TRAVELLER CLEARER GAUGE CONSEQUENCE ON YARN QUALITY

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ABSTRACT

Traveller clearer is an important part of the ring frame machine because, without it, fiber flying in the traveller cannot be cleaned. As a result, fiber congests travellers which may lead to a rise in end breakage rate as well as declination of quality of yarn. Six ring spun yarns of count 85's tex were produced by using different traveller clearer settings and Burkina Faso cotton fiber was used as a raw material. Both High Volume Instrument (HVI) along with Advanced Fiber Information System (AFIS) was used for recognizing the fiber properties. The ring-spun yarn was produced from the roving count of 985 tex and spindle speed was kept at 7000 R.P.M. with Twist Per Meter (TPM) 492. Evenness properties, as well as strength of yarns, were measured with Uster Tester-6 and Titan Single Yarn Strength Tester respectively, and end breakage rate was studied. One-way ANOVA test was accomplished for all properties of yarn by using Microsoft Excel 2019. Traveller clearer gauge with 3.10 mm shows the best result among the other samples. Yarn properties such as imperfection index, hairiness, Sh (-), tenacity, and processing performance like end breakage rate express the best values. ANOVA result shows a significant difference for all properties except elongation.

KEYWORDS

Traveller clearer; Hairiness; End breakage rate; Ring frame; ANOVA.

INTRODUCTION

The ring spinning system is the most popular spinning system among all though it is a traditional spinning system. The reason behind its popularity of this is that it is not complex and easy to operate, can produce material with suitable characteristics, and any material along with any count can be smoothly spun on it. One limitation of this spinning system is that the production rate is low due to the addition of travellers with rings and yarn [1]. Both twisting and winding mechanisms in a ring spinning system cannot be imagined without the combined work of ring and traveller. Although it is a very tiny part it plays the most significant role in this spinning [2]. The speed of the traveller can be increased but there are possibilities to melt the traveller itself due to the heat generation of the contact point between ring and traveller, damage to the ring, and increased end breakage rate of the spinning system [1]. Traveller generates heat up to 300°C due to running at a surface speed of 110–170 km/hour [3]. Several benefits such as upgrading hairiness, decreasing end breakage rate, and wear as well as bringing afterward financial profits can be possible by using a nickel-coated ring and traveller surface [4].

It was invented by Messrs in the USA in 1829 to guide the yarn onto the package [5]. The main task of a traveller is to insert twist, maintain spinning tension along with wind the yarn onto the bobbin. Higher traveller speed can be achieved by decreasing the balloon. During spinning, multiple breakages can be occurred due to the too lightweight of the traveller. Traveller clearer and traveller settings have an impact on traveller fly, if the setting is closer it generates a hit to the traveller and finally, this creates fly [6].

Traveller clearer is used to clean the fly from the outer side of the traveller. If the traveller is not cleaned properly that may lead to promote the end breakage rate, along with yarn quality deterioration [7]. One of the performances measuring factors of ring spinning and twisting devices are actuated by the act of ring and traveller. To remain the flange traveller, fly free it is essential to fine-tune the traveller cleaner accurately. Ring and traveller do not correct the quality of the sliver produced from the drawing process, but the appropriate selection of them affects yarn properties, especially yarn hairiness. The

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surface condition and eccentricity of the ring also creates problem in yarn. Academically the speed of the traveller fluctuates significantly even eccentricity of the ring at 0.3mm which leads to the traveller humming as a resulting rise in hairiness in yarn. Traveller cleaner is used in a short-staple spinning mill to keep the traveller away from gathering fibers. Loose settings of cleaner to a traveller may lead to end breakage as well as deterioration yarn quality due to the congestion of fibers in travellers creating a jam [8].

Tension forces developed from the thread balloon on the yarn are subjected to the traveller. Practically tension on yarn on the ring frame is not measured rather than it is assumed from the balloon shape. Traveller has an impact on the balancing of balloon shape during the processing of yarn [9]. The eccentricity of several parts of the ring frame creates yarn tension variation that leads to hairiness on yarn [10]. Traveller weight has a significant effect on the hairiness properties of the yarn. Hairiness affects the fabric properties and creates a problem, especially in the case of warp yarn which may break during processing along with reducing the efficiency of the process. One of the reasons for fabric pilling is yarn hairiness which affects the appearance of the fabric [11].

MATERIALS AND METHODS

Materials

Burkina Faso cotton fiber-Burkina Faso, Africa's top cotton producer- was used as a raw material to produce 85 tex card woven yarn. The cotton fiber properties were tested under standard atmospheric conditions (20±2° C and 65% RH) on a High-Volume Instrument (HVI) and Advanced Fibre Information System (AFIS). The average properties of those tests are given in Table 1.

Table 1. Fibre properties.

HVI		AFIS	
Properties	**Values**	**Properties**	**Values**
SCI	126	NEP [Cnt/g]	340
Moisture [%]	6	NEP Size [um]	699
Mic Value	4.52	SCN [Cnt/g]	21
Maturity Ratio	0.88	SCN [um]	1195
UHML [mm]	29.64	SFC [%]	10.2
UI [%]	81.25	UQL [mm]	30.6
SF [%]	10.10	5% [mm]	35.30
Strength [GPT]	31.2	Fineness [mtex]	180
Elongation [%]	4.6	IFC [%]	8.6

Methods

Initially, cotton fibre was passed through blow room line and carding machine both of which were from the Trutzschlar brand for opening and cleaning purposes. The delivery speed of the carding machine was 263 m/min to produce slivers of 6.03ktex. Next, eight card slivers were fed to the breaker drawing machine, and a drawn sliver of 6.03ktex was produced at a delivery rate of 650 m/min. Then, eight ends of the breaker drawn sliver were fed to the finisher drawing machine to get a 6.03ktex sliver at a delivery rate of 650 m/min. After that, roving of 985 tex was produced at a flyer speed of 1100 rpm, and a twist level of 43 per meter. Finally, ring staple yarn of count 85's tex was manufactured with a spindle speed of 7000rpm with a twist level of 492 /meter, along with 6 gauge settings including 2.5 mm, 2.8 mm, 2.9 mm, 3.0 mm, 3.1 mm, and 3.2 mm.

Quality parameters such as mass irregularity, yarn faults in terms of imperfection index, and yarn hairiness were measured using a Uster Tester-6 with a test number 8. The single strength and elongation of yarn were measured using a Titan Single Yarn Strength Tester with 10 samples under standard atmospheric conditions (20±2°C and 65% RH). The confidence interval attached to each figure was calculated by using the following formula as the low number of repeated measurements was used.

$$\bar{x} \pm t \frac{s}{\sqrt{n}}, \qquad (1)$$

where, $\bar{x}$ = arithmetic mean, t = statistical factor, s = standard deviation, and n = number of observations, t value for 8 and 10 samples is 2.365 as well as 2.262 respectively.

RESULTS AND DISCUSSION

Results

The results of measurements of yarn irregularity, imperfection index, hairiness, and tensile behavior of 85's tex carded ring spun woven yarn using the experimental design are given in Table 2.

Table 2. Yarn properties.

Traveller Gauge [mm]	2.50	2.80	2.90	3.00	3.10	3.20
CVm [%]	12.71	11.72	11.94	11.62	11.77	11.52
Imperfection Index [-]	42	28	23	18	16	31
Hairiness [-]	9.23	8.97	9.42	9.13	8.81	10.7
Sh [-]	1.86	1.84	1.99	1.97	1.8	2.01
Tenacity [cN/tex]	15.22	16.08	14.95	15.82	16.11	15.28
Elongation [%]	8.12	8.21	8.26	8.25	7.81	8.03
End Breakage Rate/100 Spindle-Hr.	32	40	20	37	17	21

Discussion

Yarn Unevenness

Yarn unevenness is normally expressed in two terms named unevenness percentage of mass and coefficient of variation of mass. The coefficient of variation of mass is more universe that unevenness percentage of mass. It is seen from figure 1 that gauge 3.2 mm performs well whereas the 2.5 mm gauge shows the opposite result. The result of gauge 3.2 mm is the best due to the sufficient gap for a traveller to clean up. Also observed in figure 1 is that there is no statistically significant difference among all samples except 2.5 mm.

Imperfection Index

Imperfection is a frequently occurring fault in yarn and without imperfection, it is completely unimaginable to produce yarn. It is the summation of three faults thin place (-50%)/km, thick place (+50%)/km, and neps (+200%)/km. From figure 2, it is observed that gauges 2.5mm and 3.1mm show the highest and the lowest value and they are 42 and 16, respectively. Setting 3.2 mm details 31, followed by 2.8 mm at 28, after that 2.9 mm with 23, and lastly 3.00 mm at 18. 3.1mm gauge represents the best result while 2.5mm is the reverse. It is assumed that the probable reason behind this is that in 3.1 mm gauge better fiber is incorporated into the yarn. A statistically significant difference is shown between 2.5 mm and 3.0 mm and 2.5 mm and 3.1 mm settings in Figure 2.

Hairiness

Hairiness is an important yarn parameter that depends on not only the fiber properties but also the process parameters, along with machine parts. It is such a parameter that relates to the comfortability of end products, especially for apparel. According to figure 3, the highest hairiness value of 10.7 is seen in the case of the 3.2 mm setting and the lowest one is 8.81 for the 3.1 mm gauge. 3.1 mm gauge shows the good quality of yarn because it is assumed that this gauge is optimum for traveller cleaning. Figure 4 shows that the 3.1 mm scale denotes the best result, however, 3.2 mm demonstrates the worst result. No significant difference is seen in Figure 3 except 3.2 mm gauge and Figure 4.

Tensile Strength

The tensile strength of the yarn is important for further processing. It has a great impact on the processing performance of fabric either in weaning or knitting. It is observed from figure 5 that 3.1 mm represents the highest value at 16.11 cN/tex while 2.9 mm displays the lowest value at 14.95 cN/tex. This is because it is presumed that in the 3.1 mm gauge setting, fibres are orientated straighter and more parallel. There is a statistically significant difference between 2.9 mm and 3.1 mm.

Elongation

Elongation is significant yarn property that is necessary for further end products. As can be seen from Figure 6, the bottommost figure belongs to 3.1 mm settings but the highest digit goes to 2.9 mm. The assumption behind this may be that in 2.9 mm gauge settings fibers are not incorporated in parallel into the yarn body properly. No significant difference is seen in Figure 6.

End Breakage Rate

End breakage in the ring frame creates faults in yarn as well as produces a huge amount of wastage. One of the factors that affect productivity in spinning is the end breakage rate. It also affects the speed and performance of the ring frame [7]. Figure 7 represents the highest rate in the 2.8 mm measure and the lowest rate in the 3.1 mm gauge. It is assumed that at a lower gauge setting there is a possibility to create tension on the yarn which may cause breakage while at a 3.1 mm setting, assumed optimum settings where tension on yarn is less cause a low breakage rate. There is a statistically significant difference observed in Figure 7 among all samples.

Statistical Analysis

One-way ANOVA test was completed for almost all yarn properties by using Microsoft Excel 2019. The tests were carried out at alpha level 0.05. P-values of all tests are given below.

Table 3. P-value of ANOVA test of yarn properties.

Yarn Properties Name	***P-value***
CV_m [%]	0.00*
Imperfection Index [-]	0.00*
Hairiness [-]	0.00*
Tenacity [cN/tex]	0.01*
Elongation [%]	0.55
End Breakage Rate/100 Spindle-Hr.	0.01*

Statistically, a significant difference is noticed in the case of all properties excluding elongation from the above table as the P-value is less than 0.05.

Post-Hoc Analysis

The alpha level used for comparison was 0.003 (Bonferroni correction) and the pairwise comparison number was 15. The results are given in Table 4.. There is a statistically significant difference among five pairs (Marked in star) in the event that co-efficient of variation, six pairs (Marked in star) in case of hairiness along with imperfection index, and one pair (Marked in star) in end breakage rate as well as tenacity because their value is less than Bonferroni correction factor.

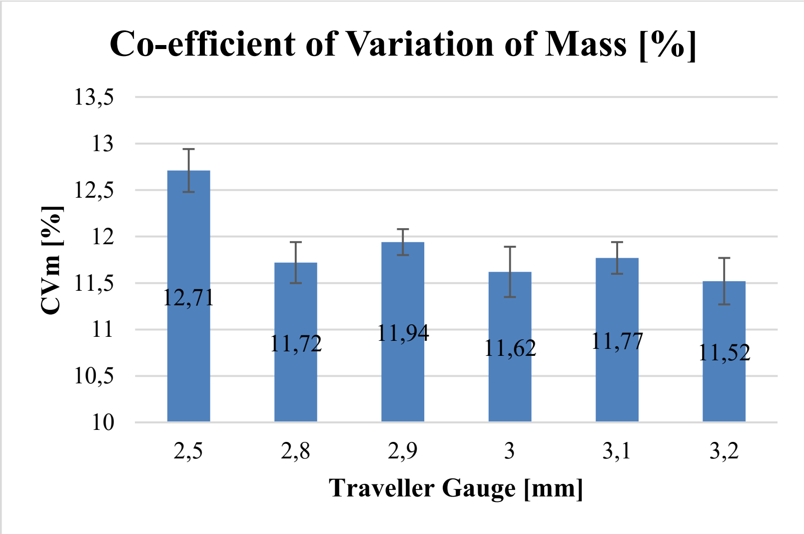

Figure 1. CV_m percentage of yarn.

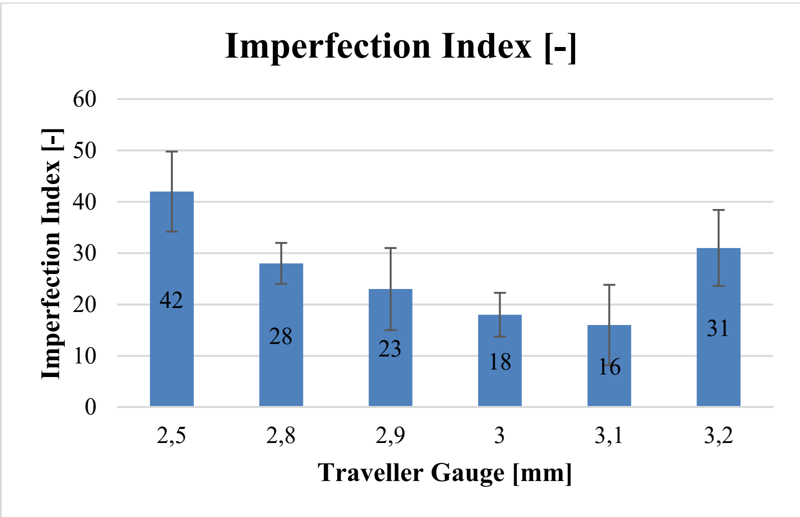

Figure 2. Imperfection of yarn.

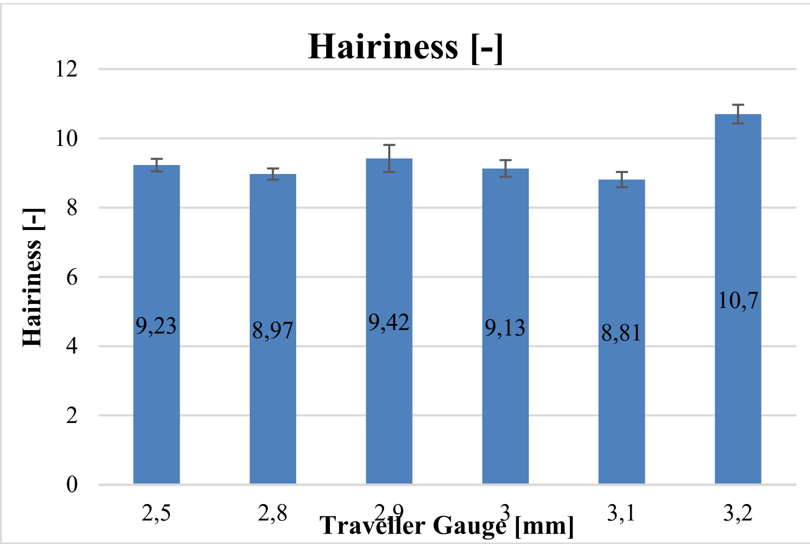

Figure 3. Hairiness of yarn.

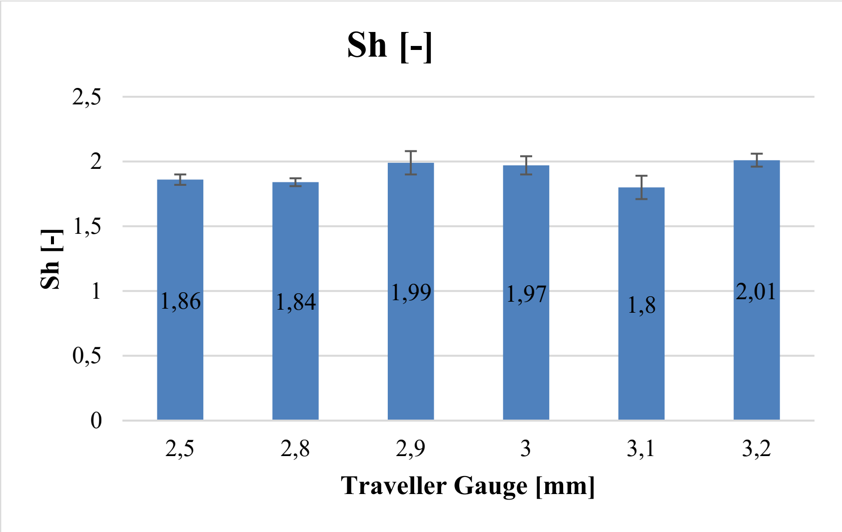

Figure 4. The standard deviation of hairiness of yarn with a cut length of 1 cm.

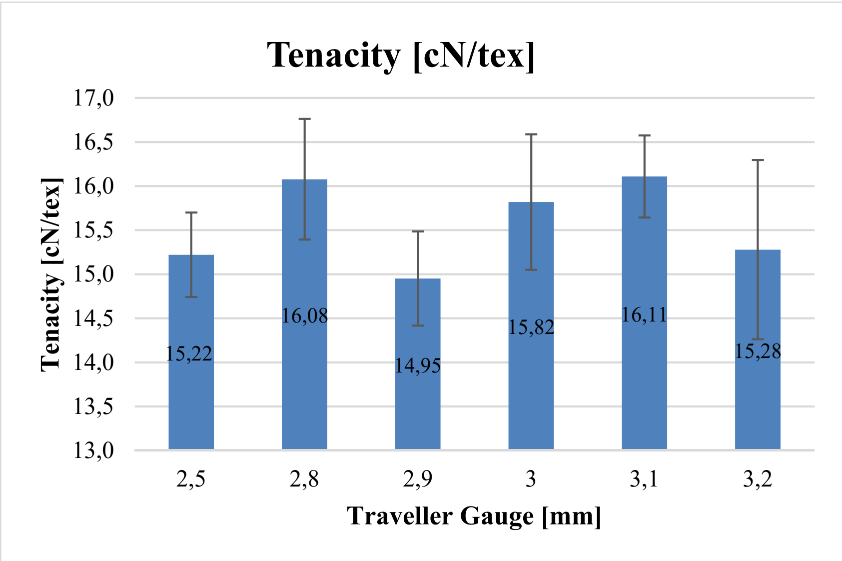

Figure 5. Tenacity of yarn.

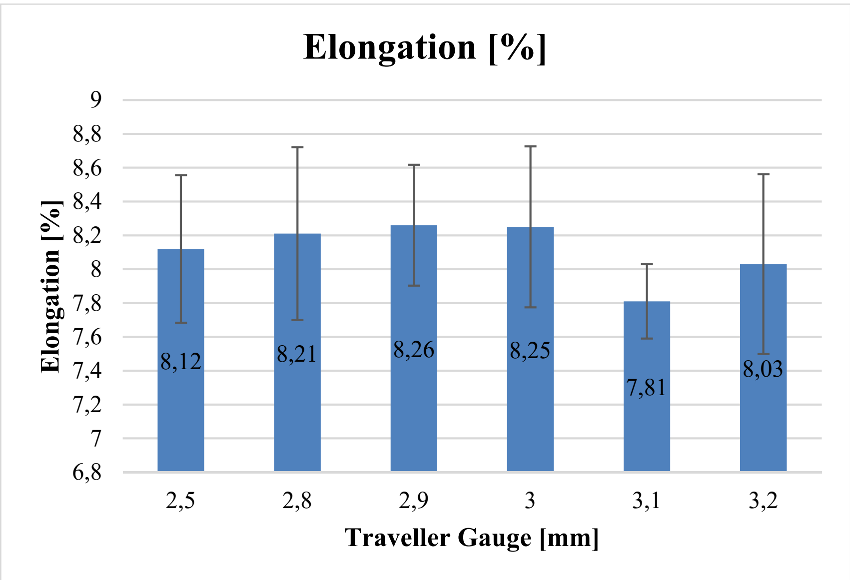

Figure 6. Elongation of yarn.

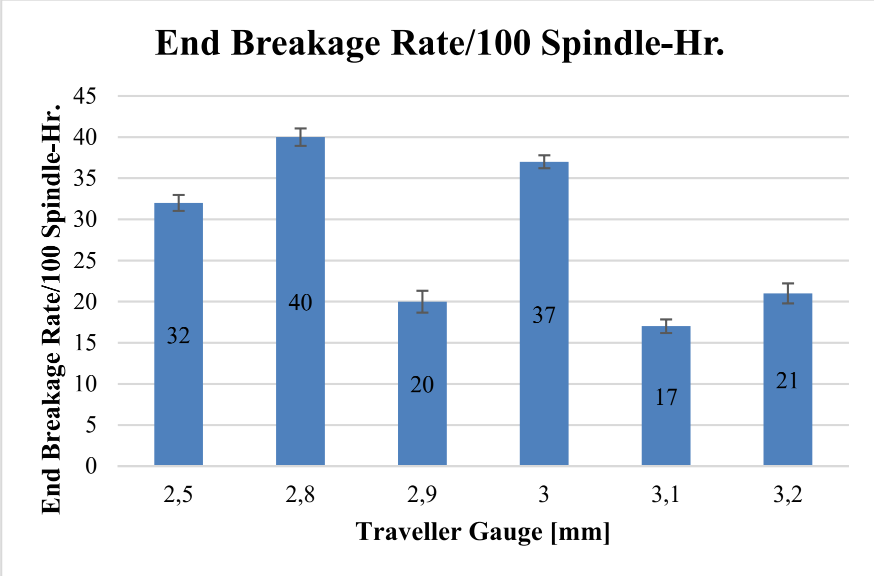

Figure 7. End breakage rate at ring frame.

Table 4. *t*-test: Two-Sample Assuming Equal Variances.

Yarn Properties	Paired Groups Names (mm)	Values of P(T<=t) two-tail	Yarn Property/Processing Parameter	Paired Groups Names (mm)	Values of P(T<=t) two-tail	Yarn Property	Paired Groups Names (mm)	Values of P(T<=t) two-tail
CVm [%]	2.5 & 2.8	0.000*	Hairiness [-]	2.5 & 2.8	0.029	Tenacity [cN/tex]	2.5 & 2.8	0.032
	2.5 & 2.9	0.000*		2.5 & 2.9	0.326		2.5 & 2.9	0.406
	2.5 & 3.0	0.000*		2.5 & 3.0	0.434		2.5 & 3.0	0.153
	2.5 & 3.1	0.000*		2.5 & 3.1	0.002*		2.5 & 3.1	0.048
	2.5 & 3.2	0.000*		2.5 & 3.2	0.000*		2.5 & 3.2	0.910
	2.8 & 2.9	0.138		2.8 & 2.9	0.023		2.8 & 2.9	0.009
	2.8 & 3.0	0.597		2.8 & 3.0	0.216		2.8 & 3.0	0.575
	2.8 & 3.1	0.529		2.8 & 3.1	0.135		2.8 & 3.1	0.001*
	2.8 & 3.2	0.282		2.8 & 3.2	0.000*		2.8 & 3.2	0.157
	2.9 & 3.0	0.073		2.9 & 3.0	0.149		2.9 & 3.0	0.051
	2.9 & 3.1	0.400		2.9 & 3.1	0.004		2.9 & 3.1	0.247
	2.9 & 3.2	0.018		2.9 & 3.2	0.000*		2.9 & 3.2	0.528
	3.0 & 3.1	0.307		3.0 & 3.1	0.025		3.0 & 3.1	0.007
	3.0 & 3.2	0.626		3.0 & 3.2	0.000*		3.0 & 3.2	0.351
	3.1 & 3.2	0.122		3.1 & 3.2	0.000*		3.1 & 3.2	0.170
Imperfection Index [-]	2.5 & 2.8	0.002*	End Breakage Rate	2.5 & 2.8	0.342			
	2.5 & 2.9	0.001*		2.5 & 2.9	0.137			
	2.5 & 3.0	0.000*		2.5 & 3.0	0.550			
	2.5 & 3.1	0.000*		2.5 & 3.1	0.074			
	2.5 & 3.2	0.025		2.5 & 3.2	0.248			
	2.8 & 2.9	0.196		2.8 & 2.9	0.004			
	2.8 & 3.0	0.002*		2.8 & 3.0	0.660			
	2.8 & 3.1	0.001*		2.8 & 3.1	0.002*			
	2.8 & 3.2	0.473		2.8 & 3.2	0.027			
	2.9 & 3.0	0.273		2.9 & 3.0	0.012			
	2.9 & 3.1	0.093		2.9 & 3.1	0.609			
	2.9 & 3.2	0.115		2.9 & 3.2	0.895			
	3.0 & 3.1	0.228		3.0 & 3.1	0.005			
	3.0 & 3.2	0.005		3.0 & 3.2	0.058			
	3.1 & 3.2	0.003		3.1 & 3.2	0.608			

CONCLUSIONS

Overall, it can be said that 2.9 mm, 3.0 mm, and 3.1 mm settings perform similar results and there is no statistically significant difference found from the confidence interval attached in each figure except end breakage rate along with tenacity between 2.9 mm and 3.1 mm, and Post-Hoc Analysis test. There is a statistically significant difference found from Post-Hoc Analysis between pair 2.8 mm and 3.1mm just in case of imperfection index, end breakage rate, and tenacity. Although 2.9 mm, 3.0 mm, and 3.1 mm gauges can be used, settings 3.1 mm is much preferred due to the imperfection index, hairiness, Sh(-), tenacity, and end breakage rate representing good results. Other properties such as evenness, and elongation are also considerable. It may be assumed that the possible reason behind this result of this sample is fibers get optimum space for cleaning of traveller which contributes to a cleaner yarn body, as well as tension on the yarn, is also proper. On the other hand, the remaining samples such as 2.5 mm as well as 3.2 mm demonstrate comparatively worst results in the case of all properties. This happened due to the much closer or wider settings of travellers clearer. The amount of breakage is observed higher in below 3.1 mm settings due to the closed position of the clearer near the traveller triggering a huge amount of tension on the yarn which may lead to more breakage.

It can be seen from the ANOVA analysis that, there is a significant difference for all samples without elongation. However, t-Test: Two-Sample Assuming Equal Variances confirms that statistically significant differences exist in five pairs, six pairs, and one pair in the case of CVm%, imperfection index as well as hairiness, and tenacity along with end breakage rate accordingly. Finally, it can be thought that a 3.1 mm gauge is suitable for better processing of fibres.

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REFERENCES

1. Cukul D. and Beceren Y.: Yarn hairiness and the effect of surface characteristics of the ring traveller, Textile Research Journal, 86(15), 2016, pp. 1668-1674. https://doi.org/10.1177/0040517515596968
2. Hossen J. and Saha S.K.: Selection of appropriate ring traveller number for different count of cotton hosiery yarn, International Journal of Engineering & Technology, 11(6), 2011, pp. 70-76.
3. Rengasamy R. S.: Developments in ring spinning, Advances in yarn spinning technology, Woodhead Publishing Limited, Cornwall, UK, 2010, p. 198, ISBN: 978-1-84569-444-9.
4. Barella A. and Manich A.M.: Yarn Hairiness Update, Textile Progress, 26(4), 2009, pp. 38.
5. Oxtoby E.: Conventional Frame Spinning Machines, Spun Yarn Technology, Wallington: Butterworth & Co Ltd, 1987, p. 121, ISBN 0-408-01464-4.
6. LRT-Hand Book of Ring Traveller.pdf, https://fdocuments.net/document/lrt-handbook.html?page=1
7. Kumar R.S.: Process Control in Ring Spinning, Process Management in Spinning, Boca Raton: CRC Press, 2015, pp. 172, ISBN-13: 978-1-4822-0837-5.
8. Reiners + Fürst Rings and Travellers, 2019, http://reinersfuerst.de/wp content/uploads/2016/12/taschenbuch_EN.pdf
9. Bracker, Short Staple Manual, pp. 1–53, 2014, https://www.rieter.com/fileadmin/user_upload/services/documents/expertise/braecker-manuals/short-staple-spinning-manual-braecker-en.pdf
10. Purushothama B.: Normal complaints from customers, A practical guide on quality management in spinning, New Delhi: Woodhead Publishing, 2011, pp. 155, ISBN: 978-0-85709-006-5.
11. Usta I. and Canoğlu S.: Influence of ring traveller weight and coating on hairiness of acrylic and cotton yarns, FIBRES & TEXTILES in Eastern Europe, 28(2), 2003, pp. 157–162.