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INVESTIGATE THE EFFECT OF SPINDLE SPEED AND TRAVELER þÿ W E I G H T O N 2 1 â N e C O T T O N R SPUN YARNS QUALITY AND PROPERTIES

MULUGETA, DANIEL

INVESTIGATE THE EFFECT OF SPINDLE SPEED AND TRAVELER WEIGHT ON 21^{s}Ne COTTON RING SPUN YARNS QUALITY AND PROPERTIES

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INVESTIGATE THE EFFECT OF SPINDLE SPEED AND TRAVELER WEIGHT ON 21^{s}Ne COTTON RING SPUN YARNS QUALITY AND PROPERTIES

BY

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Under the supervision of

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ABSTRACT

There are various parameters during yarn production which can influence the quality of yarn. Two of them are the traveler weight and spindle speed on a ring spinning machine. This work was undertaken to study the effect of traveler weight and spindle speed on the quality of 21^{s} Ne 100% cotton carded yarn. The C-type travelers were used for this study. Five different traveler 31.5, 35.5, 40, 45, and 50mg weights were used and tested at the spindle speed of 12000, 13000 and 14000 rpm. The yarn samples obtained by using different traveler's weights and spindle speed were tested for hairiness, amount of twist, tensile strength, and elongation %. Results showed that there was a decrease in the yarn hairiness as the spindle speed and traveler weight at 14000rpm and 50 mg respectively. At the spindle speed of 12000 rpm and traveler 50 mg the optimum tenacity and twist were achieved whereas the spindle speed13000 rpm and traveler 31.5 mg gave optimum elongation.

Approval page

I certify that I have supervised /read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in quality and scope, as a thesis for the fulfillment of the requirements for the degree of Master of Science in Textile Manufacturing.

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This is to certify that the thesis entitled "Investigate the effect of spindle speed and traveler weight on 21Ne cotton ring spun yarns quality and properties" submitted in fulfillment of the requirements for the degree of master's with specialization in Textile Manufacture, the Graduate program of the Ethiopian Institute of Textile and Fashion Technology, and has been carried out by **Daniel Mulugeta Mukuriaw, ID No. MTM /R/002/08** under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence Hereby can submit the thesis to the institute.

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Signature of candidate ________________

Date : ________________________________

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Abbreviations

GLM : General Linear Model
mg : Milligram

HVI : High Volume Instrument

SPSS : Statistical Package for the Social Sciences

TPM : Turns per meter

NE: English cotton count

RPM: revolution per minute

U%: unevenness

cN/Tex: centi Neuton per Tex

H: Hairiness

CM: Centimeter

BDTSC: Bahir Dar textile shear company

EiTEX: Ethiopian institute of textile and fashion technology

ASTM: American standard testing and measurement

SP: Spindle speed

T: Traveler

Avg: Average

N: Number

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Ring spinning stands alone as the primary choice to spin high quality yarn from almost any type of textile staple fiber. Other spinning systems provide higher production speed than the traditional ring spinning. However, they are restricted to only narrow ranges of textile products by virtue of their technological limitations. The primary technological limitation of ring spinning lies in the ring-traveler system (Y. E. M. Faissal Abdel-Hady, 2004). Ring frame technology is simple and old, but the quality and production requirements at the present scenario puts a lot of pressure on the technologist to bring advancement in the machine to improve the production, efficiency and quality, so that a yarn can be produce at a lower manufacturing cost.

Traveler weight determines the magnitude of frictional forces between the traveler and the ring, and these in turn influence the winding speed and balloon tension (T. Nemailal , 2002). Weight of the traveler to be selected depends upon the yarn count, yarn strength, spindle speed and raw material. Traveler weight influences on yarn quality and production. The production in terms of traveler speed can be defined as the maximum rate at which the traveler moves along the ring flange expressed in feet per minute (KANAI).

Experience has shown that, for any given traveler, there is a limit to maximum practical speed, if that is exceeded, the high amount of heat develops due to the friction with the ring. In turn, the traveler is burnt, in a very short time, and fly of the rings. When this happens in a spinning room, the "ends down" or breakage rate is increased. Yarn quality parameters can be improved by proper traveler weight selection, which results in reducing yarn breakages, mass variation, twist variation and hairiness. Thus, in this way, the increased quantity and quality of the yarn along with the low spinning cost can be obtained (Barella*, et al, 2002*).

As spindle speed is generally an important factor when considering yarn quality, the life of machine or its parts. When machine runs at maximum speed, the traveler has higher tendency to wear out. However, as long as end breakage does not occur unreasonably, there is a strong tendency to keep the speed of spinning up and replace travelers to maximize speed. Gain in production due to traveler replacement is preferred against the traveler cost (B. Azzouz*, et al, 2007*).

Light weight travelers are recommended for spinning the fine yarns and heavier weight travelers for coarser yarn spinning. Furthermore, travelers have short life; it is therefore, necessary to replace it as soon as required and avoid the unnecessary machine stoppage (S. C. I . Usta ,2002).

As far as yarn count, quality and strength are concerned, the proper size of traveler weight and spindled speed are determined. Yarn tension varies with the amount of yarn on bobbin. During winding the spun yarns, yarn tension on an empty bobbin is higher than on the full bobbin (REINERS+FURST, 1999). It is because when the ring rail is at the lower part of its traverse, the length of yarns tends to form a large balloon, due to air resistance.

1.2. STATEMENT OF THE PROBLEM

The same yarn count was produced with different spindle speed and traveler weight posses' different yarn quality parameters. This has not been identified by mill technicians and hence, they are not clear about the spindle speed and traveler weight that is specifically required for 21Ne ring frame spun yarn.

1.3. OBJECTIVES

1.3.1 General objectives:

To identify the optimum spindle speed and traveler weight to spin 21Ne cotton ring spun yarns.

1.3.2 Specific objectives:

- To select optimum spindle speed and traveler weight for specific 21Ne yarn count
- To optimize yarn quality
- To create awareness on the effects of spindle speed and traveler weight.

1.4. JUSTIFICATION

The various factors that affect the yarn quality can be, fiber causes, operator cause, environment conditioning and machine causes.The fiber causes are fineness, elongation, strength, length, micronial value, maturity and color. The environment causes are relative humidity and temperature. From Machine cause spindle speed, drafting roller setting, traveler type and weight and ring diameter.

Different scholars studied and investigated the effect of fibers, air conditioning, operator causes, and some of machine causes on yarn quality and properties. Among the machine causes except few no researchers showed the effect of spindle speed and traveler weight on yarn properties and qualities such as strength, evenness, hairiness, twist amount, elongation and mass variation percentage.

In this thesis work, I planned to study the effects of different traveler weights at different spindle speeds on yarn quality by carrying out proper testing and analysis from the produce sample yarn.

CHAPTER TWO

LITERATURE REVIEW

2.1. INTRODUCTION

The aim of the ring frame is to produce the desired yarn and this is achieved firstly by drafting the roving to the desired count, inserting twist in to the yarn and building a package for transporting the yarn to the winding department. The ring spinning machine has been in use for decades if not the last century and has remained the preferred choice of machine for the production of yarn. The reason for the continued success has been the superior quality of yarn produced by the ring spinning machine to that produced by the rotor or air jet machine. The yarns produced, when compared, are stronger than rotor or air jet produced yarns, are less hairy and hence they are preferred for skin contact fabrics (Das and Ishtiaque, 2004). Although air jets and friction spinning produce yarn at superior speeds than ring spinning, ring spinning is widely used for textile applications as it produces yarns with highest quality when compared to the other methods of production.

The ring frame normally has maximum speed of 25000rpm whereas the rotor can run at speeds of up to 120000 rpm (Khona, 1999). This thesis aims to investigate the interaction between traveler weight and spindle speed on yarn quality.

2.2. Effect of spindle speed and traveler weight on spinning tension

Spinning tension can be detrimental or beneficial to the production of yarns (Rengasamy et al., 2003). The effect depends on the magnitude of the tension which is proportional to the friction coefficient between ring and traveler, the traveler mass and the square of the traveler speed which is related to the spindle speed (Khona, 1999).

$$Tension \sim friction \times speedof\ traveler^2 traveler\ mass \ldots\ldots\ldots\ldots\ldots\ldots\ldots. equation\ (i)$$

On the other hand the spinning tension is inversely proportional to the ring diameter and the angle between the connecting line from the traveler-spinning axis to the piece of yarn between the traveler and cop. Spinning tension determines hairiness of the yarn both positively and negatively depending on the tension magnitude count ratio with lower tension resulting in greater hairiness values than with higher tensions for a given count. This is the reason why heavier travelers result in low yarn tensions but if the traveler is too heavy, the yarn hairiness will also increase. Spinning tension also affects the strength of the yarn with higher tension producing stronger yarns than with lower tensions. Increases in tension may lead to increased end breakages per 1000 spindles (Su et al., 2013).

2.3. Effect of Spindle speed and yarn properties

The spindle Speed an important technical parameter in spinning process (Md. Osman GhaniMiazi et al., 2009). Studies on the effect of speed have shown that the increase in speed does, generally, result in the decrease in hairiness for a certain range of spindle speeds (between 10000rpm and 14000 rpm) before increasing above a certain speed (about 15000 rpm).

Sengupta(1993) revealed that for polyester an increase in the spinning speed resulted in an increase in the Uster (Um%) value while for the viscose fibres there was a decrease in the Uster value. According to Sengupta, the extensibility of viscose is lower than that of polyester and as such regularity improved or increased due to the increase in the ratio of dynamic to static friction. The increase in the ratio meant that cluster fibres were not dependent on one another but behaved independently. Using a double apron system, Sengupta observed a decrease in yarn irregularity with increases in spindle speed. (Govindarajuluet al.1993) observed that for 40s, while at speeds between 10000 rpm and 13000 there was an increase in the number of thin and thick places.

Yarn hairiness is defined as the protrusion of fibers from the core of the yarn structure (I Usta and Canoglu, 2002, Xungai Wang and Lingli Chang, 2003). The effect of yarn is felt in the latter stages of production that is in weaving, knitting and winding where it may hinder the smooth processing of the products and also during the use of the garment (Lang et al., 2006). During wear, yarn hairiness affects fabric appearance, handle and thermal insulation, pilling propensity and yarn strength. Generally hairiness is affected by the spindle speed and traveler weight. Conclusions on the effect of the parameters have been drawn with most authors concluding that higher spindle speeds result in higher levels of hairiness of the yarn (Wang and Miao, 1997). Other factors to influence yarn hairiness include humidity, balloon control rings, separator plates and forward eccentricity.

2.4. Effect of spindle speed on Spinning Triangle

The zone between the line of contact of the pair of delivery rollers and the twisted end of the yarn is called the spinning triangle says Celik et al. (2004) In conventional spinning, it is formed immediately after the drafting mechanism in the ring frame (Figures 2.1) The spinning triangle is a weak zone due to less twist in that region. Under normal working conditions, most of the breaks occur in the near-vicinity of the spinning triangle. The strength of the fibrous mass in the spinning triangle determines the attainable spindle speed. Hence if the spinning triangle is avoided, or its length reduced, the achievable spindle speed could be increased, reveals, Sitra (2001)

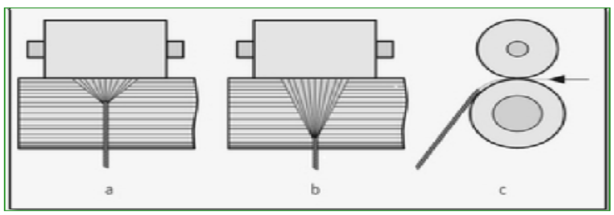

Figure 2.1 Formation of the Spinning TriangleShort (a) and long (b) spinning triangle, (c) side view

2.5. Effect of Spindle Speed on Unevenness of Yarn

The effect of spindle speed on yarn unevenness U % for 20, 25, and 30 tex yarn counts used. The result revealed that the irregularity found in the yarn with respect to the variation in spindle speed. Yarn unevenness kept on decreasing as the spindle speed was increased from 11,000 rpm up to 17,000 rpm. This can be ascribed based on the fact that as the spindle speed increase, the ratio of dynamic to static frictional force of the drafted ribbon increases. As a consequence, the floating fibers prefer to take the intermediate speed and ensure shuffling of the fibers in the drafting zone by (Ishtiaque, R. Rengasamy, and A. Ghosh 2004). These factor**s** may be responsible for the decrease in irregularity. At around 17,000 rpm, the yarn irregularity was found to be minimal. With the manner so that the erratic movement of floating fibers is restricted, reducing the yarn U%(A. Chaudhuri 2003). Beyond 17,000 rpm, the yarn irregularity started to increase again. At higher spindle speed, the rubbing forces between the yarn surface and different machine parts, together with larger balloon diameter, abrade the surface of yarn (S. Ishtiaque, R. Rengasamy, and A. Ghosh 2004), disturbing the alignment of the fiber array in yarn body. This results in increased irregularity of the yarn. It can be said that irregularity can be minimized by drafting the yarn at 17,000 rpm spindle speed. Also reveals that U% increases with decreasing count.

2.6. Effect of Spindle Speed on Hairiness Index

Yarn hairiness was found to have variation with respect to the variation in the spindle speed. These results are compared for 20, 25, and 30 tex yarns respectively. It is noticeable that hairiness kept on decreasing as the spindle speed increased from 11,000 rpm to 17,000 rpm. This may have been resulted because as the increase in spindle speed which makes the twist to flow closer to front roller nip and spinning triangle became smaller and fibers in selvedge better integrated into the yarn (F.F. Zhu, Z.L.Zhong, H. Guo, and X.G.Wang ,2012). It then started to increase after 17,000 rpm. It can be ascribed based on the fact that at higher spindle speeds, above 17,000 rpm, air drag and heat generation due to frictional contact of the fibers increases, together with the centrifugal force acting outwards on the yarn, this results in increased spinning tension and that gives more outward force of the tail end of the fibers causing formation of more protruding ends. Thus, it can be said that at 17,000 rpm we can produce a yarn that is optimum in terms of hairiness.

2.7. Effect of Spindle Speed on Yarn Strength

The results for the effect of spindle speed on yarn tensile strength such that as the spindle speed increases from 11,000 rpm up to 17,000 rpm the breaking strength correspondingly increases however it decreases gradually as the speed is increased beyond 17,000rpm. Strength of the yarn is dependent on the fiber strength initially and then the alignment of the fibers in the fiber strand(K. Cheng and C. Yu, 2003), (A. Ghosh, S. Ishtiaque, and R. Rengasamy 2005). A regular yarn without many hairs on its surface can better with stand the force acting on it. Therefore, it was found that the yarns spun at 17,000 rpm have better strength as compared to other yarn spun at lesser or high spindle speed. Drafting force increases the normal force over the fibers and this may reduce the fiber slippage and hence more fibers can be caught within the yarn twist easily, resulting in greater yarn strength. The resulted breaking force is reported to be maximum at 17,000 rpm. However, the breaking force decreases as the spindle speed increases beyond 17000 rpm. This can be based on the fact that at elevated spindle speeds, the yarn hairiness increases.

2.8. Effect of Spindle Speed on Surface Structure of Yarn

(Iftikhar Ali Sahito, AlviraAyoubArbab, and Sung HoonJeong†2015) reported that the effect of variation in spindle speed was observed on the surface structure of yarn. Video Microscope was used to view and analyze the structure of yarn and investigate the type of variation.. The fibers are seen to be in an arbitrary position within the yarn structure. The fibers are seen to be in arranged randomly, having found no proper alignment, at the yarn surface. As the spindle speed is increased, the fibers are seen to become parallel and due to that they are caught in the twist. A further increase in the spindle speed gets the fibers more parallel and yarn structure seems to be regular at 13,000 rpm and 15,000. It is seen that at 17,000 rpm spindle speed, the yarn surface structure is most smooth and are most aligned. After 17,000 rpm spindle speed, the surface structure is seen to get hairy as observable and more hairy at 21,000 rpm spindle speed and can go beyond if spindle speed is increased further.

2.9. Effect of spindle speed on yarn irregularity (u%)

(Iftikhar Ahmad, 1Nisar Ahmad Jamil and NadeemHaider, 2002) reported that highly significant effect of spindle speed levels on yarn irregularity percentage. The reported described the average u% values for 30s carded recorded at spindle speeds 15600, 16400, 17200 and 18000rpm as 11.95, 12.21, 12.09 and 12.32 % respectively. The best lowest mean value of u% was obtained at sp1 as 11.95 %, whereas, the irregularity increased significantly on increasing the spindle speed.

2.10. Effect of Traveler weight on yarn properties

A number of authors have found that with the increase in traveler weight there is an reduction in the hairiness of the yarn (I Usta and Canoglu, 2002, Pillay, 1994). The reduction thought up to a certain weight before it begins to increase again. The ring has an influence on the spinning process hence it may have an effect on the hairiness. Hairiness in turn has an effect on the energy consumption and drag hence it may affect the tension of the yarn in the spinning process (Tang et al., 2006).

(Barella*, et a*. vol. 31, 2002) mentioned that yarn quality parameters can be improved by proper traveler weight selection, which results in reduced yarn breakages, mass variation, twist variation and hairiness. Thus, in this way the increased quantity and quality of the yarn along with the low spinning cost can be obtained.

(G. R. Merril,1999, S. C. I .Usta,2002) reported that light weight travelers are recommended for spinning the fine yarns and heavier weight travelers for coarser yarn spinning. Furthermore, travelers have short life, it is therefore, necessary to replace it as soon as required and avoid the unnecessary machine stoppage.

2.11. Effect of Traveler weight on Yarn Hairiness

(Pardeep Kumar Gianchandani1 2012**)**described that the traveler weight has an influence on the yarn hairiness especially lighter weight travelers producing more hairiness as compared to the heavier weight travelers. It is because light weight travelers form large balloon size which comes in frictional contact with the spindle separators.

2.12. Effect of Traveler weight on Yarn Twist

(S. C. I .Usta,2002) reveled that variation in traveler weight has a significant impact on yarn twist (turn per meter, tpm). Generally, when ring frame operates at constant spindle speed having same traveler weight, the yarn tpm does not change. The lighter weight traveler (3.2 gm) produced a yarn of 725 tpm and the heavier weight (9.8 gm) traveler produced 670 tpm. In other words, the twist decreases with increasing traveler weight. This is because lighter weight travelers have high surface speed as compare to heavier weight traveler.

2.13 Effect of Traveler weight on Yarn Breakage

(Abdul Khalique Jhatial1, Pardeep Kumar Gianchandani1, Uzma Syed 1, Iftikhar Ali Sahito1,2012) reported that the lighter weight travelers caused more yarn breakage, hence, the machine efficiency and production was decreased. This may be because the lighter weight travelers increase the traveler speed but on the other hand it disturbs the winding speed. This disturbance causes more yarn breakages during winding and also deteriorates the yarn quality.

CHAPTER THREE

METHOD AND MATERIALS

3.1. Methods

This thesis was designed to solve the described problem by the following methods. The methods were clearly listed below.

- Identify fiber properties.
- Identify different spindle speed and traveler weight on G 35 ring frame machine.
- Sample yarns are produced with different traveler weights and spindle speeds keeping the other parameters constant.
- Study yarn properties by carrying out yarn testing using ASTM standard.
- Analyze the results using SPSS general linear model.
- Finally conclude and report based on SITRA 2010 standard.

The data related to this Thesis work was collected from BDTSC as well as from EiTEX laboratory. Relevant data related to effect of spindle speed and traveler weight properties include fiber properties, spinning machine parameters, yarn parameter, properties and test results were collected.

The data collection system includes online observation during machine setup parameters, checking documents and testing with appropriate recordings.

3.2. Materials

3.2.1. Fiber properties

The sample yarn were produced using 100% cotton which contain fiber properties were shown in Table 3.1

Table3.1 Fiber properties

Fiber Properties						
Type of fiber	Origin	Staple length(mm)	Short fiber (%)	Strength (g/tex)	Elongation (%)	Micronaire
Cotton (100%)	Ethiopia	27.66	11.9	27	6.5	3.92

3.2.2. Sliver and roving

Card and drawing frame sliver were produced by C60 carding machine and D45 drawing frame with auto leveler and roving strand produce by F15 roving frame machine.

Table3.2 sliver and roving parameters

Material	Average count(Ne)	Standard variation	Cv%
Sliver from card	0.1	0.002	2.214
Sliver from draw frame	0.11	0.002	1.852
roving	0.82	0.0079	0.975

3.2.3. Travelers

The travelers used in the study were of the flat type made from steel, hardened and tempered to give the necessary strength to prolong the life of the traveler.

Table3.3 Traveler type use

	Average mass (mg)	Traveler type (symbol)
Bracker ISO 2/0	50	T1
BrackerISO 3/0	45	T2
BrackerISO 4/0	40	T3
BrackerISO 5/0	35.5	T4
Bracker ISO 6/0	31.5	T5

3.2.4. Ring frame spinning machine

The Reiter G-35 could be used to produce the sample yarn. The speed of the machine was checked and changed verified below.

Table3.4 spindle speed rpm

Spindle speed type	Speed(rpm**)**
Sp1	12000
Sp2	13000
Sp3	14000

3.2.5. Sample combination

Five different travelers weight and three different spindle speeds were used to produce the 21Ne yarn samples, all possible combinations between the travelers and spindle speeds were used to give different treatment combinations as shown in the Table 3.5

Table3.5 sample combination

	Spindle speed RPM	Traveler type
Combination 1	Sp1	T1
Combination 2	Sp1	T2
Combination 3	Sp1	T3
Combination 4	Sp1	T4
Combination 5	Sp1	T5
Combination 6	Sp2	T1
Combination 7	Sp2	T2
Combination 8	Sp2	T3
Combination 9	Sp2	T4
Combination 10	Sp2	T5
Combination 11	Sp3	T1
Combination 12	Sp3	T2
Combination 13	Sp3	T3
Combination 14	Sp3	T4
Combination 15	Sp3	T5

3.2.6. Sample preparation

The process flow and the machines used for sample production Bahir Dar textile Shear Company are shown in Figure 3.1.

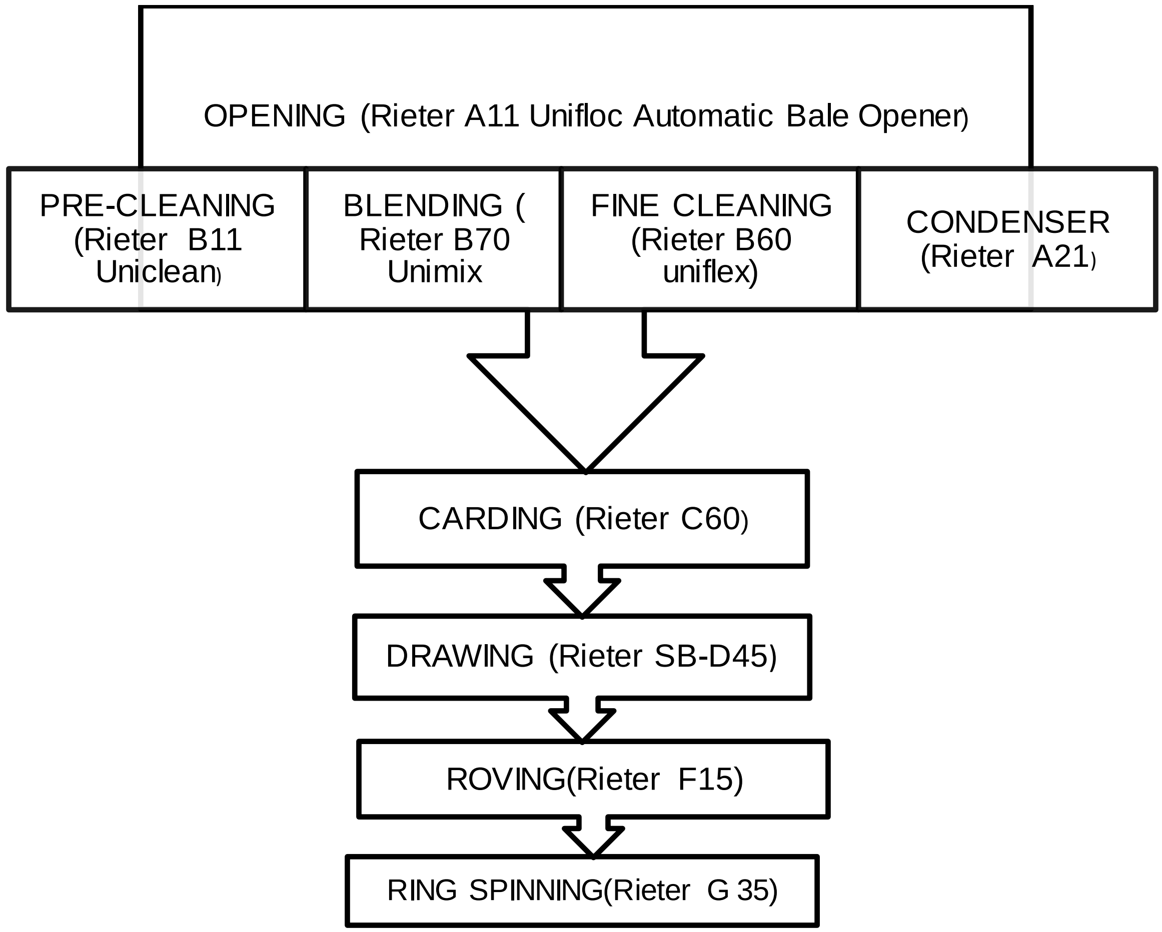

Figure 3.1 Process flow and the machines used for sample production

3.2.7 Testing equipment and Test standards

Table3.6 Testing equipment and standard

	Name of equipment	Test parameter	standard	Located in
1	HVI (Uster tester 1000)	Fiber property	ASTM D4604	EiTEX
2	Count Tester	Linear density of yarn	ASTM D1059	EiTEX
3	Uster tester-5	Hairiness	ASTM D5647	EiTEX
4	UsterTensorapid Strength tester	Yarn strength	ASTM D2256	BDTSC
5	Electronic twist Tester	Twist	ASTM D1422	EiTEX

3.2.8 Testing and Evaluation Procedures

All tests were carried out under standard atmospheric conditions, i.e. 20±2 C° temperature and 65±2 % relative humidity. The samples were conditioned for a minimum 24 hours before tests

3.2.8.1 Yarn hairiness

The standard ASTM D5647 was used for the test. The hairiness was measured using the Uster® Tester 5 Hairiness tester. The machine measures the number of hairs per centimeter by analysis a 500 meter sample at a speed of 400 m/min

3.2.8.2 Yarn twist

Twist measuring instruments based on untwist-re twist principle for measuring the twist in ring spun yarns. An automatic twist tester, which works on untwist-re twist principle in accordance with ASTM D1422 standard, and the average of 10 test results were presented for each yarn sample. In addition, twist to break test is used, where the yarn is over twisted in the original twist direction until the yarn breaks, and the yarn was untwisted and then re twisted until the yarn breaks, and the twist was calculated based on these two measurements.

3.2.8.3 Tensile strength

The standard ASTM D2256 was used for the tensile tests. The tensile strength was determined using the Tensoriped 50 centimeter of samples yarn. It was used to measure the resistance of yarn, cable and similar products. The maximum force was 50 kgf (500 Newton).It has features of reading maximum rate of breaking off. Device saves resistance of sample which was pressed between jaws device has an automatic feeding system for 10 bobbins.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 RESULT

4.1.1 Yarn Hairiness

The machine measures the number of hairs per centimeter by analyzing a 500 meter samples length**.** The yarn hairiness test result are shown in table 4.1, 4.2 and 4.3

Table4.1 Hairiness at spindle speed12000rpm

Traveler	At spindle speed 12000 rpm										
weight(mg)	number of test										
	1	2	3	4	5	6	7	8	7	10	Avg.
31.5	7.36	7.48	7.71	7.68	7.44	7.32	7.43	7.52	7.41	7.28	7.4833
35.5	7.33	7.54	7.27	7.51	7.37	7.45	7.53	7.34	7.35	7.43	7.41
40	7.21	7.3	7.18	7.27	7.53	7.41	7.11	7.5	7.49	7.56	7.3333
45	7.27	7.44	7.33	7.27	7.21	7.29	7.11	7.24	7.33	7.37	7.2767
50	7.04	7.31	7.22	7.12	7.21	7.63	7.14	7.31	7.32	7.49	7.2556

Table4.2 Hairiness at spindle speed13000rpm

Traveler	At spindle speed 13000 rpm										
weight(mg)	number of test										
	1	2	3	4	5	6	7	8	7	10	Avg.
31.5	7.46	7.5	7.35	7.45	7.23	7.65	7.56	7.4	7.28	7.53	7.4311
35.5	7.25	7.32	7.08	7.16	7.3	7.2	7.15	7.22	7.18	7.16	7.2067
40	7.19	7.03	7	7.12	7.18	7.02	7.14	7.23	7.2	7.05	7.1233
45	7.27	7.4	6.99	7.35	7.15	7.35	7.19	7.45	7.07	7.3	7.2467
50	6.64	6.87	6.82	7.23	6.95	6.83	6.74	6.79	6.88	7.15	6.8611

Table4.3 Hairiness at spindle speed14000rpm

Traveler weight(mg)	At spindle speed 14000 rpm number of test										
	1	2	3	4	5	6	7	8	7	10	Avg.
31.5	7.5	7.68	7.47	7.53	7.62	7.46	5.61	7.48	7.59	7.55	7.349
35.5	7.3	7.44	7.26	7.6	7.51	7.29	7.52	7.47	7.01	7.6	7.4
40	7.31	7.52	7.51	7.49	7.43	7.35	7.11	7.37	7.46	7.09	7.364
45	7.44	7.18	7.12	7.24	7.25	7.34	7.46	7.43	7.26	7.29	7.301
50	6.49	6.74	6.71	6.74	7.35	6.99	6.94	6.74	7.3	6.7	6.87

4.2.2 Yarn Twist

In simple terms the machine untwists 50 cm of the samples and re twists in the Z direction back to the original length. The test result are show in table 4.4,4.5 and 4.6.

Table4.4 Twist at spindle speed12000 rpm

Traveler weight(mg)	At spindle speed 12000 rpm number of test										
	1	2	3	4	5	6	7	8	7	10	Avg.
31.5	1110	989	1033	1026	1051	1028	1013	1086	1037	1022	1040
35.5	1071	1062	990	1054	1042	1049	1069	1060	970	1078	1044
40	1031	956	1071	952	1012	993	1041	940	1070	968	1003
45	958	1025	937	996	981	972	967	1015	943	999	979
50	930	908	899	882	920	884	940	912	903	874	905

Table4.5 Twist at spindle speed13000 rpm

Traveler	At spindle speed 13000 rpm										
weight(mg)	number of test										
	1	2	3	4	5	6	7	8	7	10	Avg.
31.5	1103	1113	1025	1050	1101	1044	1097	1089	1040	1065	1073
35/5	1086	1084	1005	1078	1077	1048	1076	1088	1009	1079	1063
40	1005	1018	1084	880	1004	988	1015	1011	1086	881	997
45	993	990	1011	869	978	953	984	990	1021	870	966
50	1024	856	981	985	972	952	996	876	989	985	962

Table4.6 Twist at spindle speed 14000 rpm

Traveler	At spindle speed 14000 rpm										
weight(mg)	number of test										
	1	2	3	4	5	6	7	8	7	10	Avg.
31.5	1132	1054	1156	1087	1092	1122	1112	1065	1156	1095	1107
35.5	1065	1080	1059	1052	1073	1055	1067	1081	1059	1053	1064
40	1083	955	1019	984	1016	1002	1086	965	1022	974	1010
45	994	960	1077	947	999	989	994	977	1060	947	994
50	1028	1043	993	966	1009	1006	1026	1047	982	979	1008

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4.3.3 Yarn strength

Yarn strength measured in the form of tenacity and elongation of the yarn. The sample test result are show in table 4.7, 4.8 and 4.9 for tenacity and table 4.10,4.11and 4.12 for elongation

Table4.7 Tenacity cN/Tex at spindle speed 12000 rpm

Traveler	At spindle speed 12000 rpm									
weight(mg)	number of test									
	1	2	3	4	5	6	7	8	7	10	Avg.
31.5	14.01	13.94	13.81	14.51	14.06	13.65	13.78	14.72	14.21	14.56	14.125
35.5	14.05	14.81	14.57	15.88	15.86	14.81	14.57	14.05	15.86	14.57	14.903
40	14.32	15.31	13.3	14.01	13.71	15.31	13.3	14.32	14.01	13.32	14.091
45	15.07	15.65	14.97	15.78	15.33	15.67	15.41	14.88	15.98	15.13	15.387
50	15.84	15.69	16.12	16.04	15.86	15.85	15.94	16.03	15.96	16.11	15.944

Table4.8 Tenacity cN/Tex at spindle speed 13000 rpm

Traveler	At spindle speed 13000 rpm										
weight(mg)	number of test										
	1	2	3	4	5	6	7	8	7	10	Avg.
31.5	14.7	14.21	14.46	14.31	14.82	14.23	14.19	14.46	14.22	14.75	14.435
35.5	15.02	15.17	14.2	14.63	15.38	14.5	14.62	15.13	14.79	14.6	14.804
40	15.22	14.97	14.71	14.37	14.63	14.87	14.98	15.03	15.11	14.96	14.885
45	14.72	15.26	14.03	14.18	15.61	14.3	14.82	15.05	15.06	15.12	14.815
50	16.08	15.16	14.01	15.94	15.31	14.89	15.6	15.46	15.52	15.03	15.3

Table4.9 Tenacity cN/Tex at spindle speed 14000rpm

Traveler	At spindle speed 14000 rpm										
weight(mg)	number of test										
	1	2	3	4	5	6	7	8	7	10	Avg.
31.5	14.2	14.32	14.14	14.52	14.61	14.02	14.41	14.08	14.24	14.36	14.29
35.5	15.08	15.16	13.95	14.91	14.48	14.12	14.95	15.03	14.82	15.2	14.77
40	15.6	13.98	14.36	14.2	14.35	14.52	14.23	14.33	13.87	13.75	14.319
45	14.35	15.45	15.09	14.67	13.06	14.65	15.07	14.15	14.32	14.39	14.52
50	15.22	15.89	14.24	15.16	15.49	15.23	14.35	15.45	15.21	15.5	15.174

Table4.10 Elongation in % at spindle speed 12000rpm

Traveler	At spindle speed 12000 rpm										
weight(mg)	number of test										
	1	2	3	4	5	6	7	8	7	10	Avg.
31.5	6.75	6.63	7.01	6.81	5.97	6.45	6.49	6.66	6.71	6.92	6.64
35.5	6.25	6.11	6.95	6.78	6.68	6.91	6.45	6.56	6.68	6.42	6.579
40	6.52	6.94	6.53	6.41	5.82	6.05	6.96	6.72	6.63	5.81	6.439
45	5.92	6.31	5.84	6.21	5.84	5.97	6.76	5.99	6.41	6.18	6.143
50	6.07	6.53	5.94	6.73	6.51	6.72	6.15	6.45	6.29	6.43	6.382

Table4.11 Elongation in % at spindle speed 13000rpm

Traveler	At spindle speed 13000 rpm										
weight(mg)	number of test										
	1	2	3	4	5	6	7	8	7	10	Avg.
31.5	6.45	6.56	6.67	6.42	6.25	6.13	6.92	6.78	6.68	6.9	6.576
35.5	6.3	6.21	6.5	6.24	6.35	6.6	6.74	6.62	6.66	6.71	6.493
40	6.34	6.38	6.02	6.28	6.44	6.35	6.56	5.84	6.54	6.18	6.293
45	5.98	6.15	6.13	5.64	5.78	5.8	5.46	6.01	6.2	5.49	5.864
50	6.42	6	6.31	5.56	5.84	6.62	6.72	5.44	5.62	5.69	6.022

Table4.12 Elongation in % at spindle speed 14000rpm

Traveler	At spindle speed 14000 rpm										
weight(mg)	number of test										
	1	2	3	4	5	6	7	8	7	10	Avg.
31.5	5.9	6.31	5.84	6.22	5.74	5.97	6.67	5.98	6.41	6.18	6.122
35.5	6.28	6.45	6.13	5.9	5.28	6.1	5.86	5.94	6.23	5.89	6.006
40	5.37	5.11	5.7	5.57	5.83	5.72	5.43	5.17	5.69	5.56	5.515
45	5.98	5.67	5.58	6.37	6.53	5.31	6.4	6.32	5.86	6.22	6.024
50	5.46	5.77	6	5.76	4.64	5.62	5.69	4.77	5.74	5.79	5.524

4.2 DISCUSSION

4.2.1 Yarn Hairiness

In order to evaluate the significance of the spindle speed and traveler weight and their interactions on the yarn hairiness, the analysis was performed on the test results by using **SPSS** general linear model (GLM) procedure. The results of the analysis of test are reported in Table 4.13

Table4.13 Analysis test result of spindle speed and traveler weight on yarn Hairiness

Tests of Between-Subjects Effects

Dependent Variable: Hairiness

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Spindle speed rpm	.807	2	.403	8.592	.000
Traveler weight mg	2.776	4	.694	14.786	.000
Spindle speed rpm * Traveler weight mg	1.018	8	.127	2.711	.008

Descriptive Statistics

Dependent Variable: Hairiness

Spindle speed(rpm)	Traveler number	Mean	Std. Deviation	N
12000	6/0	7.4630	.14166	10
	5/0	7.4120	.09390	10
	4/0	7.3560	.16222	10
	3/0	7.2860	.09070	10
	2/0	7.2790	.17679	10
	Total	7.3592	.15022	50
13000	6/0	7.4410	.12914	10
	5/0	7.2020	.07285	10
	4/0	7.1160	.08475	10
	3/0	7.2520	.14868	10
	2/0	6.8900	.17975	10
	Total	7.1802	.22002	50
14000	6/0	7.3490	.61511	10
	5/0	7.4000	.18463	10
	4/0	7.3640	.15558	10
	3/0	7.3010	.11464	10
	2/0	6.8700	.27572	10
	Total	7.2568	.36848	50

The Hairiness analysis results of the yarn samples in Table 4.13 and illustrated in Figure 4.1.The results show that with the 50mg traveler weight there was better control in the system than when using lighter travelers as shown by mean value (6.87) and the standard deviation (0.27). The control of the yarn during spinning was evident as the 50mg traveler weight was produce a steady balloon while with the other travelers the balloon would expand and loose shape during the spinning process.

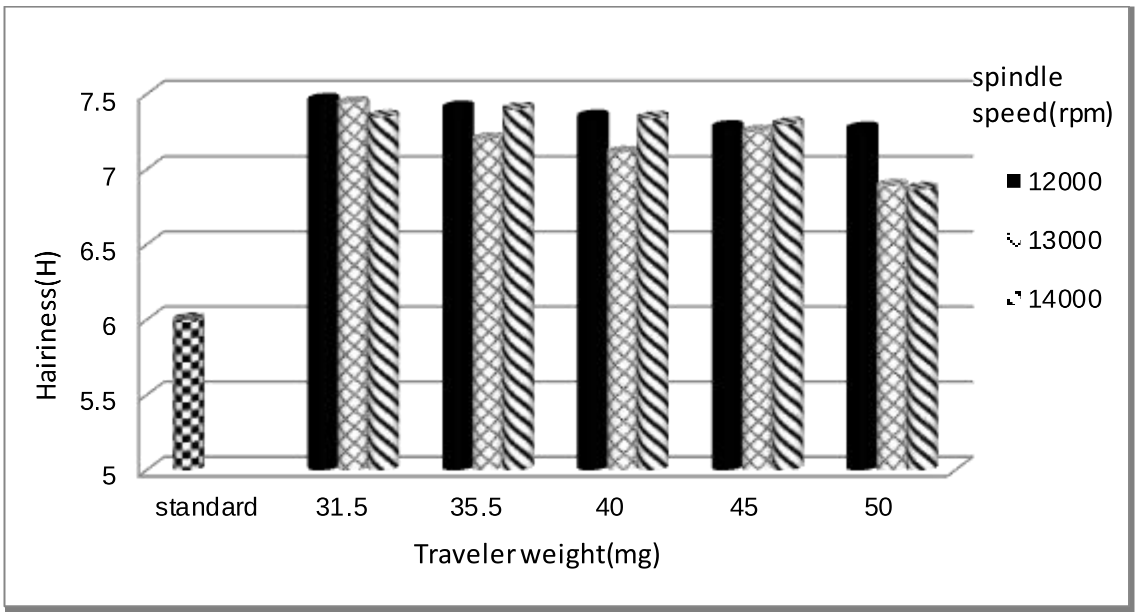

Figure 4.1 Comparison yarn hairiness in different Spindle speed and traveler weight

The results show that there was a general decrease in the average hairs per meter as the speed is increased. The trend is similar to that found by Ratnam et al. (Ratnam and Manivelu) at low speed below 10000 rpm. The minimum hairiness decreased as the speed increased as shown by the decrease in the cluster of the smaller figures in the higher spindle speed range. The results show that the spindle speed has an significant effect on the hairiness of the yarn, because as the speed was increased the hairiness per meter was decreased. On the effect of the traveler weight, significant effect considering the speed of 12000 rpm, 13000 as well as the 14000 rpm, there is a decrease in the average number of hairs of the yarn samples. This is in agreement with a number of studies that had the same observation in relation to hairiness and traveler weight (I Usta and Canoglu, 2002). The heavier traveler provides a higher spinning torque during the spinning process which results in the fibers being given a greater twisting force into the yarn thus there are shorter protruding fibers.

4.2.2 Yarn Twist

The analysis result of Yarn Twist test are reported in Table 4.14

Table4.14 Analysis test result of spindle speed and traveler weight on yarn Twist

Tests of Between-Subjects Effects

Dependent Variable: Twist(T/m)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Spindle speed rpm	45546.726	2	22773.363	13.690	.000
Traveler weight mg	292407.802	4	73101.950	43.945	.000
Spindle speed rpm * Traveler weight mg	37668.326	8	4708.541	2.831	.006

Descriptive Statistics

Dependent Variable: Twist(T/m)

Spindle speed(rpm)	Traveler number	Mean	Std. Deviation	N
12000	6/0	1039.5000	35.35264	10
	5/0	1044.2850	35.88448	10
	4/0	1003.4000	48.87528	10
	3/0	979.1700	29.40401	10
	2/0	905.1000	21.29131	10
	Total	994.2910	61.32832	50
13000	6/0	1072.7200	31.46299	10
	5/0	1062.8200	31.52994	10
	4/0	997.1900	69.72563	10
	3/0	965.9100	53.95851	10
	2/0	961.5250	53.77320	10
	Total	1012.0330	67.83060	50
14000	6/0	1107.1200	35.00009	10
	5/0	1064.2100	10.57381	10
	4/0	1010.4500	45.20905	10
	3/0	994.2710	43.60084	10
	2/0	1007.8600	27.88106	10
	Total	1036.7822	54.37947	50

The Twist analysis results of the yarn samples in Table 4.14 and illustrated in Figure 4.2. The results show that the twist values turns per meter of all the samples in the study. Overall, the mean values for each of the treatment combinations. The results show a significant difference on the effect traveler weight and spindle speed on twist value. 50mg traveler weight used at a speed of 12000rpm had the minimum value for the twist values. The 31.5mg traveler weight produced yarns with the highest maximum twist value in each combination reading.

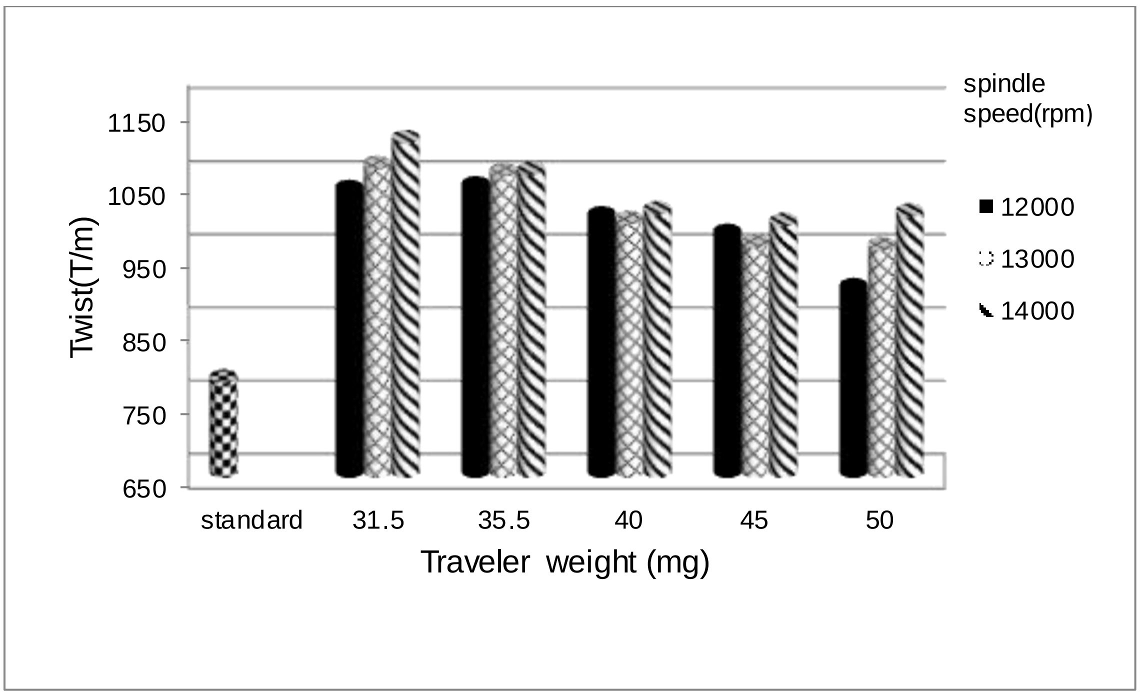

Figure 4.2 Comparison yarn twist in different spindle speed and traveler weight.

This is because lighter weight travelers have high surface speed as compare to heavier weight traveler these similar to (S. C. I **.**Usta, 2002) **.**In general when increase the speed of spindle to get high value turn per meter as well as when increase traveler weight there is decrease twist (turn per meter) there for, specific pattern can be described by the results and hence it can be said that the traveler weight and spindle speed found to be significant effect. There is interaction between the spindle speed and the traveler also significant

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4.2.3 Yarn strength

4.2.3.1 The analysis result of yarn tenacity show in the table 4.15.

Table4.15 Analysis test result of spindle speed and traveler weight on yarn Tenacity

Tests of Between-Subjects Effects

Dependent Variable: Tenacity(cN/Tex)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Spindle speed rpm	5.069	2	2.534	10.960	.000
Traveler weight mg	25.039	4	6.260	27.070	.000
Spindle speed rpm * Traveler weight mg	5.600	8	.700	3.027	.004

Descriptive Statistics

Dependent Variable: Tenacity(cN/Tex)

Spindle speed(rpm)	Traveler number	Mean	Std. Deviation	N
12000	6/0	14.1250	.36427	10
	5/0	14.9030	.71425	10
	4/0	14.8850	.25096	10
	3/0	15.3960	.36782	10
	2/0	15.8730	.29212	10
	Total	15.0364	.71918	50
13000	6/0	14.4350	.24346	10
	5/0	14.8040	.36237	10
	4/0	14.0910	.75136	10
	3/0	14.8150	.50904	10
	2/0	15.3000	.58754	10
	Total	14.6890	.64650	50
14000	6/0	14.2900	.19020	10
	5/0	14.7700	.43896	10
	4/0	14.3190	.51061	10
	3/0	14.5200	.65710	10
	2/0	15.1740	.51132	10
	Total	14.6146	.57202	50

Table 4.15 and figure 4.3 shows values for cent Newton per Tex of all the samples in the study. Overall, the mean values for each of the treatment combinations. The results show a specific trend on the effect traveler weight or spindle speed on tenacity. There were significant differences in the tenacity of the samples although higher results were seen in the 12000 rpm spindle speed at traveler weight 50mg mean value 15.87cN/tex. At spindle speed 12000 rpm the drafting speed is low compared to that at 14000 rpm.

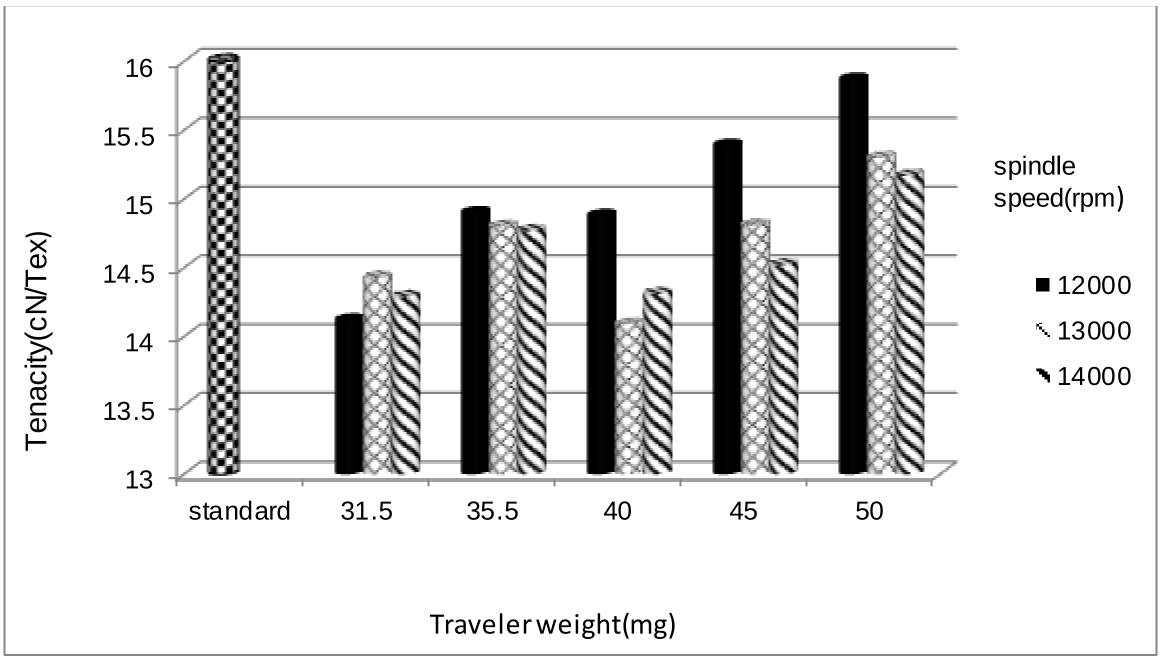

Figure 4.3 Comparison yarn tenacity in different spindle speed and traveler weight

The resulting pulling of the fibers due to tension was lower at the 12000 rpm spindle speed than at 14000 rpm. The consequence is that there is less strain on the drafted sliver and hence a more compact structure is produced by the machine at 12000 rpm. At higher speeds there is a tendency to pull the fibers from the main structure resulting in the reduction of fiber cohesion leading to lower results when the tests are carried out. The other result of increasing the spindle speed is that the traveler speed is increased hence the friction between the ring and the traveler is increased leading to increased tension in the spinning system.

4.2.3.2 Yarn Elongation

The analysis result of yarn Elongation (%) show in the table 4.16.

Table4.16 Analysis result of yarn elongation

Tests of Between-Subjects Effects

Dependent Variable: Elongation(%)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Spindle speed rpm	9.372	2	4.686	45.010	.000
Traveler weight mg	5.482	4	1.370	13.164	.000
Spindle speed rpm * Traveler weight mg	3.172	8	.397	3.809	.000

Descriptive Statistics

Dependent

Variable: Elongation(%)

spindle speed(rpm)		Mean	Std. Deviation	N
12000	6/0	6.6400	.29235	10
	5/0	6.5790	.27457	10
	4/0	6.4390	.41948	10
	3/0	6.1430	.29296	10
	2/0	6.3820	.26574	10
	Total	6.4366	.34840	50
13000	6/0	6.5760	.26463	10
	5/0	6.4930	.20150	10
	4/0	6.2930	.22598	10
	3/0	5.8640	.27175	10
	2/0	6.0220	.46473	10
	Total	6.2496	.39757	50
14000	6/0	6.1220	.28859	10
	5/0	6.0060	.32042	10
	4/0	5.5150	.24094	10
	3/0	6.0240	.40882	10
	2/0	5.5240	.45351	10
	Total	5.8382	.42894	50

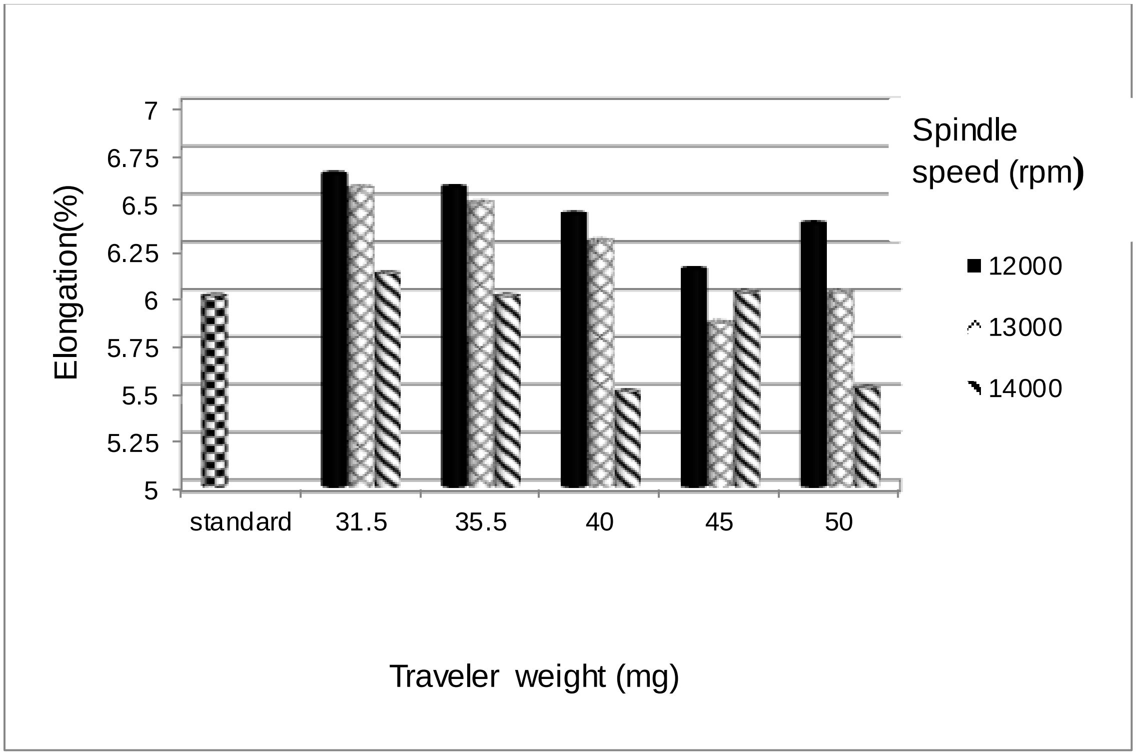

Figure 4.4 Comparison yarn elongation in different Spindle speed and traveler weight

Table 4.16 and figure 4.4 shows values Elongation (%) of all the samples in the study. Overall, the mean values for each of the treatment combinations. The results show the effect traveler weight and spindle speed on yarn elongation. There were significant differences in the elongation (%) of the samples although higher results were seen in the 12000 rpm spindle speed at traveler weight 31.5mg mean value 6.64%. At 12000 rpm spindle speed the drafting speed is low compared to that at 14000 rpm. The resulting pulling of the fibers due to tension is lower at the 12000 rpm spindle speed than at 14000 rpm. The consequence is that there is less strain on the drafted sliver and hence a more compact structure is produced by the machine at 12000 rpm. At higher speeds there is a tendency to pull the fibers from the main structure resulting in the reduction of fiber cohesion leading to lower results when the tests are carried out. The other result of increasing the spindle speed is that the traveler speed is increased hence the friction between the ring and the traveler is increased leading to increased tension in the spinning system. The increase in the tension applied to the yarn results in the straining of the yarn.

CHAPTER FIVE

CONCLUSION AND RECCOMENDATIONS

5.1 CONCLUSION.

From the investigation and the analysis of the test results of 100% 21^s Ne cotton carded yarn, the traveler weight and spindle speed combination of 50mg and 14000rpm optimal result yarn hairiness (6.87). Also the combination of 50mg traveler weight and 12000rpm spindle speed produced optimum yarn twist and tenacity value,(905 T/M, 15.87cN/Tex). The combination of 50mg traveler weight and 13000rpm spindle speed produced optimum yarn elongation (6.022%).

It can also be concluded that depending on the yarn quality requirement needed by the spinning mill, we can select the suitable combination of traveler weight and spindle speed for the yarn spun

5.2 RECCOMENDATIONS

Based on the investigation and result the spinning mill technician need to select the spindle speed and traveler weight depending on the yarn count and yarn end use requirement. We can recommend that for 21^s Ne 100%cotton carded yarn in Bahir Dar Textile Share Company to use 50mg traveler weight and 12000rpm spindle speed for a better yarn quality. Further study can be examined by using the traveler, brand of Carter and Reiners and Furst at different spindle speed also the same traveler brand by increase the spindle speed 15000up to 18000 rpm for same count of carded cotton yarn. A comparative study can be done using the different traveler number of specific brand against same count of carded cotton yarn

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