Scientific Journal of Impact Factor (SJIF): 4.72
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 9, September -2017

The Effect of Blend Composition on the Properties of Bamboo/Polyester Yarns

G. LUBNA BANU[1] , JAHAANARA RAZICK[2]

[1]*Associate Professor,Department of P.G.Studies and Research in Home Science, JBAS College for Women, Chennai, India.*

[2]*Supervisor & HOD, Department of P.G.Studies and Research in Home Science, JBAS College for Women, Chennai, India.*

Abstract - *This paper presents a study of hybrid effects on the mechanical properties of bamboo/polyester blended yarns. Most of the interactions are found to be negative and insignificant. Neps and yarn friction show positive interaction. Linear regression analysis is also found to be good in predicting the properties. Addition of polyester fibre to blends has led to an improvement of properties.*

***KEY WORDS**: Bamboo, Blended yarns, Hybrid model, Linear Regression, Quadratic Regression Model.*

I. INTRODUCTION

About seventeen years ago, [6] suggested a simple hybrid model to study the interaction between the constituents. They reported the interaction in cotton and polyester yarns which were model yarns. Besides model yarns, they also studied interaction in other cases such as polypropylene and nylon blends. They suggested empirical equations for computing interactions for which experimental values were considered. Reference [3] have defined this interaction as hybrid effect which is the deviation of a hybrid structure property from the one estimated by rule of mixture (ROM) where proportional contribution of the properties is expected. A positive interaction means a positive hybrid effect and it is called a synergetic case where the actual property is greater than the ROM prediction whereas a negative value reflects a negative hybrid effect and the actual property is below the ROM prediction. Reference [1] applied the same model to polyester cotton rotor blended yarns and computed interaction values. Subsequently, [4] studied the hybrid effects in cotton polyester ring and rotor spun yarns. Interactions between cotton and polyester fibres were evaluated by using simple rule of mixtures (ROM) and hybrid model. They have also used [6] hybrid model, which involves the use of empirical equations and experimental values which are known for random errors. The study of blended yarns using hybrid model has become an active area in research in the past few decades. The importance of hybrid effect has been discussed by [3] and [5].

Reference [2] have conducted studies of the hybrid effect in mechanical properties of Tencel blended ring, rotor and air jet spun yarns. Although their quadratic regression model is sound, no significant tests are reported for linear regression model which hinders in drawing conclusions.

Hence, the purpose of this paper is to suggest a simple method for calculating interactions between the blends. There is no need to use empirical equations as suggested by [6]. Using this equation, the interactions of the various properties of blended yarns such as tenacity, elongation, U %, thin places, thick places, neps , abrasion and friction are calculated and the level of significance for them is discussed.

II. EXPERIMENTAL PROCEDURE

2.1. Materials: Bamboo and polyester fibres where selected. Properties of these fibres are presented in Table 1.

Table 1. Fibre Properties

Specification	**Bamboo Fibre**	**Polyester Fibre**
Single Fibre Length(mm)	39.00	44.4
CV % of Length	5.4	3.3
Fibre Diameter(microns)	10	10
Fibre Fineness(dtex)	1.444	1.111
Tenacity (g/den)	2.33	5.64
CV % of Tenacity	9.7	14.3
Elongation (%)	19.0	13.6
CV % of Elongation	12.1	28.0

2.2. Method of Yarn Production.

A series of blended yarns containing blend composition of various counts was produced from bamboo and polyester fibres. Details of the yarn count and blend composition are described in Table 2.

Table 2. Details of Yarn count and Blend composition

<table>
<tr><th>S. No</th><th>Counts</th><th>Blend Composition</th></tr>
<tr><td>1</td><td>30 Ne(19.68tex)</td><td rowspan="3">100% Bamboo
75/25 Bamboo Polyester
50/50 Bamboo Polyester
25/75 Bamboo Polyester
100% Polyester</td></tr>
<tr><td>2</td><td>35 Ne(16.87tex)</td></tr>
<tr><td>3</td><td>40 Ne(14.76tex)</td></tr>
</table>

Blending of bamboo and polyester fibres was done to increase the aesthetic qualities of fabric and their performance so that the fabric will retain the best characteristics of each fibre. A predetermined quantity of fibres blended was mixed and processed in a blow room where the fibres were opened, blended and cleaned. The yarns were then passed through carding, draw frame, simplex and ring frame for spinning, at a spindle speed of 12000 rpm and a twist of 780 TPM.

2.3. Yarn testing

All the fifteen samples comprising of 100% bamboo, 100% polyester, 75/25 bamboo polyester, 50/50 bamboo polyester, 25/75 bamboo polyester for all the three different counts of 30’s, 35’s and 40’s respectively were tested for yarn tenacity, elongation, U % , thin places, thick places, neps, abrasion resistance and friction. The numbers of tests performed and the relevant standards are given in Table 3.

Table 3. Details of Yarn testing, Standards and Number of tests

S. No	Name of the Test	Test Standard	Number of Tests
1	Yarn tenacity and elongation	ASTM (D1425)	200
2	U% imperfection	ASTM (D2255)	10
3	Imperfections (thin, thick & neps)	ASTM (D2255)	10
4	Yarn friction	ASTM (D3513)	100
5	Yarn abrasion (cycles)	ASTM (D1907)	20

Yarn tenacity and elongation: This was determined in accordance with ASTM (D1425) using Uster Tensorapid 3 Tester.
U% : Yarn evenness was tested using Uster Evenness Tester 4-SX.
Imperfections: Thin Places, thick places and neps were measured using Uster evenness tester 4-SX, in accordance with ASTM Standard (D2255).
Yarn friction: This was determined by using Lawson Hemphill friction tester in accordance with ASTM Standard (D3513).
Yarn abrasion: Abrasion resistance was evaluated using Sitra Mag Yarn Abrasion Tester in accordance with ASTM Standard (D1907).

III. RESULTS AND DISCUSSION

Using the quadratic and linear regression models, the equations were obtained and are given in Table 4 and Table 5 and the trends obtained between the blend composition and the various properties are represented graphically from Figures 1 to 8. It will be noticed that yarn tenacity decreases with increase in count in 100% bamboo yarn while the reductions are much less in 100% polyester yarns and in the yarns in which the polyester fibre has been added. Elongation of 100% polyester yarns shows a higher value in comparison to 100% bamboo yarns. With the increase in count, elongation values are found to be similar. Yarn evenness is better for 100% polyester and there is an increase in yarn unevenness with the increase in count. Thin places are lower for 100% polyester and show an increase with the increase in count. Addition of polyester to bamboo has led to a reduction in thin places. The incidence of thick places is lower in 100% polyester yarn and 100% bamboo yarn. As the count becomes finer, the number of thick places shows a gradual increase. Neps show significantly lower values for 100% polyester yarns in comparison to 100% bamboo yarn. Here also with the increase in count, the neps show an increase. Yarn friction increases with an increase in polyester up to 25/75 bamboo polyester and decreases thereafter. Bamboo yarn shows the lowest value of friction and with an increase in yarn count it increases. In the other cases, the addition of polyester has led to an increase in friction. With the exception of 100% bamboo, in all the other cases; yarn friction remains almost the same with the increase in count.

With regard to yarn abrasion, polyester yarn is characterised by high abrasion value in comparison to 100% bamboo. With the addition of polyester, the abrasion resistance shows an increase. Also, as the count becomes finer, the abrasion resistance shows an increase obviously due to increase in twist (750,800,850 TPM) are used for 30Ne(19.68tex), 35Ne(16.87tex) and 40Ne(14.76tex).

Tables 4 & 5 show the equations and interactions for the various properties of blended yarns. It is apparent that in all the cases the interactions values are not significant. But $ß_1$ and $ß_2$ values are significant in most cases. Parameters like tenacity, elongation, U%, thin places and yarn abrasion show negative interactions. This would mean that the predicted values are much lower than the experimental values. There is no relationship between the count and interaction values. As regards linear regression analysis, values of $ß_1$ and $ß_2$ are significant with the exception of yarn abrasion and thick places. Values of R^2 are higher for quadratic regression model in comparison to linear regression model which shows the superiority of the former.

Table 4. Quadratic Regression model for Yarn Characteristics

Parameters (Y)	x_1	x_2	Blend type	Counts (Tex)	Quadratic Equation ($Y= ß_1x_1+ ß_2x_2 + ß_{1.2}x_1.x_2$)	ROM MODEL (Quadratic)									
						R²	SD			P Value			Significance		
							$ß_1$	$ß_2$	$ß_{1\cdot2}$	$ß_1$	$ß_2$	$ß_{1\cdot2}$	$ß_1$	$ß_2$	$ß_{1.2}$
Tenacity (g/tex)	B*	P*	B/ P*	a**	$Y=15.68x_1+33.02x_2-5.3x_1x_2$	0.983	1.168	1.168	5.310	0.005	0.001	0.423	S	S	NS
				b**	$Y=10.46x_1+30.89x_2-4.32x_1x_2$	0.981	1.468	1.468	6.672	0.019	0.002	0.583	S	S	NS
				c**	$Y=9.86x_1+28.98x_2-3.95x_1x_2$	0.957	2.114	2.114	9.606	0.043	0.005	0.720	S	S	NS
Elongation (%)	B	P	B/ P	a	$Y=10.772x_1+11.372x_2-5.668x_1x_2$	0.859	0.379	0.379	1.722	0.001	0.001	0.812	S	S	NS
				b	$Y=10.993x_1+11.493x_2-3.097x_1x_2$	0.823	0.254	0.254	1.154	0.000	0.000	0.115	S	S	NS
				c	$Y=11.996x_1+13.748x_2-8.64x_1x_2$	0.777	0.873	0.873	3.967	0.005	0.004	0.161	S	S	NS
U%	B	P	B/ P	a	$Y=15.241x_1+10.557x_2+7.55x_1x_2$	0.833	1.221	1.221	5.55	0.006	0.013	0.306	S	S	NS
				b	$Y=16.497x_1+14.969x_2-1.69x_1x_2$	0.838	0.37	0.37	1.685	0.000	0.000	0.421	S	S	NS
				c	$Y=16.654x_1+15.782x_2-0.274x_1x_2$	0.829	0.209	0.209	0.95	0.000	0.000	0.800	S	S	NS
Thin Places / km	B	P	B/ P	a	$Y=145.2x_1+130.8x_2-256x_1x_2$	0.888	14.37	14.37	65.30	0.009	0.011	0.059	S	S	NS
				b	$Y=305.4x_1+239.8x_2-448x_1x_2$	0.834	34.67	34.67	157.5	0.012	0.020	0.104	S	S	NS
				c	$Y=434.34x_1+322.34x_2-233.14x_1x_2$	0.638	52.02	52.02	236.4	0.014	0.025	0.427	S	S	NS

Thick Places / km	B	P	B/P	a	$Y=204.08x_1+68.56x_2-148.56x_1x_2$	0.778	39.86	39.86	181.1	0.036	0.227	0.505	S	NS	NS
				b	$Y=267.32x_1+86.64x_2+175.2x_1x_2$	0.775	53.22	53.22	248.80	0.037	0.245	0.544	S	NS	NS
				c	$Y=291.91x_1+137.51x_2+188.34x_1x_2$	0.736	51.65	51.65	234.7	0.029	0.116	0.506	S	NS	NS
Neps / km	B	P	B/P	a	$Y=74.65x_1+30.33x_2+81.14x_1x_2$	0.810	12.83	12.83	58.30	0.028	0.141	0.298	S	NS	NS
				b	$Y=187.36x_1+62.32x_2+51.65x_1x_2$	0.825	30.47	30.47	138.4	0.025	0.177	0.744	S	NS	NS
				c	$Y=263.38x_1+77.26x_2+250.17x_1x_2$	0.821	49.15	19.45	223.3	0.033	0.256	0.37	S	NS	NS
Yarn Friction	B	P	B/P	a	$Y=0.201x_1+0.257x_2+0.434x_1x_2$	0.857	0.030	0.030	136	0.021	0.013	0.086	S	S	NS
				b	$Y=0.263x_1+0.271x_2+0.274x_1x_2$	0.887	0.015	0.015	0.069	0.003	0.003	0.058	S	S	NS
				c	$Y=0.303x_1+0.311x_2+0.114x_1x_2$	0.589	0.015	0.015	0.069	0.002	0.002	0.241	S	S	NS
Yarn Abrasion (cycles)	B	P	B/P	a	$Y=38.68x_1+168.47x_2-74.28x_1x_2$	0.907	21	21	95.43	0.206	0.016	0.517	NS	S	NS
				b	$Y=56.88x_1+174.88x_2-58.28x_1x_2$	0.832	28.18	28.18	128	0.18	0.024	0.693	NS	S	NS
				c	$Y=68.11x_1+198.11x_2-85.71x_1x_2$	0.854	28.75	28.75	130.6	0.141	0.020	0.579	NS	S	NS

*B-Bamboo, P-Polyester, B/P-Bamboo/Polyester
**a-30Ne(19.68tex), b-35Ne(16.87tex), c-0Ne(14.76tex)

Table 5. Linear Regression model for yarn characteristics

Parameters (Y)	x_1	x_2	Blend type	Counts (Tex)	Linear Equation ($Y= ß_1x_1+ ß_2x_2$)	ROM MODEL (Linear)						
						R^2	SD		P Value		Significance	
							$ß_1$	$ß_2$	$ß_1$	$ß_2$	$ß_1$	$ß_2$
Tenacity (g/tex)	B	P	B/P	a**	$Y=15.02x_1+32.36x_2$	0.976	0.962	0.962	0.000	0.000	s	s
				b**	$Y=11.004x_1+31.436x_2$	0.978	1.085	1.085	0.002	0.000	s	s
				c**	$Y=10.356x_1+29.484x_2$	0.954	1.480	1.480	0.005	0.000	s	s
Elongation (%)	B	P	B/P	a	$Y=10.064x_1+10.664x_2$	0.098	0.645	0.645	0.000	0.000	s	s
				b	$Y=10.606x_1+11.106x_2$	0.189	0.366	0.366	0.000	0.000	s	s
				c	$Y=10.916x_1+12.668x_2$	0.248	1.077	1.077	0.002	0.001	s	s
U%	B	P	B/P	a	$Y=0.256x_1+0.312x_2$	0.679	1.139	1.139	0.000	0.002	s	s
				b	$Y=0.298x_1+0.306x_2$	0.758	0.306	0.306	0.000	0.000	s	s
				c	$Y=0.318x_1+0.326x_2$	0.822	0.143	0.143	0.000	0.000	s	s
Thin Places / km	B	P	B/P	a	$Y=113.2x_1+98.8x_2$	0.03	28.46	28.46	0.028	0.040	s	s
				b	$Y=249.4x_1+183.8x_2$	0.16	52.33	52.33	0.017	0.039	s	s
				c	$Y=405.2x_1+293.2x_2$	0.46	42.62	42.62	0.002	0.006	s	s

Thick Places / km	B	P	B/P	a	$Y=185.88x_1+50.36x_2$	0.707	30.812	30.812	0.009	0.200	s	ns
				b	$Y=289.22x_1+108.54x_2$	0.716	40.184	40.184	0.005	0.073	s	ns
				c	$Y=315.46x_1+161.06x_2$	0.652	39.908	39.908	0.004	0.027	s	s
Neps / km	B	P	B/P	a	$Y=84.8x_1+40.48x_2$	0.627	12.098	12.098	0.005	0.044	s	s
				b	$Y=193.82x_1+68.78x_2$	0.813	21.176	21.176	0.002	0.047	s	s
				c	$Y=294.66x_1+108.54x_2$	0.709	42.139	42.139	0.006	0.082	s	ns
Yarn Friction	B	P	B/P	a	$Y=0.256x_1+0.312x_2$	0.136	0.050	0.050	0.014	0.008	s	s
				b	$Y=0.298x_1+0.306x_2$	0.008	0.030	0.030	0.002	0.002	s	s
				c	$Y=0.318x_1+0.326x_2$	0.031	0.016	0.016	0.000	0.000	s	s
Yarn Abrasion (cycles)	B	P	B/P	a	$Y=29.4x_1+152.2x_2$	0.879	16.111	16.111	0.165	0.002	ns	s
				b	$Y=49.6x_1+167.6x_2$	0.815	19.893	19.893	0.088	0.003	ns	s
				c	$Y=57.4x_1+187.4x_2$	0.823	21.301	21.301	0.074	0.003	ns	s

*B-Bamboo, P-Polyester, B/P-Bamboo/Polyester
**a-30Ne(19.68tex), b-35Ne(16.87tex), c-0Ne(14.76tex)

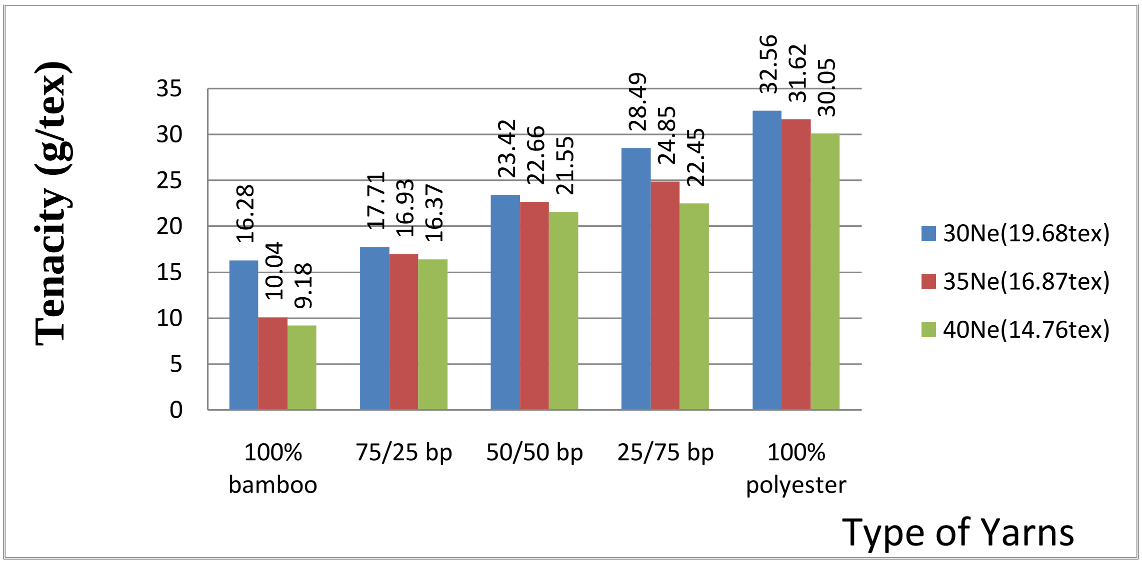

Figure 1 Effect of blend composition on Tenacity

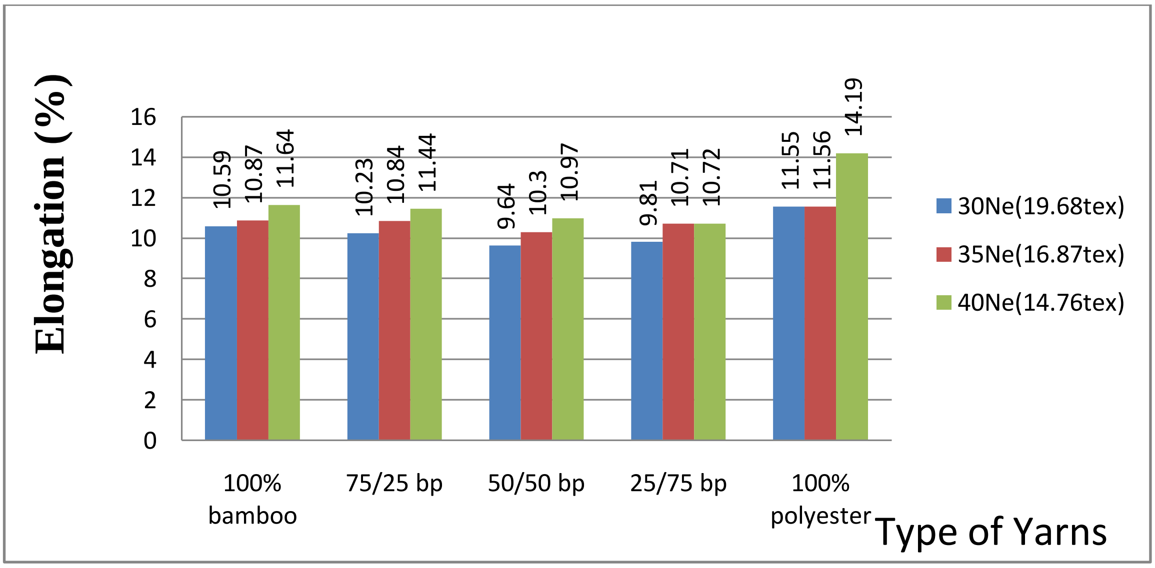

Figure 2 Effect of blend composition on Elongation

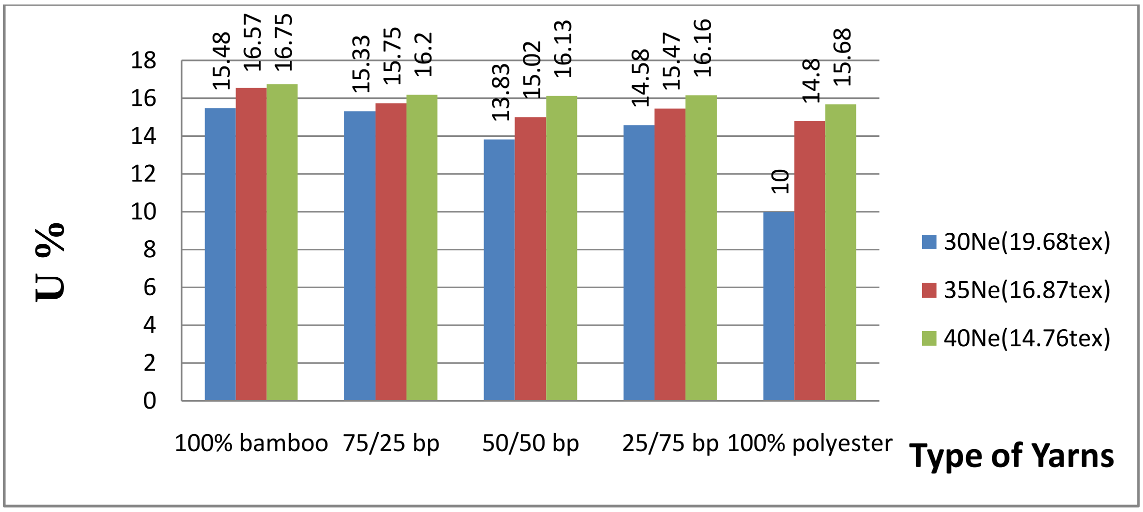

Figure 3 Effect of blend composition on U %

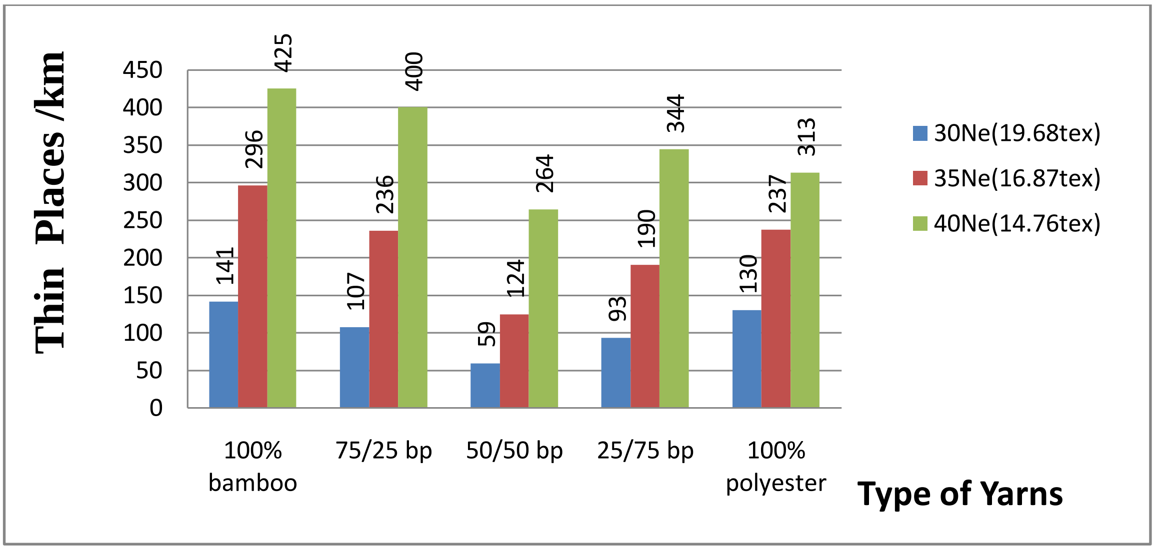

Figure 4 Effect of blend composition on Thin Places

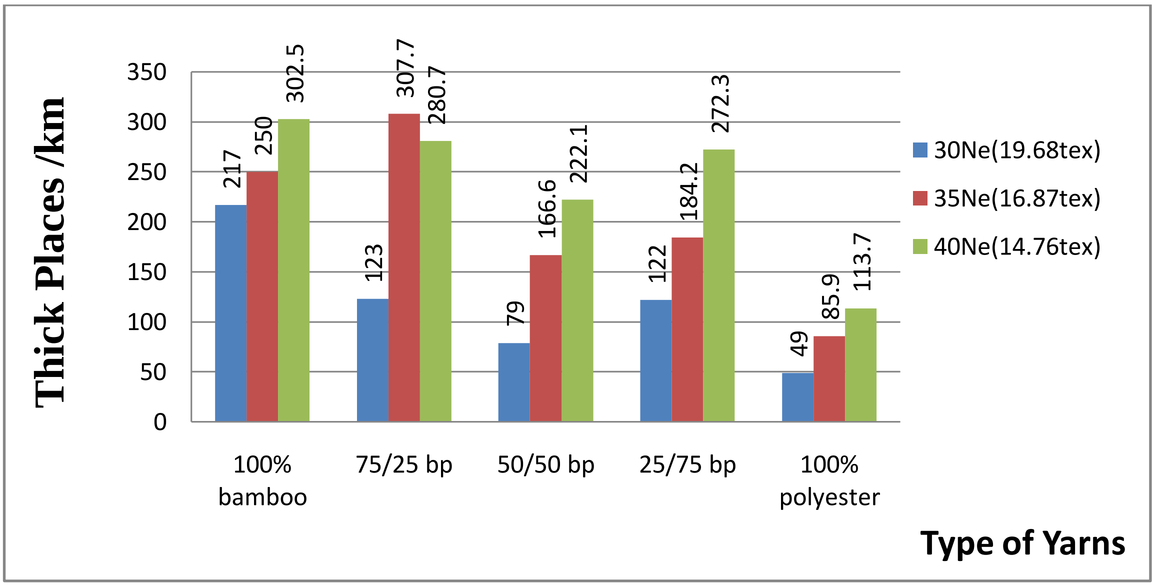

Figure 5 Effect of blend composition on Thick Places

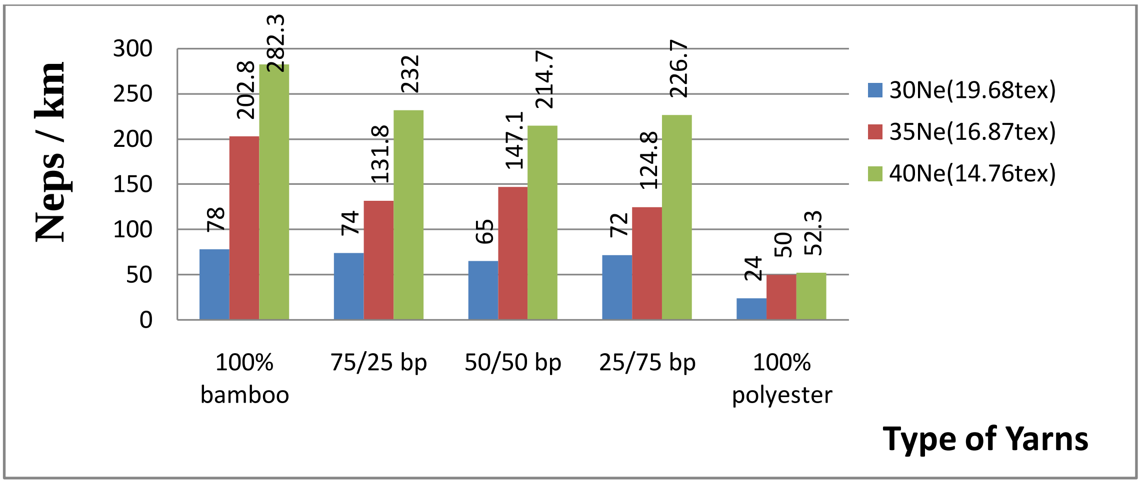

Figure 6 Effect of blend composition on Neps

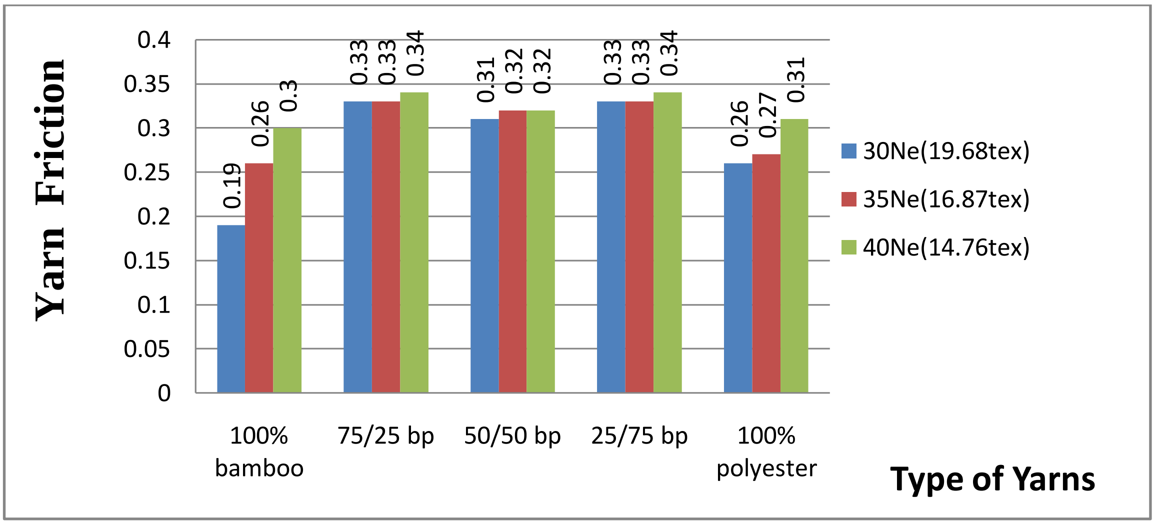

Figure 7 Effect of blend composition on Yarn Friction

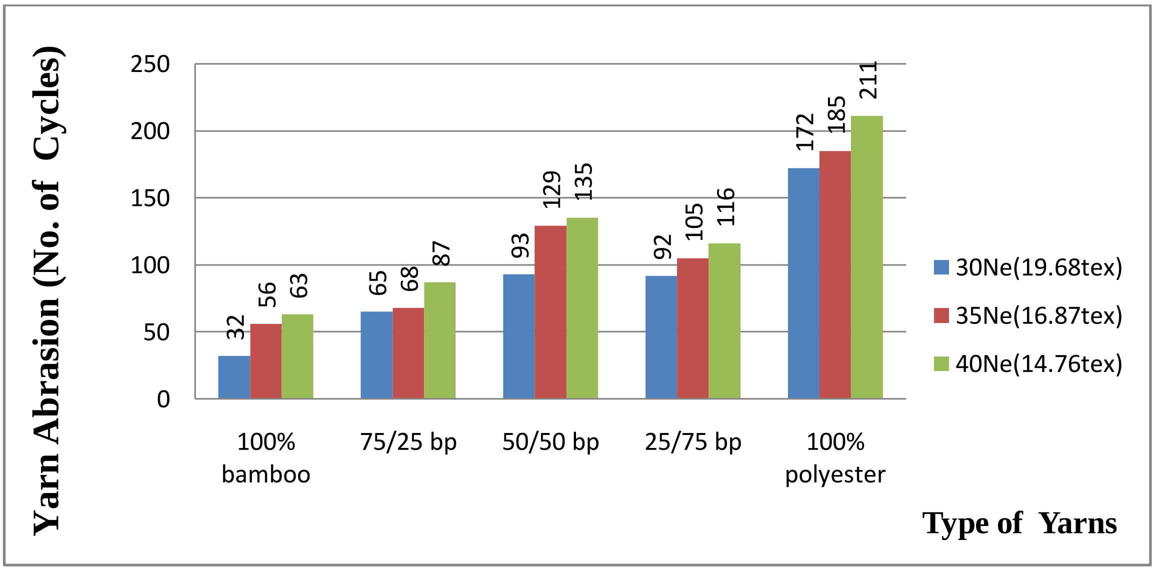

Figure 8 Effect of blend composition on Yarn Abrasion

IV. CONCLUSION

Properties of blended yarns containing bamboo and polyester are affected by blend composition. Tenacity increases with increase in count. While the tenacities are affected by the count in 100% bamboo yarn, in polyester yarns the differences are marginal. Elongation of polyester yarns is higher than that of bamboo yarn. Differences in elongation in respect of 100% polyester yarns are found to be marginal. With the increase in count, U% Imperfection are found to be better in polyester yarn in comparison with 100% bamboo yarn. Neps are found to be significantly lower for 100% polyester yarns. Yarn friction of 100% polyester yarn is higher than that of 100% bamboo yarn. Yarn friction is independent of the count. Yarn abrasion improves with the addition of polyester fibres. As the count becomes finer, yarn abrasions shows an increase.

Values of interaction are found to be negative for tenacity, elongation, thin places and yarn abrasion. However, in none of these cases are they found to be significant. In respect of neps, higher positive interactions are found in neps for 40Ne in comparison with 30Ne and 35Ne.

Values of parameters $ß_1$ and $ß_2$ are found to be significant in linear regression analysis and predictions are possible.

REFERENCES

[1] Aghasian, S., Gharehaghaji, A.A., Ghane, M., & Parsian, A. “Investigation on the properties of blended rotor-spun cotton/polyester yarn using a hybrid model”, Textile Research Journal, Vol. 99(5), pp. 459-465,2008
[2] Chattopadhyay, R., Tyagi, G.K., & Ashvani Goyal. “Studies of the hybrid effect in mechanical properties of Tencel blended ring-, rotor- and air-jet spun yarns”, The Journal of The Textile Institute, Vol. 104:3,pp. 339-349,2012.
[3] Marom,G., Fischer, S., Tuler, F.R., and Wagner, H.D., “Hybrid Effects in Composites: Conditions for Positive or Negative Effects Versus Rule of Mixtures”, Journal of Material Science, Vol.13, pp. 1419,1978.
[4] Moghassem, A.R., & Fakhrali, A., “Comparative Study on the Effect of Blend Ratio on Tensile Properties of Ring and Rotor Cotton-Polyester Blended Yarns Using Concept of the Hybrid Effect.” , Fibers and Polymers Journal, Vol.14,pp.1,157-163,2013.
[5] Pan, N., and Postle, R., “Strengths of Twisted Blend Fibrous Structures: Theoretical Prediction of the Hybrid Effects”, Journal of Textile Institute, Vol. 86,pp.559,1995.
[6] Pan, N., Chen, K., Monego, C.J., & Backer, S. “Studying the mechanical properties of blended fibrous structures using a simple model”, Textile Research Journal, Vol.70(6),pp.502-507,2000.

