 350B fibre, where the proportion of Sicala 350B in the blend was increased in 10% increments from zero through to 40%. Processing efficiency and yarn quality were measured in order to demonstrate the effect of substituting LS Upland cotton for ELS Pima cotton in a spinning mill.

The fibre properties of all three cottons tested in this study are considered exceptional. Whilst there were only small differences in fibre length properties between roller-ginned Sicala 350B and the Pima A8, which was also roller ginned (Table I), the Pima cotton had much higher bundle tenacity. This is a reflection of the Pima's inherently finer fibre (Table II), which would have positively affected the bundle tenacity result.

As to be expected, saw-ginning the Sicala 350B significantly reduced fibre length and length uniformity and increased SFC, seed-coat neps and neps. The nominal acceptable limit for neps is 250 neps per gram of fibre. In comparison to roller ginning, saw-ginning increased nep levels in the Sicala 350B cotton by nearly 100% (from 193 to 376 neps per gram) and SFC by over 50% (from 8.0% to 12.9%).

The 100% Pima cotton produced the best yarn tenacity results although there was practically no difference between 100% Pima A8 yarn and 70/30 and 60/40 Pima/Sicala 350B saw and roller-ginned yarns (Figure 5). There were significant differences in tenacity (> 8 cN/tex) between 100% Pima and 100% Sicala 350B saw and roller-ginned yarns. No difference was noted between 100% Pima A8 and 80/20, 70/30 and 60/40 blends for elongation.

Table I Fibre Results by the HVI 1000^{1*}

Variety	Gin Type	Tenacity cN/tex	Elongation %	Length mm	Uniformity Index %	Micronaire
Sicala 350B	Saw	32.0	2.4	31.2	81.3	4.2
Sicala 350B	Roller	33.0	5.5	33.8	85.1	4.2
Pima A8	Roller	48.1	5.8	34.0	86.8	4.2

¹Calibrated using HVI ICC Upland and Pima Calibration Cottons * Average of 10 tests

Table II Fineness² and Calculated Maturity Results by the Cottonscan

Variety	Gin Type	Fineness (mtex)	Maturity Ratio
Sicala 350B	Saw	192	0.82
Sicala 350B	Roller	198	0.79
Pima A8	Roller	173	0.91

²Average of 5 tests

Table III Nep, Seed-Coat Nep and SFC Results by the AFIS PRO³

Variety	Gin Type	Neps/gram	SCN/gram	SFC(w) %
Sicala 350B	Saw	376	44	12.9
Sicala 350B	Roller	193	43	8.0
Pima A8	Roller	190	22	3.7
80/20	Roller	185	35	4.4
70/30	Roller	176	20	4.4
60/40	Roller	182	36	7.9
70/30	Saw	372	44	12.6

³Average of 5 tests

A comparison of the yarn strength results with Uster Statistics 2007 shows that, with the exception of the 100% saw and roller-ginned Sicala 350B, the tenacity and elongation of the 100% Pima and the 80/20, 70/30 and 60/40 roller-ginned blends and the 70/30 saw-ginned blend were considered excellent, i.e. between the 25 and 5 percentile lines of all yarns produced world-wide. Yarns within these percentiles are considered high quality and are typically destined for modern high speed weaving and knitting machines and high quality apparel end-uses.

The most even yarns were produced from the 80/20 blend followed by the 100% Pima, 70/30 and 60/40 blends, with the 100% Sicala 350B roller and saw-ginned fibre producing the most uneven yarns (Figure 6). The evenness values, i.e. the number of thin and thick places and neps of the 100% Pima A8 yarn were somewhat higher compared with the 80/20 blend (Figure 3) and may be related to the lower percentages of noil removed from the 100% Pima treatment during combing.

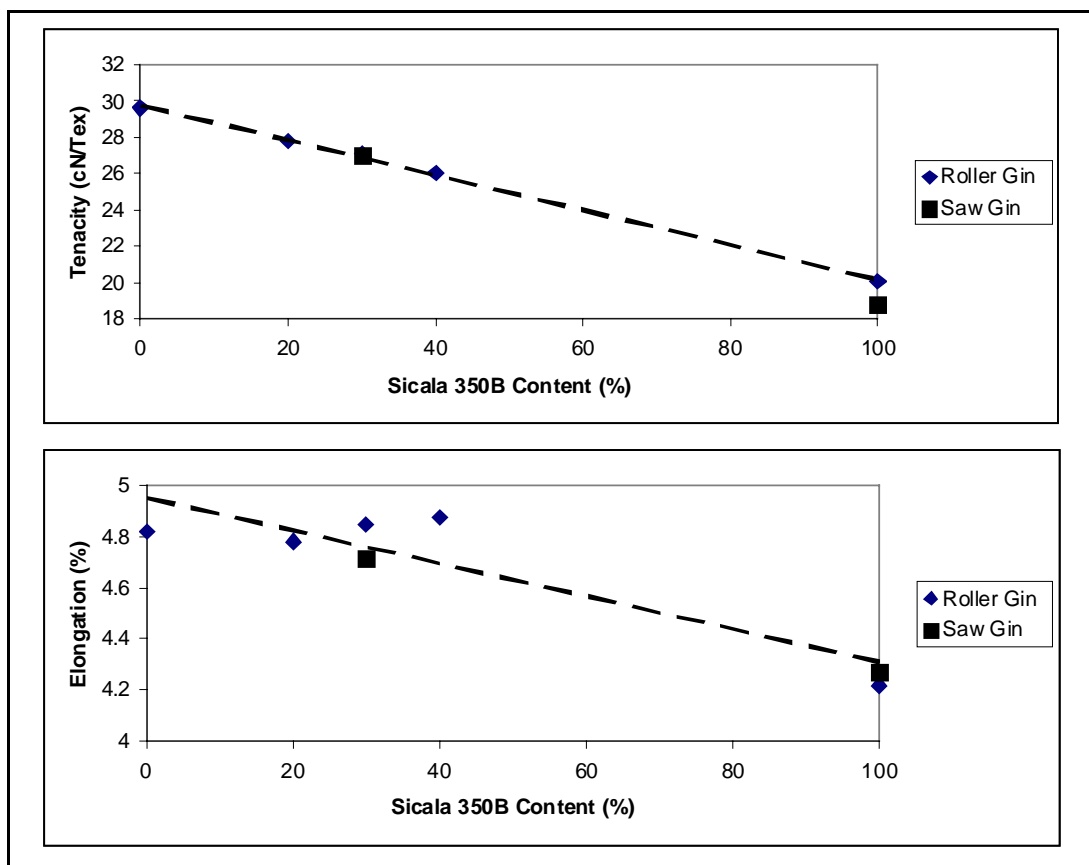


Figure 5. Yarn strength and Elongation results for various treatments. (The dotted line in each graph and the subsequent figures represents the best fit line for the Roller Gin data.)

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 all yarns produced was excellent (see Figure 7) with most treatments recording end break rates at less than 20 breaks per 1000 Spindle Hours (SpH). (The commercial limit is approximately 30 breaks per 1000 SpH.)

In summary the results from this investigation indicate that Pima cotton blends containing up to 30% saw or roller ginned Sicala 350B produce satisfactory fine count yarn of 10 tex. Whilst not statistically as strong as 100% Pima yarn, in a practical/commercial sense they are not different in tensile properties. Yarn evenness and imperfections were also not significantly affected at any blend ratio. Further trials conducted at CTFT have shown that as one produces finer yarns i.e. < 10 tex (> 60 Ne) differences in yarn quality between these same blend ratios become more pronounced.

Commercial trials are planned with a large vertically integrated textile manufacturer in Asia to verify the results achieved in this initial study.

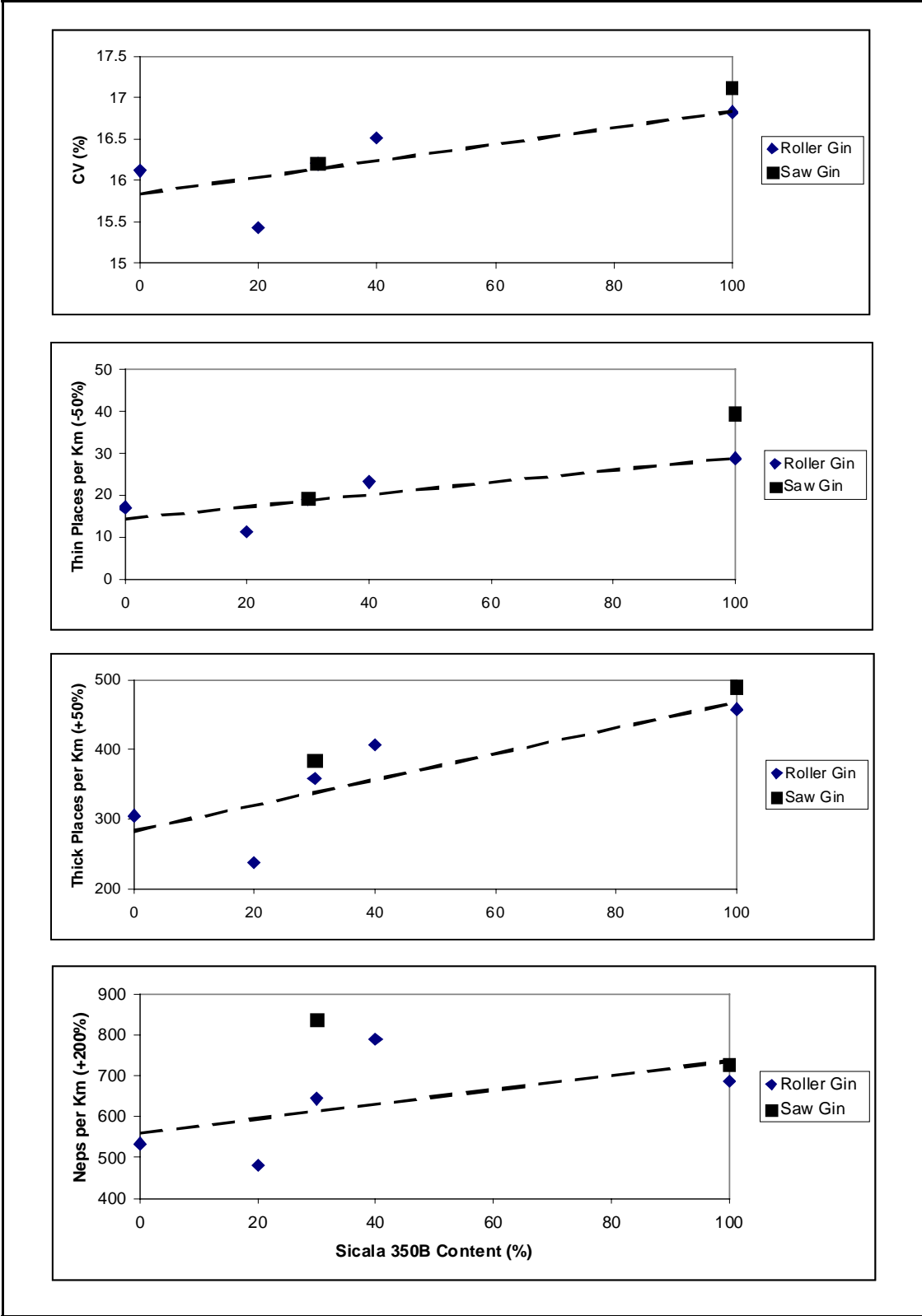


Figure 6. Evenness results for various treatments.

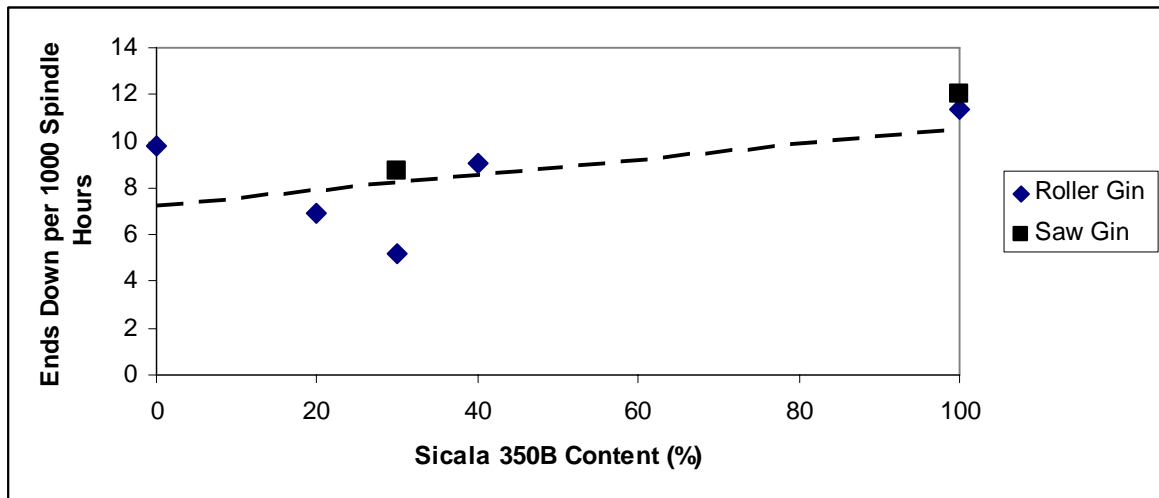


Figure 7. Ends down for various treatments.

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