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Technological Study of Auto-Leveller at Draw Frame on Cotton Yarn Quality

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Abstract: The purpose of present research was to analyze the effect of draft, sliver hank and delivery speed on the quality of cotton yarn using different auto-leveller system at draw frame. Drawing is considered to be the key process in the whole set-up of yarn formation as all efficiency and quality of subsequent process depends upon the behavior of the sliver formed at drawing stage. In present research it is elaborated that during drawing, three factors are more important i.e. break draft, delivery speed and sliver hank. The best quality of yarn is obtained by controlling these factors. Rieter RSBD-35 is better in performance as compared to Trutzschler HSR-1000 which is efficient and modern autolevelling system with high speed servo drive motor at Rieter draw frame. The overall results show that moderate break draft, D2 (1.3), delivery speed S2 (700 yards/min) and sliver hank H2 (60 grain/yards) produced the better results.

Key words: Ring spinning, draw frame, Autolevellors, mechanical variables

INTRODUCTION

On auto-leveler draw frame Tongue and Grove rollers, pneumatic transducers and other devices are used for online monitoring of sliver weight. Infect, auto-leveller at high-speed drawing frame helped a lot in producing regularities in sliver by detecting the variations at feeding point and by synchronization in quick control of weight per yard of the material. Efficiency of the control varies with auto-leveller model and technology. The auto-leveller at drawframe act on open control loop principle. According to this principle, the thickness of the arriving sliver is measured with a groove and tonge roller. The measured values are stored until the measured sliver reaches the drafting point in the main drafting area. At this moment the amount of draft size is changed by highly dynamic servo derive motor. This can even balance the smallest deviations.

One of the main tasks of the draw frame is to improve evenness over short, medium and long terms. Card sliver fed to the draw frame have a degree of unevenness that can not be tolerated in practice and slivers from the comber contain the infamous piecing these must be obscured. It should be noted however that short wave sliver evenness is not as sometimes assumed, the sole criterion for evaluating the performance of draw frame. It is true that unevenness over short length can be noticeably reduced by narrow settings of the drafting arrangement. But this is often associated with deterioration in others quality parameters of yarn. Drafting is an indispensable stage in yarn formation and plays a critical role in yarn quality. Each drafting process from carding to spinning introduces its irregularities to the product and these irregularities degrade the final textile product.

Earlier research[1] focused that in comparison of Rieter draw frame with other draw frames reveals that the Rieter always show the better results for yarn lea strength. While Douglas[2] noted that modern high-speed machinery has resulted in over all quality improvement. Haque[3] reported that drawframe with autoleveller gave the best value of yarn count as compared to without autoleveller drawframe. Jamil and Mahmood[4] concluded that increase in break draft setting at ring spinning beyond certain limit, reduce the strength and increase the evenness and neps. Siddique[5] concluded that delivery speed has significant effect on yarn count.

Subramaniam and Mohamed[6] concluded that both strength and evenness decreases as the break draft increased. Nawaz *et al.*[7] stated that count lea strength product value largely dependent upon the yarn lea strength. Ching and Sun[8] reported that in the initial drafting zone, the drafting process straighten the fibre crimps and hooks and improves the yarn quality. Klein[9] stated that short fibre has greater influence on yarn strength. Arshad[10] stated that count lea strength decreases with the addition of short fibres and moderate speed produced the lowest value of short fibres. At this age of competition, it has become necessary to produce an internationally accepted standard quality yarn and this can be achieved only by applying modern techniques during processing of cotton. The present study was proposed to investigate the effect of auto-levelling and different mechanical variables viz. break draft, delivery speed and sliver hank on drawing sliver and ultimate yarn

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quality processed at Rieter RSBD-35 and Trutzschler HSR-1000 draw frames.

MATERIALS AND METHODS

The present study was carried out initially in the Department of Fibre Technology, University of Agriculture, Faisalabad and was conducted at Sargodha Spinning Mills Faisalabad during the year 2005.

The following variables were selected at both machines

Machines	Sliver Hanks	Break Drafts	Deliver speeds
M1= Rieter RSBD-35	H_1 = 50 grains/yard	D_1 = 1.2	S_1=600 yards/min
M2= Trutzschler -HSR1000	H_2 = 60 grains/yard	D_2 = 1.3	S_2=700 yards/min
	H_3 = 70 grains/yard	D_2 = 1.3	S_3 = 800 yards/min

Yarn count: Yarn count was determined through digital Auto Sorter-III linked with computer system, which gives direct reading. A lea of 120 yards was fed to the computer to determine English count according to its operational manual recommended by ASTM[11]; the yarn count was noted from its automatic digital display.

Yarn lea strength: Pendulum type lea strength tester was used to find the lea strength in pounds. The lea of 120 yards was fed to the instrument according to the method recommended by ASTM[11].

Count lea strength product: Count and lea strength product was determined by multiplying the actual count value with respective breaking load of yarn lea of 120 yards according to British Standards[12]. CLSP = Yarn Count X Yarn Lea Strength.

Analysis of data: The data obtained was analyzed statistically using four-factor factorial in CRD, while Duncan's Multiple Range Test was applied for individual comparisons of means as suggested by Faqir[13] on M-stat computer statistical program devised by Freed[14].

RESULTS AND DISCUSSION

Yarn count: The results indicate that the effect of break draft is non-significant, where as the effect of delivery speed and sliver hank is highly significant on yarn count. In case of interactions first and second-degree order interactions remained non-significant.

Comparison of individual means in respect, to machine and model type shows that both machines have non-significant difference with each other (Table 1). The values for yarn count are noted as 10.142 at M_1 followed by 10.143 at M2 (Table 1a).

Table 1: Analysis of variance for yarn count

SOV	Df	SS	MS	F-value	p-value
M	1	0.000	0.000	0.0047	N.S
D	2	0.004	0.002	0.00464	N.S
H	2	0.413	0.217	4.5491	0.0116**
S	2	3.760	1.880	41.4007	0.0000**
MxD	2	0.008	0.004	0.0868	N.S
MxH	2	0.001	0.000	0.0063	N.S
MxS	2	0.015	0.008	0.1656	N.S
DxH	4	0.004	0.001	0.0200	N.S
DxS	4	0.006	0.002	0.0339	N.S
HxS	4	0.008	0.002	0.0452	N.S
MxDxS	4	0.010	0.003	0.0576	N.S
MxDxH	4	0.020	0.005	0.0240	N.S
MxHxS	4	0.007	0.002	0.0385	N.S
DxHxS	8	0.007	0.001	0.0202	N.S
MxDxHxS	8	0.019	0.002	0.0523	N.S
Error	216	9.808	0.045		
Total	269	14.073			

CV =2.10%, **=Highly significant, * = Significant, NS=Non-significant

Table 1a: Comparison of individual treatment means for yarn count

Machine	Means	Break draft	Means	Sliver hank	Means	Delivery speed	Means
M_1	10.142	D_1	10.147	H_1	10.192a	S_1	10.289a
M_2	10.143	D_2	10.138	H_2	10.139ab	S_2	10.139b
		D_3	10.142	H_3	10.096a	S_3	10.000c

Mean having different letter (s) differ significantly (5% level of significant)

Duncan's Multiple Range Tests in the case of different break drafts the highest value for yarn count is be recorded at D_1 followed by D_2 and D_3 with mean values as 10.147, 10.138 and 10.142, respectively. The results indicate that the effect of break draft is non- significant. The results also show that variation in count 10^s is very small and count is course and such count show very small variations upon the data.

In case of delivery speed the means obtain for yarn count are 10.289, 10.139 and 10.00 at S_1, S_2 and S_3, respectively. DMRT for comparison of individual means show that in case of delivery speed of drawframe, the highest yarn count 10.28 is found at S_1 followed by S_2 and S_3 as 10.139 and 10.00. It indicates that the delivery speed affects the yarn count. These findings are in accordance with that of Siddique[5] stated that delivery speed has significant effect on yarn count. Similarly Douglas[2] reported that yarn count, strength, irregularity and imperfections are influenced by raw material, type and machine settings. While Rehman[15] found that actual value of yarn count spun from cotton or any other fiber, generally differ from nominal value.

In case of sliver hank the means obtained are 10.192, 10.139 and 10.096 at H_1, H_2 and H_3, respectively. All these values differ significantly from each other. These values clearly indicate that by increasing the weight of sliver the yarn count decreases.

Yarn lea strength: The results indicate that the effect of break draft is significant, where as the effect of sliver hank and delivery speed is highly significant at

Table 2: Analysis of variance for yarn lea strength

SOV	Df	SS	MS	F-Value	p-value
M	1	8698.356	8698.356	60.0165	0.0000**
D	2	906.727	453.363	3.1281	0.0458*
H	2	3902.183	1951.092	13.4620	0.0000**
S	2	8529.522	4264.761	29.4258	0.0000**
MxD	2	99.249	49.624	0.3424	N.S
MxH	2	137.800	68.900	0.4754	N.S
MxS	2	56.27	28.128	0.1941	N.S
DxH	4	114.596	28.649	0.1977	N.S
DxS	4	29.375	7.344	0.0507	N.S
HxS	4	99.945	24.986	0.1724	N.S
MxDxS	4	2.719	0.680	0.0047	N.S
MxDxH	4	110.517	27.629	0.1906	N.S
MxHxS	4	274.435	68.609	0.4734	N.S
DxHxS	8	158.831	19.854	0.1370	N.S
MxDxHxS	8	74.076	9.260	0.0639	N.S
Error	216	31305.483	144.933		
Total	269	54500.070			

CV = 5.06%, ** = Highly significant, * = Significant, NS = Non-significant

Table 2a: Comparison of individual treatment means for yarn lea strength

Machine	Means	Break draft	Means	Sliver Hank	Means	Delivery speed	Means
M_1	243.433a	D_1	233.607c	H_1	232.644b	S_1	239.682b
M_2	232.081b	D_2	238.404a	H_2	238.874a	S_2	243.474a
		D_3	235.261b	H_3	241.753a	S_3	230.116c

Mean having different letter (s) differ significantly (5% level of significant)

Table 3: Analysis of variance for count lea strength product

SOV	Df	SS	MS	F-value	P-value
M	1	877975.737	877975.737	68.8513	0.0000**
D	2	89694.348	44847.174	3.2615	0.0402*
H	2	220346.895	110173.477	8.0124	0.0004**
S	2	1953389.409	976694.704	71.0307	0.0000**
MxD	2	12705.947	6352.974	0.4620	N.S
MxH	2	7925.321	3962.661	0.2882	N.S
MxS	2	2410.959	1205.480	0.0877	N.S
DxH	4	11469.966	2867.491	0.2085	N.S
DxS	4	6659.807	1664.952	0.1211	N.S
HxS	4	7779.929	1944.982	0.1414	N.S
MxDxS	4	3010.679	752.6700	0.0547	N.S
MxDxH	4	5247.184	1311.796	0.0954	N.S
MxHxS	4	35241.096	8810.274	0.6407	N.S
DxHxS	8	11628.831	1453.604	0.1057	N.S
MxDxHxS	8	20808.184	2601.023	0.1892	N.S
Error	216	29700068.66	13750.318		
Total	269	6236362.957			

CV = 4.86%, ** = Highly significant, * = Significant, NS = Non-significant

Table 3a: Comparison of individual treatment means count lea strength product

Machine	Means	Break draft	Means	Sliver Hank	Means	Delivery speed	Means
M_1	2470.38a	D_1	2418.785ab	H_1	2374.723a	S_1	2507.389a
M_2	2356.34b	D_2	2432.333a	H_2	2422.475a	S_2	2431.938b
		D_3	2388.977b	H_3	2442.897b	S_3	2301.154c

Mean having different letter (s) differ significantly (5% level of significant)

both machines. In case of interactions, all interactions regarding first and second order degree are proved to be non-significant. Duncan's multiple range tests for individual comparison of drawing machines is show that both machines have significant difference for yarn lea strength (Table 2). The best value for yarn lea strength is obtained at M_1 as 243.433 pounds followed by M_2 with its mean value as 232.081 pounds (Table 2a) This indicates that Rieter drawframe improved the strength parameters of yarn. These findings are fully supported by Anonymous[1] who stated that in comparison of Rieter drawframe with other drawframe, Rieter drawframe always shows best results for lea strength yarn might be due to natural change, different organic factors, machine settings etc.

DMRT in the case of comparison of individual treatment means of yarn lea strength at different break drafts, the highest mean value for yarn lea strength is found at D_2 followed by D_3 and D_1 as 238.404, 235.261 and 233.607 pounds, respectively. These values differ significantly with each other. Results also indicate that at too low and too high break draft the yarn lea strength decreases. Higher and lower break draft produces more

short fibre. While moderate break draft produces minimum short fibres. On the basis of these results it can be inferred that yarn lea strength and short fibre are directly related i.e. sliver with more short fibre produce weaker yarn. In this regard Jamil *et al.*[4] stated that yarn strength is significantly affected due to different level of break drafts.

In case of comparison of individual means for delivery speed the highest mean value obtained for yarn lea strength is recorded at S_2 as 243.474 followed by S_1 and S_3 with their respective values as 239.682 and 230.116 pound. It indicate that delivery speeds affect yarn lea strength. It is evident that too low and too high drawing frame speeds produce lower yarn lea strength. This might be due to fact that too low and too high speeds produce minimum fibre growth and reduce lea strength. Similarly Siddique[5] concluded that delivery speed of drawframe has highly significant effect on yarn strength and imperfections.

Comparison of individual means for yarn lea strength at different level of sliver hanks i.e. H_1, H_2 and H_3. Results show that the highest values for yarn lea strength is obtained at H_3 as 241.753 pounds followed by H_2 and H_1 with their respective values as 238.874 and 232.644 pounds.

Count Lea Strength Product (CLSP): The results indicate that the effect of break draft is significant while the effect of sliver hank and delivery speed is highly significant. In case of interactions, all first and second order degree interactions remained non- significant.

The individual comparison for count lea strength product value with respect to machines model and type is incorporate in Table 3. The highest mean value for count lea strength product is obtained as 2470.38 hanks at M_1 followed by 2356.34 hanks at M_2.

(Table 3a) Maximum count lea strength product of M_1 is attributing to its higher lea strength as Douglas[2] reported that modern drawframe are design for overall quality improvement.

DMRT in case of different break drafts the highest mean value of yarn count lea strength product is found at D_2 as 2432.333 hanks followed by D_1 and D_3 with mean values as 2418.785 and 2388.977 hanks, respectively. These values differ significantly from each other. Results also indicate that at too low and too high break draft count lea strength product decreases. Higher and lower break draft produces more short fibre as indicated in Table 3a. While moderate break draft produces minimum short fibres. On the basis of these results it can be inferred that count lea strength product and short fibre are directly related. While Klein[9] stated that short fibre has greater influence on yarn strength. Similarly previous researchers like Subramaniam and Mohamed[6] found that moderate break draft produces highest count lea strength product value while very low and very high break drafts produce lower count lea strength product of yarn.

In case of delivery speed the mean of count lea strength product is recorded at S_2 as 2431.93 hanks followed by S_1 and S_3 with mean values as 2507.389 and 2301.154 hanks, respectively. It is evident that these values significantly different from each other. This indicates that at optimum levels of speed maximum strength is achieved, while above and blow this level the strength decreases i.e. too low and too high drawing frame speed produce lower count lea strength product. This might be due to fact that too low and too high speeds produce minimum fibre growth and reduce count lea strength product. In this regards Arshad[10] stated that count lea strength decreases with the addition of short fibres and moderate speed produced the lowest value of short fibres.

As regards to sliver hank the highest values for count lea strength product is obtained at H_3 as 2442.897 hanks followed by H_2 and H_1 with values mean as 2422.475 and 2374.723 hanks, respectively. These results show that count lea strength product increases by increasing sliver weight unto certain limit.

CONCLUSIONS

The present research elaborated that during drawing, three factors are more important i.e. break draft, delivery speed and sliver hank. The best quality of yarn is obtained by controlling these factors. It is also concluded that Rieter RSBD-35 is better in performance as compared to Trutzschler HSR-1000 which is efficient and modern autolevelling system with high speed servo drive motor at Rieter draw frame.

The overall results show that moderate break draft, D2 (1.3), delivery speed S2 (700 yards/min) and sliver hank H2 (60 grain/yards) produced the better results.

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