Influence of Cotton Fibre Fineness and Staple Length Upon Yarn Lea Strength

IFTIKHAR AHMAD, SHEIKH MUHAMMAD NAWAZ AND MUHAMMAD TAYYAB
Department of Fibre Technology University of Agriculture, Faisalabad–38040, Pakistan

ABSTRACT

This paper presents the response of yarn lea strength based on cotton fibre fineness and staple length. The cotton samples of variance micronaire values (fineness) having gradual increase of different fibre length groups were selected and spun into yarn and evaluated for yarn lea strength.. Result depict that almost under each length groug , average fineness (4.3 – 4.4) recorded highest yarn strength. Yarn strength keep on growing with each increment in staple length and finally 1.09" staple cotton produced excellent yarn of 127.5 pounds strength. Both factors generated highly significant effects and were interdependent.

Key Words: Staple length; Micronaire value; Spinning performance; Yarn lea strength; Yarn quality

INTRODUCTION

Cotton is a cultured, natural product and is always referred as a non-homogeneous raw material. It exhibits variation from fibre to fibre, bale to bale, area to area, and season to season due to climatic conditions, growing areas and harvesting methods etc. Quality parameters of cotton viz. fibre length and fineness have a vital influence upon the ultimate yarn strength. Fibre length is the most important cotton fibre character which determines the amount by which fibres can overlap with one another, greater the overlapping; the easier it would be for the fibres to bound together and better would be yarn strength. This means that fibre length have a direct influence on yarn strength and could be negatively affected by shorter span length. Fibre fineness is another important fibre character affecting yarn strength. It gives number of fibres in the cross-section of yarn. Better the fineness of cotton, more would be the number of fibres per cross-section resulting in higher yarn strength. When other characteristics are same, fine fibres will produce a yarn of higher strength than coarse fibres. To obtain the better understanding of these relationships the relevant review is presented here under:

Grover and Hamby (1966) stated that with other fibre properties remaining constant, fine fibres would produce a yarn with higher strength than will coarse fibres.
Sattar and Hussain (1985) concluded that fibre fineness seems more significant and contributes more than the fibre strength to yarn strength.

Ramey and Beaton (1989) mentioned that the major fibre properties contributing to yarn strength are fibre strength, fibre shape and a measure of fibre length uniformity.

Broughton *et al.* (1992) acknowledged that increasing fibre length results in improved yarn strength because a long fibre generates a greater frictional resistance to an external force. He also stated that at high fibre length the tensile strength of the fibres becomes the controlling factor of yarn

strength. Amjad (1999) reported that longer the fiber, higher would be the yarn strength. Anonymous (2000) reported that yarn strength and yarn elongation could be negatively effected by shorter span length. Anonymous (2001) declared that yarns made from finer fibres results in more fibres per cross section, which in turn produces stronger yarn.

This paper presents the response of yarn lea strength based on cotton fibre fineness and staple length.

MATERIALS AND METHODS

Cotton bales of different micronaire value having same staple length were sorted out from the mills godown stock and then various length groups having a gradual increase in micronaire value were selected. In this way fifty-five samples, with five lengths against eleven micronaire levels were selected as follows;

	M_1	M_2	M_3	M_4	M_5	M_6	M_7	M_8	M_9	M_{10}	M_{11}
L_1	M_1L_1	M_2L_1	M_3L_1	M_4L_1	M_5L_1	M_6L_1	M_7L_1	M_8L_1	M_9L_1	$M_{10}L_1$	$M_{11}L_1$
L_2	M_1L_2	M_2L_2	M_3L_2	M_4L_2	M_5L_2	M_6L_2	M_7L_2	M_8L_2	M_9L_2	$M_{10}L_2$	$M_{11}L_2$
L_3	M_1L_3	M_2L_3	M_3L_3	M_4L_3	M_5L_3	M_6L_3	M_7L_3	M_8L_3	M_9L_3	$M_{10}L_3$	$M_{11}L_3$
L_4	M_1L_4	M_2L_4	M_3L_4	M_4L_4	M_5L_4	M_6L_4	M_7L_4	M_8L_4	M_9L_4	$M_{10}L_4$	$M_{11}L_4$
L_5	M_1L_5	M_2L_5	M_3L_5	M_4L_5	M_5L_5	M_6L_5	M_7L_5	M_8L_5	M_9L_5	$M_{10}L_5$	$M_{11}L_5$

L_1= 1.05 inch; L_2= 1.06 inch; L_3=1.07 inch; L_4=1.08 inch; L_5=1.09 inch, and M_1= 3.8μg/inch; M_2= 4.0μg/inch; M_3= 4.1μg/inch; M_4=4.2μg/inch; M_5= 4.3μg/inch,; M_6= 4.4μg/inch,; M_7= 4.6μg/inch,; M_8=4.8μg/inch; M_9= 5.0μg/inch,; M_{10}= 5.1μg/inch,; M_{11}=5.2μg/inch

The cotton samples were evaluated for the following physical characteristics.
Fibre characteristics. Physical characteristics of cotton samples (i.e. length and fineness) were determined mostly with the help of "High Volume Instrument " HVI-900A, according to the standards of committee ASTM (1997a).
Yarn preparation. After the evaluation of the physical characteristics of the raw material, each cotton sample was opened manually and processed in the blow room. Then each sample was processed in carding and drawing section

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without changing any mechanical set up. The samples of sliver were processed to form roving of the same hank; roving samples were then spun in to ultimate yarn of the 20^s count at the same ring spindles. The yarn samples thus prepared were tested according to the standard methods as recommended by ASTM committee.

Yarn lea strength. Lea strength of yarn was determined on a pendulum type tensile tester by "Skein method" recommended by ASTM Committee (1997b).

Statistical Analysis. Completely Randomized Design was applied in the analysis of variance of data for testing the differences among various quality characters as suggested by Steel and Torrie (1984). Duncan's Multiple Range test was also applied for individual comparison of means among various quality characters. The data was subjected to statistical manipulation on computer employing M-Stat micro computer program devised by Freed (1992).

RESULTS AND DISCUSSION

Yarn lea strength. Statistical analysis of variance in respect of yarn lea strength of MNH-93 cotton variety is presented in Table I which shows that the differences in the mean values due to different levels of micronaire and fibre length were highly significant, where as, the interaction of micronaire value and fibre length ($M \times L$) was significant.

Comparison of individual mean values of yarn lea strength for different levels of micronaire value given in Table II reveals the highest value of yarn lea strength at M_6 as 122.6 pounds followed by M_5, M_4, M_7, M_8, M_3, M_{10}, M_9, M_{11}, M_2 and M_1 with their mean values as 121.0, 120.0, 119.1, 116.3, 113.6, 112.1, 111.0, 107.5, 105.1 and 96.67 pounds respectively. The present results show that cotton samples with micronaire levels M_4 to M_7 gave the best values of yarn lea and the micronaire levels below and above these values gave low value of yarn lea strength. Previously, Grover and Hamby (1966) stated that with other fibre properties remaining constant, fine fibres would

produce a yarn with higher strength than will coarse fibres. In the same line, Anonymous (2001) declared that yarns made from finer fibres results in more fibres per cross section, which in turn produces stronger yarn.

Further Comparison of individual mean values of yarn lea strength for fibre length levels given in Table II exposes the highest value of yarn lea strength at L_5 as 116.2 pounds followed by L_4, L_3, L_2 and L_1 with their mean values as 115.8, 113.4, 112.0, and 108.5 pounds respectively. The present results are fully supported by Broughton and his co-workers (1992) they acknowledged that the increasing fibre length results in improved yarn strength because a long fibre generates a greater frictional resistance to an external force. They also stated that at high fibre length the tensile strength of the fibres becomes the controlling factor of yarn strength.

Considering the interaction of micronaire value and fibre length ($M \times L$), the Table III indicates that the cotton samples with five fibre length levels having micronaire value M_6 has the maximum value of yarn lea strength as 127.5 pounds at fibre length level L_5. While the remaining mean values are ranked as 125.3, 122.6, 121.0 and 116.7 pounds for fibre length levels L_4, L_2, L_3 and L_1 respectively. The range of yarn number for over all cotton samples is noted from 93.35 to 127.5 pounds with minimum value for yarn sample M_1L_1 (3.8 μg/inch, 1.05 inch) and maximum for M_6L_5 (4.4 μg/inch, 1.09 inch). The best values of yarn lea strength are obtained at middle levels of micronaire ($M_4 = 4.2$, $M_5 = 4.3$, $M_6 = 4.4$ and $M_7 = 4.6$ μg/inch) against higher fibre length levels ($L_4 = 1.08$ and $L_5 = 1.09$ inch).

The fibre properties have various degree of influence on yarn lea strength as it is mentioned by Sattar and Hussain (1985), they concluded that the fibre fineness seems to be more significant and contributes more than the fibre strength to yarn strength. Similarly, Ramey and Beaton (1989) stated the major fibre properties contributing to yarn strength are fibre strength, fibre shape and a measure of fibre length uniformity. While studying the relationship between fibre and yarn properties, Amjad (1999) reported that longer the

Table I. Analysis of variance for lea strength

S.O.V.	D.F	S.S.	M.S.	F. Value	Prob.
M	10	3.700	0.370	17.2311	0.0000 **
L	4	4.206	1.052	48.9659	0.0000 **
M × L	40	26.150	0.654	30.4420	0.0000 *
Error	220	4.725	0.021		
Total	274	38.782			

** = Highly Significant; * = Significant

Table II. Comparison of individual mean values for lea strength (lbs)

Micronaire value	Mean value	Micronaire value	Mean value	Fibre length	Mean value
M_1	96.67 [h]	M_7	119.1 [b]	L_1	108.5 [d]
M_2	105.1 [g]	M_8	116.3 [c]	L_2	112.0 [c]
M_3	113.6 [d]	M_9	111.0 [e]	L_3	113.4 [b]
M_4	120.0 [b]	M_{10}	112.1 [de]	L_4	115.8 [a]
M_5	121.0 [ab]	M_{11}	107.5 [f]	L_5	116.2 [a]
M_6	122.6 [a]				

Any two means sharing a letter do not differ significantly at 5% level of probability

fiber, higher would be the yarn strength. Likewise, Anonymous (2000) reported that yarn strength and yarn elongation could be negatively effected by shorter span length.

CONCLUSION

Lower and higher micronaire values deteriorate the yarn lea strength and higher value of fibre length gives best yarn lea strength.

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