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Minimizing Stickiness from Imported Cottons by Using Chemical Additives and their Ultimate Effect on Tensile Properties of Yarn

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ABSTRACT

The contamination of honeydew (stickiness) is a serious problem with the imported cottons used by the local textile industry. In case of heavy stickiness, the contaminants may continue to accompany the fiber through fiber processing and ultimately affect the yarn quality especially its tensile properties. The use of chemical additives is reported as an effective technique for minimizing the cotton stickiness. This paper reports the effect of different additives at variable concentrations on stickiness level and tensile properties (lea-strength, single yarn strength, elongation & count lea strength product value) of the spun yarn of two imported cotton varieties (Sudani & American Pima). Results showed that the additives and additive concentrations had highly significant effect on the tensile properties of the spun yarn. The yarn properties were degraded by increasing the concentration of the additives.

Key Words: Cotton stickiness; Cotton contamination; Chemical additives; Yarn strength; Yarn elongation

INTRODUCTION

Cotton stickiness becomes apparent when the contaminants present on the cotton fibres began to obstruct with the normal operation of the spinning processes (Khalifa, 2001). These contaminants are the sticky sugar deposits produced either by the insects (for example white fly & aphids) or by the cotton plant itself (Abidi & Hequet, 2005). These deposits are often referred to as honeydew (Gutknecht *et al.,* 1986) and it is the main source of sugars that can result in sticky lint. Sticky cotton is a worldwide problem. In some cotton growing regions, the potential to produce sticky cotton is always present (Khalifa &Gameel, 1982). There is no efficient method to test for cotton lint stickiness; therefore, textile spinning mills may un-expectedly buy bales of sticky cotton.

Different techniques such as blending, relative humidity (Gutknecht *et al*., 1986), machine setting (Chellamani, 2004) and the use of spinning additives (Brushwood, 2005) can be applied to overcome the problem of sticky cotton. Nevertheless each method has its own merits and de-merits, for instance increase of relative humidity creates difficulties in the processing of cotton (Brushwood, 2005), whereas the inappropriate machine setting increase the stress on fiber, which results in fibre breakage and weaker yarn. The chemical additives are applied during ginning and spinning to control stickiness. Certain chemicals can also be applied at the gin stage to facilitate processing during spinning. Nevertheless, the use chemical additives on cotton fibre have some impact on the spun yarn quality. Fonteneau-Tamine and Gourlot (2001) concluded that the tensile properties of the ring spun yarn decrease as stickiness increases. Similarly Hequet and Abidi (2002) reported that stickiness caused by honeydew contamination has been reported to cause residues build-up on the textile machinery, which may cause subsequent irregularities or yarn breakage. These irregularities have an adverse effect on the tensile properties of the yarn.

Although there is little research on stickiness in Pakistani cottons, acute problem of stickiness is reported in the imported cottons processed by the local textile mills. In this context, the main objective of this research paper was to measure the stickiness from imported sticky cottons and to analyze the effect of stickiness-controlling chemical additives upon tensile parameters of spun yarn.

MATERIALS AND METHODS

The research work was conducted in the Departments of Fibre Technology and Chemistry, University of Agriculture, Faisalabad and Gulshan Textile Mills Ltd., Kasur. The lint samples of American 'SJV Pima' and Sudani 'Brakat' cotton varieties were taken from the running stock of mills and determined for stickiness, application of different spinning additives and assessment of raw material and spun yarn characteristics.

Stickiness measurement. The samples of lint cotton were measured for stickiness according to the chemical method for cotton lint stickiness grading based on total soluble sugars concentration developed by Ali and Abdelatif (2001). The degree of stickiness can be determined according to the following ranges:

Reducing sugar in mg/100 g lint	Degree of Stickiness
0-499	free of stickiness
500-699	1 light stickiness
700-899	2 moderate stickiness
900-1100	3 heavy stickiness
Over 1100	4 very heavy stickiness

Application of spinning additives. The spinning additives were applied at 0.1 - 0.2% by weight of cotton to sticky cotton with same amount of water. Three additives at variable concentration were applied to remove the stickiness from Sudani and Pima cotton. Following variables were selected to study their effects.

Cotton Varieties:

V1 = Sudani (BARAKAT); V2 = Pima (SJV)

Neutralizer (Additives)

A1 = Flerol BW (Polyglycol Ether Fatty Acid Ethoxylates)

A2 = UPG-100 (Modified Polyglycol)

A3 = HT-60 (Ethoxy Amine)

Concentration of additives (%)

C1 = 0.50; C2 = 0.100; C3 = 0.125; C4 = 0.150; C5 = 0.175; C6 = 0.200.

Processing of sticky cotton. Spinning is an operation of making yarn from fibres by drafting and insertion of twist. All processes from blow room to roving frame are the preparatory ones for the formation of the yarn. After application of additive, the cotton samples of American Pima SJV and Sudani BARAKAT were processed through blow room, carding, drawing, roving and ring frame sections separately to make into 40^s yarn. However the concentration C_5 and C_6 were not used for the spinning of the yarn due to poor results in fibre characteristics. Following yarn characteristics were measured.

Yarn tensile properties. Tensile properties viz., single yarn strength and yarn elongation were measured with 'Uster Tensorapid', which applied the constant rate of extension (CRE) principle of testing. The procedure is given in detail in ASTM Committee Standards (1997). The yarn lea-strength was determined on pendulum type tester by "Skein method" and count lea strength product value was calculated by multiplying the count value with the respective lea strength as suggested by ASTM Committee Standards (1997).

Statistical analysis. Duncan's multiple range test was applied for comparison of individual means among various quality characters (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

Stickiness level. The lowest value of stickiness was observed in American Pima cotton (V2) as 613 followed by Sudani cotton (V1) as 642, respectively (Table I). It has been reported by Perkins (1984) that if cationic additives are utilized, they will not be completely removed downstream in textile processing and will result in reduced scouring and dyeing efficiency. The individual comparison of mean values of fibre strength for different additive (A1, A2 & A3), indicate that the best value is obtained for A1 (Flerol BW) as 613, which show non-significant difference with A2 (UPG-100) but significant difference with A3 (HT-60) with mean values 626 and 643, respectively. In a previous study Foulk and Mcalister (2002) analyzed that acid catalysis can be apply at processing stage to solve the sticky problems.

The individual comparison of mean value due to additive concentrations (C1, C2, C3, C4, C5 & C6) showed that best value is obtained for C6 as 599, which differ non-significantly with C5 as 609, but significantly differ with C1 and C2, C3 and C4 with mean values 658, 643, 631 and 623, respectively (Table I). The results are in conformity to those of Gamble (2002), who narrated that after additive application moderately contaminated cotton with an initial stickiness rating of 2 was reduced to a stickiness rating of 1, while severely contaminated cotton was reduced from 4 to 2 in stickiness rating. In a previous study Khalifa and Gameel (1982) reported that honeydew contaminated cotton in Sudan is a serious problem during processing and it can also be a problem during mechanical harvest with spindle pickers. Klein (1998) argued that cotton grows in various soils in various climates and with annually changing climatic conditions. The fibre therefore, cannot be homogeneous in their characteristics.

Yarn lea strength. The mean values of yarn lea strength at two varieties indicating highly significant difference between V1 and V2 as shown in Table II. The best value of yarn lea strength was observed in American Pima cotton as 54.89 lbs followed by Sudani 'Barakat' cotton as 50.52 lbs. The individual comparison of mean values of yarn lea strength for different additives (A1, A2 & A3) showed that all of values have highly significant difference with respect to one another (Table II). The best value is obtained for A1 (Flerol BW) as 53.44 lbs followed by A2 (UPG-100) and A3 (HT-60) with mean values 52.77 and 51.89 lbs, respectively. It has been reported by Gamble (2002) that when contaminated cotton is treated with (w/w) acids the rate of thermo chemical degradation of sugars is started and strength is decreased.

The individual comparison of mean value of yarn lea strength due to additive concentrations showed that all the values differ significantly from one another (Table II). The best value is obtained for C1. It was evident from the data that with an increase in additive concentration, the yarn strength was decreased. In a previous study Gohl and Vilensky (1987) reported that cotton fibre were weakened and destroyed by acids, mineral or inorganic acids being stronger than organic acids destroyed the cotton polymer more rapidly.

Single end strength. Effect of cottons varieties (V), additives (A) and additives concentration (C) for the single end strength were highly significant, while all the interactions remain non-significant (Table III). The best mean value of single end strength was observed for American Pima cotton as 207.58 g followed by Sudani 'Barakat' cotton as 190.94 g, respectively. Better yarn strength of V_1 was due to higher fibre strength. Previously

Amjad (1999) argued that strength is a dominating factor for fibre, keeping other parameters same. It seems that 50% of the total yarn strength depended upon the fibre strength, since higher the fibre strength is related to higher yarn strength.

The individual comparison of mean values of single end strength for different additive indicated significant difference with respect to one another. The best value is obtained for A_1 (Flerol BW) as 202.02 g followed by A_2 (UPG-100) and A_3 (HT-60) with mean values 199.47 and 196.28 g, respectively. Chellamani (2004) opined that although various methods such as maintaining the relative humidity below 50%, reducing the speed of carding and drawing machines, application of hydro-carbon plus surfactant additives are effective for processing sticky cottons, the best remains the preventive method. Individual comparison of mean values of single end strength due to additive concentrations although showed significant differences, but the best value was obtained for C1 (Table III). Therefore, increase in additive concentration decreased the yarn strength. Mauersberger (1987) argued that under some conditions even very dilute solution of common inorganic acids reduce the strength.

Yarn elongation. The individual comparison indicated significant difference between the varieties and the best value of yarn elongation was observed for American Pima cotton as 6.97% followed by Sudani BARAKAT cotton as 6.40%, respectively (Table IV). Powell (2006) reported that American SJV Pima quality is one of the best in the world" and it has been steadily improving with improved varieties and producer care in growing and harvesting the crop. The individual comparison of mean values of yarn elongation for different additives showed highly significant difference and best value was obtained for A1 (Flerol BW) as 6.78 followed by A2 (UPG-100) and A3 (HT-60) with their mean values 6.69 and 6.58%, respectively. These comparisons for additives indicated that the best value was obtained for C1 as 6.78% followed by C2, C3 and C4 with mean values 6.72, 6.65 and 6.59%, respectively. This showed that when we increase additive concentration, the yarn elongation is decreased. Mauersberger (1987) explains that under some conditions even very dilute solution of common inorganic acids reduce the strength of cotton.

Yarn count lea strength product. The DMR test for the individual comparison of mean values of yarn count lea strength product (CLSP) of two varieties indicated highly significant difference (Table V) and the best value of yarn count lea strength product was observed in American Pima cotton as 2766.3 hanks followed by Sudani Barakat cotton as 2543.3 hanks, respectively. Anonymous (2005) reported that long staple Pima cotton have higher strength among other cottons. The individual comparison of mean values of yarn count lea strength product for different additive (A1, A2 & A3) showed that all of the values have highly significant difference with respect to one another. The best value is obtained for A1 (Flerol BW) as 2693.0 hanks followed by A2 (UPG-100) and A3 (HT-60) with mean values 2657.9 and 2613.5 hanks, respectively (Tale V). Gamble (2003) indicated that cotton fiber surface chemical components including sugars, waxes and soluble metal salts affect yarn spinning through inter-fiber fractional forces.

The individual comparison of mean value of yarn count lea strength product due to additive concentrations

Table I. DMR test for comparison of individual treatment means for stickiness Level

Variety	Additive	Concentration
V1 = 642 a	A1 = 613 b	C1 = 658 a
V2 = 613 b	A2 = 626 b	C2 = 643 ab
	A3 = 643 a	C3 = 631 b
		C4 = 623 bc
		C5 = 609 cd
		C6 = 599 d

(Mean values having different letters differ significantly at 0.05 level of probability)

Table II. DMR test for the comparison of individual treatment means for yarn lea strength

Variety	Additive	Concentration
V1 = 50.52 b	A1 = 53.44 a	C1 = 53.47 a
V2 = 54.89 a	A2 = 52.77 b	C2 = 52.97 b
	A3 = 51.89 c	C3 = 52.44 c
		C4 = 51.92 d

Mean values having different letters differ significantly at 0.05 level of probability

Table III. DMR test for the comparison of individual treatment means for single end strength

Variety	Additive	Concentration
V_1 = 190.94 b	A_1 = 202.02 a	C_1 = 202.15 a
V_2 = 207.58 a	A_2 = 199.47 b	C_2 = 200.23 b
	A_3 = 196.28 c	C_3 = 198.23 c
		C_4 = 196.42 d

Mean values having different letters differ significantly at 0.05 level of probability

Table IV. DMR test for the comparison of individual treatment means for yarn elongation

Variety	Additive	Concentration
V_1 = 6.40 b	A_1 = 6.78 a	C_1 = 6.78 a
V_2 = 6.97 a	A_2 = 6.69 b	C_2 = 6.72 b
	A_3 = 6.58 c	C_3 = 6.65 c
		C_4 = 6.59 d

Mean values having different letters, differ significantly at 0.05 level of probability

Table V. DMR test for the comparison of individual treatment means for CLSP

Variety	Additive	Concentration
V_1 = 2543.3 b	A_1 = 2693.0 a	C_1 = 2694.3 a
V_2 = 2766.3 a	A_2 = 2657.9 b	C_2 = 2668.2 b
	A_3 = 2613.5 c	C_3 = 2641.7 c
		C_4 = 2615.0d

Mean values having different letters differ significantly at 0.05 level of probability

(C1, C2, C3 & C4) showed the best value is obtained for C1 (0.100) as 2694.3 hanks followed by C2 (0.125), C3 (0.150) and C4 (0.175) with mean values 2668.2, 2641.7 and 2615.0 hanks, respectively. This indicated that when we increase additive concentration, the CLSP value is decreased, however measures like steam, dry heat and acid catalysis decreased the fibre quality (Foulk & Mcalister, 2002).

CONCLUSIONS

All sources of variance (the cotton varieties, spinning additives & concentrations) had significant effect of stickiness level and the tensile properties of the spun yarn. The additive A1 (Flerol BW) removed maximum stickiness and the spun yarn was also of better tensile parameters. The good yarn characteristics were found at additive concentrations the minimum (C_1 to C_2), because at higher concentration stickiness is removed but fibre characteristics are damaged and thus ultimate yarn tensile characteristics are deteriorated. Pima SJV yielded good results regarding fibre and yarn characteristics than Sudani Barakat after application of the spinning additives.

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