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The Effect of Machine Setting On Weft- Knitted Fabric Properties

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IN the field of garments manufacture produced from circular weft knitted fabrics, it is important that we understand the variables and processes used so that we can predict their impact on dimensional changes. This helps in solving technical problems and satisfying consumer needs. The present investigation was carried out using circular knitting machine gauge 24. It identified the effect of changing various settings of the machine on the characteristics of the knitted fabric produced. Three fabrics were used from combed cotton yarns with count 20/1, 24/1and 30/1 Ne to produce (parasula) single jersey. A regression analysis equation was used to predict fabric specifications. The scheme of research depended on producing three knitted fabric samples from every count with different cylinder diameter opening. Therefore, nine samples were used to investigate the change that happened to the fabric after relaxation, such as: fabric width, fabric weight, stitch density ~~at~~ in wall and course directions, and stitch length. The second stage of investigation was after dyeing and drying all the samples, which were produced under the same condition to identify the extent of the change in their specifications. The final Finishing stage set the fabric width at four different measurements for all samples to study the effect of drying heat on the weight/m^2, stitch density wall/course, stitch length and shrinkage in wall and course directions.

Keywords: Weft knitted fabric, Drying heat, Various settings of the machine, Yarn count, Wall and course density, Stitch length, Fabric shrinkage, Feeding rate.

It is a well-known fact that the use of weft knitted fabrics for garment manufacturing is increasing, as the knitted goods offer several advantages that are very suitable for apparel.

Advantages

- From the user side: quick response to market requirements by offering controllable stretch through the construction, easy care, good body fitting, soft handle, and cooling or warming depending on construction.
- From the Manufacturing side: higher productivity (3 times higher than weaving looms), manufacturing costs for knitted goods are approx 50% lower than for woven fabric, lower capital investments, suitable for all types of fibers, and sizing/desizing operations are not necessary.

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Although the processing of weft knitted fabrics has been carried out mostly in tubular form on circular machines, it is to be understood that processing in tubular form has its disadvantages.

Disadvantages

- The fabric is produced in large batches; hence, process control becomes difficult, resulting in high consumption of utilities like steam and water, defect from rubbing and abrasion during wet processing, dyeing and drying. Therefore, one of the most important reasons for adopting open width processing of knitted goods is to produce good quality fabrics consistently with a high degree of flexibility and replication and at lower costs to meet the stringent demands of the customers (J. Strohle & C.N. Guruprasad, 2002).

- Shrinking after washing is considered a serious problem for cotton knitted fabrics.-The high level of fabric shrinking remains a problem in garment form. The quality of knitted good is mainly determined by the change of width and length of the finished garments. The insufficient stability of knitted goods can alter their quality, (Baber Shahbaz, Muhammad Nawaz and Umar Deaz Gill, 2001).

  - For the hydrophilic fibers (cotton and wool), wet relaxation brought about an increase in the numerical values of Kc and Kw, (*i.e.*, length and width shrinkage) caused by a change in the loop shape as the fabrics passed from the dry relaxed state to the more stable wet relaxed state. It was further showed that the fabric dimensions determined by the length of the loop, (Nicholes Hahn, 1996).
  - It was also showed that as fabric length decreased, fabric width increased in a way that suggests further relaxation of loop shape, (Knapton and Fong,1970).
  - It was suggested that many of the difficulties caused by excessive shrinkage could be alleviated by knitting fabrics as strain free as possible by careful adjustment of the knitting machine settings, (Black, D. H, 1974). Black concluded that width-wise shrinkage decreased with the increase in stitch length and takedown tension.
  - Chaudhry and Sengupta found multiple correlations between fabric shrinkage and count crimp contract and residual yarn shrinkage (Baber Shahbaz, 2001.Muhammad Nawaz and umar Deaz Gill).

  - Sharma *et al* (1985) reported that with a decrease in yarn twist factor the shrinkage decreased and with higher twist, shrinkage increased. He further stated that fabric area shrinkage increased with tightness factor. It was observed that with the increase in yarn count and machine gauge, the shrinkage increase for the same tightness factor.

  - In addition, it was mentioned that fabric dimension would vary with d/1, where d is the effective yarn diameter and 1 is the stitch length, (little, 1978)/ (Baber Shahbaz, Muhammad Nawaz and umar Deaz Gill, 2001). It was reported that altering certain settings on the knitting machine such as takedown tension, stretcher board width can result in significant changes in fabric dimensions.

Materials and Methods

Machine settings

The knitted fabric samples were made of 100% cotton, Table 1 shows the Mayer & Cie single jersey machine specification and setting used.

TABLE 1. Machine Specifications.

gauge	24 needle/inch
Diameter of cylinder	26/inch
Number of needle	1944
Number of feeder	84
Apparatus for positive feeding	With belt, cylinder
Machine speed	17cycle/sec
The lower tension	50

The methods used to produce the sample

Nine samples were produced using combed cotton in three yarn counts 20/1, 24/1, 30/1 (Ne) at different adjustment of supplier setting 170, 155, and 135.

Changes to fabric properties were recorded, including fabric width, fabric weight, the number of courses and stitch length.

TABLE 2. The machine setting.

Sample no	Yarn Count Ne	Adjustment of supplier	Feeding rate/m/min	Yarn tension	rate of tension	Machine speed cycle/sec
1	20/1	175	١١١،٣	7.5	16	17
2	20/1	155	٩٧,٦	4.5	12	17
3	20/1	135	٨٥,١	2.5	10	17
4	24/1	175	١١,٣	7.5	١٦	17
5	24/1	155	٩٧,٦	4.5	12	17
6	24/1	135	٨٥,١	2.5	10	17
7	30/1	175	١١١,٣	7.5	16	17
8	30/1	155	٩٧,٦	4.5	12	17
9	30/1	135	٩٧,٦	2.5	10	17

The dying method

After knitting, the fabric was dyed under the same condition in one bath using a winch machine.

The finishing process

The finishing process included drying, open width under 180 ^{o}C degree of heat at a feed speed of 8 m/sec. The open width was set at four different widths for each lot to study the effect of drying heat on fabric properties.

The physical properties test

The physical properties of these fabrics were tested in standard condition in accordance with:

- Yarn count: measure the yarn count according to ASTM D V7, 2002.
-- Stitch length test according ASTM D, 3887, P.176
-- Shrinkage % according to AATCC, 135, 2003, P.233.
- Fabric weight square according to ASTM D, 3776, P.85.

Results and Discussion

Tables 3, 4, and 5 show the fabric width after drying and after finishing.

TABLE. 3. Shows the test results of fabrics knitted by using count (20/1).

Sample no	Adjust-ment of supplier	Weight (g/m2)	Widt h/cm	Stitch wall/ cm	Stitch course/cm	Stitch length (mm)	Shrink-age wall (%)	Shrinkage course (%)
١	175	١٦٧,٦	٨١	١١,٨١١	١٣,٩٧٦	٣,٥٨	٧,٢٢	١٣,١
2	175	١٦٥,٢	٨٢	١١,٨١١	١٥,١٠	٣,٥	١١	0
٣	175	١٦٢,٤	٨٣	١١,٨١١	١٥,١٠	٣,٥١	٨	٢
٤	175	١٦٢	٨٤	١١,٨١١	١٥,١٠	٣,٤	٥,٣	٠,٦
5	155	٢١٦,٦	٧٤	١٣,٣٨٥	٢١,٢٦٠	٣,٤٥	٧,٧	١٠,٣
6	155	٢١٦,٢	٧٦	١٣,٣٨٥	٢١,٢٦٠	٣,٢٥	٥,٥	٣,٥
7	155	٢٠٢	٧٧	١٢,٩٩٢	٢١,٥٧٥	٣,١٥	٧	٢
8	155	١٩٨	٧٩	١١,٨١١	٢١,٢٦٠	٣,٠	٨,٤	٨,٤
9	135	٢٣٤,٢	٦٩	١٤,١٧٣	٢١,٢٦٠	٢,٦٧	٨,٢	٥,٧
10	135	٢٣٤,٨	٧٠	١٤,٤٠٩	٢١,١٠٢	٢,٥٨	٤	0
11	135	٢١٩,١	٧٤	١٢,٥٩٨	٢٢,٠٤٧	٢,٤٦	٥	٥
12	135	٢١٤,٥	٧٥	١٣,٣٨٦	٢١,٢٦٠	٢,٣٧	٧,٣	١٢

TABLE. 4. Shows the test results of fabrics knitted by using count (24/1).

Sample no	Adjust-ment of supplier	Weight (g/m2)	Width/ cm	Stitch wall/cm	Stitch course/cm	Stitch length mm	Shrinkage (%) wall	Shrinkage (%) course
13	١٧٥	١٦٤	٧٦	١٢,٢٠٥	١٣,٨١٩	٣,٤٥	١٢	٤
14	١٧٥	١٥٠	٧٩	١٢,٢٠٥	١٣,٧٨٠	٣,٤٠	٥	٥
15	١٧٥	١٤٩	٨٠	١١,٨١١	١٤,١٧٣	٣,٣٥	٦	٣
16	١٧٥	١٤٥	٨٢	١١,٤١٧	١٤,٤٠٩	٣,٣	٤	٢
17	١٥٥	١٩٥,٣	٧٢	١١,٨١١	١٧,٧١٧	٣,٥	٦,٧	٦,٧
18	١٥٥	١٧٧,٦	٧٤	١٢,٢٠٥	١٧,٧١٧	٣,١	٨	٥
19	١٥٥	١٥٨,٨	٧٥	١٢,٧١٧	١٦,٧٧١	٣,١٥	٨	٥
20	١٥٥	١٣٤	٧٦	١٢,٥٩٨	١٦,٩٢٩	٣,٢٣	٨	٨
21	١٣٥	١٩٢,٦	٧٠	١٤,٠١٦	٢٠,٤٧٢	٢,٧١	٦,٦	٣,٧
22	١٣٥	١٨٩,٦	٧١	١٣,٧٨٠	٢٠,٧٠٩	٢,٦٥	٨	٤
23	١٣٥	١٨٨,١	٧٢	١٣,٧٨٠	٢٠,٤٧٢	٢,٧	٧	٥
24	١٣٥	١٨٥,٥	٧٣	١٣,٧٨٠	٢٠,٨٦٦	٢,٧١	٦	٦

TABLE. 5. Shows the test results of fabrics knitted by using count (30/1).

Sample no	Adjustment of supplier	Weight (g/m2)	Width/ cm	Stitch wall/cm	Stitch course/ cm	Stitch length (mm)	Shrinkage wall(%)	Shrinkage course(%)
25	١٧٥	٥٦,٤	٧٩	١٢,٣٢٣	١٢,٧١٧	٣,٥٥	١٦	٣
26	١٧٥	١٠٣,٥	٨٠	١٢,٣٢٣	١٢,٨٣٥	٣,٥٣	١٤	١,٣
27	١٧٥	٧٥,٤	٨٢	١٢,٣٢٣	١٢,٨٣٥	٣,٥٣	١٢	١
28	١٧٥	١٠١,٧٥	٨٤	١١,٤١٧	١٣,٥٨٣	٣,٥٢	١٠	٢
29	١٥٥	١٢١,٧	٧٣	١٣,٥٠٤	١٦,١٤٢	٣,٣٣	١٢	٤
30	١٥٥	١٢٢,٥	٧٥	١٢,٩٩٢	١٦,٣٧٨	٣,٢٠	١٠	٧
31	١٥٥	١١٧,٢	٧٦	١٢,٣٢٣	١٥,٩٨٤	٣,١٩	٨	٦,٢
32	١٥٥	١١٧,٤	٧٧	١٢,٤٤١	١٦,٣٧٨	٣,١٧	٧,٥	٨
33	١٣٥	١٣٤	٦٩	١٢,٢٠٥	١٩,٢٩١	٢,٧٤	٧,٥	١,٣
34	١٣٥	١٣٨,٤	٧٠	١٣,٥٠٤	١٩,٩٢١	٢,٧٢	٤	٣,٢
35	١٣٥	١٣٥	٧١	١٣,٧٨٠	١٩,٦٨٥	٢,٧	٤,٤	٧,٨
٣٦	١٣٥	131.8	٧٤	١٣,٣٨٦	١٩,٢٩١	2.67	٤	٨

Previous tables indicate that significant changes in fabric properties have occurred in all samples after the dyeing and finishing processes.

Multi Regression Analysis Equations

Analysis regression is a mean to express the relation between variables in the state of equation to predict variable (y) value by independent value, the following equations were considered:

Fabric weight square equation -

Stitch / wall equation

-Stitch course equation

-Shrinkage in wall direction equation

-Shrinkage in course direction equation

The relation between feeding rate, yarn count, and the effect on the properties of knitted fabric

Effect of feeding rate and yarn count on the weight per square meter

Figures 1, 2, and 3 show the inverse relationship between feeding rate and the weight/m^2 of the fabrics made of yarn 20/1, 24/1, 30/1 Ne.

Effect of feeding rate and yarn count on width (cm):

Figure 4 shows inversely relationships between feed rates and the width of the fabrics made of yarn 20/1, 24/1, 30/1 Ne, before drying, but Figures (5, 6) show a direct relationship after drying and finishing.

Effect of feeding rate and yarn count on the stitch/ inch in wall direction

Figure 7 shows direct relationship between feeds rates stitch for column/inch to fabrics before drying but Fig (8, 9) shows inversely proportionally between feeding rate, number of stitch for wall/inch for fabrics after drying and finishing.

Effect of feeding rate and yarn count on the stitch/ inch in course direction

Figures 10, 11, and 12 show that there is inverse correlation between the feeding rate and stitch /inch in course direction under all condition.

Effect of feeding rate and yarn count on the shrinkage in wall direction

Figures 13 and 14 show a direct relationship between feeding rates and shrinkage % in the wall direction, but gives an inversely relationship between feeding rate and shrinkage % in the course direction of the finished fabrics.

TABLE. 6. Regression summary of fabric weight.

STAT. MULTIPLE REGRESS.	**Regression Summary for Dependent Variable : WT (mb.sta) R= .95059293 R^2 = .90362693 Adjusted R^2 = .90084693 F(3,104) = 325.05 P<0.0000 Std. Error of estimate : 12.562**					
N=108	BETA	St. Err. of BETA	B	St. Err. Of B.	t (104)	p-level
Intercept			533.2336	13.63949	39.0948	0.00000
YC	-.835067	.030441	-8.0704	.29420	-27.4322	0.00000
YFL	-.444679	.030441	-1.6639	.11390	-14.6067	.00000
CW	-.092468	.030441	-3.2848	1.08139	-3.0376	.003015

YC: Yarn count YFL: Feeding rate CW: Diameter of cylinder

WT = 533.2336 – 8.0704 YC – 1.6639 YFL – 3.2848 CW

TABLE. 7. Regression summary of stitch/in in the wall direction.

STAT. MULTIPLE REGRESS.	**Regression Summary for Dependent Variable : W (mb.sta) R= .72273313 R^2 = .52234318 Adjusted R^2 = .50846431 F(3,104) = 37.910 P<0.0000 Std.Error of estimate : 1.7277**					
N=108	BETA	St.Err. of BETA	B	St. Err. Of B.	t (104)	p-level
Intercept			48.82723	1.87553	26.0338	0.00000
YC	.034962	.067771	.02087	.040454	. 5159	.607026
YFL	-.696185	.067771	-.16090	.015663	-10.2727	.00000
CW	-.190911	.067771	-.41889	.148699	-2.8170	.005801

YC: Yarn count YFL: Feeding rate CW: Diameter of cylinder

W = 48.82723 + 0.02087 YC - 0.1609 YFL – 0.419 CW W: wall

TABLE. 8. Regression summary of stitch/in in the course direction.

STAT. MULTIPLE REGRESS.	Regression Summary for Dependent Variable : C (mb.sta) R=. 91936250 R^2 = .8422741 Adjusted R^2 = .84076281 F(3,104) = 189.32 P<0.0000 Std. Error of estimate : 3.2169					
N=108	BETA	St. Err. of BETA	B	St. Err. Of B.	t (104)	p-level
Intercept			122.3592	3.492085	35.0390	0.000000
YC	-.292584	.038577	-.5713	.075322	-7.5844	.000000
YFL	-.871429	.038577	-.6588	.029163	-22.5892	.000000
CW	.015275	.038577	.1096	.276865	.3960	.692940

YC: Yarn count YFL: Feeding rate CW : Diameter of cylinder

C = 122.3592 – 0.5713 YC – 0.6588 YFL + 0.1096CW C: course

TABLE 9. Regression summary for Shrinkage % at wall direction equation.

STAT. MULTIPLE REGRESS.	Regression Summary for Dependent Variable : S1(mb.sta) R=. 51141677 R^2 = .26154712 Adjusted R^2 = .24024559 F(3,104) = 12.278 P<0.0000 Std. Error of estimate : 2.8701					
N=108	BETA	St. Err. of BETA	B	St. Err. of B.	t (104)	p-level
Intercept			-6.63778	3.115586	-2.13051	.035487
YC	.285017	.084265	.22730	.067201	3.38241	.001014
YFL	.367116	.084265	.11335	.026018	4.35671	.000031
CW	-.213396	.084265	-.62556	.247015	-2.53246	.012821

YC : Yarn count YFL : Feeding rate CW : Diameter of cylinder

S1 = - 6.63778+0.22730 YC+0.11335 YFL– 0. 62556 CW

S1: shrinkage in wall direction

TABLE. 10. Regression summary for Shrinkage % in course direction.

STAT. MULTIPLE REGRESS.	Regression Summary for Dependent Variable : S2 (mb.sta) R=. 39997836 R^2 = .15998269 Adjusted R^2 = .13575142 F(3,104) = 6.6023 P<0.00040 Std. Error of estimate : 2.9015					
N=108	BETA	St. Err. of BETA	B	St. Err. Of B.	t (104)	p-level
Intercept			14.72500	3.149720	4.67502	.000009
YC	-.112676	.089873	-.08518	.067938	-1.25373	.212751
YFL	-.312400	.89873	-.09143	.026303	-3.47603	.000744
CW	.222920	.089873	.61941	.249721	2.48039	.014728

YC: Yarn count YFL: Feeding rate CW: of Diameter of cylinder

S2 = 14.72500 – 0.08518 YC – 0.09143YFL + 0.61941 CW

S2: SHRINKAGE AT COURSE DIRECTION

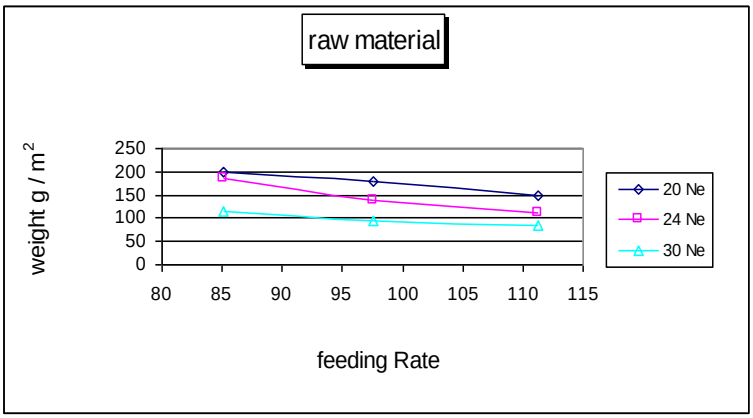

Fig. 1. Effect of feeding rate on the weight per square meter for different counts.

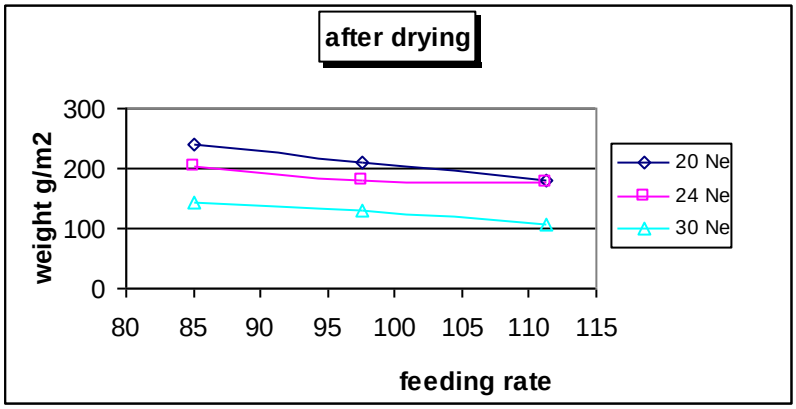

Fig. 2. Effect of feeding rate on the weight per square meter for different counts.

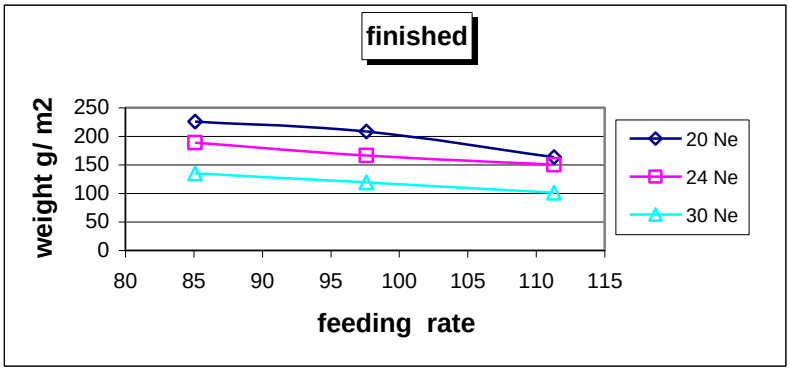

Fig. 3. Effect of feeding rate on the weight per square meter for different counts.

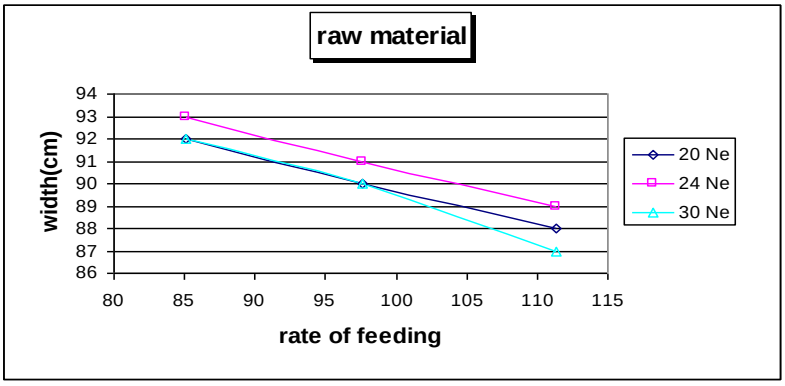

Fig. 4. Effect of feeding rate on the width/cm for different counts.

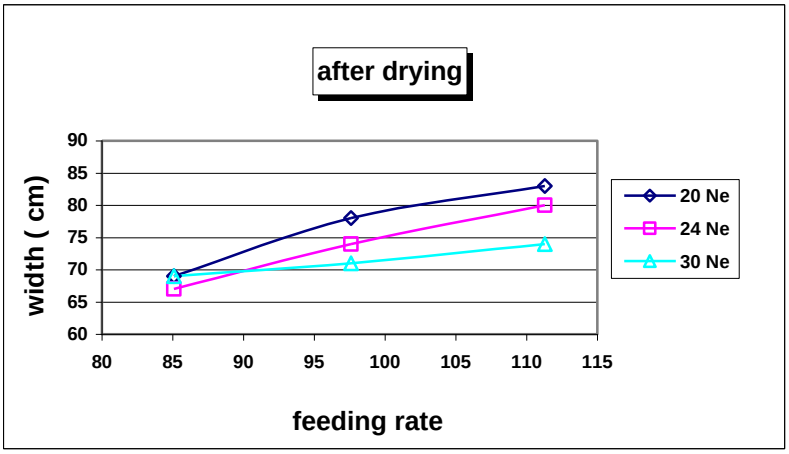

Fig. 5. Effect of feeding rate on the width/cm for different counts.

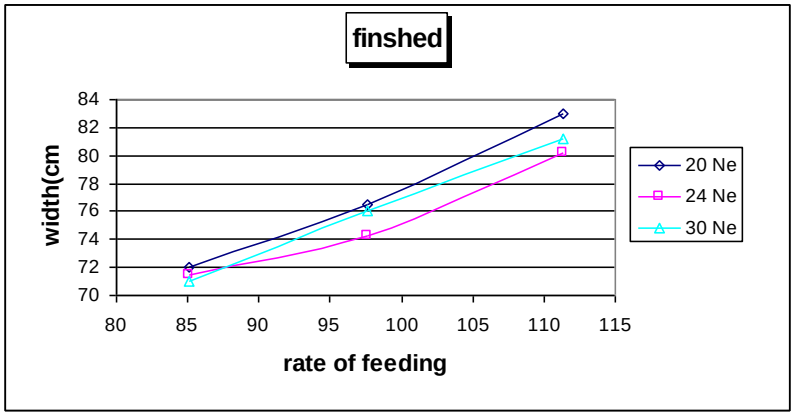

Fig. 6. Effect of feeding rate on the width/cm for different counts.

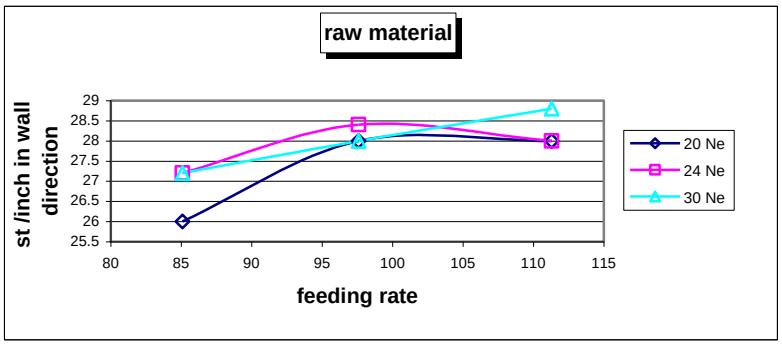

Fig. 7. Effect of feeding rate on the stitch/in in the wall direction for different counts.

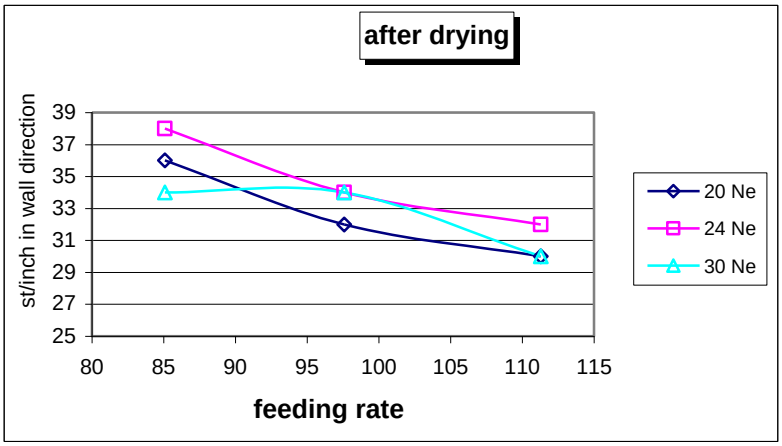

Fig. 8. Effect of feeding rate on the stitch/in in the wall direction for different counts.

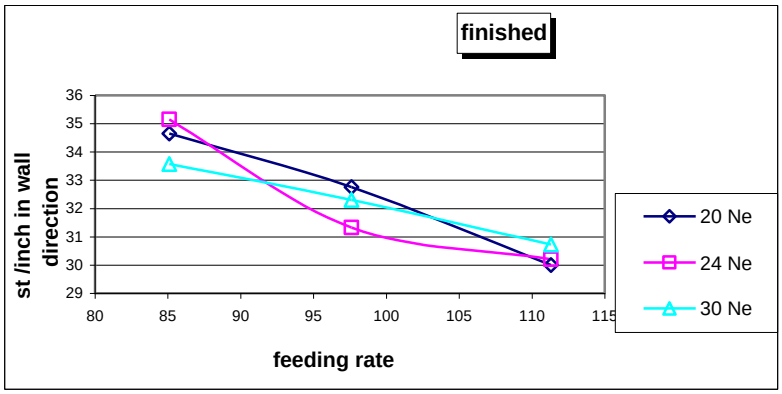

Fig. 9. Effect of feeding rate on the stitch/in in the wall direction for different counts.

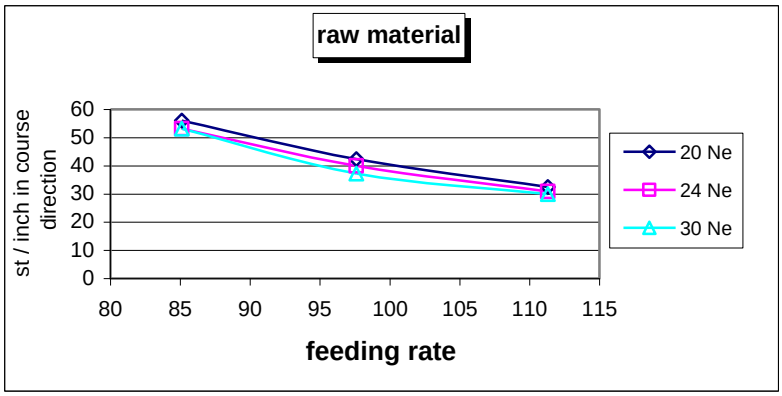

Fig. 10. Effect of feeding rate on the stitches/inch in course direction for different counts.

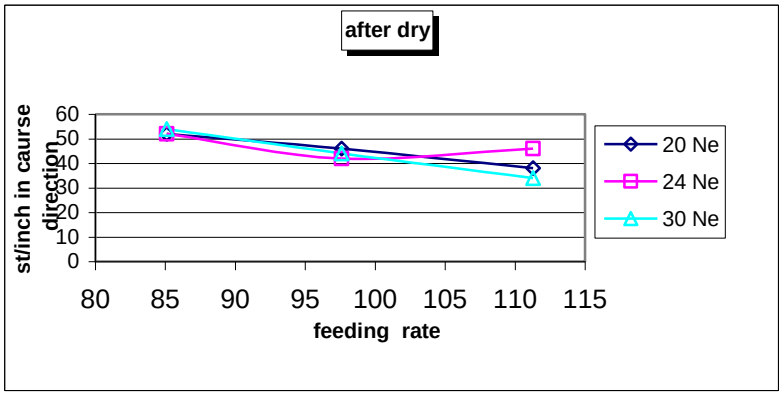

Fig. 11. Effect of feeding rate on stitch/inch in course direction for different counts.

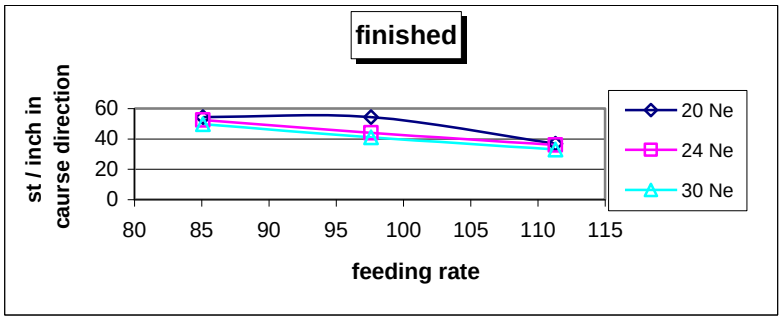

Fig. 12. Effect of feeding rate on stitch / course direction for different counts.

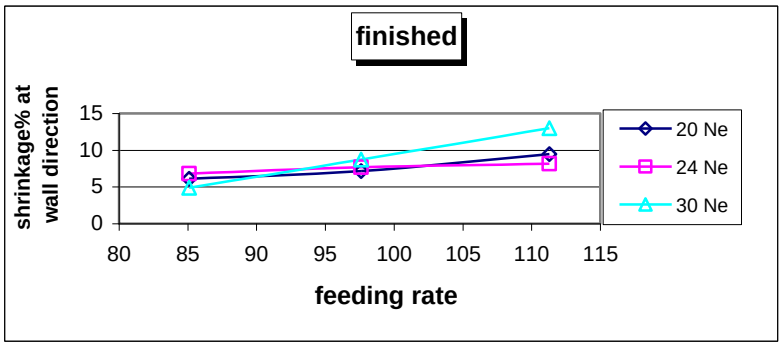

Fig. 13. Effect of feeding rate on shrinkage % at wall direction for different counts.

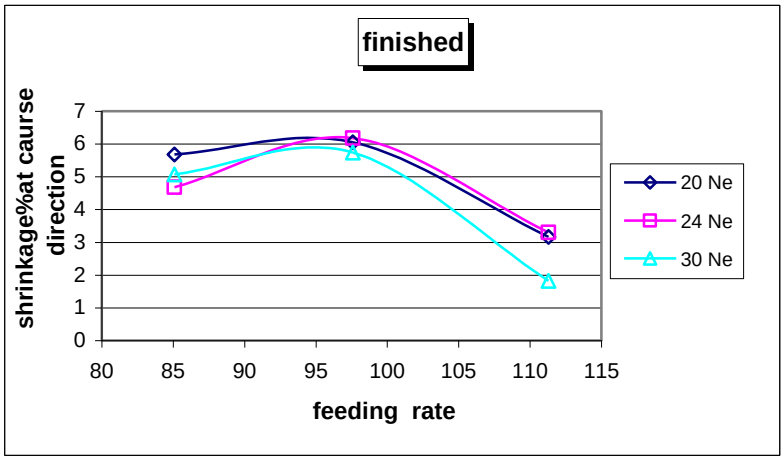

Fig.14. Effect of feeding rate on shrinkage % at course direction for different counts.

Conclusion

The aim of this research was to study the effect of feeding rate on some knitted fabric properties such as the weight per square meter, the stitches/cm in the wall and course directions, fabric width, shrinkage in the wall and course direction for different yarn counts: 20/1, 24/1 and 30/1, at different conditions: after knitting (greige), after dyeing, and after finishing. The following relationships can be concluded from the obtained test results:

1- Effect of feeding rate and yarn count on the weight of square meter:

There is an inverse relationship between feeding rate, weight/m^2 for different yarn count 20, 24, 30 Net.

2- Effect of feeding rate and yarn count on fabric width (cm):

There is an inverse relationship between feeding rates and the width of fabrics for yarn count 20/1, 24/1, 30/1 before, but a direct relationship after drying and finished.

3- Effect of feeding rate and yarn count on stitch/ inch in course direction:

There is an inverse correlation between the feeding rate and stitch /inch of course under all condition.

4-Effect of feeding rate and yarn count on shrinkage % in the wall direction:

There is a direct relationship between feeding rates and shrinkage % in the wall direction for finished but it gives inversely relationship between feeding rate and shrinkage % in course direction after finished.

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تاثير ضبط الماكينة على خواص اقمشة تريكو اللحمة

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في مجال تصنيع الملابس الجاهزة ، من المهم أن نفهم مدى اهمية العمليات المستخدمة حتى نستطيع التنبؤ بخصائص الاقمشه والمنتج. وهذا يساعد في التخطيط لاحتياجات المستهلكين ، وعلى حل بعض المشاكل التقنية. وأجري البحث الحالي باستخدام ماكينة التريكو الدائرى عيار ٢٤ والتعرف على أثر تغيير ضبطات الماكينة على الاقمشة المنتجة. استخدمت ثلاثة انواع من الخيوط القطنية الممشط نمر ٢٠ / ١ ، ١١/٢٤ / 30 لإنتاج (براسولا) جيرسي. تم استخدام معادلة تحليل الانحدار للتنبؤ بمواصفات الملابس. خطة البحث تعتمد على إنتاج ثلاثة عينات من قماش التريكو من كل نوع من الخيوط باستخدام ثلاثة مستويات من فتح الطارة المتحكمه فى مقدار تغذية الخيط ، و تم انتاج تسعة عينات اساسية من اقمشة التريكو ، وقد تم دراسةالتغيير الذي حدث للقماش الخام بعد الاسترخاء مثل (عرض القماش) ، والوزن من القماش ، وكثافة الغرز فى اتجاة الصف والعمود وطول الغرزة، وفى المرحلة الثانية بعد مرور القماش من المجفف صبغت كل العينات التي أنتجت تحت نفس الظروف والمواصفات لتحديد (مدى) التغير في المواصفات بعد عملية التجفيف . والمرحلة النهائية (التجهيز)تم ضبط العرض الى أربعة عروض مختلفة لكل العينات ، لدراسة تأثيردرجة الحرارة لجميع العروض على (الوزن / م ، الغرزة فى اتجاه العمود و الصف ، طول الغرزة والانكماش فى اتجاة الصف و العمود) .