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Comparative Study of Effect of Stitch Length and Yarn Count on Fabric Width and Stiffness of Different Weft Knitted Single Jersey Structures

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ABSTRACT

In this study the authors analyzed on the effects of stitch length and Yarn Count on fabric width and stiffness of weft knitted single jersey fabrics. On this study different types of weft knitted single jersey fabrics have been used like as single jersey plain, single lacoste, double lacoste and polo pique fabric. The dimensional stability of knit fabrics is an important area of the knitting industry. Stitch length, yarn count, structure of fabric influence the dimensional stability of fabric. These various factors influence the dimensional stability as well as the bending length. Dimensional changes occur during production or washing or wearing. Here stiffness of the fabric was determined using the instrument Shirley Stiffness Tester. It was found after completing the work that the fabric width increases gradually with the increase of stitch length. Single jersey plain fabric has the lowest fabric width and double lacoste has the highest fabric width and fabric width decreases gradually in finer yarn. It was also found that the bending length decreases gradually with the increase of stitch length.

Key words: Stiffness, Knitted Fabric, Yarn Count, GSM, Stitch

INTRODUCTION

Knit fabric properties can be changed due to the use of various count of yarn, type of yarn (ring, rotor, and compact), quality of yarn, stitch length or loop length, structural geometry and fiber composition of yarn etc [1]. Knitted fabric consists of loops, which intermeshed each other. Loops can have different appearance, according to shape of yarn path. Thus, different structural elements exist in the knitted fabric [2]. Knitting is frequently used method for fabric production. Knitted fabric is unique in structure that it possesses a high order of elasticity and recovery. Since the last few years knitted fabrics are used in manufacturing of fashion garments and even it has the potential in the formal wear segments also. Shrinkage is one of the most serious problems of the fabric faults. Especially, it is obtained in single jersey knitted fabric. Because of different of both side of single jersey knit fabric & side (Face or back) of the single jersey always tends to create curling. Thus, shrinkage is formed in single jersey mostly, where the other fabric is not so affected greatly as compared with it [3]. For that reason it is very important to know that what is or are the effects of stitch length and Yarn Count on fabric width and stiffness. In other word, unlike woven or bonded fabrics which possess a low degree of elongation, knitted fabric can be stretched to considerable length and will gradually return to its original shape. Knit fabrics provide comfortable wear to almost any style of garment [4].

The dimensional stability of knit fabrics is an important area of the knitting industry. Stitch length, yarn count, structure of fabric influence the dimensional stability of fabric [5]. These various factors influence the dimensional stability as well as the bending length. Bending length is the length of fabric that will bend under its own weight to a definite extent. It is a measure of the stiffness that determines draping quality. It is also called stiffness of drape or drape stiffness [6]. Bending length is expressed in centimetres. Fabrics with a bending length of less than 2 cm are too flexible to be tested by the cantilever method and a heart loop method is advised [7]. Another measure of the stiffness is the flexural rigidity which measures the actual forces produced in bending and is therefore dependent on fabric weight [8]. This study has been carried out to investigate the effect of stitch length and yarn count on fabric width and stiffness of different weft knitted single jersey structures.

MATERIALS AND METHODS

Materials

In this research work 100% Cotton z twisted yarn was used with different count like as 28 Ne, 30 Ne and 32 Ne. Electronic Balance, Counting Glass, Pin, Marker Pen, Shirley stiffness tester, Scissor and Scale were also used here. Single Jersey Circular Knitting Machine that was used for knitting is shown below in the Fig 1 and specifications in Table 1. Shirley Stiffness Tester that was used for bending length measurement is shown in Fig 2.

Fig. 1 Single jersey circular knitting machine

Fig. 2 Shirley Stiffness Tester

Table- 1 Specifications of Single Jersey Circular Knitting Machine

parameters	Machine Type	Machine gauge	Cylinder diameter	No. of feeders	No. of tracks	Total no. of needles	Type of needle	Rotation of cylinder	Creel capacity	Oiling system
Specification	Single knit	24G	10 inch	30	4	744	Latch needle	Clockwise	60	pneumatic

METHODOLOGY

Knitted Fabric Production Process

Needle set-out and cam arrangements were set in 3 tracks to produce plain structures. Then 30 cones of 28 Ne yarn were set in the creel stands. The diameter of Quality Adjustment Pulley (QAP) was adjusted to 15.46 cm to maintain stitch length of 2.66 mm. Then fabric was produced by using 30 feeders. After that diameter of QAP was adjusted to 16.66 cm to maintain stitch length 2.86 mm and produced another sample of plain structure. Then stitch length was changed to 3.07mm by adjusting diameter of QAP to 17.86 cm and produced another sample of plain structure.

After producing above three samples of three different stitch length of same count, yarn count were changed to 30 Ne and 32 Ne to produce three different stitch lengths. By following the same sequence nine samples of single lacoste, double lacoste and polo pique structures were produced at three different stitch length. In case of single lacoste and polo pique structures 28 cones and 28 feeders were used as they have four courses structural repeat. For this research work total 32 samples were produced and shown in the Table-2.

Measurement of Fabric Width

Fabric width was measured according to the B.S 1930:1953. The samples were conditioned in standard atmospheric condition of $20^0C \pm 2^0C$ temperature and 65%±2% relative humidity. Samples were laid on a flat horizontal surface for removing wrinkles without stretching. The edge of the counting glass was positioned of so that it is either parallel to or perpendicular to the line of wales. Then wales were counted along width of the fabric by the counting glass. The formula to find out the fabric width is Fabric width (inch) = $\frac{\text{Total number of needles}}{\text{Wales per inch}}$

After calculating the fabric width from 10 different places average fabric width was taken and presented in table 3.

Measurement of Fabric stiffness or Bending Length

For the measurement of Bending Length test specimens were cut into (6 x 1) inch from cotton knitted fabrics. Both the template and specimen were transferred to the platform with the fabric underneath. Then both were slowly pushed forward. The strips of the fabric were commenced to droop over the edge of the platform and the movement of the template and the fabric were being continued until the tip of the specimen viewed in the mirror cuts both index lines. Then the bending length immediately was read off from the scale mark opposite a zero line engraved on the side of the platform. Each specimen was tested two times, at head end and tail end in wales direction. In this way, two samples of each structure were tested. Finally mean values for the bending length in wales direction were calculated.

Table-2 Following are the Details of Produced Samples

Sample number	Structure	Stitch length (mm)	Yarn count (Ne)	Structure code
1	Single jersey plain	2.66	28	SJP
2	Single jersey plain	2.86	28	SJP
3	Single jersey plain	3.07	28	SJP
4	Single jersey plain	2.66	30	SJP
5	Single jersey plain	2.86	30	SJP
6	Single jersey plain	3.07	30	SJP
7	Single jersey plain	2.66	32	SJP
8	Single jersey plain	2.86	32	SJP
9	Single jersey plain	3.07	32	SJP
10	Single lacoste	2.66	28	SL
11	Single lacoste	2.86	28	SL
12	Single lacoste	3.07	28	SL
13	Single lacoste	2.66	30	SL
14	Single lacoste	2.86	30	SL
15	Single lacoste	3.07	30	SL
16	Single lacoste	2.66	32	SL
17	Single lacoste	2.86	32	SL
18	Single lacoste	3.07	32	SL
19	Double lacoste	2.66	28	DL
20	Double lacoste	2.86	28	DL
21	Double lacoste	3.07	28	DL
22	Double lacoste	2.66	30	DL
23	Double lacoste	2.86	30	DL
24	Double lacoste	3.07	30	DL
25	Double lacoste	2.66	32	DL
26	Double lacoste	2.86	32	DL
27	Double lacoste	3.07	32	DL
28	Polo pique	2.66	28	PP
29	Polo pique	2.86	28	PP
30	Polo pique	3.07	28	PP
31	Polo pique	2.66	30	PP
32	Polo pique	2.86	30	PP
33	Polo pique	3.07	30	PP
34	Polo pique	2.66	32	PP
35	Polo pique	2.86	32	PP
36	Polo pique	3.07	32	PP

Table-3 Fabric width in Different Stitch Length and Structure at 28 Ne, 30 Ne and 32 Ne

Yarn count	Fabric structure	Width of 2.66mm stitch length	Width of 2.86mm stitch length	Width of 3.07mm stitch length
28 Ne	DL	31.39	32.78	34.44
	PP	29.88	30.87	32.92
	SL	25.31	29.06	31.93
	SJP	21.38	23.03	23.85
30 Ne	DL	30.24	31.39	33.21
	PP	29.06	30.37	32.07
	SL	24.55	27.76	30.62
	SJP	20.27	22.01	22.82
32 Ne	DL	28.95	30.74	32.21
	PP	27.97	30.12	31.26
	SL	24.08	27.25	29.29
	SJP	18.79	20.72	22.08

RESULTS AND DISCUSSIONS

The effects of stitch lengths and structures on fabric width at different yarn counts are summarized in the Table 3. It is shown from the above graph (Fig 3 to Fig 5) that fabric width increased with the increase of stitch length within the same yarn count. When loop length increases, the course length also increases. As Course length is proportional to fabric width so fabric width increases. Also when loop length increases the number of wales per unit width decreases. As we know that number of wales per unit width is inversely proportional to fabric width so, fabric width increases. This phenomenon was found common to all four structures.

Figures 6 - 8 describe that fabric width decreased when yarn count gets finer within the same stitch length. As yarn count getting finer the loops becomes more flexible. So the wales come closer to each other causing more shrinkage across the width. So number of wales per unit width increases. As we mentioned earlier number of wales per unit width is inversely proportional to fabric width so, fabric width decreases. This phenomenon is found common to all four structures.

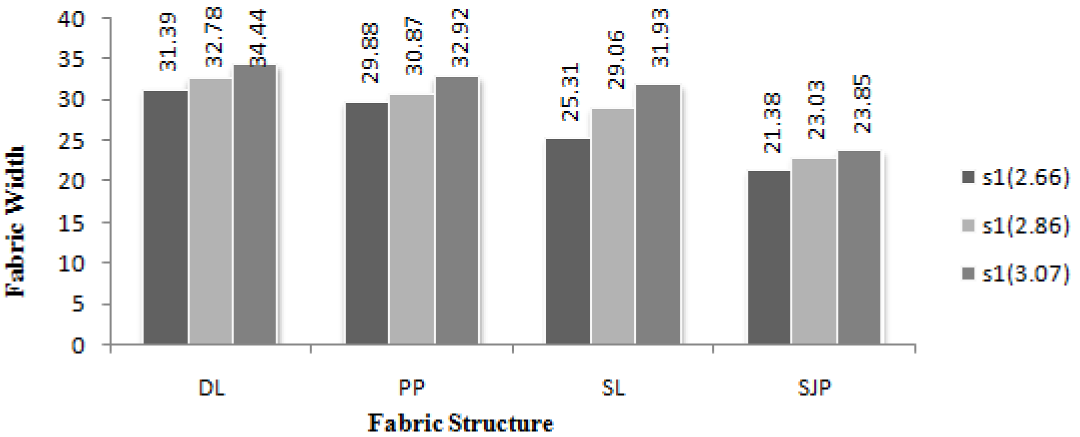

Fig. 3 Effect of stitch length and structure on Fabric Width at 28 Ne

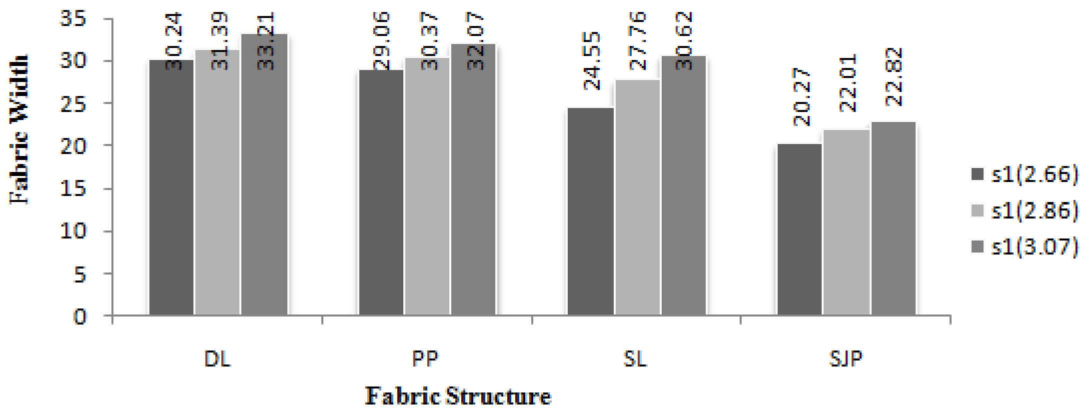

Fig. 4 Effect of stitch length and structure on Fabric Width at 30 Ne

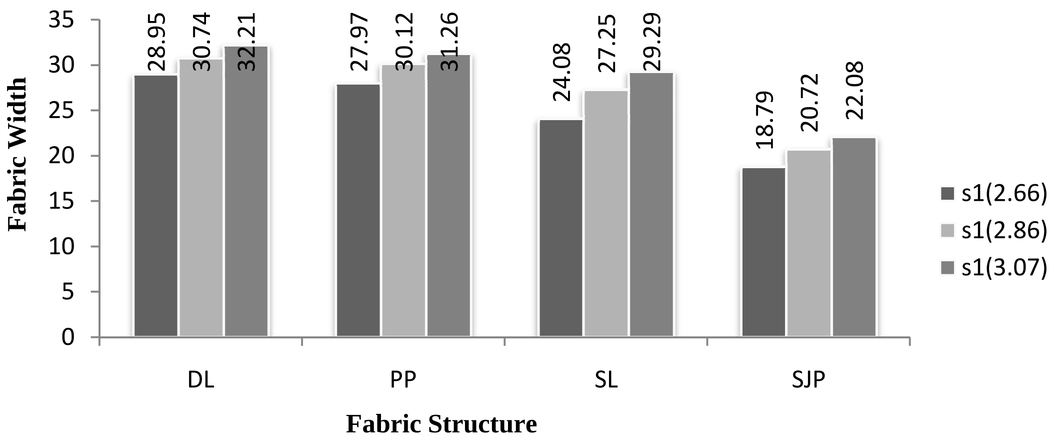

Fig. 5 Effect of stitch length and structure on Fabric Width at 32 Ne

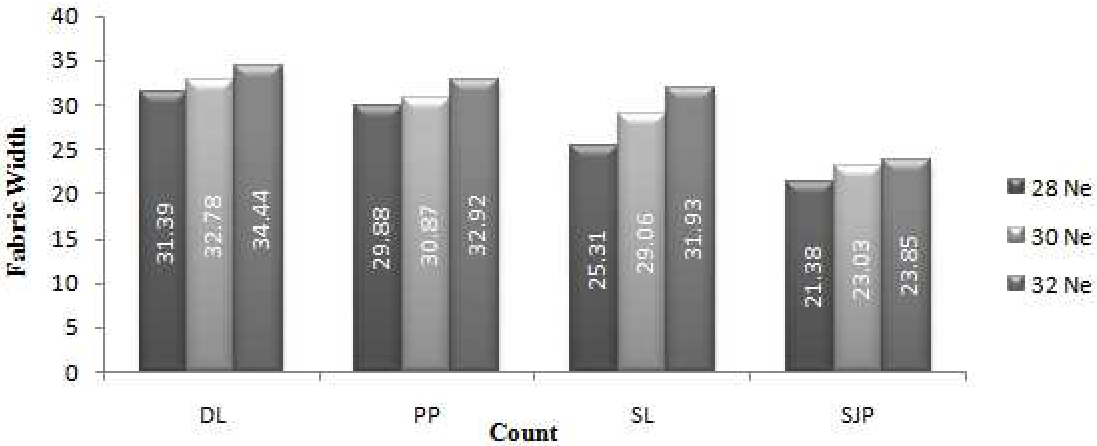

Fig. 6 Effect of count and structure on Fabric Width at 2.66mm stitch length

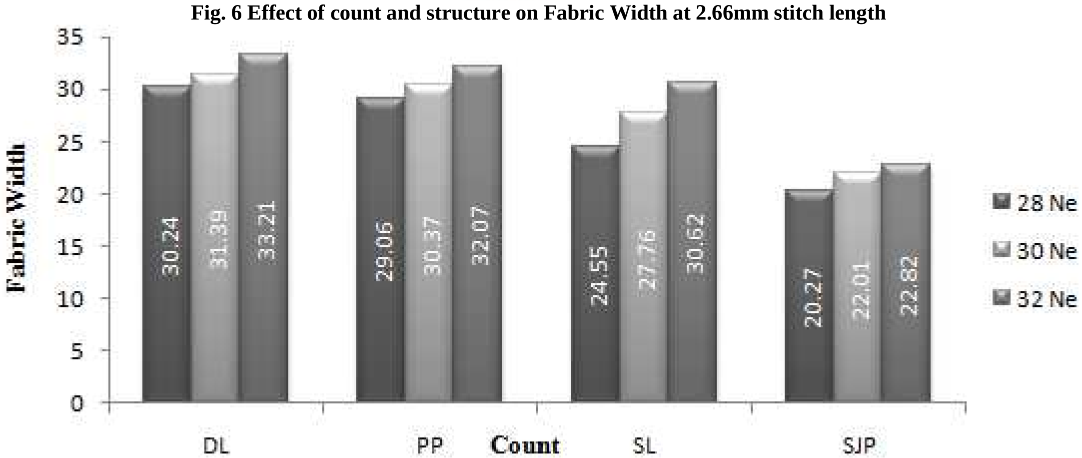

Fig. 7 Effect of count and structure on Fabric Width at 2.86mm stitch length

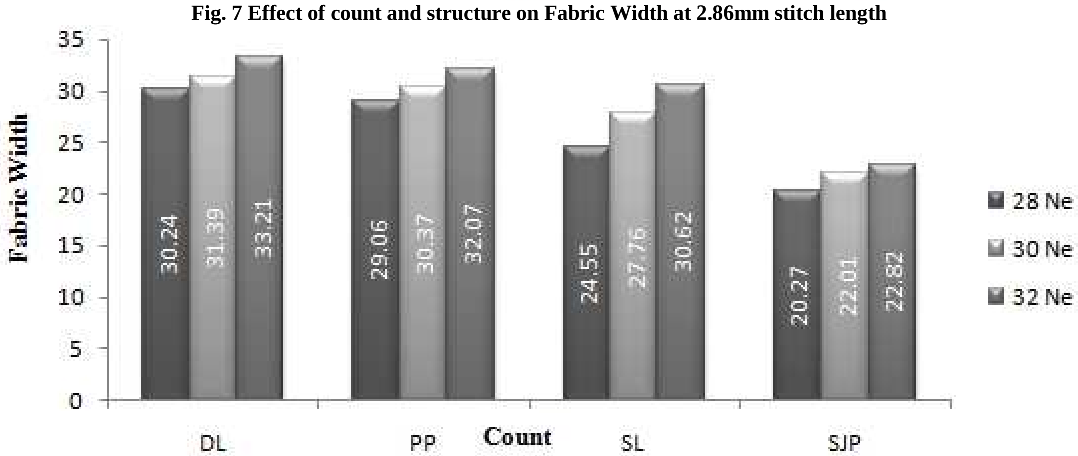

Fig. 8 Effect of count and structure on Fabric Width at 3.07mm stitch length

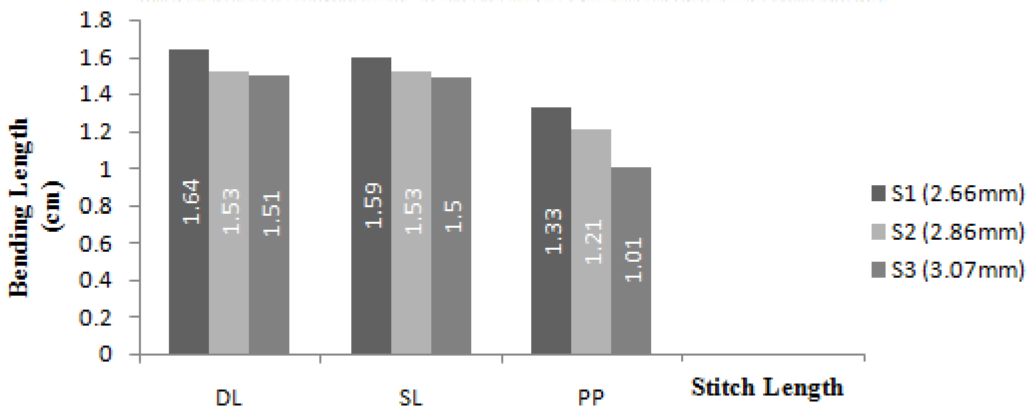

Fig. 9 Effect of stitch length and structure on bending length at 28 Ne

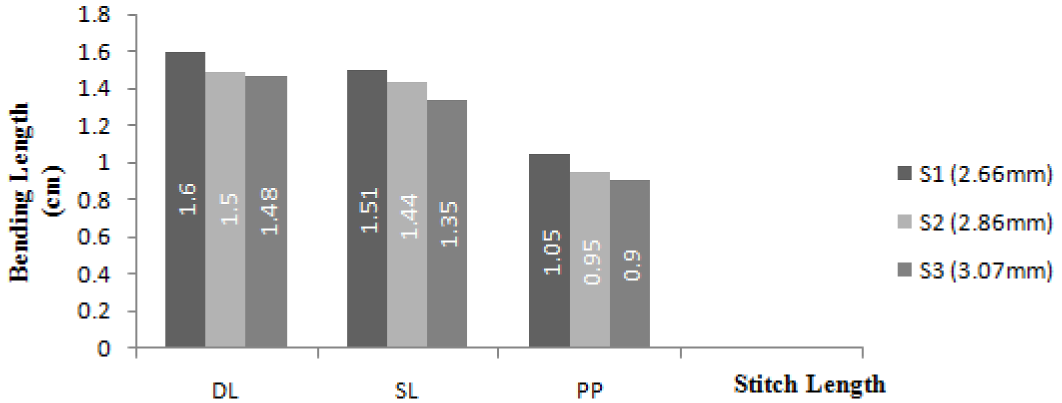

Fig. 10 Effect of stitch length and structure on bending length at 30 Ne

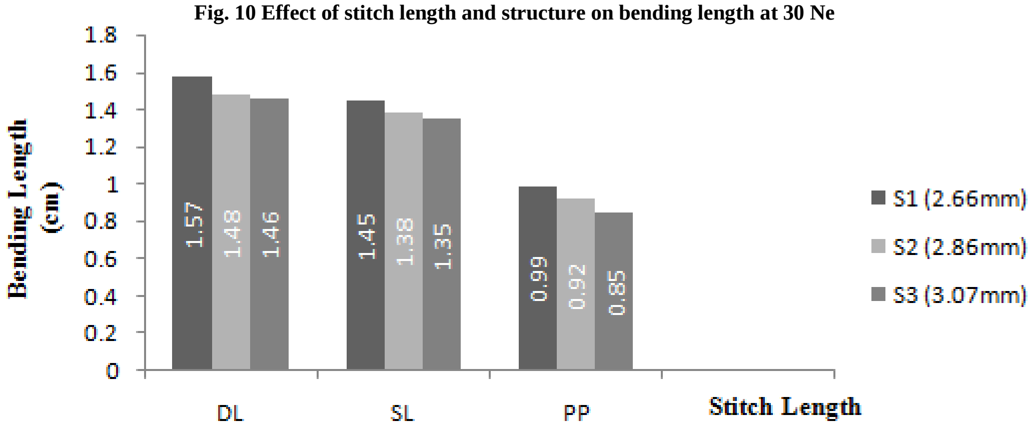

Fig. 11 Effect of stitch length and structure on bending length at 32 Ne

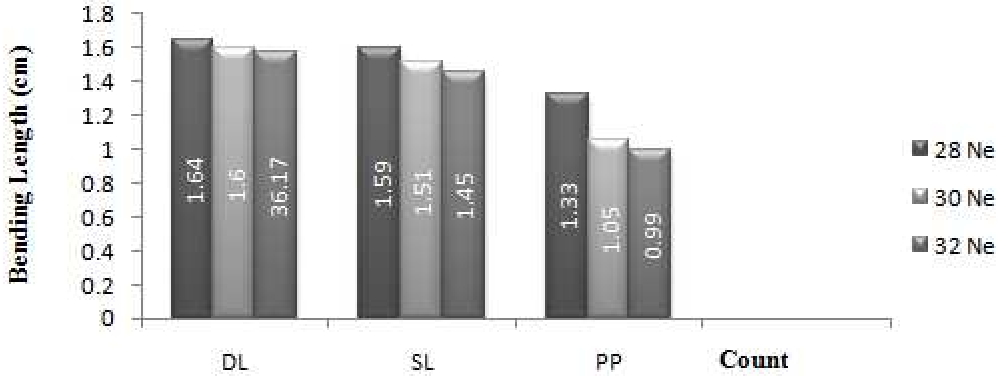

Fig. 12 Effect of count and structure on bending length at 2.66mm

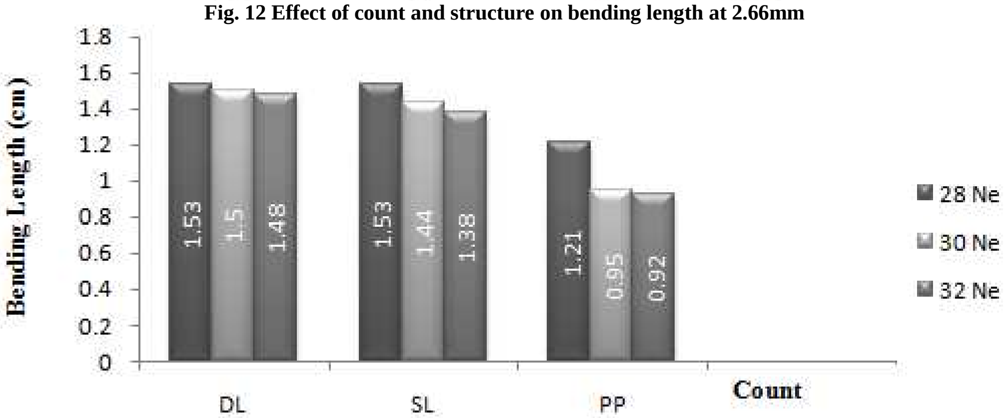

Fig. 13 Effect of count and structure on bending length at 2.86mm

Again keeping the yarn count and stitch length constant when we compare the width of fabric among different structures we can see that plain possess lowest value and double lacoste possesses highest value. This is because double lacoste has tuck stitches which are wider than knit stitches in plain structure. It can also be seen from the graph that fabric width has gradually decreased according to the sequence – double lacoste, polo pique, single lacoste and single jersey plain.

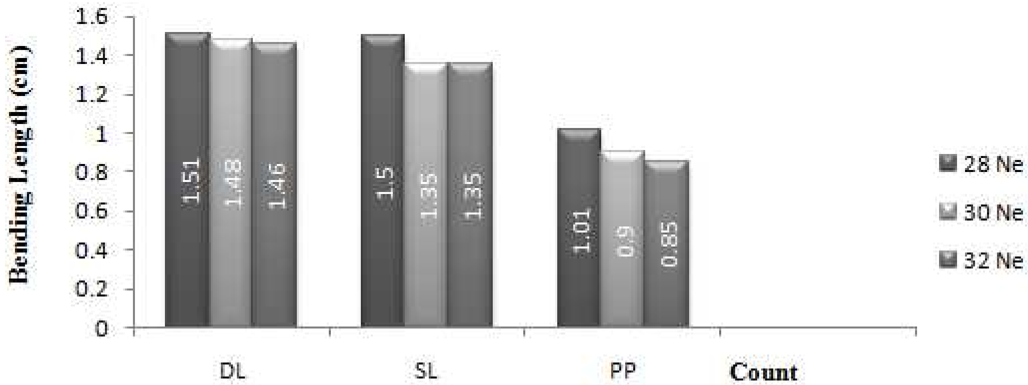

Fig. 14 Effect of count and structure on bending length at 3.07mm

Table-4 Bending length in Different Stitch Length and Structure at 28 Ne, 30 Ne and 32 Ne

Yarn count	fabric structure	Bending length in 2.66mm stitch length	Bending length in 2.86mm stitch length	Bending length in 3.07 mm stitch length
28Ne	DL	1.64	1.53	1.51
	SL	1.59	1.53	1.50
	PP	1.33	1.21	1.01
30Ne	DL	1.60	1.50	1.48
	SL	1.51	1.44	1.35
	PP	1.05	0.95	0.90
32 Ne	DL	1.57	1.48	1.46
	SL	1.45	1.38	1.35
	PP	0.99	0.92	0.85

The effects of stitch lengths and structures on bending length at different yarn counts are summarized in the Table -4. It is observed from the Fig no 9 to Fig no 11 that bending length has decreased with the increase of stitch length within the same yarn count. With minimal stitch length stitch density become higher which makes a fabric denser and more compact. As a result fabric becomes stiffer. When stitch length increases stitch density as well as fabric compactness decreases which makes a fabric limper. If other parameters such as machine gauge, yarn count, fabric structure, twist per inch, etc. remain the same. This phenomenon is found common to all other three structures.

It is seen from the graph (Fig 12 to Fig 14) that bending length decreased as yarn count gets finer while the stitch lengths remain the same. When yarn fineness increases its mass per unit length decreases. Fabric produced with such yarn become less compact and limper if other parameters such as machine gauge, stitch length, fabric structure, twist per inch, etc. remain the same. As a result bending length decreases. This phenomenon is found common to all three structures.

Again keeping the yarn count and stitch length constant if we compare the bending lengths among different structures we can see that polo pique possesses the lowest value and double lacoste possesses the highest value. This is because polo pique has 50% tuck stitch and 50% knit stitch in its structural repeat which makes it less denser than double lacoste. Bending length of plain structure was not measured as cantilever principle is not suitable for it. It can also be seen from the graph that bending length has gradually decreased according to the sequence- double lacoste, single lacoste and polo pique.

CONCLUSION

The results of this research work indicate that the fabric width, bending length of knitted fabrics is directly related to the stitch length, yarn count and knitted structures. It was found that fabric width increased with the increase of stitch length within the same yarn count. When loop length increases, the course length also increases. In case of all four structures it was found that fabric width increased with the increase of stitch length. On the other hand fabric width decreased when yarn count gets finer within the same stitch length. Because of finer yarn count the loops becomes more flexible, so the wales come closer to each other causing more shrinkage across the width. As a result number of wales per unit width increases. As it was known to us that the number of wales per unit width is inversely proportional to fabric width, so fabric width decreases to all four structures.

When it was comparer the width of fabric among different structures keeping the yarn count and stitch length constant we have seen that single jersey plain fabric possess lowest value and double lacoste possesses highest value. This is because double lacoste has tuck stitches which are wider than knit stitches in plain structure. It was found that fabric width has gradually decreased according to the sequence – double lacoste, polo pique, single lacoste and single jersey plain. Bending length is measured to determine draping quality of the fabric. In this study one of the important focuses was to determine the stiffness or bending length of the fabric and found that bending length decreased with the increase of stitch length within the same yarn count. When stitch length increases stitch density as well as fabric compactness decreases which makes a fabric limper. If other parameters such as machine gauge, yarn count, fabric structure, twist per inch, etc. remain constant bending length decreased with the increase of stitch length for all other three structures.

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Conflicts of Interest
The authors declare that there is no conflict of interest regarding the publication of this paper.

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