GRADUATE COURSE ON COTTON FIBERS AVAILABLE THROUGH DISTANCE EDUCATION

A new graduate course will be offered this fall taught by ITC Assistant Director Eric Hequet. The course, PSS 5376 - Advanced Studies in Cotton Fibers, will be taught on the Texas Tech campus but utilize the TTVN video network and be available as a distance education graduate course throughout Texas.

NEW PERSONNEL

- Mourad Krifa has joined the ITC to provide leadership in yarn spinning research. He received his Ph.D. in Engineering Science from the Université de Haute Alsace in Mulhouse, France, where his applied research emphasis was on textile processing.
- SunHo Lee comes to the ITC to advance the program of research in image analysis applications to fibers, yarns and fabrics. He received his Ph.D. in Image Engineering from Chung-Ang University in Seoul, Korea and worked for Hyundai Electronic Industries Company. He came to the ITC from the University of Tennessee, Knoxville, where he was a Visiting Research Scholar.
- Emily Johnson is the new ITC Accountant. She received her degree in Accounting from Texas Tech University and previously worked for Plains Cotton Cooperative Association.
- Scott Irlbeck is the new Communications Coordinator. He received his degree in Journalism from Texas Tech University. He previously worked as the Agri-business Director for KAMC-TV and as a Media Relations Specialist for a private refrigeration company.

RESEARCHERS RECOGNIZED

Eric Hequet, Assistant Director, was appointed an alternate editor for Textile Technology by the *Journal of Cotton Science*. He was also elected Vice-Chairman of the Fineness and Maturity Working Group for cotton, sponsored by the International Textile Manufactures Federation.

Dr. Noureddine Abidi, Head of Finishes/Chemical Research, received the Texas Tech Chancellor's Award of Excellence. The University-wide award recognizes the highest level of daily commitment to quality and service.

ITC TRAVEL

- 2002 Beltwide Cotton Conference, Atlanta, GA, January 8-12, Dean Ethridge, Eric Hequet, James Simonton, S.S. Ramkumar, Noureddine Abidi
- Texas Seed Trade Production & Research Conference, Dallas, TX, February 4, 2002, presentation, Ethridge
- New Mexico Seedman's Association Annual Meeting, Clovis, NM, February 15, 2002, presentation, Ethridge
- University of Alberta, Canada, March 13, 2002, seminar, Ramkumar
- Institute for Textile & Process Engineering, Denkendorf, Germany, March 10-11, 2002, Ethridge, Hequet
- International Committee on Cotton Testing Methods & 26th International Cotton Conference, Bremen, Germany, March 12-16, 2002, Ethridge, Hequet
- Textile Institute's 2002 Annual Conference, Cairo, Egypt, March 23-27, Ramkumar
- University of South Florida Annual Conference, April 17, 2002, Ramkumar

*Note: The three previous issues of Textile Topics (Summer 2001, Fall 2001,and Winter2002) were not produced. We regret the hiatas in our quarterly series and we will try to ensure that all future issues are delivered on schedule.

COMPACT SPINNING: NEW POTENTIAL FOR SHORT STAPLE COTTONS

Mourad Krifa
Eric Hequet
Dean Ethridge

INTRODUCTION

During the last two decades, components of ring spinning machines have been greatly improved. Changes in drafting systems, drive systems, and robotics have enabled large gains in productivity, flexibility, and quality (Stahlecker, 1995; Seuberling, 1995; Hequet, et. al, 1998).

Most of the technical advances in ring spinning were aimed at improving the performance of the existing technology. In recent years, however, a bona fide innovation has occurred. It is called "compact" or "condensed" spinning, because it minimizes width and height of the spinning triangle associated with ring spinning (see Figure 1).

Several experts have described the technical principles of compact spinning that result in a more organized structure without peripheral fibers and with a better twist distribution (Artzt, 2000; Meyer, 2000; Olbrich, 2000; Stalder, 2000). As a result of this enhanced structure, the compact yarn shows higher strength, reduced hairiness, and improved evenness (see Figure 1).

The first compact spinning system to be commercialized is by the Rieter Corporation and is called Com4® spinning. This system was designed and is marketed only for use with extra-long-staple cottons to make only the very fine yarn sizes (i.e., 50 Ne and finer). However, compact spinning systems are also made by Suessen (the EliTe®) and by Zinser (the Air-Com-Tex 700®), both which are designed to accommodate the full spectrum of staple lengths spun today. These compact spinning systems offer the possibility of using cottons with shorter staple lengths to produce high-quality yarns that heretofore required long- or extra-long-staple cottons.

This paper reports results obtained from spinning various Texas upland cottons, along with some other representative U.S. upland cottons, on both conventional and compact spinning systems. The spinning machines used were the Suessen Fiomax 1000 (for conventional ring spinning) and the Suessen EliTe 1000 (the Fiomax 1000 fitted with the compacting system). The focus is twofold: (1) evaluate the performance of these cottons on modern conventional ring spinning machines, and (2) evaluate the improvements in performance resulting from compact spinning.

PROCEDURE

Thirty-one bales of Texas upland cotton were selected in a manner to ensure nine groupings of fibers with different values for fiber length and micronaire. Sampling strata and the resulting number of bales in each stratum are as follows:

Length Groups	Micronaire Groups		
	Low (<3.85)	Medium (3.85-4.35)	High (>4.35)
Short (<1.03")	5 bales	4 bales	3 bales
Medium (1.03"-1.08")	2 bales	4 bales	5 bales
Long (>1.08")	2 bales	1 bale	5 bales

The main cause of differing numbers of bales in each stratum (or cell) was the initial bale selection process being based on USDA classing data, but more exacting measurements taken at the International Textile Center shifted some of the bales to different categories. (Each bale was sampled at 10 layers throughout, with HVI measurements being done on each layer. Each measurement consisted of 4 replications of micronaire and 10 replications of length and strength.)

In addition to the Texas bales, 6 representative, high-quality bales were selected from other regions of the U.S. cotton belt: 3 bales from the Delta and 3 from California. Thus, all 6 of these bales fell into the "long" length category and care was taken not to get micronaire values higher than 4.90 from the Delta. The California cottons were all high-quality Acala varieties. The purpose of these 6 cottons, all of which are deemed appropriate for use on ring spinning systems, was to provide a better frame of reference for evaluating the performance of the Texas cottons.

A statistical summary of the HVI fiber data for all 37 bales used in the study is given in Table 1.

Preliminary experiments were done to evaluate the spin-ability limits of a representative Texas bale from each sampling strata. These experiments enabled an efficient selection of yarn sizes to make in the larger experimental design. Results from this made it clear that the compact spinning technology would open the

ring spinning to cottons that are not generally considered suitable for this process. Indeed, all of the test cottons could be taken far beyond typical spin-ability limits on a conventional ring spinning system. The experimental procedure used on all 37 cotton bales is shown in Figure 2. The yarn sizes for each length group were chosen to enable useful comparisons between the conventional and compact yarns.

The yarn produced at the close of these trials was tested for the following properties:

- Evenness on UT3 (10 bobbins; 400 m/bobbin)
- Single end break (10 bobbins; 10 breaks/bobbin)
- Skein break (10 bobbins; 1 skein/bobbin)
- Hairiness on Zweigle hairiness tester (10 bobbins; 100 meters/bobbin)

RESULTS AND DISCUSSION
Evenness Parameters

Analysis of variance on the yarn evenness data is summarized in Table 2. It accounts for the part of output variance from the yarn count within each length group (Length Group x Count), then tests for the effects of categorical factors (Spinning System, Length Group, and Length Group x Spinning System). Results indicate that, after controlling for the yarn count within length groups, there is no significant effect of compact spinning on yarn evenness parameters of the UT3.

The 26 Ne yarn size was the only one spun for every cotton bale (Figure 2). Therefore, it is used to illustrate the yarn evenness parameters resulting from the spinning trials (Figure 3). The results are similar for the other yarn sizes.

The 25% and 50% quality levels of the USTER Statistics are shown by the horizontal lines on the graphs in Figure 3, in order to provide benchmarks for the results shown. To facilitate reading the results, the 31 Texas cottons are listed first on the horizontal axis, followed by the 3 Delta cottons and then the 3 California cottons.

Conclusions from Figure 3 include the following:

- The compact spinning did not make much difference in the yarn evenness data from the UT3.

- Most of the Texas cottons compared well with the Uster Statistics; they fared worst for the thin places and best for the neps.

- Most of the Texas cottons performed better than the Delta cottons and some of the Texas cottons compared favorably with the California cottons.

Yarn Hairiness

The scatter plot showing UT3 hairiness indexes (H) for conventional versus compact yarns is given in Figure 4. The hairiness index values are highly correlated, but the values are significantly lower for the compact yarns (as shown by comparison with the equality line in Figure 4). In fact, the hairiness levels for the compact yarns are generally low enough to rank well into the best quartile of the Uster Statistics.

The scatter plot showing the Zweigle hairiness indexes (S3) for conventional versus compact yarns is given in Figure 5. Unlike the results with the UT3, the correlation between values for compact versus non-compact spinning is very low. The hairiness levels of the compact yarns are generally very low regardless of the levels exhibited by the conventional yarns. However, a few of the yarns in all length groups had S3 values that were quite high.

The foregoing observations are corroborated by the analysis of variance results in Table 3. The effect of compact spinning is highly significant, as is the interaction between length groups and compact spinning (Group x Spinning System).

The interaction effect (Group x Spinning System) may be visualized by charting the average H or S3 values for each length group on each of the spinning systems. This is done for the H values in Figure 6, using the 26 Ne yarn as a reference point. This shows that yarn hairiness improvement is greater for the shortest fibers (Length Group 1). The experimental design explicitly targeted the distinct length groups. However, there are other significant interaction terms that could have been explored (e.g., Strength Group x Spinning System, Short Fiber Content Group x Spinning System, Fineness Group x Spinning System, etc.). It is expected and that inclusion of these could alter the residual effect detected for the Length Group interaction term.

Yarn Tensile Properties

The relationships between conventional and compact yarn tensile properties are represented in Figures 7 and 8, for elongation and single-end strength respectively. The analysis of variance results for these two tensile properties are summarized in Table 4.

These results show that compact spinning resulted in a highly significant improvement in both elongation and strength of yarns. While the slight deviations of the regression line slopes suggest a possible interaction between compact spinning and these tensile properties (Figures 7 & 8), the analysis of variance (Table 4) shows that the "Length Group x Spinning System"

interaction term is not statistically significant at a 5% confidence level.

The average yarn strength values for each length group and for both conventional and compact spinning systems are illustrated in Figure 9. Again, 26 Ne yarn is used as reference point. While the gap between conventional and compact yarns is somewhat wider for the shortest fibers (Length Group 1), this difference was not statistically significant. As with the hairiness, it is quite likely that interactions with other variables affecting the yarn strength are occurring besides length groups. An alternative experimental design that allowed inclusion of these other variables might reveal a stronger residual effect for length groups.

A charting of the yarn strengths and elongations from each cotton bale with conventional versus compact spinning is given in Figure 10. It clearly shows that the compact spinning resulted in a generally higher strength and greater elongation for the 37 bales of cotton. It should be noted that the Texas cottons were specifically selected to include a wide spectrum of the cottons produced in this very large state, while the Delta and California cottons were selected to be representative of the average length of the upland cottons from these areas. The range of micronaire was selected in the same manner for all three locations. Clearly many of the Texas cottons perform equal to or better than the selected Delta cottons and some of the Texas cottons are comparable to the selected California Acala varieties.

CONCLUSION

The yarn structure resulting from compact spinning technology appears to get very close to a maximum utilization of each fiber in the yarn bundle. This makes it possible to achieve higher yarn strength from any fibers used. However, the improvements in yarn strength appear to be greater for shorter stapled cottons than for the longer staple lengths. These results made it clear that some fibers that were inadequate for use in conventional ring spinning may be spun satisfactorily on the compact system.

As expected, compact spinning greatly reduced the hairiness of yarns. As with the tensile properties, the greatest reductions in hairiness occurred with the shorter stapled fibers.

Compact spinning did not result in significant improvements in any of the yarn evenness parameters tested with the UT3. Furthermore, this conclusion held for all staple length categories.

Taken together, these results suggest that compact spinning technology may enable us to extend the use of shorter stapled cottons into the manufacture of finer yarns than has heretofore been feasible. It exemplifies a technological innovation that, instead of making greater demands on fiber properties, actually compensates for the lack of certain fiber properties.

Finally, these results reveal that some of Texas' cottons are among the best upland cotton fibers produced in the U.S. Thus, on average the Texas cottons performed as well as or better than the high-quality Delta cottons on both the conventional and compact ring spinning systems. And a subset of the Texas cottons performed as well as or better than the high-quality California cottons.

REFERENCES

Artzt P., 2000. The special structure of compact yarns - Advantages in downstream processing. Beltwide Cotton Conferences, January 4-8, San Antonio, TX (USA), National Cotton Council of America. Memphis, TN (USA), pp. 798-803.

Hequet E., Ethridge D., and Cole W. D., 1998. Evaluation of improvement in yarn quality with new ring spinning frame. Textile Topics (4: fall 1998): 2-8.

Meyer U., 2000. Compact yarns: innovation as a sector driving force. Melliand International, 6 (1): 2.

Olbrich A., 2000. The AIR-COM-TEX 700 condenser ring spinning machine. Melliand International, 6 (1): 25-29.

Seuberling J., 1995. Advanced standard in ring spinning. Melliand International (1): 25-26.

Stahlecker H., 1995. Fiomax: High speed spinning machine. Melliand International (1): 27-28.

Stalder H., 2000. New spinning process ComforSpin. Melliand International, 6 (1): 22-25.

Table 1: Summary of main HVI fiber properties of the 37 bales.

	Mean	Minimum	Maximum	Std. Dev.
Micronaire	4.2	3.7	4.8	0.352
Length (")	1.06	0.99	1.18	0.050
Uniformity (%)	82.2	81.1	84.2	0.728
Strength (g/tex)	28.4	22.3	33.4	2.514
Elongation (%)	6.4	5.7	7.2	0.414
Leaf grade	1.4	1.0	2.7	0.462
Rd (%)	76.0	72.7	79.2	1.673
+b	9.5	8.1	11.1	0.652

Table 2: Testing compact spinning effect on yarn evenness.

Factor	CV%	Thin Places	Thick Places	Neps (+140%)	Neps (+200%)	Neps (+280%)
Length Group x Count	***	***	***	***	***	***
Spinning System	NS	NS	NS	NS	NS	NS
Length Group	NS	NS	**	**	*	NS
Length Group x Spinning System	NS	NS	NS	NS	NS	NS

***Significant at α = 0.001; **Significant at α = 0.01; * Significant at α = 0.05; NS = not significant

Table 3: Testing compact spinning effect on yarn hairiness.

Factor	Ut3 H	Zweigle S3
Length Group x Count	***	NS
Spinning System	***	***
Length Group	***	NS
Length Group x Spinning System	***	**

***Significant at α = 0.001; **Significant at α = 0.01; * Significant at α = 0.05; NS = not significant

Table 4: Testing compact spinning effect on yarn tensile properties.

Factor	Elongation (%)	Single break strength (cN/tex)	Skein break (lbf. Ne)
Length Group x Count	***	***	***
Spinning System	***	***	***
Length Group	**	NS	NS
Length Group x Spinning System	NS	NS	NS

***Significant at α = 0.001; **Significant at α = 0.01; * Significant at α = 0.05; NS = not significant

Conventional Spinning Triangle

Compact Spinning Triangle

sliver width B

sliver width B

airflow

clamping line

height spinning triangle

height spinning triangle

spinning tension

spinning tension
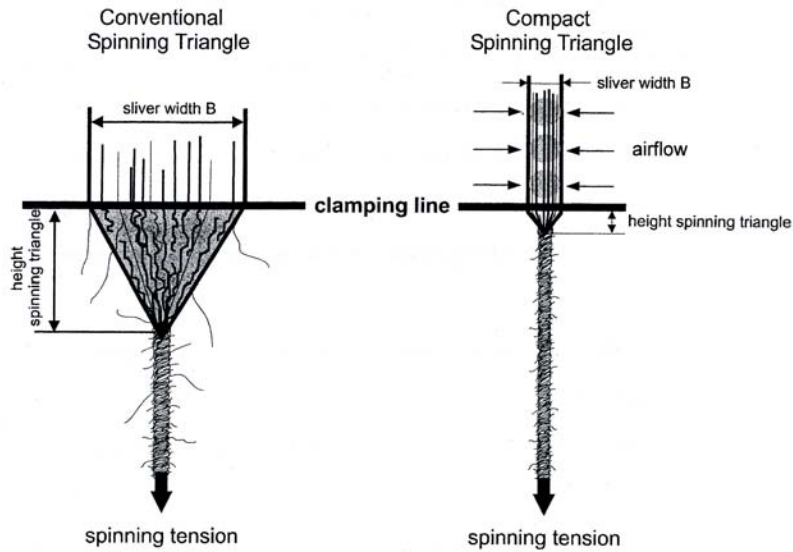
Source: P. Artzt, D. Betz, W. Joas,
Inst. of Textile Technology and Process Engineering
Denkendorf, Germany

Ring Yarn

Compact Yarn

200 µm

200 µm
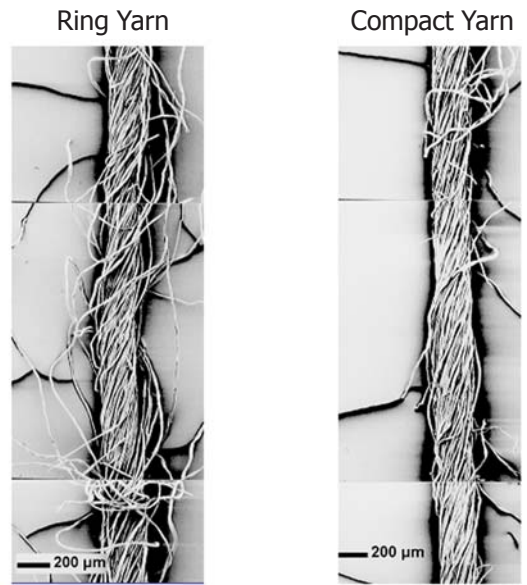
Source: Zinser|Saurer Group

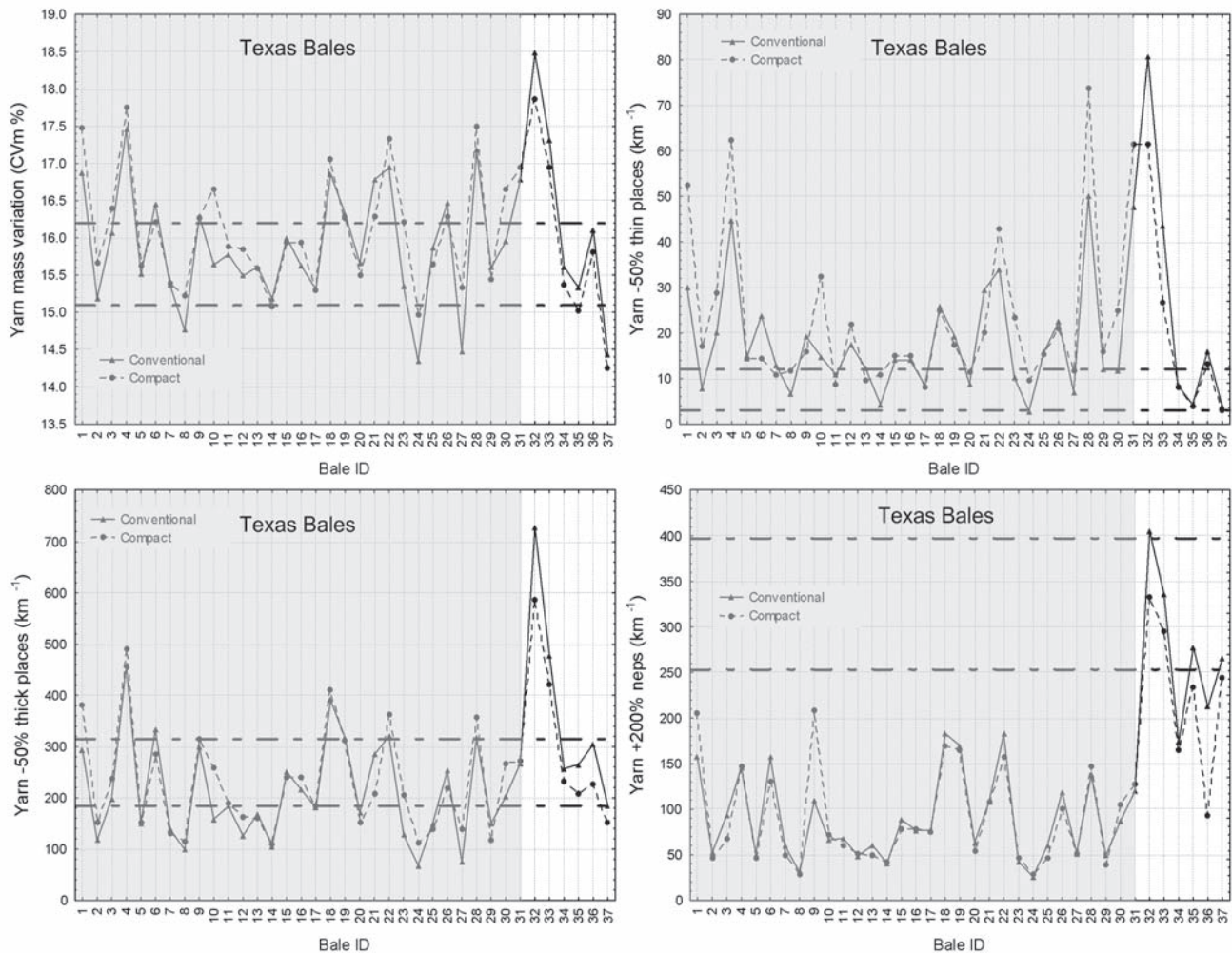Figure 1: Spinning Triangle and Yarn Structure; Conventional Ring Spun Yarn Versus Compact Yarn

Figure 3: 26 Ne Conventional and Compact Yarn Evenness Perameters
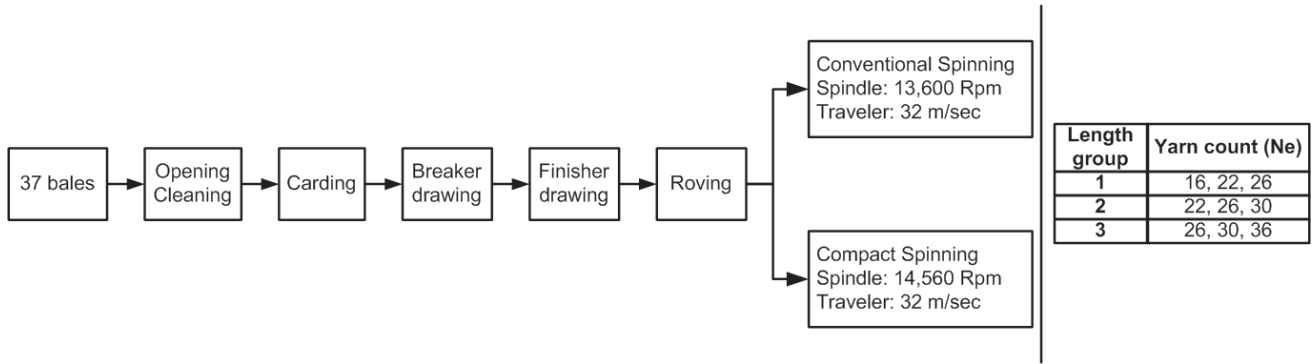
Figure 2: Spinning Procedure
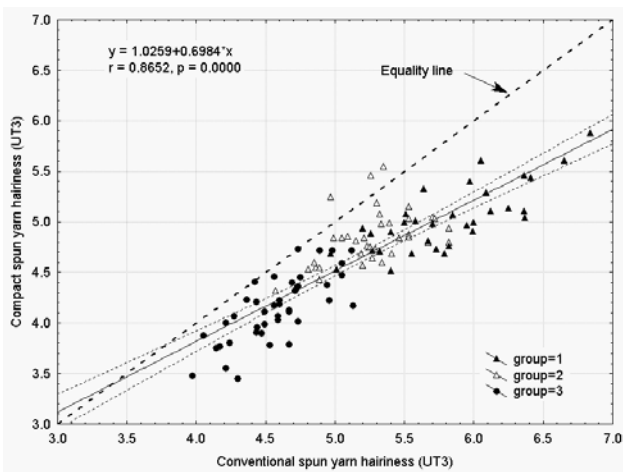
Figure 4: Hairiness (UT3), Conventional vs. Compact Yarns (26 Ne)
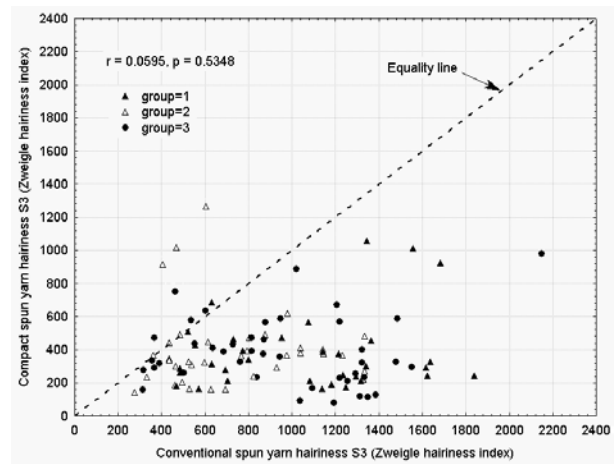
Figure 5: Hairiness (S3), Conventional vs. Compact Yarns (26 Ne)
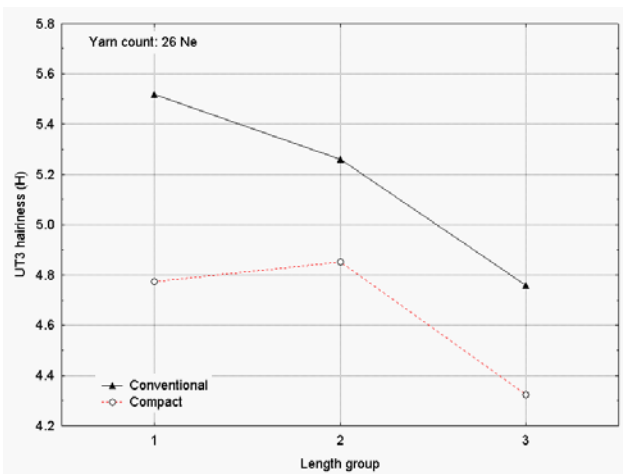
Figure 6: Average Hairiness (UT3) by Length Groups, Conventional vs. Compact Yarns
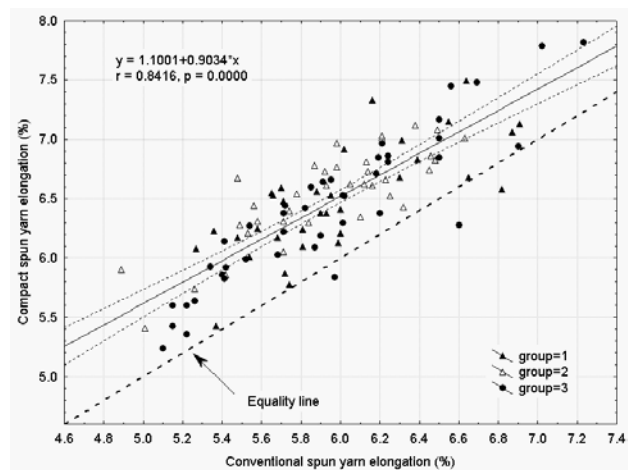

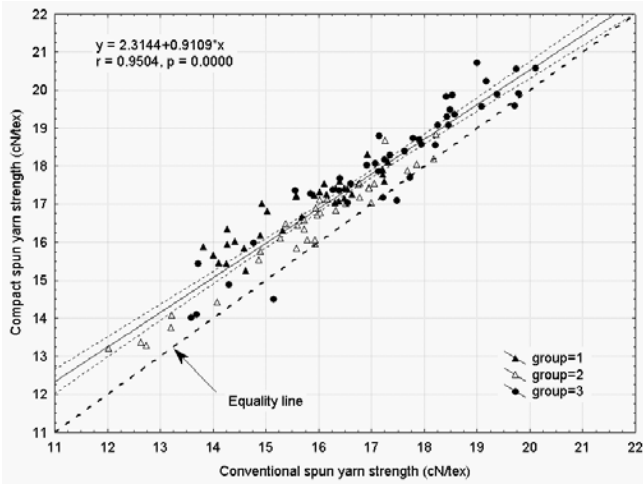Figure 7: Elongation (%), Conventional vs. Compact Yarns (26 Ne)

Figure 8: Single-end Break Strength (cN/tex),
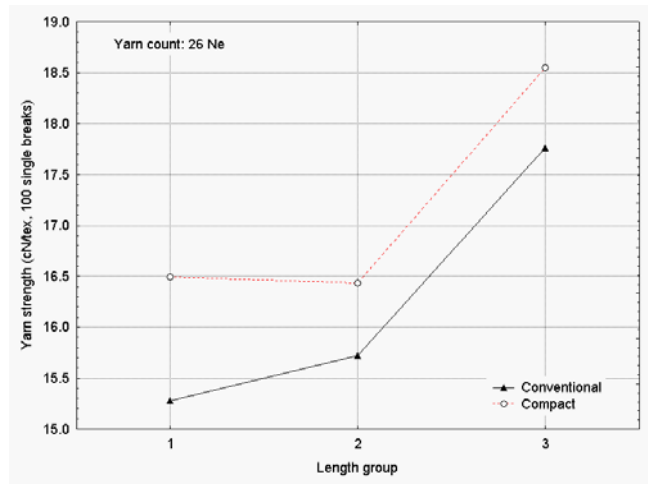Conventional vs. Compact Yarns (26 Ne)

Figure 9: Average Yarn Strength (cN/tex) by Length
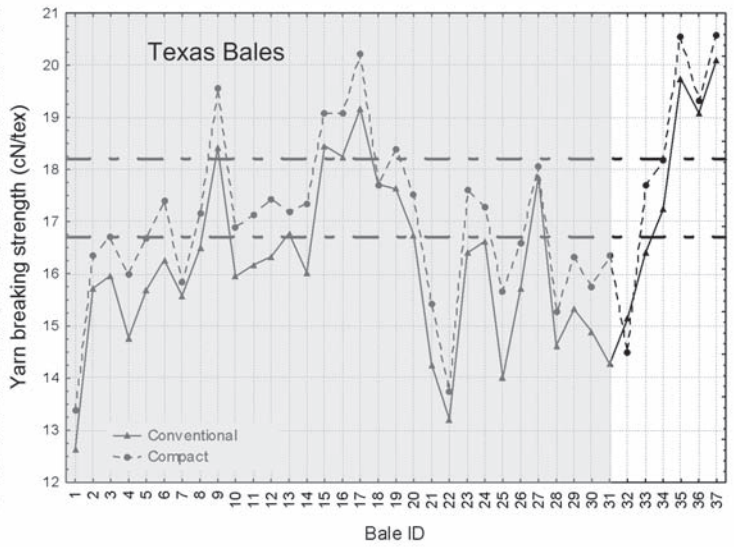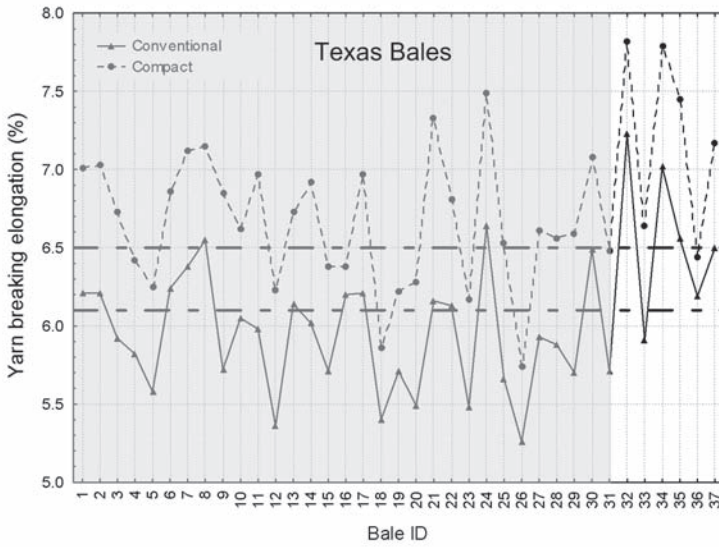Groups, Conventional vs. Compact Yarns

Figure 10: 26 Ne Conventional vs. Compact Yarn Tensile Properties